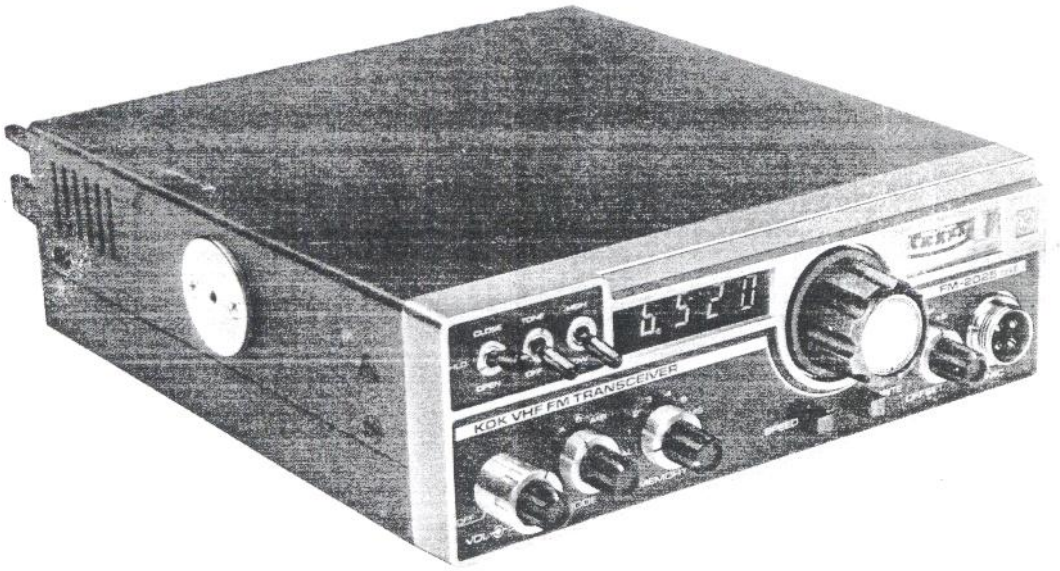
C-MOS MICROPROCESSOR CONTROLLED

DIGITAL PHASE LOCKED SYNTHESIZER

2m FM TRANSCEIVER



MODEL: FM-2025A/E mark II

OPERATOR'S INSTRUCTIONS

KDK KYOKUTO DENSHI CO., LTD.
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5000
KDK VHF FM TRANSCEIVER
SPEED
WRITE
MIC
MODE
MEMORY

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1. GENERAL FEATURES

A. MICRO-PROCESSOR CONTROLLED: - DRAWING UPON KDK'S MANY YEARS OF EXPERIENCE IN THE DESIGN AND PRODUCTION OF VHF, FM, MOBILE TRANSCEIVERS, ANOTHER KDK "IN-HOUSE" PROGRAMMED MICRO-PROCESSOR CHIP HAS BEEN DEVELOPED TO ACHIEVE THE MOST ADVANCED, EFFICIENT AND "EASY-TO-USE" CONTROL SYSTEM. The computor's various functions are established by diode mattrixes (BCD coded) which may be rearranged by simple diode changes in order to match differring operating conditions which may be dictated as a result of the user moving to another country. This also provides maximum flexibility to cope with future changes in national and or regional band plans. These functions are as follows:

a) MINIMUM OPERATING FREQUENCY, (LF)
Can be set between 143.000 and 148.995MHz.

b) MAXIMUM OPERATING FREQUENCY, (HF)
Can be set between 144.000 and 150.000MHz.

c) MAXIMUM TRANSMIT FREQUENCY, (THF)
Can be set between 144.000 and 150.000MHz.

d) OFFSET FREQUENCY, (OFF x 1, OFF x 10)
Can be set to any frequency between 10KHz and 1MHz, in increments of 10KHz.

e) DIAL STEP INCREMENTS, (E)
Can be set at 5KHz or 12.5KHz (1 or 0)

f) BAND SCAN INCREMENTS, (BS)
Can be set between 5KHz and 80KHz in any increment of 5KHz (12.5 - 200KHz in 12.5KHz increments).

B. FREQUENCY COVERAGE: - 143.000 - 148.995MHz, (144.000 - 148.9875MHz) in 5KHz (12.5KHz) steps in order to cover the entire amateur band.

C. DIALLING SYSTEM: - A solid state photo-interruptor system using LED's and photo-sensors are used to provide 30 pulses with each revolution of the DIAL. A speed up switch is provided to facilitate frequency changing between widely separated frequencies. Depressing the SPEED button results in each pulse shifting frequency by 100KHz (125KHz).

D. ELECTRONIC MEMORIES: - A total of 10 channels, A1 - A5 plus B1 - B5 is provided. The division of memory channels into two groups facilitates memory use during mobile operations. An internal back-up NICAD battery is installed in order to prevent loss of memory while the transceiver is not connected to any external power source. Once fully charged, this battery will hold memory contents for more than a year as current drain is an infinitesimal 57nA. Memory A1 is a priority channel and operation of the WRITE switch while MEMORY switch is in the DIAL position will result in the selected frequency being written into this memory channel, A1.

E. DUPLEX OPERATION USING MEMORY CHANNELS: - Setting the MODE switch to position AxB results in the unit receiving on frequencies memorized in memory channels A1 - A5 and transmitting on frequencies in channels B1 - B5. For example, if the memory switch is set on position 1, the unit will receive on the frequency A1 and transmit on frequency B1 with the frequency shifting automatically in accordance with the operation of the microphone P/T switch. The frequency DISPLAY will always show the frequency actually in use. As a maximum of 5 such duplex send and receive frequencies can be stored in the memory, this mode of operation provides a very speedy and convenient means of working with repeators when compared to using the OFFSET switch described in the next paragraph.

F. DUPLEX OPERATION USING OFFSET SWITCH: - In SIMPLEX position, transmit and receiving frequencies are identical. In plus and minus .6 positions, the transmitter will operate on frequencies 600KHz above or below the receiving frequency, respectively. This can be very convenient when working with a repeator located as a result of BAND SCANNING. The actual transmitting and receiving frequencies are displayed on the front panel LED display.

G. BAND SCANNING: - The receiver scans upward in 5KHz (12.5KHz) increments starting from the frequency written in to memory channel A5 until reaching the frequency memorized in channel B5 and then returns to frequency A5 and thus continues to scan all frequencies between these two limits as established by the operator. Scanning is started whenever the SCAN MODE switch is set to CLOSE or OPEN. In the CLOSE mode of scanning the scanning will stop whenever a frequency is scanned which is busy. In the OPEN mode the scanning will stop whenever an OPEN (unused) frequency is located. For CLOSED scanning, a discriminator ZERO detector is activated to prevent the scanner from stopping prior to reaching the true center frequency.

H. MEMORY SCANNING: - The unit will continuously scan the frequencies stored in memory channels A1 - A5 (MODE switch in position A) or B1 through B5 (MODE switch in position B). CLOSED and OPEN modes of scanning are identical to that described under band scanning in the preceding paragraph. Setting the SCAN MODE switch to the center (HOLD) position will permit immediate operation of the transmitter on the frequency located through scanning.

I. RECEIVER: - UHF MOS-FETS are employed in the RF amplifier and mixer stages to provide an exceptional sensitivity and cross modulation characteristic. An electronic auto peak tuning system are employed in the front end in order to keep sensitivity and selectivity constant over the wide range of 143.000 - 149.000 covered. A monolithic crystal filter is used in the 1st IF and a ceramic 9-pole filter is used in the 2nd IF circuitry to obtain an optimum selectivity characteristic. A one-chip, multi-purpose LSI is used in the 2nd IF circuitry to achieve a well balanced receiver with improved reliability.

