IC-210

144MHz FM TRANSCEIVER

取 扱 説 明 書

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ICOM

SECTION I - SPECIFICATIONS

GENERAL:

Frequency Coverage	144.00 MHz to 146.00 MHz
Number of Solid State	Transistors 54
	FET 13
	PUT 2
	IC 6
	Diode 53
Modulation Type	F3
Supply Voltage	13.8V ±15%
Current Drain	Transmit: Max. (10W) average 2.5A
	Min. (0.5W) average 1.2A
	Receive: Max. audio 0.6A
	Standby 0.4A
Antenna Input	50 ohms unbalanced
Size	111mm x 230mm x 260mm
Weight	7.2 Kg (include IC-3PU 1.8 Kg)

TRANSMITTER:

Frequency Range:	144.00 MHz to 146.00 MHz (±690 KHz for Repeater Use Available)
Frequency Control	Variable Frèquency Oscillator
Maximum Frequency Deviation	5 KHz
Modulation System	Variable Reactance Phase Modulation
Multiplier	(133.3 MHz + 10.7 MHz) x 1

TRANSMITTER:

Frequency Range:	144.00 MHz to 146.00 MHz (±600 KHz for Repeater Use Available)
Frequency Control:	Variable Frequency Oscillator
Frequency Composition	133.3 MHz (Controlled by PLL with VFO) + 10.7 MHz (+600 KHz)
Maximum Frequency Deviation	5 KHz
Modulation System	Variable Reactance Phase Modulation
Multiplier	(133.3 MHz + 10.7 MHz) x 1
Audio Input	500 ohm dynamic Microphone with Push to Talk Switch
RF Power Output	10 Watts to 0.5 Watts Variable
Spurious Response	−60 db, or better

RECEIVER:

Frequency Range	144.00 MHz to 146 MHz
Frequency Control	Variable Frequency Oscillator
Reception System	Double Superheterodyne
Intermediate Frequencies	1st Intermediate: 10.7 MHz
	2nd Intermediate: 455 KHz
Sensitivity	Better than 0.4 V at 20 db quieting
	S+N+D/N at 1 V input, 30 db or more
Spurious Response	−60 db, or better
Squelch Gain	−8 db, or less
Selectivity	±8 KHz/6 db point, ±16 KHz/−5 db point
Audio Output	1.5 Watts (8 ohm load)
RIT Coverange	±8 KHz Adjustable
Marker Frequency	Every 50 KHz or 250 KHz

PHASE LOCKED LOOP:

PLL Lock Range	2.5 MHz, or more
PLL Local Oscillator Frequency	122.045 MHz (13.560 MHz x 9)
	123.255 MHz (13.672 MHz x 9)
PLL Comparative Frequency	11.255 MHz - 12.255 MHz (VFO)
	Two extra crystal sockets installed Extra VFO (11.255 MHz - 12.255 MHz) availble
Protection Devices for PLL Unlock	Automatic Capture Circuit by Sawtooth Oscillation
	Transmission Suspension Circuit at Unlock
	Transmission Suspension Circuit at Low Voltage
	Reception Squelch Circuit

SECTION II - DESCRIPTION

This transceiver employs a Phase Locked Loop Synthesizer which is capable of full coverange operation with the installed VFO between 144.00 MHz to 146.00 MHz. In addition, the transmit frequency may be decreased by 600 KHz on any frequency for use with Repeators.
This is an extremly durable transceiver, which has state of the art devices such as Integrated Circuits, Field Effect Transistors, varactor and zener diodes engneered into a tight knit straight forward electronic design throughout both transmitter and receiver. Reliablity, low current demand, compactness, unexcelled performance and ease of operation are the net result.

The dual conversion receiver with its FET front end and high-Q helicalized cavity resonators boasts low noise and sensitivity of 0.4UV, or less. Signal gain of 90 db or more is accomplished from the second mixer back by virture of a 6 stage IF amplifier. The need for additional front end RF amplification is thus eliminated. The first local oscillator controlled by the PLL and the crystal-controlled second local oscillator produce unmatched stability. Audio reproduction is of an unusally high order of distortion free clarity.

The transmitter section will produce a minimum of 10 Watts RF output. High-Q and shielded stages provide minimum interstage spurious response. An encased low pass filter is placed at the output to further insure undesirable frequency products are not emitted. An ingenious final PA transistor protection device, (APC), is incorporated in the final output circuitry. A tiny VSWR bridge and four DC amplifier constantly monitor the output for high VSWR, a shorted or absent antenna load, or other difficulty that would cause irreparable final transistor damage. Should these difficulties occur, the APC instantaneously disables the final PA.

The installed VFO, which acts as the Comparison Frequency in the PLL section, is so stabile that deviation is less than ±1.5 KHz between −10C and +60C degrees. This stability also appears at the output because of the mixing system employed. A special geared mechanism with two different speeds, joined to the VFO, results in smooth tuning.

All circuitry is constructed in a series of modules which are easily removable for servicing. The modules are housed in a sturdy aluminum frame, which is in turn housed in a rigid metal case, providing an extremely durable and rugged unit. Test points are brought up from all major circuits to facilitate maintenance checks and trouble shooting should the necessity arise.

A modern styled face plate, easy-to-read meters, and convenient controls with specialized design complete the unit's styling. The IC-210 is a welcome addition to any fixed station or automobile.

SECTION III - INSTALLATION

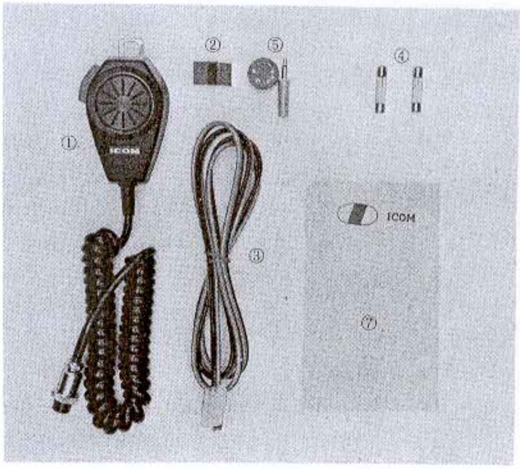
3.1 Unpacking:

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

3.2 Accessaries: (Fig. 1)

Make sure the following accessaries for the model IC-210 are included.

(1) Microphone (dynamic type) 1
(2) Microphone hook 1
(3) Power cord 1
(4) Spare fuses (5A) 2
(5) Plug for speaker 1
(6) Instruction manual 1
(7) Silicon cloth 1



3.3 Location:

The IC-210 is designed for high convenience in fixed station use. Beneath the front of the cabinet is a foldaway stand that can be used to tilt the set up, or folded flat when not in use. An optional automobile bracket matched with this transceiver is available for use in your automobile. Any place where it can be mounted with metal screws and bolts will work.

3.4 Power Requirement:

The transceiver is supplied ready to operate from any regulated 13.8V DC, 3 ampere negative ground source, by simply plugging the DC cord provided in the same receptacle into the transceiver (See Fig. 3). Any 100, 117, 220 and 240V AC source can be used by plugging the optional AC power supply, the IC-3PU, into the transceiver.
When used as a fixed station, plug the IC-3PU in the space provided in the back of the case tighten the locking screw, and then plug the AC cord into any convenient AC socket. Removing the IC-3PU when using the IC-210 in mobile operation, will make the IC-210 quite a bit lighter. (See Fig. 6 and 7)

A convenient Mobile Mounting Bracket is available as an accessory. It can be ordered from your dealer or distributor.

If an AC power supply other than the matching IC-3PU is used, be sure it is adequately regulated for both voltage and current. Low voltage while under load will not give satisfactory results from your transceiver. Receiver gain and transmitter output will be greatly impared.

If the supply voltage happens to decrease to less than 10.5V DC, the operation of the transceiver will be suspended in order to prevent misoperation. This indication will be shown by the center meter light going out.

Inserting the IC-3PU in the transceiver automatically switches the supply source from external to the IC-3PU. The IC-3PU must be removed from the transceiver when a DC power supply is used.

CAUTION: EXCESSIVE VOLTAGE (ABOVE 15VDC) WILL CAUSE DAMAGE TO YOUR TRANSCEIVER. BE SURE TO CHECK THE SOURCE VOLTAGE BEFORE PLUGGING IN THE POWER CORD.

