7. THEORY OF OPERATION

Circuit Composition And Operation Theory

The basic explanation for the circuit composition

the two board controlling the analog circuit parts and the digital circuit parts for the other control.

Receiver

transmission parts is composed in the double conversion system, which has the 1st IF Frequency of 21.7MHz and the 2nd IF frequency of 450KHz. With the sawfilter which has an excellent band characteristice and skite characteristice, the 2 pole MCF used in the 1st IF, and the 4 pole ceramic filter in the 2nd IF, the reception interrupting factors such as the image and the sensitivity repression are reduced for the more stable reception.

RF Frontend

The signal received by the antenna will be transmitted to the band pass filter through the antenna switching circuit consisted of L38, L39, C319, C321 and C322. The front RF amplifier transistor Q101 consists of the sawfilter and input/output band pass filter. Sawfilter has the bandwidth of approximately 4MHz, primarily diminishes the other signal rather then the 1st IF image and other signal within the reception band and amplifies only the necessary signal within the RF.

1st Mixer

The receiver signal which has been amplified in the RF fronted is provided to the base of the 1st mixer Q102. The 1st L/O signal provide from the VCO is supplied to the emitter of Q102 and converted to the 1st IF 21.7MHz.

1st IF Filter and 1st IF Amplifier

The signal covered by Q102 to 21.7MHz, the 1st frequency, change its impedance through C113, L16, and then is infused to the fundamental MCF which has the center frequency of 21.7MHz and the band width of +/-3.75KHz.
Here, the signal reduces the image and other unwanted signal for the 2nd IF, and changes its impedance again through the R116 and C117. Then the signal is infused to the Q103, the 1st IF amplifier. The signal infused to the Q103 is amplified approximately by 20dB in other to acquire the required reception sensitivity, and infused to the IC101 which functions as the 2nd mixer, the 2nd IF amplifier, and the FM detector.
2nd Mixer, 2nd IF, FM Detector (IC101)

The receiver IF signal of 21.7MHz, which has been infused to IC101 is mixed with the 2nd L/O signal of 21.250MHz, and converted to 450KHz, the 2nd IF frequency. The receiver signal converted to the 2nd IF frequency passed through the CF13, the ceramic filter of 450KHz again. After the limiting inside the IC101 and the FM demodulating by the quarature detector inside the IC101, the signal offers the output through the 9th pin of the IC101.
The 2nd L/O signal of 21.250MHz which infused to the IC101 filters and uses directly the crystal of 21.250MHz. The squelch circuit is composed to detect the noises from the received signal demodulate in the 9th pin of the IC101. For this purpose, the noise filter is using the OP amplifier inside the IC101.

De-Emphasis and 300Hz HPF (IC401)

The audio signal which has been FM demodulate in the IC101 is supplies to the IC401 which function as the De- emphasis and 300Hz HPF.
Since the IC401D has the 300Hz HPF with the 1st characteristics and the De-emphasis characteristice with the cornor frequency of approximately 200Hz, and IC401A, the IC401B, and the IC401C has the 300Hz HPF with the 6th characteristices, they function as a normal De-emphasis and also reduce the signal such as CTCSS to unwanted noises from the speaker.

Audio Power Amplifier (IC402)

The received audio signal which has been adjusted to the appropriate volume in the VR11 are supplied to the 2nd pin of the IC402 and amplified approximately by 20dB. Then, it turns up the speaker with the maximum output of 0.3Watts.
The 7th pin of the IC401 is the audio mute terminal. If a voltage supply to the 6th pin of the IC401 is supplied to this terminal, the IC401 stops functioning as the audio power amplifier regardless of the signal supplied to the 2nd pin of the IC401, and there is no sound emitter from the speaker.

Transmitter

The transmission parts of the KF-310 is designed to amplify the RF signal oscillated and modulated by the synthesizer to approximately 500mW by the power transistor of Q306.

Pre-emphasis and 300Hz HPF, Limiter (IC501B, 501C)

The voice signal input from the microphone is pre-emphasized at the IC501B, and at the same time, the components below 300Hz are reduce to minimize the influence to the CTCSS tone.
The signal which comes out of the IC501B is limited to a certain amplitude at the IC501C for the voice signal not to exceed the allowable band width assigned for transmission.

3KHz LPF (IC501A, IC501D)

After passing the IC308C limiter, the signal is combined with the CTCSS tone at the digital circuits, passes the RV51, and is supplied to the 3KHz LPF has the 4th characteristices and adjusts the assigned frequency band width not to exceed the allowable range.