G. TRANSMITTER: - The VCO oscillates directly at the transmitter output frequency eliminating the need for any multiplication or mixing stages resulting in an extremely clean spur free signal. The transmitter's reliability is improved by the use of a reduced number of amplification stages. This is followed by the latest power module which is impervious to an infinite VSWR. An APC (Auto Power Control) circuit is provided to prevent over-power transmission which further improves the reliability of the transmitter. This APC also prevents transmission in cases of PLL unlock to prevent possible off-band transmissions. Front panel switch selection of HIGH (25 watts) and LOW (3 watts) is provided so that power appropriate to the operator's need can be selected. An IC with an automatic level control circuit is used as the microphone amplifier eliminating the need for any diode clipping circuits and thus reduces distortion. The modulator applies direct frequency modulation to the VCO resulting in extremely distortion-free modulation.

2. OPERATING CONTROLS AND FUNCTIONS

TONE When ON, a tone signal is superimposed on the transmitted carrier in one of two modes as selected by an internal switch. 100Hz (1750Hz).

SCANNING MODE In CLOSE position receiver scans until a channel in use is encountered. In OPEN position, receiver scans until an open (vacant) channel is encountered. Center position is HOLD which permits transmitting and receiving on frequency located by scanning.

POWER SWITCH

HIGH = 25 watts
LOW = 3 watts

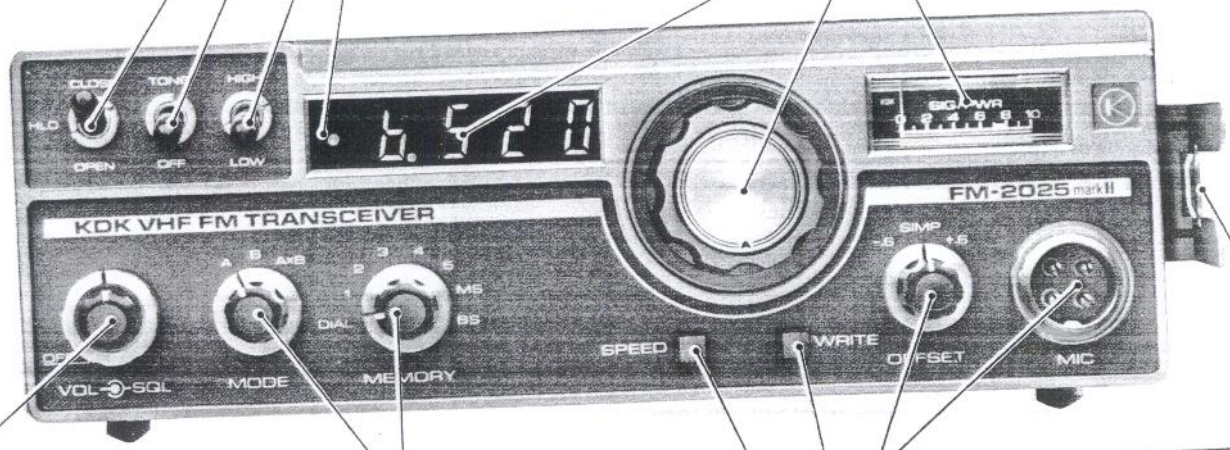
RCV INDICATOR Lights up whenever receiver is unsquelched by an incoming signal. (Or by manual operation of SQL control.)

FREQUENCY DISPLAY 4 digits of LED display starting with last MHz digit, i.e. 6.520 for 146.520MHz

NOTE: When E model operates on a 5 digit frequency like 144.0125 the 5th digit 5 is dropped and display shows only 4.012.

DIAL With MEMORY switch in DIAL position, each click of DIAL changes frequency by 5KHz (12.5KHZ). Depressing speed button increases dialling speed to 100KHz (125KHz). Clockwise rotation increases and counter clockwise rotation decreases frequency.

METER "S" meter for receive. Output power indication during transmit. Solid state auto switching between receive and transmit.



POWER, VOLUME, SQUELCH Small knob controls power switch and volume. Turning clockwise turns on main power, further rotation increases volume.

Outer knob is squelch control. Turning clockwise mutes receiver when sq. threshold is reached. Turning further increases depth of threshold.

MODE A and B positions designate memory channel group. AxB position for duplex operation using memory channels. Receives on A and transmits on B memory channel frequencies.*

MEMORY AND SCANNING DIAL position, operating frequency controlled by DIAL.

1 through 5, designate memory channels 1 through 5.

MS - MEMORY scanning.
BS - BAND scanning.

SPEED Depress to speed up dialing rate. Each click of DIAL will shift frequency by 100KHz (125KHz). Locks in both normal & depressed positions.

WRITE Depress switch to WRITE in frequency to MEMORY channels. Simultaneously erases frequency previously stored in that memory channel.

Non-locking type switch.

MIKE CLIP For retaining microphone when not in use. Can be mounted on either side of transceiver.

MICROPHONE 4 pin receptacle for connection of microphone.

NOTE: Wired with 13.5 Vdc for operation of touch-tone microphones, condensor microphones, etc.

OFFSET SIMP - simplex. Receives and transmits on same frequency.

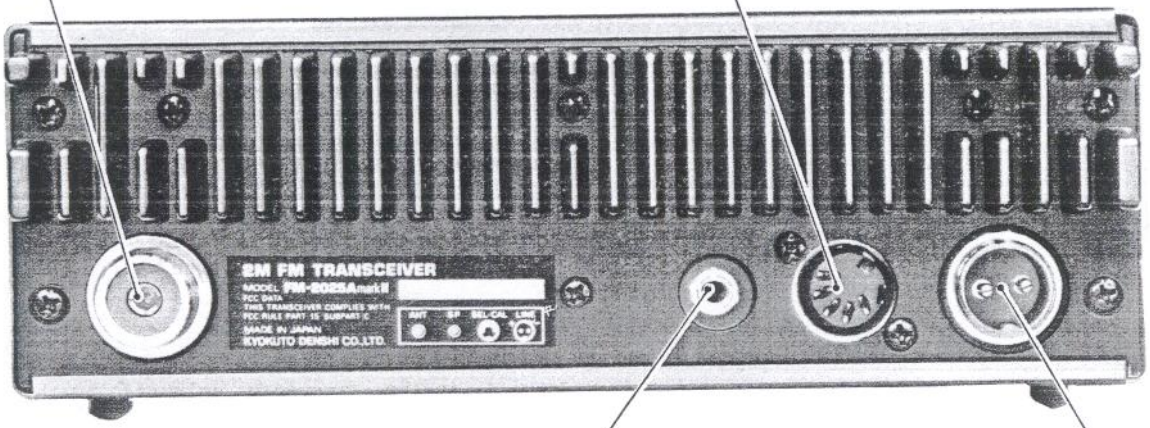
-.6 = transmit frequency 600KHz* below receive frequency.
+.6 = transmit frequency 600KHz* above receive frequency.

Can be reprogrammed for other offset by changing internal diode mattrix.

* NOTE: ACTUAL OPERATING FREQUENCIES, BOTH TRANSMIT AND RECEIVE, ARE DISPLAYED AT ALL TIMES DURING DUPLEX OPERATIONS USING EITHER THE AxB MEMORY MODE, OR THE OFFSET SWITCH.

ANTENNA CONNECTOR SO-239 type coaxial connector for antenna. Will accept both metric and inch threaded plugs.

ACCESSORY CONNECTOR Fully wired for connection of KDK SC-12A SELCAL, phone-patch and other similar accessories requiring receiver audio output, connection to internal speaker, modulation input, P/T circuits and 13.5 volts supply.