Included with your transceiver is a DC power cable with plug attached. The Red Wire is positive (+), the Black, negative (–). If your mobile installation permits, it is best to connect these directly to the battery terminals. This arrangement eliminates random noise and transient spikes sometimes found in automotive accessory wiring. If such an arrangement is not possible, then any convenient B+ lead in the interior of the vehicle and the negative frame can be utilized. Your transceiver provides an internal DC filter that will take out most of the transient noise. Remember, the unit operates on a negative ground system only - it cannot be used in a positive ground automobile. After making your connections, simply insert the plug into your transceiver.

3.5 Antenna:

The most important single item that will influence the performance of any communication system is the antenna. For that reason, a good high-quality, gain antenna of 50 ohms impedance is recommended, for fixed or mobil use. In VHF as well as the low bands, every watt of ERP makes some difference. Therefore, 10 watts average output plus 3 db of antenna gain equals 20 watts ERP, presuming low VSWR of course. The few more dollars investment in a gain type antenna is well worth it.

When adjusting your antenna, whether mobile or fixed, by all means follow the manufacturer's instructions. There are some pitfalls to be aware of. For example, do not attempt to adjust an antenna for lowest VSWR when using a diode VSWR meter not engineered for VHF applications. Such readings will invariably have error of 40% or more. Rather, use an in line watt meter similar to the Drake WV-4 or Bird Model 23 with VHF cartridge. Further, when adjusting a mobile antenna, do with the motor running preferably above normal idling speed. This will insure proper voltage level to the transceiver.

Do not become alarmed if your transceiver fails to transmit at times during the antenna tune-up procedure. Remember, your transceiver has a built-in Automatic Protection Circuit (APC) that will disable the transmitter if excessive VSWR, a shorted coaxial line or connector, or other antenna deficiency is present. A quick check on a good 50 ohm dummy load will show the transceiver to be working. The difficulty will lie with the antenna or its transmission line. The RF coaxial connector on the rear chassis mates with a standard PL-259 connector.

3.6 Microphone:

A high quality dynamic microphone is supplied with your transceiver. Merely plug it into the proper receptacle on the front panel.

This microphone is of 500 ohms impedance with a normal output of 6mV. Should you wish to use a different microphone, make certain it is of equal impedance and output level. Under no circumstances use a "gain pre-amp" or ceramic type microphone. The audio system in your transceiver is more than adequate and additional pre-amplification is unnecessary. To use this class of microphone is to invite distortion and possible damage to the transceiver.

3.7 VFO:

The IC-210 is equiped with a stably VFO in the PLL (Phase Locked Loop) circuit, to allow you to tune across the entire 144 to 146 MHz band. When the Course switch is placed in the LB (low band) position, the VFO will tune from 144 to 145 MHz. With the Cource switch in the HB (high band) position, the VFO will tune from 145 to 146 MHz. This is of course with the Function switch in the VFO position.

3.8 External Speaker:

An external speaker jack and plug is supplied with your unit, if another speaker or headset use is desired. In either case the impedance should be 8 ohms. The use of external speaker jack will disable the internal speaker.

3.9 CO Extra Crystal Sockets:

The VFO provides transmit and receive operation on any frequency between 144.00 MHz and 146.00 MHz. It is convenient, however, to install a crystal for a regularly used frequency such as a club or repeater frequency. There are 2 extra crystal sockets in the CO-MARKER module. They work at the A and B positions of the Function switch. when the Course switch is in the HB or LB position on the panel. The frequencies are given as follows:

Mixing Freq. (MHz) = 11.255 MHz + Desired Operating Freq. – 144 or 145

For example, if you desire to operate on 144.60 MHz and 145.85 MHz

Mixing Freq. 1 = 11.255 + 144.60 – 144 = 11.855 (MHz)

Mixing Freq. 2 = 11.255 + 145.85 – 145 = 12.105 (MHz)

If the above 11.855 MHz crystal is placed in the crystal socket A and the Function switch is in the A position, when the Course switch is in the LB position, the output is 144.60 MHz. When the Course switch is in the HB position, the output is 145.60 MHz. In these cases, the Duplex system is also effected.

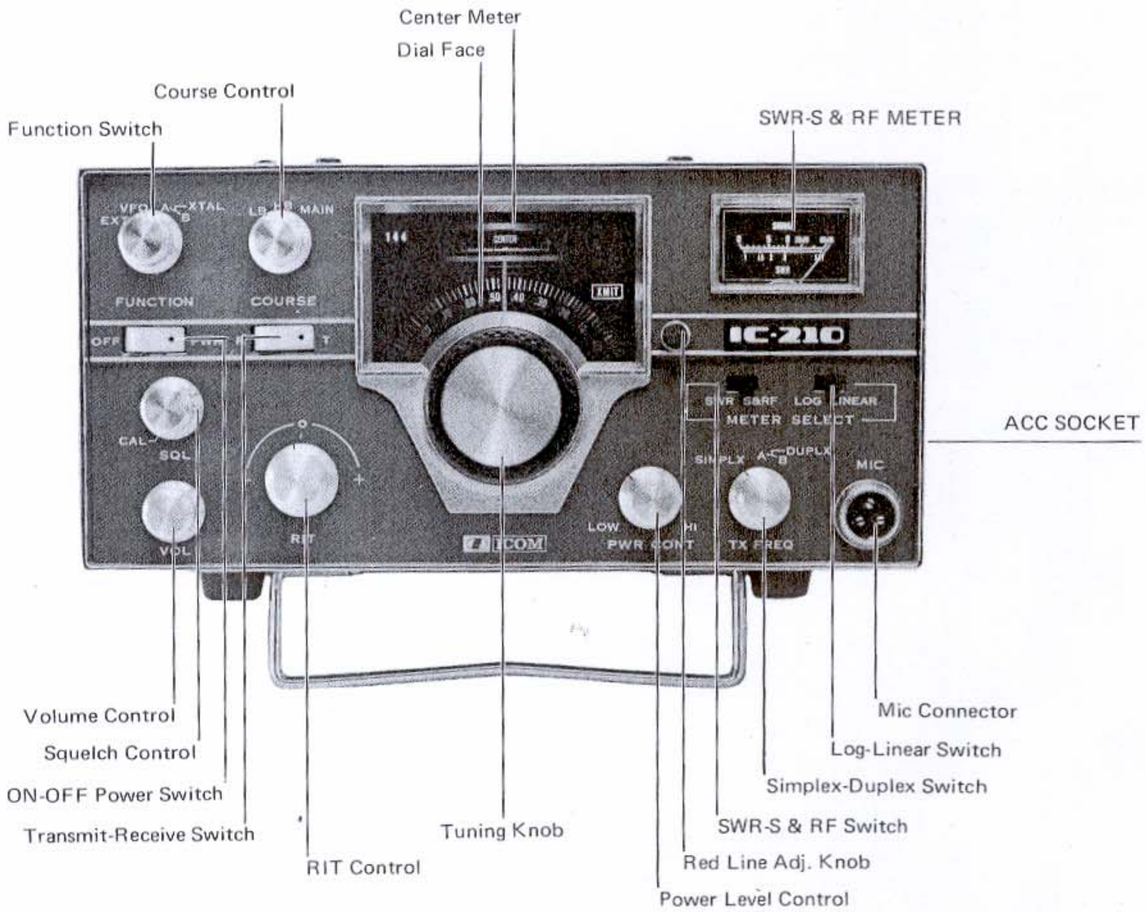
The frequencies are tuned with the trimmers shown in the Fig. 6, by using a frequency counter connect to (J1 of the test point) in the module. If the frequency counter can read as far as 144 MHz, the frequencies may be tune in transmision status. The frequencies of both transmit and receive are identical because of the synthesized system.

CAUTION: BEFORE YOU INSTALL ANY SPARE CRYSTAL, CHOOSE A FREQUENCY THAT WILL NOT ALLOW ANY POSITION OF THE VFO TO PRODUCE A FREQUENCY THAT IS OUT OF THE 144 MHz - 146 MHz BAND, WHILE USING THE NEWLY INSTALLED CRYSTAL.

