7. THEORY OF OPERATIONS

Circuit Composition and Operation Theory

The basic explanation for the circuit composition the one board controlling the analog circuit parts and the digital circuit parts for the other control.

Receiver

Receive parts is composed in the double conversion system, which has the 1st IF Frequency of 21.7 MHz And 2nd Frequency of 450 KHz The 2 pole MCF used in the 1st IF, and the sensitivity repression are reduced for the more stable reception.

RF Front end

The signal received by the antenna will be transmitted to the band pass filter through the antenna switching circuit consisted of C44, L7 The front RF amplifier transistor Q1 consists of the L301, C302 input band pass filter and L305, L307, C314, saw filter output band pass filter primarily diminishes the other signal rather then the 1st IF image and other signal within the reception band amplifier only the necessary signal within the RF

1st Mixer

The receiver that has been amplifier in the RF front end is provided to the base of the 1st mixer Q2. The 1st L/O signal provide from the VCO is supplied to the emitter of Q2 and Converted to the 1st IF 21.7 MHz

1st IF Filter and 1st IF Amplifier

The signal converted by Q2 to 21.7 MHz, the 1st frequency, change its impedance through C61,
L14 and then is infused to the fundamental MCF which has the center frequency of 21.7 MHz and the width of +/- 3.75 KHz. Here, the signal reduces the image and other unwanted signal for the 2nd IF , and changes its Impedance again through the R9 and C5. Then the signal is infused to the Q3, the 1st IF amplifier. The signal infused to the Q3 is amplifier approximately by 20 dB in

other to acquire the required reception sensitivity, and infused to the IC1 which functions as the 2nd mixer, the 2nd IF amplifier, and the FM detector.

2nd Mixer, and IF, FM Detector (IC1)

The receiver IF signal of 21.7 MHz, which has been infuse to IC1 is mixed with the 2nd L/O signal of 21.25 MHz, and converted to 450 KHz, the 2nd IF frequency. The receiver signal converted to the 2nd IF signal frequency passed through the CF1, the ceramic filter of 450 MHz again. After the limiting inside the IC1 and the FM demodulating by the quadrature detector inside the IC1, the signal offers the output through the 9th pin of IC1.The 2nd L/O signal of 21.25 MHz which infused to the IC1 filter and uses directly the crystal of 21.25 MHz. The squelch circuit is composed to detect the noised from the received signal demodulate in the 9th pin of the IC1. For this purpose, the noise filter is using the amplifier inside the IC1.

De-Emphasis and 300 Hz (IC103)

The audio signal which has been FM demodulate in the IC1 is supplies to the IC103 which function as the De-emphasis and 300 Hz HPF. Since the IC103 has the 300 Hz HPF with the 1st characteristics and the De-emphasis characteristics with the center frequency of approximately 200 Hz,the IC103A has the De-Emphasis characteristics, the IC103B, and the IC103C has the 300 Hz HPF with the 6th characteristics, they function as a normal De-emphasis and also reduce the signal such as CTCSS to unwanted noised from the speaker. Audio Power Amplifier (IC101) The receiver audio signal which has been automatic adjusted to the appropriate volume in by VR1 are supplied to the 2nd pin of the IC101 amplifier approximately by 20 dB. Then, it turns up the speaker with the maximum output of 0.3 watts. The 7th pin of the IC101 is the audio mute terminal.

Transmitter

The transmitter parts of the M-222P is designed to amplify the RF signal oscillated and modulated by the synthesizer to approximately 500/2000 mW by the power transistor of Q200.

Pre-emphasis and 300 Hz HPF, Limiter (IC104A, 104B)

The voice signal input from the microphone is pre-emphasized at the same time, the components below 300 Hz are reduce to minimize the interference to the CTCSS tone.

The signal which comes out of the IC104B is limited to a certain amplitude at the IC104B for the voice signal not to exceed the allowable band width assigned for transmission.

3 KHz LPF (IC104C, IC104D)

After passing the IC104B limiter, the signal is combined with the CTCSS tone, passes the RV4, and is supplied to the 6 KHz LPF has the 4^{th} characteristics and adjust the assigned frequency band width not to exceed the allowable rang.