EXTERNAL SPEAKER JACK For connection of an external speaker for improved reception quality. Impedance 4 - 8 ohms.

POWER CONNECTOR For connection of DC power input. Voltage should be 13.8 volts, ±10%, with negative ground. Transceiver equipped with reverse polarity protection.

IMPORTANT: USE ONLY 7A FUSES!

3. INSTALLATION AND OPERATION

A. MOBILE INSTALLATION

A-1 Install the mounting bracket provided under the dashboard or other convenient location using the 4 x 12mm self tapping screws and plain washers packed in the microphone carton. A 3mm hole is the proper size hole for using these 4mm self tapping screws.

A-2 Mount the transceiver in the bracket using the two winged screws. Select the best angle of installation for ease of operation while driving.

A-3 Connect antenna coax to the ANT receptacle on the rear panel.

A-4 Plug in the power cable to the LINE connector, also on the rear panel. Connect the other end of the cable to vehicle power source at as low an impedance point as possible. If possible, connect directly to the battery terminals, or main fuse panel. Red lead is positive and black lead is negative.

A-5 Plug microphone connector to receptacle on front panel.

B. FIXED INSTALLATION

B-1 The transceiver is equipped with small rubber feet which lift the bottom surface off the supporting surface below so that sound can be heard from the speaker. However, for better audio quality as well as ease of operation, it is suggested that the front panel be tilted slightly upwards. An extra mobile mounting bracket may be used for this purpose and is available optionally from KDK distributors and dealors.

B-2 Connect antenna feedline to ANT receptacle on rear panel. A proper sized battery or regulated supply of 6 or more amperes is needed to operate the transceiver at HIGH power. Supply voltage should be 13.8 volts ±10%.

B-4 Plug in microphone connector to the front panel MIKE receptacle.

C. PREPARATION FOR OPERATION

Confirm that an antenna, power supply and microphone are connected as described in either paragraph A or B above. Then set controls as follows:

C-1 POWER switch (VOL knob): - ON
C-2 SCAN switch: - HOLD (Center position)
C-3 TONE switch: - OFF (Center position)
C-4 POWER switch: - LOW or HIGH
C-5 VOL knob: - Approximate center position
C-6 SQL knob: - Fully counter-clockwise
C-7 MODE switch: - A
C-8 MEMORY switch: - DIAL
C-9 SPEED button: - OFF (extended)

D. RECEIVING

D-1 During the preparation steps listed above, the meter lamp will light up, operating frequency will be displayed by the DISPLAY LED's, the RCV LED will light up and internal receiver noise will be heard from the speaker.

D-2 Rotate the DIAL and thus vary frequency. Turning it in a clockwise direction will increase frequency and rotation in the reverse direction will decrease frequency. Each click of the DIAL will shift frequency by 5KHz (12.5KHz). If DIAL is rotated continuously in a clockwise direction, eventually the maximum frequency of 148.995 MHz (148.9875MHz) will be reached beyond which point further rotation of the knob will not result in any further increase in frequency. In the reverse direction, the lowest frequency of 143.000MHz (144.000MHz) will be reached and again, further rotation of the DIAL will not result in any further decrease of frequency.

D-3 SPEED button: - In the OFF or extended position, each click of the DIAL changes frequency in steps of 5KHz (12.5KHz). Depressing the SPEED button will speed up dialling so that each click changes frequency by 100KHz (125KHz). The button is of the locking type and can be returned to it's extended position by pushing it a second time.

D-4 SQUELCH knob: - During periods when no signal is being received, internal receiver noises will be heard from the speaker which can be quite annoying. Rotate the SQL knob in a clockwise direction until these noises are no longer heard. The RCV LED will be extinguished just as the noises are completely muted. When an incoming signal is received, the RCV LED will light up, the S meter will show a deflection according to the relative strength of the signal, and audio will be heard from the speaker. Rotating the SQL knob beyond this point where the noises are just muted will result in weaker signals not breaking through the SQUELCH. The best setting of this knob is a matter of operator preference as well as the result of considering what type of signal, strong or weak, the operator is expecting.

E. MEMORY CHANNELS

E-1 Frequency WRITE-in to memory channels: - Set MEMORY switch to the DIAL position and locate frequency which is to be stored in memory channel. Next, set MODE switch to A or B as desired and MEMORY switch to whichever memory channel, 1 - 5, which is to be used. Now depress the WRITE button and the selected frequency will be stored in the memory channel. This can be confirmed by observing the display LED's which will show the frequency being written in as soon as the WRITE button is depressed.

E-2 Priority Memory Channel, A1: - Depressing the WRITE switch while MEMORY switch is in the DIAL position results in the frequency selected by the DIAL being written in to the memory channel, A1 (without switching the memory switch to position A1). This is useful for temporary storage of a frequency which will be recalled for use immediately. (Thus, it is recommended that frequencies which are to be stored and re-used for long periods of time not be stored in channel A1).

F. MEMORY SCANNING (MS)

F-1 Set MODE switch to A, MEMORY switch to MS, and adjust squelch knob so RCV LED is just extinguished. Selecting the CLOSE position of the SCAN MODE switch causes the unit to scan memory channels A1, A2, A3, A4, A5, A1, A2.....A5, A1, etc. continuously. As soon as a signal apears on a memory channel as it is being scanned, scanning will stop and remain on that channel. As soon as the signal ceases, scanning will be resumed until the next closed (busy) channel is encountered. Similar scanning of the B memory channels is possible by setting the MODE switch on B. Selection of the AxB mode will result in scanning of the A memory channels (receive) only.

F-2 Scanning in the OPEN mode is identical to the above excepting that scanning will stop at the first open or unused frequency encountered. Scanning will resume as soon as a signal is received on this frequency. This mode of scanning is useful for locating a vacant channel when operating in congested areas.

F-3 Scan Hold: - Returning the SCAN mode switch to the center or HOLD position stops the scanning and permits transmitting on the memory channel frequency located through scanning.

F-4 Scan Release: - When it is desired to resume scanning, while scanning has stopped at a CLOSEd channel, and before the signal on that channel ceases, switch the SCAN mode switch from CLOSE to OPEN and then return the switch to the CLOSE position. If, in the same manner, scanning is to be resumed when the scanning has stopped on an OPEN channel, switch the mode switch to CLOSE and then return to the OPEN position.

G. BAND SCANNING (BS)

G-1 The frequencies stored in the A5 and B5 memory channels are the lower and upper limits for band scanning, respectively. CLOSE and OPEN modes of scanning are performed in the same manner as for memory scanning described in the preceeding paragraph.

NOTE: It should be noted that scanning commences from the lower limit set up in memory A5 and proceeds upwards to the upper limit set up in memory B5. Thus scanning cannot take place if frequency stored in B5 is lower than frequency in A5. In such cases, the scanner will cause the 2nd digit of the display LED to blink slightly. This should not be mistaken for a malfunction of the transceiver.

G-2 Scan Release: - If scanner has stopped at a busy channel during closed scanning or at a vacant channel during OPEN scanning, and it is desired to resume scanning immediately, shift the main dial one click to the right (shift frequency upwards). Scanning will resume immediately.

H. TRANSMITTING

It is recommended that good operating practice of listening on a frequency to determine the frequency is clear before transmitting, be followed, in order to avoid interferring with a contact already in progress.

H-1 Selection of transmitter output power: - Set POWER switch to either HIGH (25 watts) or LOW (3 watts) as appropriate for the contact to be made.