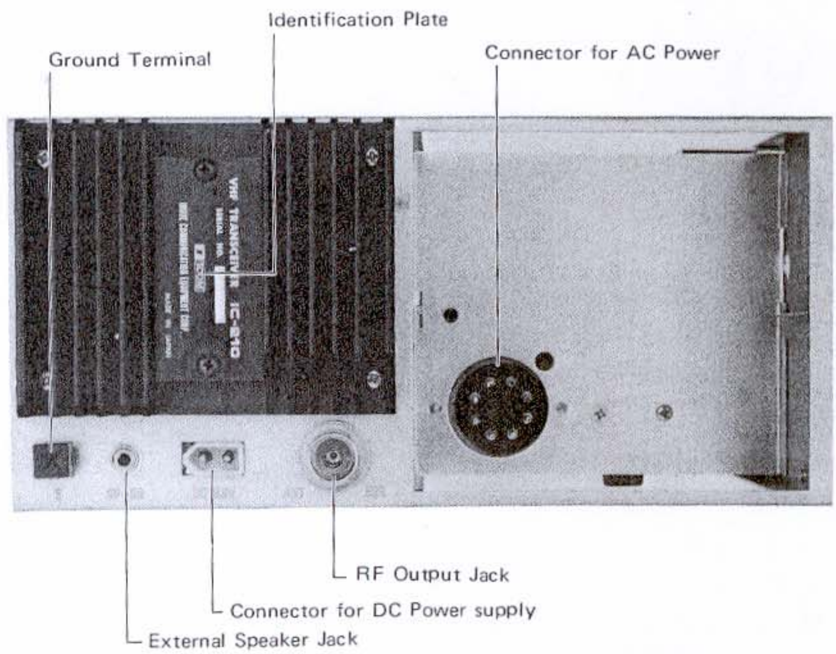
To order additional crystals from a manufacturer, the following correlation data is provided. Remember to specify high activity as a prerequisite to your acceptance.

Crystal Data	HC-25/
Holder Type:	0.0025%
Calibration Tolerance:	20 pF
Load Capacitance:	15 ohms or less
Effective Resistance:	11.255 – 12.255 MHz
CO Frequency:	"AT" optimum angle ±2min.
Cut:	

FRONT CONTROL (Fig. 2)



REAR PANEL (Fig. 3)



SECTION IV - CONTROL FUNCTIONS

4.1 Front Control

a. On-Off Power Switch: For AC and DC.

b. Receive and Transmit Standby Switch: The set is internally wired for push to talk.

c. Squelch Control and Calibration Knob: Controls threshold point of the receiver. During calibration turn to the CAL position (fully counter-clockwise).

d. Volume Control: Controls audio output level of the receiver.

e. RIT Control: For adjusting the receive frequency about ± 8 KHz.

f. Function Switch: The Xtal A and B position are for extra crystal in the CO module. In the Ext. position, the output frequency is controlled by another extra VFO connected with the accessory 9 pin-socket. The Function Switch is coupled with the Course Switch.

g. Course Switch: The HB (high band) position is for 145 to 146 MHz and the LB (low band) for 144 to 145 MHz. In the Main position, 145.00 MHz can be selected wherever the Course Switch may be.

h. Power Control: In the fully clockwise position, the output power is 10 Watts and in fully counter clockwise position, the power is 0.5 Watts.

i. TX Frequency Control: In the Simplex position, the transmit frequency is the same as the receive frequency. In the Duplex position, the transmit frequency is increased or decreased to be a frequency which is decided by the crystal inserted in the MIX module. The IC-210 is designed to transmit at any frequency difference up to at least 600 KHz above or below the receive frequency for repeater use.

The frequencies of an upper and lower side are calculated as follows:

Mixing Freq. (MHz) = 10.7 MHz ± Desired Freq. Difference

For example, if you desire to operate in the difference of +500 KHz and −600 KHz of the receive frequencies;

Mix. Freq. 10.7 MHz + 500 KHz = 11.2 MHz
Mix. Freq. 10.7 MHz − 600 KHz = 10.1 MHz

Your unit is installed with a 10.1 MHz crystal in the MIX module for −600 KHz repeater use.

j. SWR-S & RF Switch: In the S & RF position, the meter indicates the strength of an input signal in receive and the output power in transmit.
As to the standing wave ratio, after the meter indicator is adjusted to the Set position on the meter by the SWR control located insides (See Fig. 6), you can read the standing wave ratio on the meter by switching the SWR-S & RF switch to the SWR position.

k. LOG-LINEAR Switch: In the LOG position the S meter indicates a signal logarithmically and in the LINEAR position, the meter indicates the signal linearly in receive. The RF output is always indicated linearly in transmit.

l. Dial face adjustment knob:. When the indication of the dial face slips off with the the actual frequency, the red indicator on the right or left slightly by the knob after removing in the counter clockwise direction. If the knob is removed, it must be replaced after the adjustment.

m. Meter: The RF output power, the SWR in transmit and the signal strength in receive are indicated.

n. Center Meter: Indicates the error against the receive frequency.

o. Center Meter Illumination: The PLL unlock status is indicated by the illumination of the meter light going out.

p. Microphone Plug: A 500 ohm microphone with push to talk is fitted.

q. Dial Scale: The wide lines indicate every 100 KHz and the narrow lines, every 20 KHz from 00 to 1.00.

r. Tuning Knob: 1 MHz is covered by a special double geared system. 3/4 revolution of the knob covers about 80 KHz with the ratio of 36 : 1 and more than 3/4 revolution changes the ratio to 6 : 1.

s. Indication Lamps: In the LB position of the COURSE switch, the numbers "144" are illuminated and in the HB position, the "145" are illuminated with a green light. In the MAIN position, the letters are "MAIN" are illuminated with an orange light.

In the VFO position of the FUNCTION switch, the dial face is illuminated and in the XTAL position, the illumination for the dial face goes out and the letters "Xtal" are lit.

The illumination of the Center meter acts as a indicator of the PLL status. If the illumination goes out, the transceiver can not operate because of the PLL's unlocked status.

4. 2 Rear Panel

a. Ground Terminal: Connect to ground to prevent an electric shock if possible.

b. External Speaker Jack: The external speaker impedance should be 8 ohms. The use of the external speaker jack will disable the internal speaker.

c. RF Output Jack: Should be connected with a 50 ohm load and accepts standard PL-259 coaxial connector.

d. DC Power Supply Plug: An DC cord is provided. The red wire is positive and the black wire is negative.

e. AC Power Supply Plug: Accepts the exclusive IC-3PU. By inserting the IC-3PU the power sourse is switched from the DC to the AC automatically. Remove the IC-3PU when using DC.

f. Identification Plate: States model, serial number and date of manufacture.

4. 3 Access Cover

Three controls and a switch are installed inside, as follows.

a. Tone control: The tone of the sound in receive is controlled.

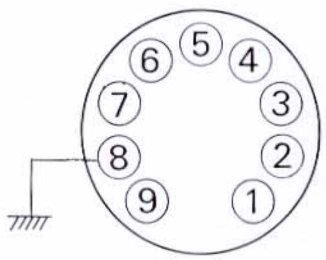
b. SWR-SET: In the S & RF position in transmit, the meter indicator must be set to the SET position by the control and the meter indicates the standing wave ratio in the SWR position of the SWR-S switch.

c. MIC-GAIN Control: Controls modulation level in transmit. Adjust the level in accordance with your surrondings.

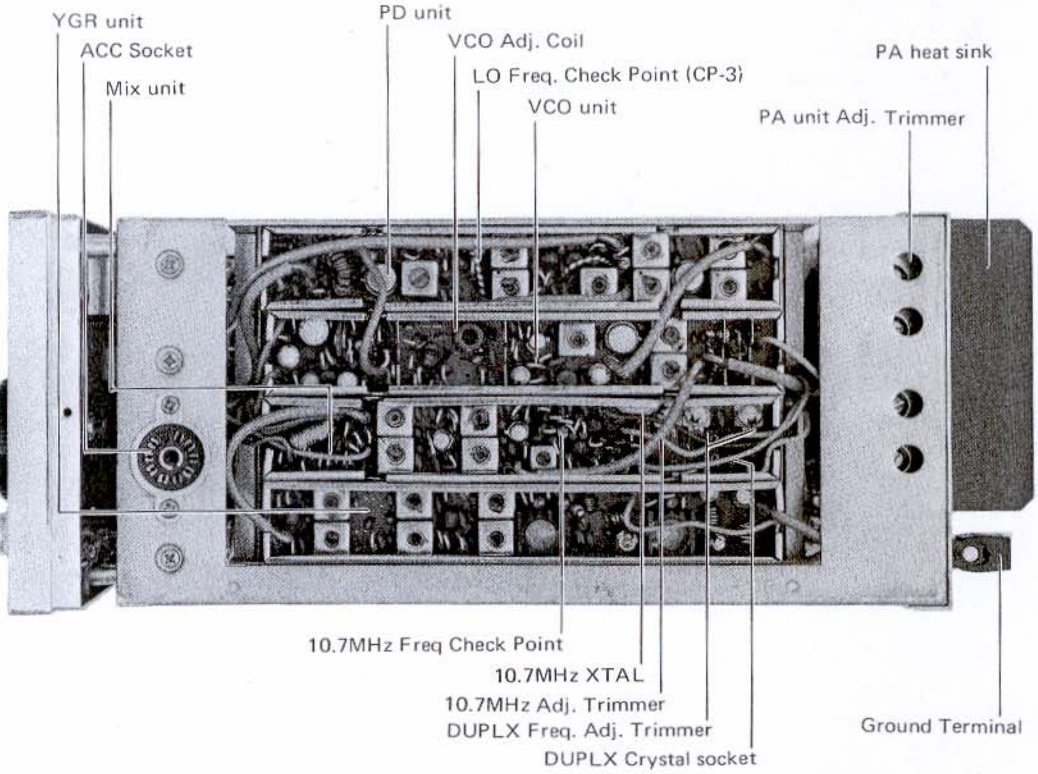
d. MARKER Switch: Selects every 250 KHz or every 50 KHz marker frequency.

