Circuit Description/Theory of Operation

There are two PCBs in 21-1821 including RF board and Baseband board. The RF board consists of a Low Noise Amplifier (LNA), a mixer, an IF amplifier, a FM demodulation IC (MC3361), a Voltage Controlled Oscillator (VCO), a Phase Locked Loop (PLL), a VCO buffer amplifier, two RF amplifiers and a RF power amplifier. While the Baseband board consists of a Micro Controller Unit (MCU), MIC amplifier, audio amplifier, power switches, low battery detector, low temperature cut off comperator, DC charging circuit.

A. VCO

The VCO circuit composes of a cascode configuration Colpitt oscillator. 2 RF transistors Q1 and Q2 realise the configuration. The bottom transistor Q2 is a standard Colpitt type oscillator, the resonating element is a wire wound type air coil L7. By controlling the bias voltage of varactor diode D4 (and hence the capacitance), the resonating frequency of the oscillator will then be under controlled. The VCO had a tuning range of about 40MHz which will be used as both transmitting carrier and receiving LO. The second transistor Q1 serves as a buffer amplifier to the VCO which can improve the load-pull characteristics of the oscillator. Applying MIC audio signal to another varactor diode D7 made the FM modulation.

B. 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 Q4 and Q5, is using cascode configuration with the merits of having low noise figure, highly stabilized and high insertion gain.

The LO signal is generated by the VCO as mentioned before. The spurious generated will be further filtered by the tank circuit L8 and C39 and slightly coupled to the mixer. The LO frequency is controlled by the PLL (phase locked Loop) chip TB31202. The reference frequency of the PLL chip is 10.25MHz which is generated by the on-chip oscillator and crystal Y2. With different temperature characteristic capacitors C45 and C44, the frequency of the VCO is stabilized within 2.5ppm from -10 to 50 degree C.

The first image rejection filter, U3, is a SAW (surface acoustic wave) device, with the merits of having low insertion loss and high stop band attenuation.

The mixer is a common emitter configured transistor Q6. It converts the RF signal to an IF of 10.7MHz. This IF will further be filtered by the ceramic filter Y1.

The IF amplifier, Q7, is used to further amplify the filtered IF signal before inputting to the FM-IF (IC3361) chip.

Inside the FM-IF chip, the IF signal is further down converted to 450kHz second IF 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 L17. Lastly, the Squelch level of the unit is controlled by adjusting (R32) the demodulated noise level to the internal op-amp of the FM IF chip 3361.

C. TX section

The TX carrier is also generated by the VCO circuitry with the control from PLL chip. The VCO signal is coupled to amplifier Q10. The amplified signal from Q10 will feed to the driver stage by Q9. The output signal is then applied to the class-C power amplifier Q3 and Q8. The harmonic of the carrier will be suppressed by the low-pass filter realised by L13, L16, L1 and the nearby capacitors.

Baseband Board

The baseband PCB consists of voltage regulator, Mic amplifier, audio amplifier, power switches, low battery detector, low temperature cut off comparator and all the necessary control circuitry that controlled by MCU (U201).

The operating voltage of the circuit is stabilised by the 4V voltage regulator U202. Since this product is a 14-channel selectable device, a dip switch DP201 is used for channel selection. 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 SW202. Then the audio signal is amplified by audio amplifier U204. The amplified audio signal is then applied to the 8 ohm speaker.

The acoustic input picked up by the microphone will be pre-emphasised, amplified and level limited by U203B. The audio signal will be then band limited by U203A. Before modulating the carrier, this signal amplitude is controlled by the variable resistor VR204 such that the FM deviation can be controlled.

In order to have a longer battery life, power management is inevitable. Under normal or stanby 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. Transistors of Q202, Q205 and Q206 are used as the switches of 4V_PLL, 4V_RX and 4V_TX respectively.

The low battery detection circuit is realised by the op-amp U203C. Since the op-amp U203 has 4 internal individual op-amps, the modulation limiter and pre-emphasis is realised by U203B and U203A respectively. The last one, U203D, is for low temperature detection in order to cut off the power of RF circuit.

21-1821 has 3 external keys for PTT, Monitor 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. When the Monitor key is pressed, the unit will be forced to RX mode to monitor any signal exists in the air.