H-2 Transmission: - Depress the Press-to-talk (P/T) switch on the microphone, hold the microphone about 5 cm away from the mouth and speak into the microphone in a normal tone of voice. Depressing the P/T switch keys the transmitter and the front panel meter will point to about 8 when transmitter output is 25 watts.

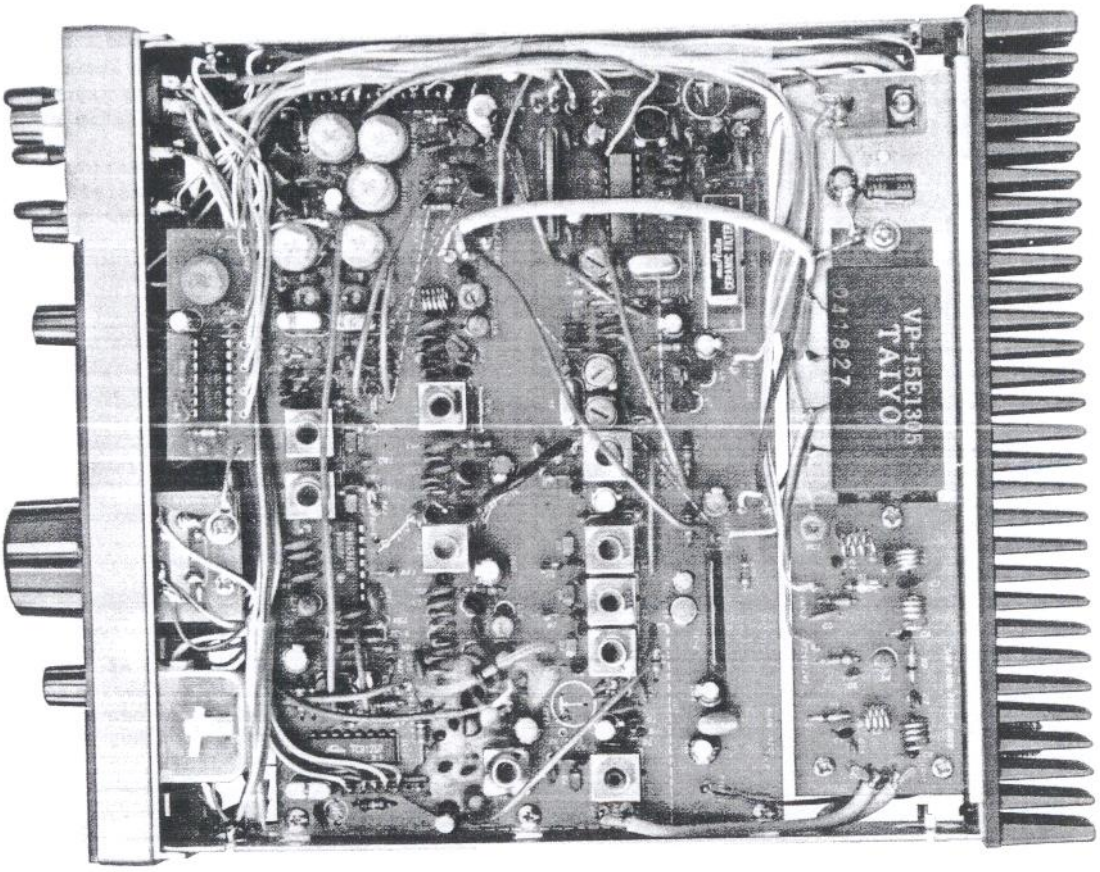
H-3 Cross Mode Operations: - Setting the MODE switch to AxB selects this mode of operation. Memory channel frequency A1 through A5 as selected by the MEMORY switch is used for receiving, and the corresponding B memory is used for transmitting. The transceiver switches frequency between the A and B memory channels automatically in accordance with the operation of the P/T switch on the microphone. The frequency in use is displayed at all times on the front panel display LED's. (For example, if memory switch is set on 1, frequency A1 is used for receiving and B1 for transmitting). This mode of operation is convenient for operating with repeators with non-standard (other than ±600KHz) offsets.

H-4 Offset switch: - When OFFSET switch is set to SIMP, the transceiver operates on the same frequency for both receiving and transmitting (excepting when operating in the AxB mode). In the + and - .6 positions, the transmitting frequency is 600KHz higher, or lower, respectively, than the receiving frequency. The front panel LED's display the frequency in use at all times.

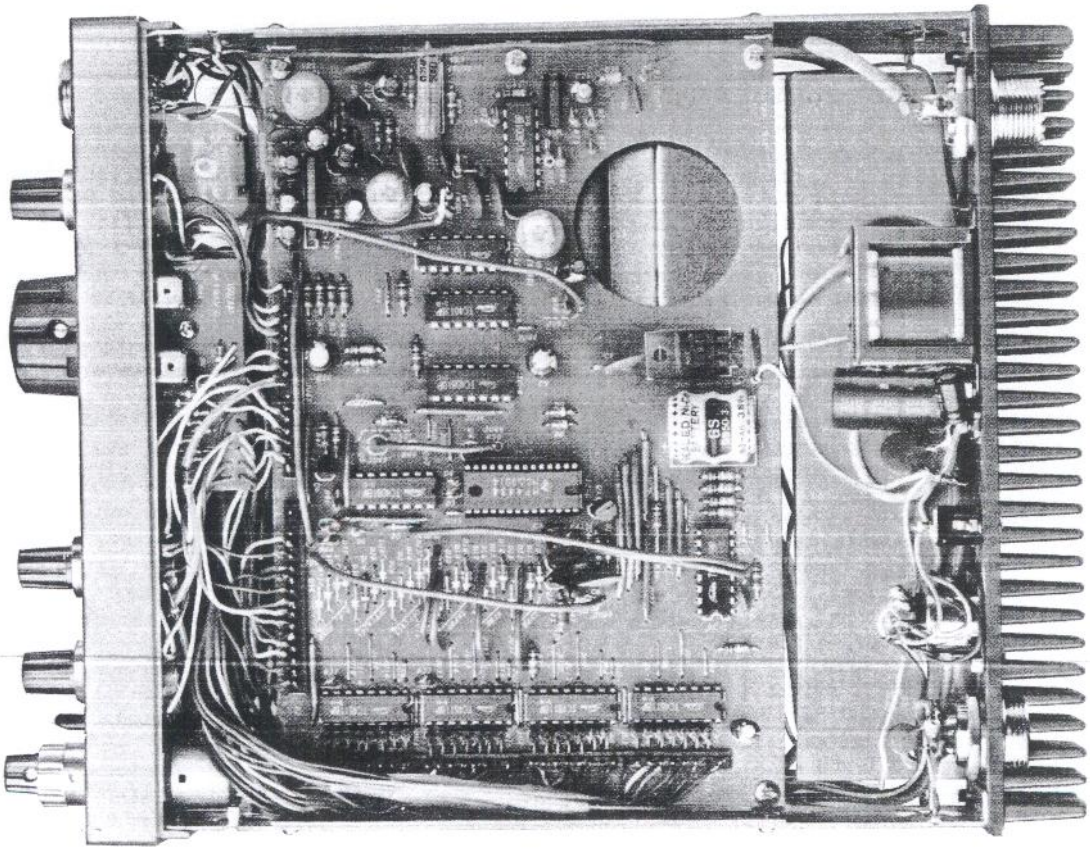
NOTE: The transmitter is interlocked so that if the + or - 600KHz offset would cause the transmitter to exceed the lower or upper transmitting limits and result in an "out-of-band" transmission, the transmitter is stopped so that such an off-band transmission cannot take place.