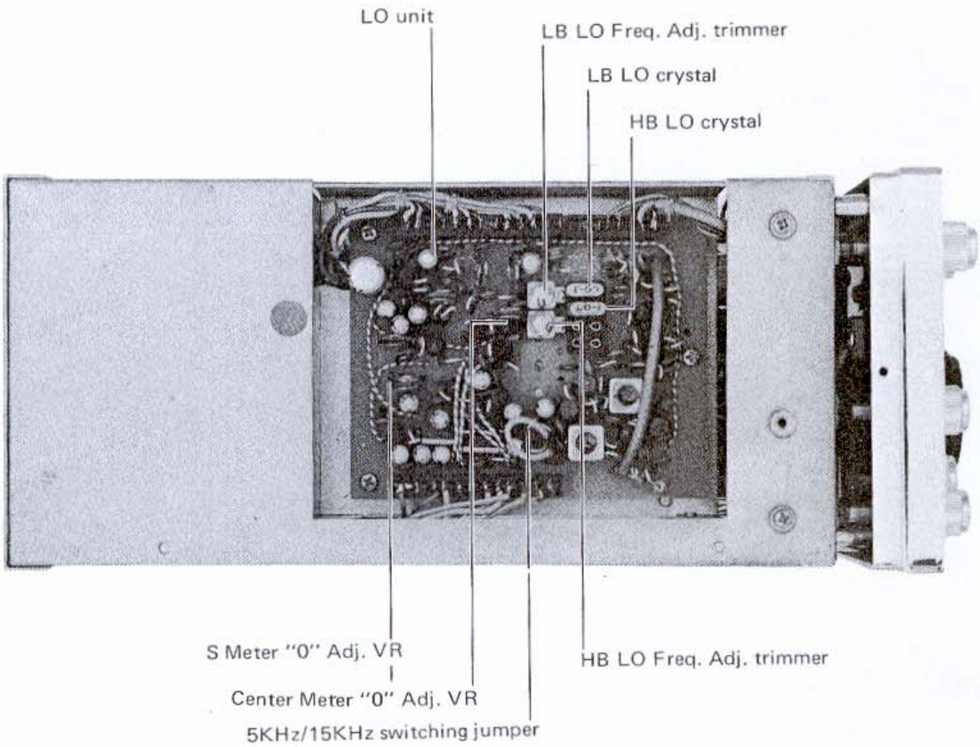
4. 4 Accessory Socket

1. Discriminator output
2. DC. 9 volts.
3. DC. 13.8 volts.
4. P.T.T. switch.
5. Detector output.
6. Modulation input.
7. External oscillator input.
8. Ground.
9. VFO CO output.

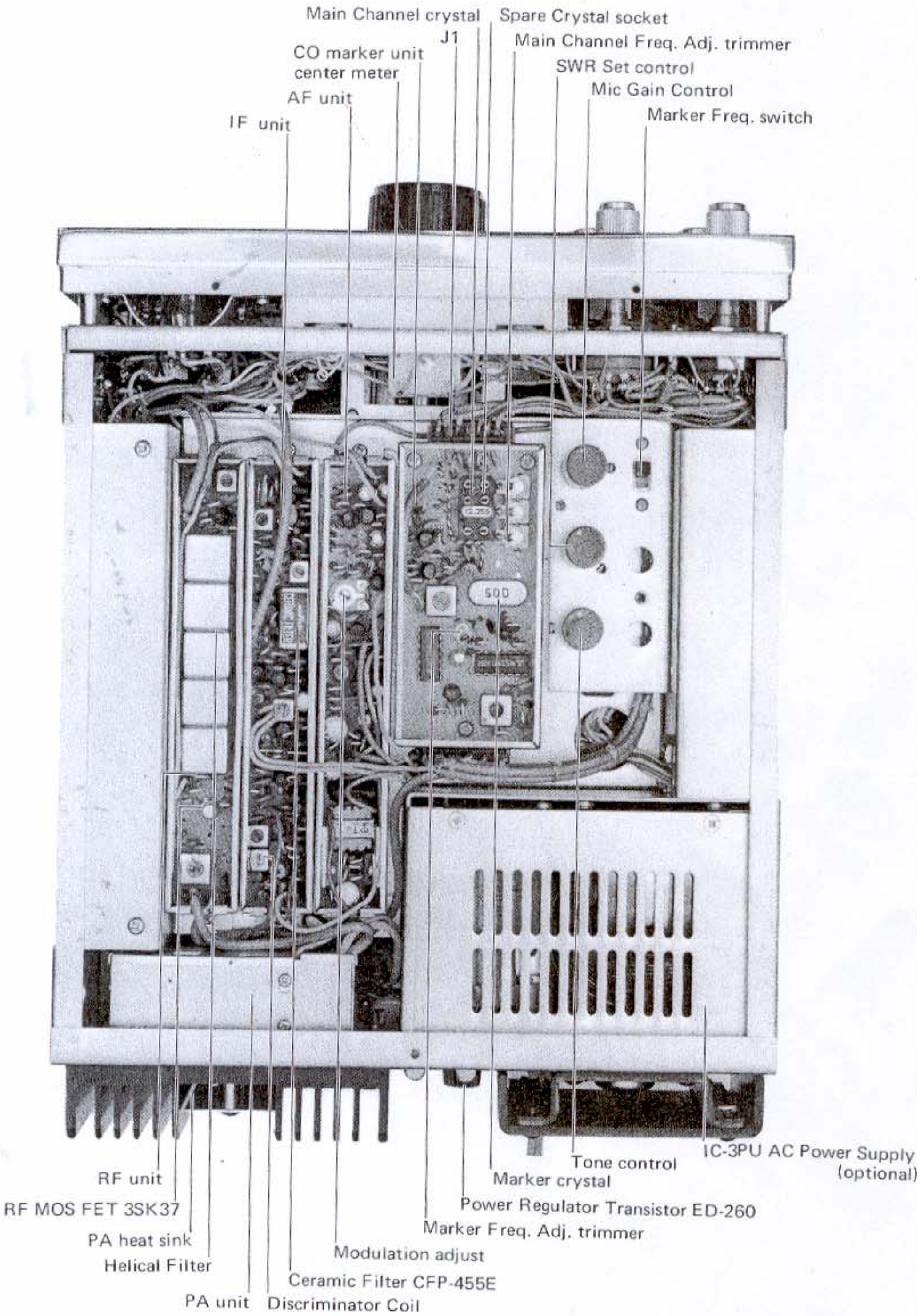


SIDE VIEWS (Fig. 4)

