



THEORY OF OPERATION

Circuit Composition and Operation Theory

The basic explanation for the circuit composition

FR560FM consists mainly of the two board controlling the RF circuit parts and the digital circuit parts.

FRS Receiver

FR560FM receiver parts are composed in the double conversion system, which has the 1st IF Frequency of 10.7MHz and the 2nd IF frequency of 450KHz, with the Frontend circuit which has an excellent band characteristic and skirt characteristic, the 1 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 frontend through the antenna switching circuit consisted of C61, D1, L14, C62 and L11. The frontend consists of the RF amplifier transistor Q7 and input/output band pass filter (CF2). 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 Q8. The 1st L/O signal provided from the VCO circuit (Q2) is supplied to the emitter of Q8 and converted to the 1st IF 10.7MHz.

1st IF Filter and 1st IF Amplifier

The signal converted by Q8 to 10.7MHz, the 1st frequency, changes its impedance through L7 and then is infused to the fundamental MCF which has the center frequency of 10.7MHz and the band width of +/-180KHz.

Here, the signal reduces the image and other unwanted signal for the 2nd IF, and changes its impedance again through the L8 and C20. Then the signal is infused to the Q1, the 1st IF amplifier. The signal infused to the Q1 is amplified approximately by 20dB in order to acquire the required reception sensitivity, and infused to the IC3 which function as the 2nd mixer, the 2nd IF amplifier, and the FM detector.

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

The receiver IF signal of 10.7MHz, which has been infused to IC3 is mixed with the 2nd L/O signal of 10.250MHz, and converted to 450KHz, the 2nd IF frequency. The receiver signal converted to the 2nd IF frequency passed through the CF2, the ceramic filter of 455KHz again. After the limiting inside the IC3 and the FM demodulating by the quarter detector inside the IC3, the signal offers the output through the 9th pin of the IC3.

The 2nd L/O signal of 10.250MHz which infused to detect the noises from the received signal

demodulate in the 9th pin of the IC3. For this purpose, the noise filter is using the OP. Amplifier inside the IC1.

De-Emphasis

The audio signal which has been FM demodulate in the IC3 supplies to R18, C53 which function as the De-emphasis.

Audio Power Amplifier (IC6)

The received audio signal which has been adjusted to RV101, 102, 103 is supplied to the IC6 and amplified approximately by 20dB. Then, it turns up the speaker with the maximum output of 0.5Watts.

The 2th pin of the IC6 is the VDD.

FRS Transmitter

The transmission part of the FR560FM is designed to amplify the RF signal oscillated and modulated by the synthesizer to approximated below 500mW(ERP) by the power transistor of Q3,4, 6, 11.

Pre-emphasis (IC5)

The voice signal input from the microphone is pre-emphasized at the IC5. The signal which comes out of the IC5 is limited to a certain amplitude for the voice signal not to exceed the allowable band width assigned for transmission.

TX Power(Q3,4,6,11)

The transmitted signal amplified to 0.5Watts here passes the TX LPF of the 2nd characteristic of the L12 and the L13, and RX / TX switching takes place by the D2.

Frequency Synthesizer

FRS Voltage Control Oscillator(VCO)

The VCO of oscillates $462.5625\text{MHz}/2$ under the transmission condition and $473.2625\text{MHz}/2$ under the reception condition. The VCO consists of the colpitt oscillator of the Q2, and contains the oscillator frequency of approximately 10.7MHz during the transmission / reception conversion. That is since the VCO should oscillate relatively high frequency during reception compared to transmission.

Therefore as a result, the C58 is added in parallel to the resonance circuit of the VCO to oscillate a low frequency. During transmission, a relatively low frequency should be oscillated compared to reception.

The VCO is controlled by the IC1 PLL IC in order to oscillate the accurate frequency. The output frequency of the VCO is supplied to the IC1 PLL IC immediately. At the IC1, 10.250MHz by the X2 is compared to the output frequency of the VCO. The VCO is controlled through the loop filter consisted of the R24, R12 and the C15 in order to oscillate the stable frequency wanted for the radio. The VCO controlled voltage which has passed the loop filter supplies to the D4 variator diode, and the VCO and oscillate the PLL programmed frequency by the capacity variation in the D4.

PLL Frequency Synthesizer (IC1)

The PLL synthesizer of the signal loop PLL circuit with the reference of 6.25KHz.

The IC1 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 10,250MHz is connected to the pin 2 of the IC1 to oscillate the frequency of 10.250MHz.

The phase detector sends out the output power to the loop filter through 10th pin of the IC1.

If the oscillation frequency of the VCO is low compared to the referenced frequency, the phase detector sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector sends out the output power in negative pulse. 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

$$N = 462.5625\text{MHz} / 0.0125\text{MHz} = 37005$$

CPU and Memory

Most of the control functions are controlled by the IC4 CPU.

FM Radio Receiver

FR560FM FM radio receiver parts are composed in the single conversion system, which has the IF Frequency of 10.7MHz, with the Frontend circuit which has an excellent band characteristic and skirt characteristic, the 1 pole MCF used in the Frontend, and the 2 pole ceramic filter in the 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 frontend through the antenna switching circuit consisted of L29, C205, L31, D9. The frontend consists of the RF amplifier transistor Q13 and input/output band pass filter (CF4). Band pass filter has the bandwidth of approximately 25MHz, primarily diminishes the other signal within the reception band and amplifies only the necessary signal within the RF.

Mixer, IF, FM Detector(IC4)

The receiver RF signal, which has been infused to IC4 is mixed with the 1st L/O signal of FM VCO, and converted to 10.7MHz, IF frequency. IF frequency passed through the CF3, the ceramic filter of 10.7MHz again. After the limiting inside the IC4 and the FM demodulating by the quarter detector inside the IC4, the signal offers the output through the 14th pin of the IC4.

De-Emphasis

The audio signal which has been FM demodulated in the IC4 supplies to R46, C84 which function as the De-emphasis.

FM Radio Voltage Control Oscillator (VCO)

The VCO oscillates 76.8MHz – 97.2MHz under FM radio mode. The VCO consists of the Colpitts oscillator of the Q12.

The VCO is controlled by the IC1 PLL IC in order to oscillate the accurate frequency. The output frequency of the VCO is supplied to the IC1 PLL IC immediately. At the IC1, 10.250MHz by the X2 is compared to the output frequency of the VCO. The VCO is controlled through the loop filter consisted of R45, R58 and the C76 in order to oscillate the stable frequency wanted for the radio. The VCO controlled voltage which has passed the loop filter supplies to the D8,20 varactor diode, and the VCO oscillates the PLL programmed frequency by the capacity variation in the D8,20.