4. INTERNAL VIEWS

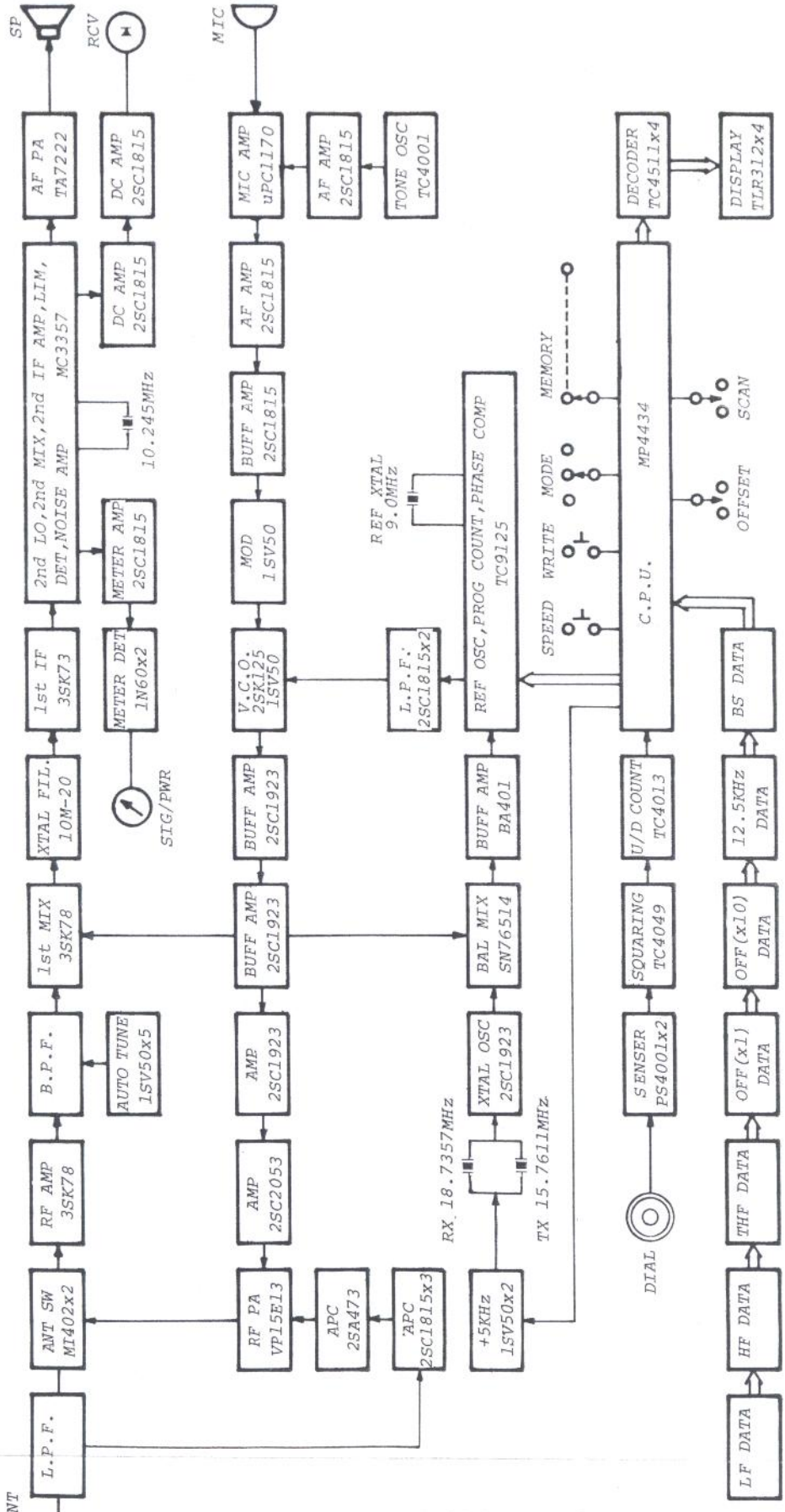
TOP VIEW



BOTTOM VIEW



5. BLOCK DIAGRAM



6. CIRCUIT DESCRIPTION

A. RECEIVER

A-1 RF Amplifier: - The signal input from the SO-239 connector, J5, passes through L6 and L5 of the low pass filter unit and is then connected to the MAIN UNIT PCB RX input terminals P4 and P5 (ANT). The signal then passes through the auto-tuned circuit L1, D2 and is amplified by the MOS-FET, Q1. It is then applied to the three stage peak tuned circuits of L2 - L4 and D3 - D5. These are electronically tuned in order to keep sensitivity constant over the wide spread of frequencies covered as well as attenuating out-of-band signals. The signal is then applied to Q2, a MOS-FET used as the first mixer.

A-2 First Mixer: - The mixer injection signal of 133MHz from the PLL is passed through an electronic tuned circuit, L5 and D6 which serves to keep the injection signal constant at optimum level. This signal is then injected to gate 2 of Q2 where it is mixed with the signal applied to gate 1. Mixing of the signals result in a converted signal at the 1st IF frequency of 10.7MHz which appears at the drain of Q2.

A-3 1st IF Amplifier: - The converted 10.7MHz signal is applied to the monolithic crystal filter with a ±10KHz/3dB characteristic which in conjunction with tuned circuits XF, L6 and L7 further attenuates out-of-band signals. The signal is then amplified by MOS-FET Q3 and is applied to the following stages, IC-1. D7 and D8 in the output coil, L8, prevent the application of over voltage signals to the succeeding stages and is a limitor which prevents distortion due to the application of over voltage signals to the succeeding stages.

A-4 2nd Mixer through Detector Circuitry: - IC-1 is a multi-purpose one chip IC which contains the 2nd local oscillator, the 2nd mixer circuitry, the 2nd IF amplifier, the limitor, the quadrature detector, noise amplifier and the muting circuit and permits the reduction in the number of discrete components thereby greatly enhancing the reliability of the transceiver. IC-6 contains all of the external CR components needed for IC-1 and again further reduces the number of components.

The signal inputs from pin 16 of IC-1 and is mixed internally with the 2nd local oscillator output which is controlled by crystal, X1, connected between pins 1 and 2 of the IC. The converted 455KHz signal appears at pin 3 from where it is passed through the ceramic filter, CF, with a ±8KHz/6dB bandwidth. The signal is then applied to pin 5 and is internally amplified and limited. The limited signal is outputed from pins 7 and 8 and is detected by the internal quadrature detector in conjunction with the quadrature coil, L11. The detected audio output signal appears at pin 9.

A-5 Audio Amplifier: - The audio output from pin 9 is applied to pin 7 of IC-6 and passes through the internal de-emphasis circuit. It's output appears at pin 8 and is connected to pin 4 of IC-2 after passing through the front panel volume control, VR. This amplified output is connected to the internal speaker. IC-2 is a high output, low distortion audio IC which includes protective circuitry against the application of over-voltages as well as shorted outputs. It also includes an audio muting circuit. The muting signal from IC-1 is applied to pin 3 of this IC which is the muting terminal.

A-6 Squelch circuit: - The demodulated signal appearing at pin 9 of IC-1 is applied to pin 7 of IC-6, the CR module. It passes through the low pass circuit in IC-6 and is then applied to the AF mute circuitry. Its level is controlled by the front panel squelch control, which is connected between pins 1 and 4 of IC-6.

A-7 S-Meter circuit: - The S-meter signal is taken from the output side of the ceramic filter, CF, and is amplified by transistor, Q5. It is rectified in a voltage doubling circuit D12 and D13 and is then applied to the meter to indicate the relative strength of the incoming signal. The meter is set at the factory to five a full scale deflection with about a +20dBm signal. Larger signals are clipped by saturating the amplifier.