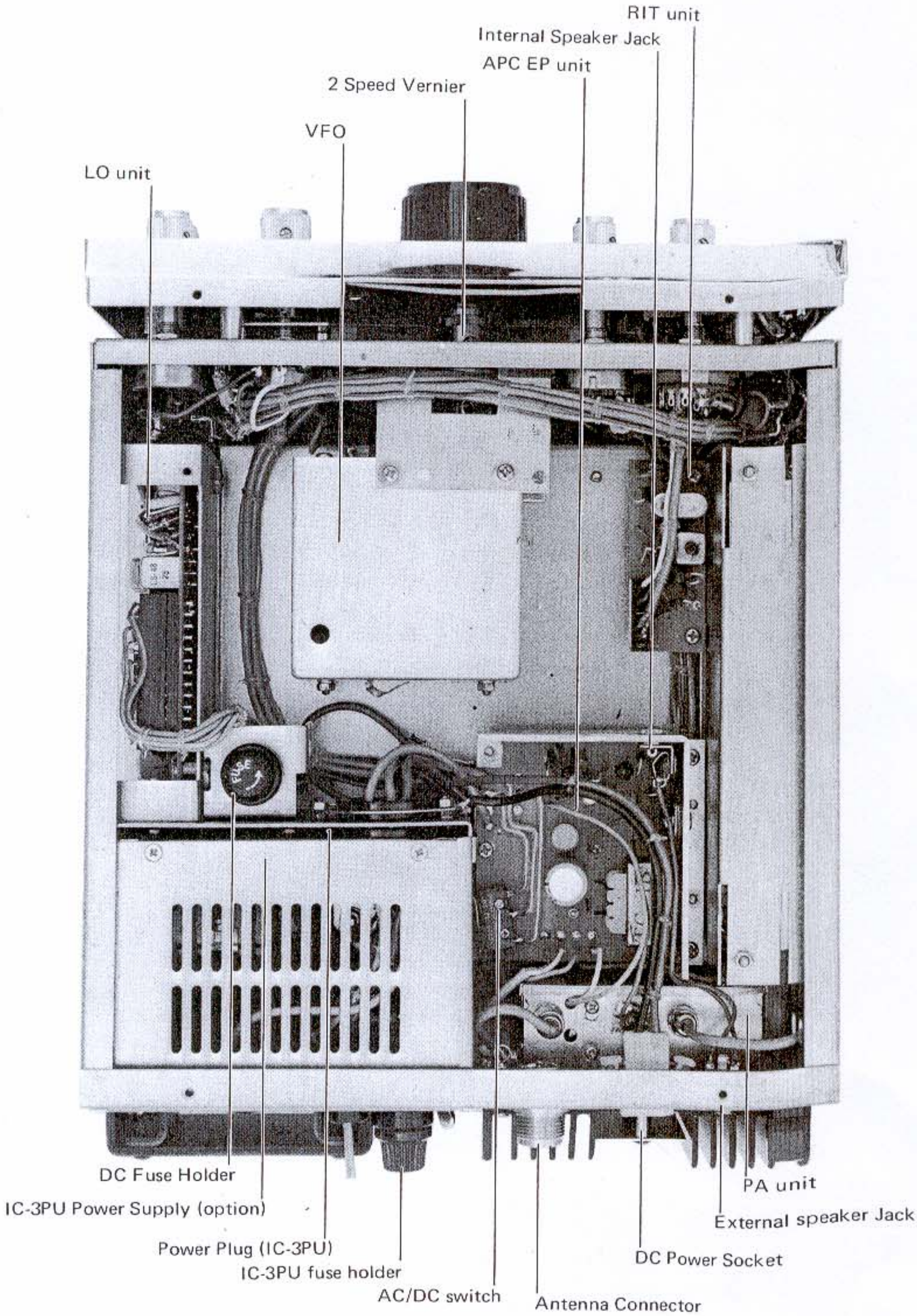




TOP VIEW (Fig. 6)



BUTTOM VIEW (Fig. 7)



SECTION V - OPERATION

5. 1 Initial Preparation

a. Make sure the power switch is in the Off position and the T-R switch is in the R position.

b. For AC operation using the exclusive IC-3PU, power supply, make sure the AC voltage plug on the fuse holder of the IC-3PU is set for your AC line voltage. The IC-3PU is switchable to 100, 117, 220 or 240V. AC.

c. For DC operation, note the IC-3PU must be removed from the IC-210, then connect the DC power supply cable to the DC power supply receptacle. The red lead should be connected with the positive side of the power source and black lead to the negative side.

d. Don't remove and replace the power supply cable, antenna and external speaker with the power on.

e. If the fuses blow, a 1A for 200V AC and a 5A in 13.5V DC should be used.

f. Connect the antenna to the antenna coax connector. Make sure the coax line is of the correct impedance (50 ohms) and is neither shorted nor open. In the event that these leads are improperly connected, the IC-210 will not function. However no damage will be incurred since protection provided in the IC-210 will cause the fuse to blow.

g. Turn the volume and squelch controls to the maximum counter clockwise position.

5. 2 Operation

a. Place the FUNCTION switch in the VFO position and the COURSE switch in the LB, HB or MAIN position.

b. Place the tuning scale at any frequency you desire.

c. Place the RIT in the center position.

d. Turn the SQL. control clockwise to just before the CAL. position.

e. The METER SELECT switches should be in the S & RF position, and the LOG or LINEAR position.

5. 3. Reception

a. Turn the power switch on (before turning on, make sure the T-R switch is in the R position).

b. Adjust the volume control to a comfortable listeng level of noise, if no noise is present.

c. Carefully adjust the squelch control clockwise until the noise just disappears. This is proper squelch threshold setting and must be done when no signal is present. Your transceiver will now remain silent until an in-coming signal is received which opens the squelch. If the squelch is unstable due to the reception of weak or unstable stations, adjust the squelch control further until the proper threshold is obtained.

d. When a signal is received or the squelch is opened, the letters "RECV" in the center window, are illuminated.

e. The S meter indicates the signal strength of the in-coming station linearly or logarithmically.

f. The Center meter shows the difference between your receive crystal frequency and the frequency of the receiving signal. If there is some difference, you can compensate for it with the RIT control.

g. In the CAL position of the Squelch control knob, the marker will work. The marker frequencies of every 50 KHz or every 250 KHz can be selected by the Marker switch located under the Access cover. By these frequencies the dial face scal can be adjusted accurately.

h. Adjust the tone in receive as you desire with the TONE control located under the Access cover.

5.4 Transmitting

a. Turn the power control (PWR) to the maximum counter clockwise position (LOW).

b. Place the TX FREQ switch in the SIMPLEX position.

c. Set the MIC gain control, under the Access cover, to 2/3 open.

d. Set the T-R switch to the T position, or push the PTT button on the microphone and set will transmit. At the same time the red letters "XMIT" will be lit, and the blue "RECV" letters will go out. The S & RF meter will indicate the relative output power. The needle will be on or near the 20 db mark on the meter scale for high power, and just a little over one for low.

e. Now turn the PWR control fully clockwise (High Position).

f. Turn the SWR Set control, under the Access cover, until the meter needle reaches the SET position, with the meter switch in the S & RF position.
Place the switch in the SWR position, and the meter will indicate reflected SWR.

h. Hold the microphone about 10 cm from your mouth and speak in a normal voice. Shouting does not increase your communication range. The microphone is a dynamic type, and provides good pickup for all voice levels.

i. To receive again, just release the PTT button.

5.5 For Repeater Use

You can transmit at 600 KHz below any receive frequency for repeater use by placing the TX FREQ switch in the Duplex B position. The Duplex A position is for an extra crystal for repeater use. You may transmit at any frequency difference up to at least 600 KHz above or below the receive frequency, by installing a crystal in the spare crystal socket in the MIX module in accordance with the formula shown in 4-1 i.

CAUTION: MAKE SURE THE TRANSMIT FREQUENCY WILL NOT BE BELOW 144.00 MHZ WHEN YOU OPERATE IN THE DUPLEX POSITION.

P.L.L. Synthesizer (Phase Locked Loop)

The P.L.L. consists of four modules: Voltage Controled Oscillator, Phase Detector, Local Oscillator and Comparison Oscillator.

SECTION VI - THEORY OF OPERATION

6.1 VCO Module

The VCO is a self oscillating circuit with a frequency range of 133.3 MHz and 135.3 MHz, externally voltage controlled. In receive, this frequency is used as the first local oscillator, and in transmit, 10.7 MHz is added to produce 144.00 to 146.00 MHz.

Q4 is a Hartly oscillator circuit, whose output frequency is determined by L1, C9, C12, and D1. The capacitance of D1, a variable capacitance diode, is changed by the bias voltage applied to either side. Q2 is an unijunction transistor. Q3, a DC amplifier, is biased so that with no signal applied to the gate, is will be cut off. When Q3 is cut off, Q2 produces a sawtooth wave at a frequency decided by the time constant of R6, R8, and C4. The voltage of this sawtooth wave is fed to D1 through R11, causing the VCO to sweep between 133.3 MHz and 135.3 MHz.