TX Power (Q304)

The transmitted signal of approximately 7mW, combined at the driver TR is supplied to the base of the Q304 amplifier. The transmitted signal amplified to 0.47W here passes the TX LPF of the 2nd characteristicod of the L36 and the L37, and RX/TX switching takes place by the D32. After this, the signal is provided to the antenna the TX LPF of the 1st characteristices, consisted of the L38.

Frequency Synthesizer

Voltage Control Oscillator (VCO)

The VCO of oscillates 462.5625MHz to 467.7125MHz under the transmission condition and 440.8625MHz to 446.0125MHz under the reception condition. The VCO consists of the clip oscillator of the Q203, and contains the oscillator frequency of approximately 21.7MHz during the transmission / reception conversion. That is since the VCO should oscillate relatively low frequency during reception compared to transmission, the D21 is directly biased by the Q201. Therefore as a result, the C203 is added in parallel to the resonance circuit of the VCO to oscillate a low frequency. During transmission, a relatively high frequency should be oscillate compared to reception. Therefore, the D21 is adversely biased by the Q201, and as a result, the C203 which is added inparallel to the resonance circuit of the VCO is removed to oscillate the desired transmission frequency.
The VCO is controlled by controlled by the IC201 PLL IC in order to oscillate the accurate frequency. The VCO is controlled by the IC201 PLL IC in order to oscillate accurate frequency. The output frequency of the VCO is supplied to the IC201 PLL IC immediately. At the IC201, the X-tal(21.250MHz) is compared to the output frequency of the VCO. The VCO is controlled through the loop filter consisted of the R211,R217, and the C218,R209,C215 in order to oscillate the stable frequency wanted for the radio.
The VCO controlled voltage which ahs passed the loop filter is supplies to the D22 varactor diode, and the VCO an oscillate the PLL programmed frequency by the capacity varation in the D22. In addition, the L23 on the VCO circuit functions as frequency for the VCO to be properly controlled by the IC201 PLL IC.

RX/TX Buffer Amplifier (Q204, Q303)

The RF signal oscillate at the VCO is provide to the Q102 RX 1st mixer through the Q204 during the reception, and is provide to the Q304 power driver amplifier through the Q303 during the transmission.

PLL Frequency Synthesizer (IC201)

The PLL synthesier of the signal loop PLL circuit with the reference of 6.25KHz. The IC201 PLL IC includes all the functions such as the reference oscillator, the driver, the phase detector, the lock detector, and the programmable divider.
At the reference oscillator, the X-tal(21.250MHz) is connected to the pin 11 of the IC201 to oscillate the frequency of 21.250MHz. The X-tal(21.250MHz) is the temperature compensation circuit to maintain the frequency withen the allowable error range even under a low temperature of -20℃.
The phase decetor send out the output power to the loop filter through 3rd pin of the IC201. If the oscillation frequency of the VCO is low compareed to the referencd frequency, the phase decetor sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase decetor send out can maintain the frequency set.

The programmable diceder divider maintains the desired frequency with the 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 462.5625MHz

N = 462.5625MHz / 0.00625MHz = 74010

CTCSS Processing

RX CTCSS Tone Processing

The received CTCSS tone is sent out through 9th pin of the IC101, and supplies to the IC602 switching capacitor filter through the IC601 analog switch. The voice band signal which can affector the reception of the CTCSS tone is decreased enough at the IC602. The cut off frequency at the IC602 is adjusted by the IC301 CPU to suit the characteristice of the CTCSS tone.
The CTCSS tone received at the IC602 is supplies to the 19th pin of the IC301 CPU, and receives the desired CTCSS tone.

TX CTCSS Tone Processing

The TX CTCSS tone composed at the IC301 CPU is properly reduce at the R706, and R602, and the R601, and supplies to the IC602 switchied capacitor filter reduce enough the components in the high frequency which can affect the voice communication. And then, the TX CTCSS tone is combined with the TX voice signal through the IC601 analog switch, and supplies to the RV51 TX deviation control volume.

CPU and Memory

Most of the control functions of the KF-310 are controlled by the IC301 CPU.
The IC301 CPU has the internal ROM in the capacity of 16Kbyte, and the program for the operation of the IC301.
When the power of turned on, the IC301 reads the data necessary for the operation from the IC701 EEPROM, and decide the operation channel, frequency, etc.
If the user alters any parameter of the radio, the IC301 updates the altered parameter to the IC305.