A-8 RCV LED circuit: - The muting signal from pin 13 of IC-1 is passed through the DC amplifier, Q7 and Q6, and drives the RCV LED. The LED lights up when an incoming signal is received, providing a "frequency busy" indication. This serves to alert the operator to an incoming signal even when the volume control is turned completely off as well as when the unit is being used in conjunction with a KDK SEL-CALL unit.

A-9 RF ATT circuit: - The RF ATT circuit reduces the gain of the RF amplifier, Q1, by changing the voltage applied to gate 2 of the MOS-FET. The amount of gain reduction is set to about 15dB by the internal variable resistor, VR1. This feature is useful when encountering severe adjacent channel interference as well as when plotting antenna beam patterns.

B. TRANSMITTER

B-1 Microphone Amplifier: - The audio signal from the microphone is applied to terminals P9 and P10 of the CONTROL UNIT and after being adjusted for level by VR1 is applied to pin 1 of IC-12, a microphone amplifier IC with internal ALC (automatic level control). IC-12 consists of an amplifier, detector amplifier circuit, level shifting circuit, detector and ALC. Pin 3 is the output terminal. The output is amplified by Q8, impedance matched by Q7, and then applied to the modulator varicap in the VCO circuit after first being set in level by control VR2.

B-2 Transmitter Amplifier stages: - The output from the VCO at L17 of the MAIN UNIT is connected through C63 to Q11 and Q12 where it is amplified to about 500mW. This amplified output appears at pins P17 and P18. The output is connected to the power module, IC-1 located on the rear chasis where it is amplified to about 25 watts. This power output is applied to the low pass filter unit. Transistor Q1, connected to the power circuit of the module is for setting transmitter HIGH and LOW power, (3 watts, 25 watts). It is also the APC transistor for blocking transmitter output during PLL unlock conditions.

B-3 Low Pass Filter and Antenna Switching unit: - The output from the power module is impedance matched by trimmer VC1 and is then passed through a three stage low pass filter consisting of L1 - L3 and C2 - C4 for sufficient reduction of spurs. The output then passes through switching diode, D2, and is connected to the antenna receptacle through one more stage of low pass filtering, made up of L6 and C8. 12 volts is applied to terminal P2 during transmitting and thus current flows through D2, L5 and D3, causing D2 to conduct and pass the transmitter output to the antenna connector. Any signal leaking through L5 to D3 is grounded, as D3 is also conducting and thus the signal cannot feed through C10 to the receiver. When the P/T voltage (12V) is removed from P2, the incoming signal from the antenna connector passes through 10 and is applied to the receiver.

C. PLL (PHASE LOCKED LOOP)

C-1 VCO circuit: - The VCO circuit is composed of Q8, L12, C48, VC1 and D15. The dc voltage from the phase comparator is applied to the varicap diode, D15, to control oscillating frequency and lock in to the phase lock loop. During reception, a voltage is applied to D14 through Q15, shorting out C48 and thus lowering the

basic oscillating frequency of the VCO. Thus the VCO's output becomes the receiver 1st local oscillator injection signal. During transmitting, the control voltage is removed from D14, eliminating the short across C48, thus raising the VCO's frequency to the transmitting frequency. The modulation signal is applied to varicap D16 in the VCO circuit making up a direct frequency modulation circuit. The output of the VCO is bufferred by transistors, Q9 and Q10, and appears at the output of L17, from where it is connected to the receiver's first mixer, the transmitter straight amplifier stages as well as the PLL mixer.

C-2 PLL Local Oscillator: - The local oscillator consists of the receiver circuit, X2, D22, and the transmitter circuit, X3, D23, and transistor, Q20. During reception, a control voltage is fed to D24 through resistors R72 and 73 causing D24 to conduct and thus X2 to oscillate. During transmission, Q14 and Q19 conducts, thus causing D25 to conduct and X3 to oscillate. The voltage on D24 is grounded by Q19, causing X2 to cease oscillating. The oscillator output passes through D21, L22, D26 and D27 so that the 7th harmonic is extracted for reception and the 9th harmonic for transmission. These signals are fed to the mixer. D22 and D23 are for varying the frequency by 5KHz and these varicaps are fed an appropriate control voltage to vary the oscillator frequency by 5KHz.

C-3 Mixer and Buffer stage: - The mixer uses a double balanced mixer, IC-3. The local oscillator signal is applied to pin 11, the VCO output to pin 5 and the converted signal of 1.15 - 7.14MHz (2.15 - 7.137MHz) is outputed from pin 13. This output is passed through the low pass filter, L23, C88 and C89 in order to remove undesirable harmonics. This filtered output is applied to pin 1 of IC-4, the buffer amplifier. Output from the buffer appears at pin 4 of IC-4 which is then applied to the PLL IC.

C-4 PLL IC circuit: - IC-5 contains the frequency standard oscillator, dividers, phase comparator, programmable divider and latch circuits. The frequency standard is controlled by the crystal, X4, connected to pins 2 and 3 and oscillates at 9MHz. Control data connected to pins 4 - 8 establishes its dividing ratio resulting in an accurate frequency standard output of 10KHz (12.5KHz). The signal from the buffer stage, IC-4 is applied to pin 9. The divide ratio is established by control data applied to pins 4 through 8. The divided signal is compared in the phase comparator with the 10KHz standard. The phase comparator outputs a pulse from pin 15 which relates to the phase difference between the 10KHz standard and the PLL signal. This pulse output is converted to dc by the active dc low pass filter consisting of Q21 and Q22. This dc output is used to lock the VCO as well as provide the dc tuning voltage, (TV) for electronic auto-tuning circuits in the receiver.

Pin 13 is the unlock detection output and is raised to H level whenever the PLL is out of lock. Pin 13 is connected to Q18, Q17 and Q16 of the APC circuit and stops the transmitter during PLL unlock conditions.

D. DISCRIMINATOR ZERO DETECTOR

Use of only the RCV LED signal for stopping the scanner can and will cause the scanner to stop before reaching the true center frequency of the signal, particularly when scanning in 5KHz steps. Therefore, a discriminator center detection circuit has been added and its output is fed to an AND circuit together with the RCV LED signal in order to stop the scanner only at the center of the channel. The center signal of approximately 2 volts from the DISC terminals is fed to IC1-1 and IC1-2 to detect the center. (2V $\pm$1V), and outputs a signal from IC1-2. This output is inverted in IC1-3 and is applied to AND circuit, IC1-4 together with the RCV LED signal from the receiver, causing the scanning to stop only when signals appear from both the RCV circuit and the zero detector. This control signal is outputed from IC1-4. During scanning in the OPEN mode, this center detection circuit would result in the scanner stopping whenever it sensed an off-center situation with a signal being received.

As this is not desirable, the center detector is disabled by changing pin 12 to an L level during open mode scanning. Thus for OPEN mode scanning, the scanner is controlled only by the RCV LED signal from the receiver.

E. CONTROL UNIT

All control functions of this transceiver are obtained dynamically by utilizing the micro-processor chip, MP-4434 which contains programming developed by KDK. The MP-4434 is equipped with the 4 bit input terminals, K1 - K8, the time division signal output terminals, R0 - R9 and decode outputs O0 - O7. The MP-4434 thus controls all the functions such as dialing, memory, PLL data, display data, etc.

E-1 INITIALIZING OF PROGRAM

Initializing instructions are issued to the CPU by applying outputs O0 - O6 of IC-6 through BCD coded diode matrixes to the K1 through K8 input terminals. These are as tabled below.