The positive pulse from Q2's output is taken externally through Q1, a source floor amplifier, to indicate a PLL locked status. Part of the VCO output is fed to the PD module from Q5, a buffer amplifier, from pin 5. The other part is amplified by IC1, and then sent to the MIX and RF modules from pin 7 and 9, as a local oscillation voltage.

6. 2 PD Module

The LO signal from pin 3 is tripled by Q2. The collector circuit of Q2, consisting of L8 and C32, is tuned to 39 MHz. The 39 MHz signal taken from the secondary of L8 is tripled again by Q3 to 120 MHz. After the signal is filtered in a double 120 MHz circuit, consisting of L9, C35, C37, C38, and L10, it is fed to Q1 through the secondary of L10 to C12.

A signal from the VCO through pin 2, of the PD module, passes through a double tuned filter, consisting of L1, C1, C2, C3, C4 and L2,and is then amplified by IC1 (LM703). The signal is again filtered through another 134 MHz double tuned filter consisting of L3, C8, C9, C10 and L4. The signal from the secondary of L4, as well as the LO signal, is fed to the base of Q1.

Because Q1, whose collector circuit is tuned to 11 MHz, acts as a mixer, a balance of the LO and VCO frequencies (Locked Loop IF) is taken from the collector circuit. This signal is amplified by IC 2 and then fed to a phase detector consisting of D1 and D2.

The PD is supplied with a CO signal through pin 5 of the PD module. When the Locked loop IF matches the CO frequency, the PD output, a positive voltage, is maximum. The phase difference between the CO and Locked Loop IF changes from –90 degrees to O degrees. The PD signal passes through a low pass filter consisting of L7, R8, R9 and C25, and then through pin 7 to the VCO.

6. 3 LO Module

Q1 is a Clap crystal oscillator circuit. The base is connected with X1, X2, X3 or X4 through switching diodes, D1, D2, D3 and D4. These crystals are selected by S2, the COURSE switch. Each crystal is connected in series with a variable capacitor, C7, C8, C9 and C10, so the frequency of each crystal can be tuned accurately. X1's frequency is 13.560 MHz and X2's is 13.672 MHz.

Optional frequencies can be placed in X3 and X4. The output of the oscillator is fed to the base of Q2 from the emitter of Q1 through capacitor C13. Q2 is a buffer amplifier, whose collector circuit consisting of L1 and C18, is tuned to the 13 MHz band. The signal from the secondary of L1 is fed to a bridge circuit which consists of R47, L12, D5, R18 and R19. This circuit is tuned to the 13 MHz band by D5 and L12. D5, a variable capacitance diode, is biased by R16 and R22.

D5 is driven, through R21, by the modulator signal from J3, pin 13. The capacitance of D5 is altered in accordance with the modulator signal giving the LO signal Phase modulation by the bridge becoming unbalanced. The modulated LO signal is fed to the base of Q3, amplified and then fed to the PD module through J1, pin 6.

A DC voltage from pin 5 of J2 is amplified by Q5, then picked up from pin 7 and 9 of J2 as a signal for the S meter. R42 is the sensitivity control and R41 is the zero adjust. In tramsmit pin 5 of J2 is given the voltage indicated by the SWR module in proportion to the output power in the forward direction and the S meter acts as an RF meter.

Q6 and Q7 are DC amplifiers for the AGC control. When the meter switch is in the linear position the emitter circuit of Q6 is cut off by S6, the meter switch, so the AGC may not function. A constant voltage can be picked up from pin 6 of J2 as an AGC signal because Q7 acts as an AVR regulated by D7, a zener diode.

When the meter switch is in the LOG. position, the base of Q6 is driven by a DC output in proportion to the receiving signal from Q5 and the output of the collector of Q6 is again amplified by Q7 to be an AGC signal.

A circuit is installed in this module to control the power supply for transmitting and receiving. When the emitter of Q11 is grounded through pin 10 of J3 by the PTT switch, the voltage at the base of Q12, connected also with the collector, is reduced. Because of the ground potential at the emitter of Q12, Q13 will conduct. Then the voltage of the power supply to the transmit section, which is connected with the collector of Q13 can be taken through pin 8 of J3.

A part of the voltage that is regulated by D12 is taken through pin 9 of J3 as the power for the modulation amplifier etc.

At this time, Q14 is cut off because of the ground potential applied to it's base. As the base of Q11 is connected with a signal supplied from the MIX module when the PLL is out of lock through pin 11 of J3 and the base of Q11 is forced to the grounded potential, the power supply to the transmitting section can not be supplied, even if the emitter is grounded.

In reception with the PTT switch off, Q11, Q12, and Q13 cut off and the power supplied to the AF section through pin 4 of J3 can be taken from the emitter of Q14.
A part of the power, regulated by D14 and Q15, is taken through pin 2 of J3 as a power supply for the receiving section.
Q8 and Q9 are DC amplifiers to control the signal indicator light. The base of Q8 is driven by a signal of positive potential supplied from the AF module through pin 6 of J3 when the squelch is on. Also Q9, connected with the collector of Q8 conducts, and the collector circuit turns on the light on the panel indicating the signal through pin 5 of J3.

6.4 CO Module

Q1 is an 11 MHz band crystal Clap oscillator. The base of Q1 is connected with three crystals, X1, XA or XB through switching diodes, D1, D2 and D3, which are selected by S1 and S2.
X1 is connected to the MAIN position of S2, the COURSE switch, and XA and XB are connected to A and B position of S1, the FUNCTION switch on the panel. At the EXT and VFO position of S1, the power supply to Q1 and Q2 is turned off by S2. Q2 is a buffer amplifier, the collector circuit of which consists of L1, C16 and C17, is tuned to the 11 MHz band. The output is fed to the PD module as one of the CO signals from J1, pin 6 to S2. IC1 is a marker oscillator and oscillates at 500 KHz using X2. The frequency can be tuned accurately by C20. IC2 is a frequency devider and produces 250 KHz or 50 KHz signal.
The switch is S8 (MARKER switch). The signal is amplified again by IC1 and is taken through Q3. The collector circuit of Q3 consists of L3 and C28 is tuned to 140 MHz band and this signal includes every 250 KHz or 50 KHz between 144 MHz and 146 MHz. The marker signal is supplied from the secondary of L3 in the CO-MARKER module to the RF module. The power supply to IC1, IC2 and Q3 is turned on or off by the calibrator switch R5, squelch control knob on the panel.

6.5 VFO Module

Q1 is a self oscillating Clap circuit. The frequency, variable from 11.255 to 12.255 MHz, can be changed continuously by C1 · C2 is a capacitor for setting frequency. C23, C3, C4, and C5 are temperature coefficient capacitors and are effective between –10 and +50 degrees centigrade.

Q2 and Q3 are buffer amplifiers which isolate the VFO from changing loads. The collector circuit of Q3, consisting of C18, C19 and L5 is tuned to the 11 MHz band. The signal is fed to the PD, as the CO signal, from J4 to S2. The VFO and CO marker unit signals are switched by S1 and S2, the FUNCTION and COURSE switches respectively.

6. 6 Mixer Module

In this module a control circuit is installed to stop operation of the transceiver if the VCO unlocks. A pulse of sweep signal is fed to the base of Q1 from the VCO module when the VCO is unlocked. The component of this signal is amplified by a complimentary amplifier consisting of Q1 and Q2. The collector of Q2 produces a pulse which is detected by D9 and then fed to the base of Q4, which then conducts. An additional circuit is also installed to avoid a misoperation of the PLL function. Q3 is an N-gate Thyrister, a programable unijunction transistor which conducts when the voltage of the gate becomes lower than the anode. The anode is given a regulated voltage by a zener diode, D1, and the gate is given the voltage decided from the power supply.

When the power supply voltage reduces from the specified voltage, Q3 conducts because of the voltage of Q3's gate being lower than that of it's anode. The result is R2 produces voltage descent, which turns on Q4. The collector circuit connected with the LO module through J3 makes the LO stop operation in transmit. At the same time the base voltage of Q4 through D3 is fed to the squelch circuit in the AF module and mutes the audio circuit.

As the result, any misaction in the PLL circuit can be elliminated. Besides these operations, the pulse from Q2 cuts off Q9 through R4 and R34 to reduce the current of the collector of Q9 and makes PL9, the meter light, turn off, indicating an unlocked status.

