

6. THEORY OF OPERATION

KACE ELECTRONICS
FCC ID: MUDFR-130A
EXHIBIT #: 8A

Circuit Composition And Operation Theory

The basic explanation for the circuit composition

FR-130A consists mainly of the two boards controlling the analog circuit parts and the digital circuit parts for the other control.

Receiver

FR-130A receiving parts is composed in the double conversion system, which has the 1st IF Frequency of 21.4MHz and the 2nd IF frequency of 455KHz. With the frontend circuit Which has an excellent band characteristic and skirt characteristic, the 1 pole MCF used in the 1st IF, and the pole ceramic filter in the 2nd IF, the reception interruption 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 frontend through the antenna switching circuit consisted of L101, L102, C102, C103 and D101(PIN DIODE). The frontend consists of the RF amplifier transistor Q250 and input/output band pass filter. The input/output band pass filter has the bandwidth of approximately 10MHz, primarily diminishes the other signal rather than 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 frontend is provided to the base of the 1st mixer Q2. The 1st L/O signal provided from the PLL circuit is supplied to the emitter of Q2 and converted to the 1st IF 21.4MHz.

1st IF Filter and 1st IF Amplifier

The signal covered by Q2 to 21.4MHz, the 1st IF frequency changes it and then is infused to the fundamental MCF which has center frequency of 21.4MHz and the bandwidth of $\pm 3.75\text{KHz}$.

Here, the signal reduces the image and other unwanted signal for the 2nd IF, and changes its impedance again through the L6 and C10. Then the signal is infused to the Q3, the 1st IF amplifier. The signal infused to the Q3 is amplified approximately by 20dB in order to acquire the required reception sensitivity, and infused to the IC101 which functions the 2nd mixer, the 2nd IF amplifier, and the FM detector.

2nd Mixer, 2nd IF, FM Detector (IC101)

The receiver IF signal of 21.4MHz, which has been infused to IC101 is mixed with the 2nd L/O signal of 20.945MHz, and converted to 455KHz, the 2nd IF frequency. The receiver signal converted to the 2nd IF frequency passed through the CF3, the ceramic filter of 455KHz again. After the limiting inside the IC101 and the FM demodulating by the quadrature detector inside the IC101, the signal offers the output through the 9th pin of the IC101.

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

The audio signal which has been FM demodulate in IC101 is supplies to C29, R25 which function as the De-emphasis.

Audio Power Amplifier (IC402)

The received audio signal which has been adjusted to the appropriate volume in the VR1 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 IC402 is the audio mute terminal. If a voltage supply to the 7th pin of the IC402 is not supplied to this terminal, the IC402 stops functioning as the audio power amplifier regardless of the signal supplied to the 6th pin of the IC402, and there is no sound emitted from the speaker.

Transmitter

The transmission part of the FR-130A is designed to amplify the RF signal oscillated and modulated by synthesizer to approximately below 300mw(ERP) by the power transistor of Q101.

Pre-emphasis (IC301)

The voice signal input from the microphone is pre-emphasized at IC301A. The signal which comes out of the IC301B is limited to a certain amplitude for the voice signal not to exceed the allowable bandwidth assigned for transmission.

TX Power

The transmitted signal of approximately 7mW, combined at the PLL module is supplied to the base of the Q102 amplifier. The transmitted signal amplified to 0.4 Watts here passes the TX LPF of the 2nd characteristics of the L104 and the L103, and RX/TX switching takes place by the D102. After this, the signal is provided to the antenna the TX LPF of the 1st characteristics, consisted of the L101.

Frequency Synthesizer

Voltage Control Oscillator (vco)

The VCO of the FR-130A oscillates 462.5625MHz under the transmission condition and 441.1625MHz under the reception condition. The VCO consists of the colpitt oscillator of the Q202, and contains the oscillator frequency of approximately 21.4MHz during the transmission / reception conversion. That is since the VCO should oscillate relatively low frequency during reception compared to transmission, the D201 is directly biased by the Q203.

Therefore as a result, the C208 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 D201 is adversely biased by the Q203, and as a result, the C208 which is added in parallel to the resonance circuit of the VCO is removed to oscillate the desired transmission frequency.

The VCO is controlled by controlled by the IC102 PLL IC in order to oscillate the accurate frequency. The VCO is controlled by the IC102 PLL IC in order to oscillate accurate frequency. The output frequency of the VCO is supplied to the IC102 PLL IC immediately. At the IC102, TCXO(12.8MHz) by the TCXO is compared to the output frequency of the VCO. The VCO is controlled through the loop filter consisted of the R122, C130 and the C131 in order to oscillate the stable frequency wanted for the radio.

The VCO controlled voltage which passed the loop filter is supplies to the D202 varactor diode, and the VCO an oscillate the PLL programmed frequency by the capacity variation in the D202. In addition, the L202 on the VCO circuit function as frequency for the VCO to be properly controlled by the IC102 PLL IC.

RX/TX Buffer Amplifier (Q105, Q106)

The RF signal oscillate at the VCO is provide to the Q2 RX 1st mixer through the Q106 during the reception, and is provide to the Q102 power driver amplifier through the Q105 during the transmission.

PLL Frequency Synthesizer (IC102)

The PLL synthesier of the FR-130A consists of the signal loop PLL circuit with the reference of 6.25KHz. The IC102 PLL includes all the functions as the reference oscillator, the driver, the phase detector, lock detector, and the programmable divider.

At the reference oscillator, the 12.8MHz TCXO of the TCXO is connected to the pin 11 of the IC102 to oscillate the frequency of 12.8MHz. The TCXO(12.8MHz) is the temperature compensation circuit to maintain the frequency within the allowable error range even under a low temperature of -20°C.

The phase decetor send out the output power to the loop filter through 3rd pin of the IC102. IF the oscillation frequency of the VCO is low compared to the referened frequency, the phase decetor sends out the output power in positive pulse. IF the oscillation frequency of the VCO is high, phase decetor sends out the output power in negative pules. Therefore, the VCO can maintain the frequency set.

The programmable divider maintains the desired frequency with the control from the CPU. The dividing ratio, "N" to oscillate the desired frequency is as below :

$$N = \text{VCO oscillation frequency} / \text{reference frequency}$$

IF the desired frequency is 462.5625MHz

$$N = 462.5625\text{MHz} / 0.00625\text{MHz} = 74010$$

CPU

Most of the control function of the FR-130A are controlled by the IC501 CPU. The IC501 CPU has the internal ROM in the capacity of 8Kbyte, and the program for the operation of the IC501.

This cpu control the 14channel display by up and down switch programed in cpu