Tx Power (Q200)

The transmitted signal of approximately 7/15 mW, combined at the driver TR is supplied to the base of the Q200 amplifier. The transmitted signal amplifier to 500/2000 mW here passes the TX LPF of the 2^{nd} characteristics of the L10 and the L9, and RX/TX switching takes place by the D6. After this, The signal is provided to the antenna the TX LPF of the 1^{st} characteristics, consisted of the L8.

"FRS" Frequency Synthesizer

Voltage Control Oscillator (VCO)

The VCO of oscillates 462.5500 MHz to 467.7125 MHz under the transmission condition and 440.8500 MHz to 446.0125 MHz under the reception condition. The VCO consist of the clip

Oscillator of the Q4, and contains the oscillator frequency of approximately 21.7 MHz during the transmission/reception

conversion. That is since the VCO should oscillate relatively low frequency during reception compared to transmission, the D3 is biased by the Q11.
Therefore as a result, the C19 is added in parallel to the resonance circuit of the VCO to oscillate a low frequency. During transmission, a relatively high frequency should be oscillated compared to reception. Therefore, the D3 is adversely biased by the Q11, and as a result, The C19 that is added unparallel to the circuit of the VCO is removed to oscillate the desired transmission frequency. The VCO is controlled by the IC3 PLL IC in order to oscillate accurate frequency. The output frequency of the VCO is supplied to the IC3 PLL IC immediately. At the IC3, TCXO (21.25 MHz) by the TCXO is compared to the output frequency of the VCO.
The VCO is controlled the loop filter consisted of the R28, R29 and the C33, C41, C68 in order to oscillate the stable frequency wanted for the radio. The VCO controlled voltage which as passed the loop filter is supplies to the D4 varactor diode, and the VCO an oscillate the PLL programmed frequency by the capacity variance in the D4. In addition, the L4 on the VCO circuit function as frequency for the VCO to be properly controlled by the IC3 PLL IC.

RX/TX Buffer Amplifier (Q7)

The RF signal oscillate at the VCO is provide to the Q2 RX 1st mixer through the Q7 during the reception, and is provide to the Q9 power driver amplifier through the Q7 during the transmission.

PLL Frequency Synthesizer (IC3)

The PLL synthesizer of the signal loop PLL circuit with the reference of 6.25 KHz. The IC3 PLL IC includes all the function such æs the reference oscillator, the driver, the phase detector, the lock detector, and the programmable divider. At the reference oscillator, the 21.25 MHz TCXO of the TCXO is connected to the pin 11 of the IC2 to oscillate the frequency of 21.25 MHz. The TCXO (21.25 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error rang even under a low temperature of -

30° C. The phase detector send out the output power to the loop filter through 3rd pin of the IC3. If the oscillation frequency of the VCO is low compared to the reference frequency, the phase detector sends out output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send put can maintain the frequency set. The programmable divider maintain the desired frequency with control from the CPU. The dividing ratio, "N" to oscillate the desired frequency is as below :

N = VCO oscillation frequency / reference frequency

If the desired frequency is 462.5625 MHz

a) TX

N = 462.5625 MHz / 0.00625 MHz = 74010

b) RX

N = [462.5625 MHz – 21.7 MHz] / 0.00625 MHz = 70538

CTCSS Processing

RX CTCSS Tone Processing

The received CTCSS tone is sent out through 9th pin of the IC1, and supplies to the IC107. The voice signal which can effected the reception of the CTCSS tone is decreased enough at the IC107. The cut off frequency at the IC107 is adjusted by the IC2 CPU to suit the characteristic of the CTCSS tone.

The CTCSS tone received at the IC107 is supplies to the 10th pin of the IC2 CPU, and receives the desired CTCSS tone.

TX CTCSS Tone Processing

The TX CTCSS tone composed at the IC2 is properly reduce at the R63 and supplies to the IC107 switched capacitor filter reduce enough the components in the high frequency which can effect the voice communication. And then, the TX CTCSS tone is combined with the TX voice signal through the RV4 TX deviation control volume.