The transmit signal consists of a 10.7 MHz, ±600 KHz in duplex operation, and the VCO frequency. A Clap oscillator circuit, consisting of Q8, oscillates with excellent stability. Three crystals, X1, X2, X3, can be installed and are selected by switching diodes D5, D6, and D7, which are controlled by S3 (Tx Freq. knob) on the front panel. When S3 is in the Simplex position, a 10.7 MHz crystal is connected. When in the Duplex A position, an 11.3 MHz is connected, and in the Duplex B, a 10.1 MHz xtal is used. Q7 is a buffer amplifier whose collector circuit is tuned to the 11 MHz band by RF transformer L5. Q6 is a dial gate MOSFET. The VCO signal, injected into gate 1 and the 10.7 MHz (±600 KHz in duplex), injected into gate 2, are hetrodyned. The Drain circuit consists of L4, C14, C15, C16, and L3. The signal is filtered through a dual tuned circuit to the 144 MHz band in the drain circuit, and then amplified by Q5, a buffer amplifier. The signal is further filtered through a double tuned circuit to the 144 MHz band consisting of C6, C7, C8, L1, and L2, then fed to the YGR module through pin 6.

6. 7 Receiver RF Amplifier and First Mixer Module

The input signal is amplified by the field effect cascade amplifier, Q1 (3SK37), and passed into the RF filter. This filter is a high Q helicalized resonators with excellent bandpass characteristics and shockproof construction. From the output of the helicalized resonators the signal is fed to the gate of the first mixer, Q2 (2SK19) where it is mixed with the output from VCO, which is fed into the source of Q2 to obtain the 10.7 MHz of IF signal. The output of the mixer is fed through the first caramic filter FL 1 (SFC 10.7 MA) to the IF amplifier. All the transistors in the receiver RF unit are field effect transistors, which have the highest possible sensitivity and signal to noise ratio and the lowest possible cross modulation.

6.8 Receiver 1st IF amplifier, 2nd IF amplifier, Limiter and Discriminator Module

The 10.7 MHz signal from the first ceramic filter in the RF unit is amplified by Q1 (2SC372) and fed to the gate of the 2nd Mixer Q2 (2SK19) through the 2nd ceramic filter FL 1 (SFC 10.7 MA). The variable resistor in the emitter circuit of the First IF transistor Q1 adjusts the IF gain and S-meter sensitivity. The 2nd Oscillator Q9 (2SC372) is crystal controlled and operates on 10.245 MHz. The output is taken from the emitter of Q9 and fed into the gate of the 2nd Mixer Q2 (2SK19) to obtain the 455 KHz. IF signal, which is passed through the 3rd ceramic filter FL 2 (CFP 455E) and amplified by Q3, Q4, Q5, Q6, Q7 and Q8 (2SC372s). The output of Q8 is then demodulated in the discriminator circuit, consisting of L4 (LS-14), L5 (LS-15), and D7 and D8 (1N60s).

6.9 Receiver Audio Amplifier, Squelch Amplifier Module

The output of the discriminator drives two circuits the audio amplifier and the squelch. The audio signal, after being adjusted by the volume control R-1, is then fed to Q10 and Q11 (2SC372 and 2SC373), followed by the audio power amplifier stage Q8 and Q9 (2SD235s), which gives an audio output of 1.5 watts.

The squelch circuit is made up of Q5, Q6 (2SC372s), Diodes D3, D4 (1N60s), and Q7 (2SC373). In the absence of a signal, the noise component at the output of the discriminator is amplified by Q5 and Q6. Diodes D3 and D4 rectify this amplifier component, Q7 couples it through the 10 K ohm R-2 squelch control to the DC amplifier and Q7's output is coupled to the base circuit of Q11. When the squelch control is adjusted, the amount of DC required to cut off Q11 is found, thus establishing the squelch threshold. When a signal is incoming via the discriminator, this bias is overcome, permitting the audio amplifier and driver to perform normally.

6.10 YGR Module

A signal from the Mixer module is amplidied by Q1, a class A amplifier, passed through a 144 MHz band pass filter, and then amplified by Q3, also a class A amplifier. Further, the signal passes through a double tuned circuit consisting of L5, C15, C29, L6 and C16, is amplidied by Q4, and then fed to the base of Q8 through a matching network consisting of L7, C29, C19, and L8.

Q5 is a class C amplifier. The signal from Q5 is fed through a 50 ohm matching circuit consisting of L9, C23, L10, and C26, then sent from pin 1 to the PA Module.

6. 11 PA Module

The signal from the YGR is amplified to 10 watts by transistors Q1 (2SC1011) and Q2 (2SC1177). Transistor Q2 is the power output stage and is coupled to antenna through the sprious filter consisting of L10, L11 and L12 and the Automatic Protection Circuit. The APC acts to decrease the power output of transistors Q1 and Q2 in the PA stage if the antenna is seriously mismatched. A reflected power detector is provided by L13 and D3 (1N60) in the PA module. When the antenna is mismatched, this circuit senses a high reflected power and provides base drive to transistor Q1 in the APC-EP module. This transistor will conduct sufficient base drive to reduce the base drive of transistor Q2 in the APC-EP module.

When transistor Q2 begins to cut off it reduces the drive to the complementary transistor pair, consisting of Q3 and Q4 in the APC-EP module. This pair acts as a series regulator for the voltage supplied to the driver transistor Q1 and the power output transistor Q2 in the PA module. When they begin to cut off, due to a lack of base drive, the voltage being supplied to Q1 and Q2 is reduced to about six or eight volts which reduces the power output to safe level. This lower power prevents damage to Q1 and Q2 when the antenna is mismatched.

6. 12 General operation of the PLL

When 124.045 MHz is selected as the LO frequency and 11.255 MHz as the CO frequency, the VCO begins to sweep at about 133 MHz.

Accordingly, as the VCO frequency comes up to 135.30 MHz, the LLIF also comes up to 11.255 MHz, the CO frequency, so that the phase difference of both frequencies occurs between −90 and 0 degrees.

At this time, Q3's gate in the VCO module is given the PD output, and the drain current produces voltage drop by R8 so that the voltage increase at CP1 stops. As the result, the VCO frequency is held at 135.300 MHz exactly.

Suppose the VCO frequency becomes higher a bit for some reason. Since the PD output increases positively, the voltage at CP1 decreases. When the voltage at either side of D1 in the VCO module decreases, it's capacitance increases, causing the VCO frequency to decrease. Then the voltage at CP1 comes to a balance so that the oscillation of Q2 in the VCO module stops, and the PLL maintains a locked status.

If on the other hand the VCO frequency decreases, the opposite reaction occures to stabilize the VCO.