ITEM		SPECIFICATION	SET EX-FACTORY		REMARKS
a: LF	(Min. Freq.)	O0 to K1 - K8	3	143MHz	3 - 9 (143 - 149MHz)
b: HF	(Max. Freq.)	O1 to "	9	149MHz	4 - 10 (144 - 150MHz)
c: THF	(TX Max. F.)	O2 to "	9 (6)	149MHz (146MHz)	3 - 10 (143 - 150MHz)
d: STEP	(Dial Step)	O3 to K1	0 (1)	5KHz (12.5)	1:12.5KHz
e: OFF (x1) OFF (x10)	(Offset)	O4 to K1 - K8	600KHz		10KHz x n(60) = 600KHz n = 00 - A0
f: BX	(B Scn Step)	O6 to "	1	5KHz (12.5)	5KHz x n (3) = 15KHz n = 0 - 15

a) LFBE (Low frequency band edge): - Output from O0 is applied to K input terminals through BCD coded diode mattrix D10 - D13. NOTE: A change of crystal is required if it is desired to set this limit at frequencies other than 143.000 or 144.000MHz.

b) HFBE (High frequency band edge): - Output from O1 is applied to K input terminals through BCD coded diode mattrix D14 - D17. For example, if the limit is to be set at 10 (150MHz) the maximum upper frequency becomes 149.995MHz.

c) THFBE (Transmit high frequency band edge): - Output O2 is applied to K terminals through BCD coded mattrix D18 - D21. If control data exceeds this maximum, the R9:TSTOP signal is outputed and operates the APC circuit to stop the transmitter.

d) STEP: - Output O3 is applied to input K1 through D22. The existance or lack of this diode establishes the frequency shift for each click of the dial. (0=5KHz, 1= 12.5KHz)

e) OFFSET: - Output O4 is applied to K inputs through BCD coded mattrix D23 - D26 (x1). Also, output O5 is applied to mattrix D27 - D30 (x10). The combination of these two systems establishes the OFFSET frequency.

PLL basic step (10 or 12.5KHz) x established data (x10) (x1) = OFFSET frequency.

Example 1: 10KHz x 60 = 600KHz
Example 2: 10KHz x A0 = 1MHz
Example 3: 12.5KHz x 48 = 600KHz
Example 4: 12.5KHz x 80 = 1MHz

f) BAND SCAN STEP (BS): - Output O6 is passed through IC7-4 and connected to K inputs in conjunction with diode mattrix D31 - D34 in BCD coding and establishes the stepping rate for scanning.

Dial step x programming data = BS step. (5 or 12.5KHz x 0 - 15 = 5 - 80KHz or 12.5 - 200KHz.)

Example 1: 5KHz x 3 = 15KHz
Example 2: 12.5 x 2 = 25KHz

F. DIALLING SYSTEM

The slots in the dial disc mounted directly on the dial shaft passes between the photo-interruptors (D1, D2) of the dialling mechanism and generates 2 signals (CK, U/D) between which there is a 90 degree phase difference. These two signals are shaped by passing through IC10/1-2 (CK), IC10/3-4 (U/D), then, if dialling UP, the IC-9 FF latches the U/D signal by the CK signal. Next, the time division signal R7 opens the AND-gate of IC8/1-2 and the CK signal is passed to K1 and the latch signal is passed to K4 thus instructing the CPU to dial UP or DOWN.

G. OPERATING FUNCTIONS

G-1 Memory switch functions: - Time division signal, R0 is passed through the memory switch (SW5) and the diode mattrix (SW UNIT) and is applied in BCD coding to K terminals 1, 2, 4 & 8. The memory switch selects the DIAL, memory channel read and write, memory scan and band scanning functions in this manner.

a) DIAL = R0 to K8 (Code 8)
b) MEMORY = (1 - 5) = R0 to K1, 2 & 4 (Coded 1 - 5)
c) MEMORY SCAN = R0 to K2 and K4 (Coded 6)
d) BAND SCAN = R0 to K1, 2 and 4 (Coded 7)

G-2 Dialing SPEED up switch: - Output from R1 from the CPU is applied to input K2 through the SPEED switch. The CPU then issues the instructions to speed up dialing steps by a multiplying factor of 10 against the basic PLL standard frequency of 10 (12.5)KHz.

G-3 OFFSET function: - Output from R1 in conjunction with the TX 8 volt supply is applied to AND gate IC7-1. The output from the gate is passed through the OFFSET switch (SW6) so that:
a) SIMPlex to 0,
b) DOWN to K4, and
c) UP to K8.

G-4 Memory Write function: - Output from R2 is passed through the WRITE switch (SW1) and applied to K4. This instructs the writing in of the selected frequency to the selected memory channel.

G-5 SCAN function: - R2 is passed through the SCAN switch (SW3) and applied to K2 to signal the start of scanning.

G-6 MODE switch functions: - R2 is passed through the mode switch (SW4) and applied to K1. Application of the R2 signal signifies memory channels A and the lack of this signal signifies channels B. In MODE switch position AxB, the AND circuit of IC8-4 is used so that A channel is specified for receive and B channel for transmit.

H. PLL OUTPUT

IC-6 (Oo - O3) supplies BCD coded PLL data and IC-6 (R8) supplies the latching pulse for the previous data and thus specifies the dividing ratio for the PLL programmable counter.

I. DISPLAY OUTPUT

IC-6 (Oo - O3) supplies the BCD coded display data, and IC-6 (R1 - R4) supplies the digit switching signals dynamically. This dynamic data is fed to IC-1 (x1KHz) so that the drivers supply static signals to the 7 segment display LEDs, D1 - D4.

J. CPU HALT DETECTION

a) During transmission: - In order to prevent the time division signals of the CPU from feeding into the transmitter carrier, the system has been designed to stop the operation of the CPU during transmission. The transmit signal in the form of the TX 8 volts is applied to AND gate IC7/2 together with output O7. Output from the gate is applied to K8 causing the CPU to HOLD and stop the generation of the time division signals (O7 = H level).

b) When main POWER switch is turned off: - When the power switch is turned off, the 5 volt supply voltage starts to fall. This turns transistor Q6 off, thus the collector of Q6 attains an H level which is used as the Power Off signal. This signal is applied to AND gate IC7/3 together with signal R7 and the gate output is applied to K8. This immediately causes the entire CPU to turn all outputs off and to halt its operations. At this time the CPU is backed up by the internal battery, also, the CPU switches itself to the reduced current drain mode.

K. POWER SUPPLY

a) An 8 volt supply is generated by a voltage regulator IC-2, mounted on the rear panel of the chassis.

b) A regulated 5 volt supply is utilized for the control circuitry and is supplied by IC-11 mounted on the control PCB.

c) The internal battery is charged while power is turned on through resistor, R39. When the main power switch is turned off, the 3.6 volts from the battery is fed back to the CPU through resistor R39 in order to hold the contents of the CPU memories.

7. ADJUSTMENTS

A. RECEIVER

A-1 Alignment of RF tuned circuits: - Apply a 146MHz signal modulated by a 1KHz signal with ±3KHz deviation to the ANT terminal. Adjust coils, L1 - L5 and L6 - L8 so that the front panel S meter gives maximum deflection. Peak coil L11 in order to obtain maximum audio output from the detector.

CATUION: - Do not attempt to adjust any other coils as such adjustment may affect SINAD sensitivity, as best sensitivity does not necessarily coincide with peaking of the front panel meter reading.

A-2 Calibration of 1st Local Oscillator frequency (VCO): - Connect a frequency counter to test point, TP-1. Set front panel controls for an operating frequency of 144MHz. Vary VC-3 so that the counter reads exactly (f-10.7MHz) = 133.7MHz. Now change operating frequency to 144.005MHz. Adjust resistor VR7 so that the counter reads exactly (f-10.7) = 133.705MHz.

