60-4019 FRS circuit description

VCO Board

60-4019 is a single board design with a VCO module on it, which is a single channel CH1 FRS. The VCO circuit composes of a cascode configuration Colpitts oscillator. 2 RF transistors Q201 and Q202 realise the configuration. The bottom transistor Q202 is a standard Colpitts type oscillator, the resonating element is a air coil L201. By controlling the bias voltage of varactor diode VD1(and hence the capacitance), the resonating frequency of the oscillator will then be under controlled. The VCO had a tuning range of about 20MHz which will be used as both transmitting carrier (462.5625MHz) and receiving LO (451.8625MHz). The second transistor Q15 serves as a buffer amplifier to the VCO which can improve the load-pull characteristics of the oscillator.

A. Main Board

The main PCB consists of TX, RX , baseband and all the necessary control circuitry. Basically RF and baseband circuit are subdivided into two parts. The RF parts are put on the upper half of the PCB and remaining lower half PCB will be the baseband and MCU circuitry.

A: RX section

This product employs the traditional double conversion superheterodyne method. It mainly consists of a LNA (low noise amplifier), a LO(local oscillator), a mixer, an IF (intermediate frequency) amplifier and a FM-IF demodulation IC.

The LNA, which is composed by transistor Q1 and Q2, is using class A configuration with the merits of having low noise figure, highly stabilizing and high insertion gain.

The LO signal is generated by the VCO module as mentioned before. The spurious generated will be further filtered by the C63 and slightly coupled to the mixer. The LO frequency is controlled by the PLL (phase locked Loop) chip KB8825 (or TB31202). The reference frequency of the PLL chip is 10.25MHz which is generated by the on-chip oscillator and crystal X1. With different temperature characteristic capacitors C8 and C10, the frequency of the VCO is stabilized within 2.5ppm from -10 to 50 degree C.

The mixer is a common emitter configured transistor , Q3. It converts the RF signal to an IF of 10.7MHz. This IF will further be filtered by the ceramic filter F2.

The IF amplifier, Q13, is used to further amplify the filtered IF signal before inputting to the FM-IF chip U1 KA3361.

Inside the FM-IF chip, the IF signal is further down converted to second IF at 450 KHz for demodulation. The second LO signal is generated by the reference oscillator of the PLL chip. The second IF is also further filtered by the ceramic filter for better adjacent channel rejection response. The second IF signal is then demodulated by the quadrature coil L8. The demodulated audio signal will be de-emphasised and input to the audio amplifer , U5, to drive the speaker. The ON/OFF and sound level of the speaker is controlled by adjusting the variable resistor SW2.

Lastly, the Squelch level of the unit is controlled by adjusting (VR1) the demodulated noise level to the internal op-amp of the FM IF chip KA3361.

B: TX section

The TX carrier is also generated by the VCO module with the control from PLL chip. The VCO signal is coupled to amplifier Q4. The output signal will be generated by the class A power amplifier Q5. The harmonic of the carrier will be suppressed by the low-pass filter realised by L10, L11, L4, L5 and the nearby capacitors.

C: Baseband Section

The operating voltage of the circuit is stabilized by the voltage regulator U6. The demodulated audio signal will go through the de-emphasis process before feeding to the audio amplifier and the volume is controlled by adjusting VR SW2.

The acoustic input picked up by the microphone will be pre-emphasised, amplified and level limited by U2B. The audio signal will be then band limited by U2A. Before modulating the carrier, this signal amplitude is controlled by the variable resistor VR2.

The baseband signal is mainly controlled by the audio amplifier U5, op-amp U2 and the MCU U4. In order to have a longer battery life, power management is inevitable. Under normal or standby circumstances, the MCU will be in RX mode for a short moment with speaker muted to check whether we need to turn on the speaker to alert the user. However, in most of the time, the MCU will shut down the whole unit to save power. As a result, by turning on and off the units with different duty cycle, the current consumption can be saved to extend the battery life.

The low battery detection circuit is realised by the op-amp U2C. Since the op-amp U2 has 4 internal individual stage, the modulation limiter and pre-emphasis is realised by U2B and U2A respectively. The last one, U2D, is for low temperature detection in order to cut-off the power of RF circuit.

60-4019 has 2 external keys for PTT and Call function. Once the PTT is pressed, the MCU will generate a beep tone to the speaker to alert the user the unit is under TX mode. When the Call key is pressed, a MCU generated dual tone signal will modulate the carrier to alert the recipient. The maximum duration of each call tone is less than 15 seconds as required by FCC.