SECTION VIII - MAINTENANCE

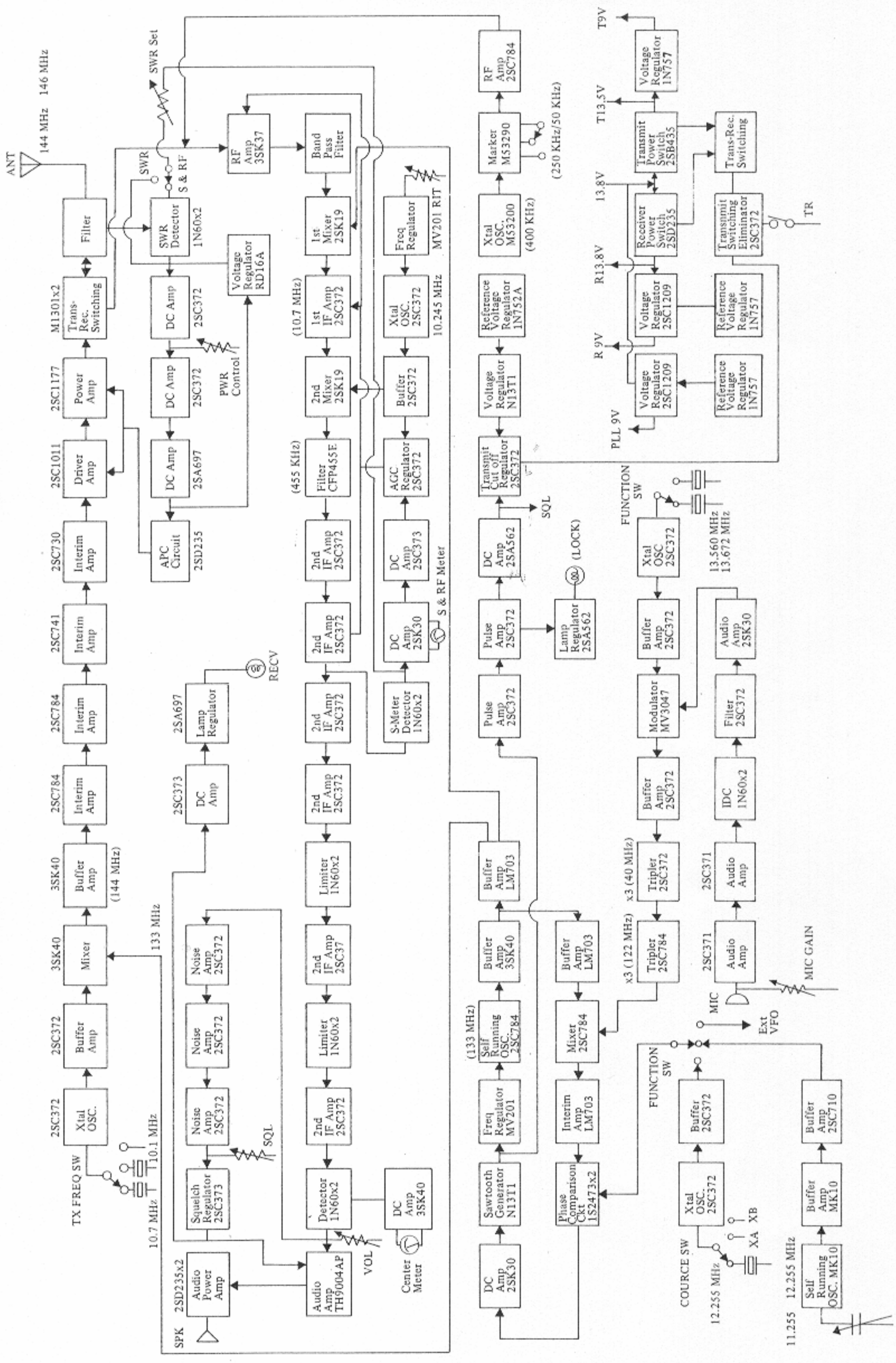
7. 1 The necessity of completely realigning the unit is unlikely. The most common cause of breakdown is component failure. It is felt that the average owner would not have the necessary equipment and facilities to accomplish realignment in any case, if it did become necessary. Great care and precision are employed in its manufacture, and service is provided to ensure it meets specifications. Adjustments not outlined herein should not be undertaken by the owner.

This equipment has been carefully aligned with very expensive and accurate equipment, including a Spectrum Analizer to reduce Spurious Radiation.

Do not adjust, replace parts, or perform any type of maintenance unless you are fully qualified to do so. This pertains especially to coils and variable resistors related to PLL system.

Do not attempt to adjust these under any circumstances.

SECTION IX - BLOCK DIAGRAM



SECTION IV - ALIGNMENT CHART

MODULE	NO.	NAME	BASE	EMITTER	COLLECTOR	DRAIN	ANY OTHERS
RF	Q1	3SK37	0(G1)	0.3(G2)	0.2(S)	7.8	LINEAR
RF	Q2	2SK19	0(G)		1.1(S)	8.1	
AF	Q1	2SC372	0.5	0.03	3.3		TRANSMIT
AF	Q2	2SC372	3.3	2.6	5.4		TRANSMIT
AF	Q3	2SC372	7.7	7.7	9.4		TRANSMIT
AF	Q4	2SK30	0(G)		0.8(S)	5.4	RECEIVE
AF	Q5	2SC372	1.2	0.6	8.7		RECEIVE
AF	Q6	2SC372	1.2	0.6	7.0		RECEIVE
AF	Q7	2SC372	0.3	0	6.0		RECEIVE
AF	Q8	2SD235	7.0	6.5	12.0		RECEIVE
AF	Q9	2SD235	0.5	0	6.5		RECEIVE
AF	Q10	2SC372	0.6	0.05	1.3		
AF	Q11	2SC373	1.3	0.6	11.4		
IF	Q1	2SC372	1.3	0.6	8.5		
IF	Q2	2SK19	0(G)		1.3(S)	8.4	
IF	Q3	2SC372	0.7	0	3.0		
IF	Q4	2SC372	5.8	5.2	6.5		
IF	Q5	2SC372	0.7	0	1.0		
IF	Q6	2SC372	3.2	2.7	3.4		
IF	Q7	2SC372	5.2	4.9	6.0		
IF	Q8	2SC372	2.0	1.3	5.3		
IF	Q9	2SC372	1.8	1.2	8.8		
CO. MRK	Q1	2SC372	2.5	2.0	8.6		AT MAIN CHANNEL
CO. MRK	Q2	2SC372	4.0	3.4	8.4		AT MAIN CHANNEL
CO. MRK	Q3	2SC763	4.0	3.0	7.2		R. CAL
LO	Q1	2SC372	2.4	2.0	8.0		
LO	Q2	2SC372	2.0	1.4	7.8		
LO	Q3	2SC372	1.7	1.1	3.2		
LO	Q4	3SK40	0(G1)	0(G2)	0.8(S)		
LO	Q5	2SK30	0(G)		0.5(S)		
LO	Q6	2SC373	0.3	0.1	6.3		LINEAR
LO	Q7	2SC372	6.3	9.1	12.1		LINEAR
LO	Q8	2SC373	0.4	0	0.1		
LO	Q9	2SA697	12.9	13.8	13.6		
LO	Q10	2SC1209	9.4	11.8	8.7		
LO	Q11	2SC372	0.9	0.2	0.2		TRANSMIT
LO	Q12	2SA697	0.2	0.9	0		TRANSMIT
LO	Q13	2SB435	13.8	13.8	0		RECEIVE
LO	Q14	2SD235	13.0	12.3	13.8		RECEIVE
LO	Q15	2SC1209	9.2	8.6	11.6		
PD	Q1	2SC784	1.2	0.6	8.4		
PD	Q2	2SC372	0.8	0.6	8.5		
PD	Q3	2SC784	1.2	0.6	8.6		
PD	IC1	LM703	8.0	1.4	0	1.4	8.0 8.4
PD	IC2	LM703	8.0	1.4	0	1.7	8.0 8.4
VCO	Q1	2SK30	4.0(G)		3.5(S)	13.5	LOCKED STATE
VCO	Q2	N13T1	5.6(G)	0(K)	5.2(A)		LOCKED STATE
VCO	Q3	2SK30	0.25(G)		1.0(S)	5.2	
VCO	Q4	2SC784	1.0	1.3	8.2		
VCO	Q5	3SK40	3.2(G1)	0(G2)	8.0		
VCO	IC1	LM703	7.7	1.4	0	1.4	8.0 8.4
MIX	Q1	2SC373	0	0	13.8		
MIX	Q2	2SA562	2.7	2.7	0.1		
MIX	Q3	N13T1	8.2(G)	7.0(K)	6.0(A)		
MIX	Q4	2SC372	0.1	0	13.8		
MIX	Q5	3SK40	0(G1)	3.3(G2)	0.4(S)	8.8	
MIX	Q6	3SK40	1.4(G1)	2.6(G2)	1.4(S)	6.8	
MIX	Q7	2SC372	2.6	2.0	8.4		
MIX	Q8	2SC372	2.8	2.0	8.6		
YGR	Q1	2SC784	2.3	1.5	12.5		TRANSMIT
YGR	Q2	2SC784	2.2	1.5	13.0		TRANSMIT
YGR	Q3	2SC741	0.4	0.7	13.0		TRANSMIT
YGR	Q4	2SC730	0	0	13.0		TRANSMIT
PA	Q1	2SC1011					
PA	Q2	2SC1177					
APC. EP	Q1	2SC372	0.1	0	3.4		TRANSMIT
APC. EP	Q2	2SC372	1.9	2.4	12.8		TRANSMIT
APC. EP	Q3	2SA697	12.8	13.5	12.1		TRANSMIT
APC. EP	Q4	2SD235	12.1	11.4	13.5		TRANSMIT
VFO	Q1	MK10	0(G)		2.0	5.4	
VFO	Q2	MK10	0		2.0	4.0	
VFO	Q3	2SC710	4.0	4.0	9.0		
RIT	Q1	2SC373	2.5	2.0	88.5		