A-3 Adjustment of zero detector: - Apply a signal of correct frequency to the ANT input. Connect a VTVM to pin 13 of IC-1 of the detector unit. Slowly rotate resistor VR1 in a clockwise direction until the VTVM reading switches from 4 to 0 volt. Leave VR-1 set at this point. Now rock the DIAL ±5KHz and confirm that VTVM reading rises to +4 volts with a change of 5KHz in either direction.

B. TRANSMITTER

B-1 Calibration of Transmitter frequency: - (MAIN UNIT). Connect a dummy load to the ANT receptacle and a frequency counter to test point, TP-1.

a) Set transceiver to a frequency of 144.000MHz, key transmitter and adjust VC-4 so counter reads 144.000MHz.

b) Set transceiver to a frequency of 144.005MHz, key transmitter and adjust VR8 so counter reads 144.005MHz.

B-2 Transmitter Tuning: - (MAIN UNIT). Connect a dummy load and power meter to ANT receptacle. Set transceiver to 146.000MHz (145.000MHz). Turn resistor VR6 (H) to extreme clockwise position thus disabling APC. Select HIGH output power, key transmitter and adjust L18, VC2 and VC1 of the LOW PASS unit for maximum output.

After tuning is completed, return VR6 (H) to approximate original position where output reads 25 watts.

B-3 Adjustment of modulation (DEVIATION): - CONTROL UNIT:

a) Deviation may be increased by rotating resistor VR2 in a clockwise direction. The unit has been set for ±5KHz deviation at the factory. Maximum deviation attainable is approximately ±10KHz.

b) VR1 is for varying microphone amplifier gain. Rotating this control in a clockwise direction increases gain, and in the reverse direction reduces gain. An excessive increase in mike amplifier gain will not result in increased deviation unless the deviation control is advanced simultaneously. Such excessive gain will only result in distortion of the modulation as well as increasing pickup of background noises. Thus it is recommended that this control not be touched unless a microphone with a considerable difference in output from the standard KDK microphone supplied with the transceiver is to be used.

c) The unit has been set at the factory by applying a 1KHz/25mV signal to the microphone input terminal with resistor VR1 turned fully clockwise. VR2 is then adjusted for a deviation of ±5KHz. The input is then reduced to 2.5mV and VR1 is set for a deviation of ±3KHz.

B-4 Calibration of Multi-Purpose Tone Oscillator: - CONTROL UNIT.

a) Calibration of frequency: - Set TONE MODE switch, SW1 in the CONT (continuous) position and adjust frequency by varying VR3. Turning the control to the right increases frequency, and in the reverse direction the frequency is reduced.

b) Adjustment of Modulation Deviation: - Leave TONE MODE switch set at CONT and adjust resistor VR4. Turning the control to the right increases deviation, and in the reverse direction deviation is reduced.

c) Setting of TONE MODE switch: - Setting the internal TONE MODE switch (SW1) in the CONT (continuous) position results in a tone modulated signal being transmitted whenever the front panel TONE switch is set in the TONE position. In the BUR (burst) position, the transmitter will emit a tone modulated signal of approximately .5 second duration as soon as the transmitter is keyed, provided that the front panel TONE switch is left in the TONE position.

B-5 Adjustment of Transmitter Output: - (MAIN UNIT)

a) Adjust resistor VR6 (H) to set transmitter output at 25 watts.

b) Adjust resistor VR5 (L) to set transmitter output at 3 watts.

NOTE: Both VR6 and VR5 may be set for output of any amount between the limits of 25 and 3 watts. This is convenient for setting output to match input requirements of linear amplifiers and transverters.

B-6 Adjustment of Transmitter Meter Reading: - (MAIN UNIT).

Connect a 50 ohm dummy antenna to the ANT connector. Key the transmitter and adjust resistor VR4 (TM) so that the front panel meter reads 8 with a transmitter output of 25 watts.

8. SPECIFICATIONS: FM-2025A/E mark II *

1. GENERAL

Semi-conductors:	FET x 4, TR x 25, IC x 20, Diodes x 67
Frequency Range:	143.000 - 148.995MHz (144.000 - 148.9875MHz)
Dialing Steps:	30 clicks per rev., 1 click = 5KHz (12.5KHz)
Memory Capacity:	A1 - A5, B1 - B5 for total of 10 memory channels
Memory Scanning:	Scanning of A1 - A5, or B1 - B5 with zero center sensing circuit. OPEN & CLOSE modes, with HOLD
Band Scanning:**	Cont. between any two freq. within frequency range covered. Lower and upper limits operator programmed in memory channels A5 and B5. With zero center sensing circuit. OPEN & CLOSE modes, with HOLD.
Band Scanning Steps:	5KHz (12.5KHz). Can be reprogrammed by changing internal diode mattrix in any multiple of 5KHz from 5 - 40KHz. (12.5 - 200KHz)
Type of Emission:	F3
Antenna Impedance:	50 ohms, nominal. Unbalanced feed.
Supply Voltage:	13.8v, ±10%, negative ground.
Current Consumption:	Receive -- standby, 0.3A, volume max., 0.6A Transmit -- 25 watts - 6.5A, 3 watts - 2.5A.
Dimensions:	60h x 180w x 195d -- body only. (mm) 65h x 235w x 242d -- incl. protruding items.
Shipping Dimensions:	100h x 235w x 365d -- (mm)
Weight:	2.25KGs (Body only), 3.2Kgs GWT in shipping carton.

2. TRANSMITTER

Frequency coverage:	143.000 - 148.995MHz/5KHz steps (144.000 - 145.9875MHz/12.5KHz steps)
Output:	25 watts (High), 3 watts (Low).
Modulation:	Variable reactance frequency modulation (Direct VCO mod.)
Maximum Deviation:	±5KHz
Spurious Emissions:	Better than -60dB to carrier.
Repeator tone:	100Hz (1750Hz) adjustable.
Repeator Offset:	±600KHz (User programmable with diode mattrix)
Microphone:	600 ohms dynamic type with P/T switch.

3. RECEIVER

Frequency coverage:	143.000 - 148.995MHz/5KHz steps (144.000 - 148.995MHz/12.5KHz steps)
Receiver type:	Double Superheterodyne
Intermediate Freqs:	1st - 10.7MHz, 2nd - 455KHz.
Sensitivity:	S/N better than 35dB - 1uV, better than 0.35uV for 20dB noise quieting. SINAD less than 10% dist, .5uV.
Squelch Sensitivity:	Better than 0.15uV.
Bandwidth:	±6KHz, -6dB
Selectivity:	±16KHz, -60dB
Image Ratio:	Better than 70dB
Output:	More than 1.5 watts, THD 10%/8 ohms

4. ACCESSORIES INCLUDED

Microphone:	Hand held, dynamic, 600 ohms with P/T switch.
Power Cable:	With fuse holder, 7A fuse and 2 prong metal connector.
Spare Fuse:	7A, one piece.
External speaker plug:	Miniature phone plug type.
Mounting Bracket:	Steel, uni-chrome plated.
Microphone Hangar:	1 piece.
Instruction Manual:	Including circuit diagram (fold-in)
Misc. Hardware:	4 x 10mm self tapping screws, 4 pieces. 5mm washers, 4 pieces Transceiver mounting screws (wing), 2 pieces.

* Figures in ( ) for FM-2025E mark II

** 144.00 ±5KHz cannot be used for band scanning due strong receiver spur at 144.00MHz. (16th harmonic of 9MHz frequency standard oscillator)

KDK