Theory of Operation

1. PLL Frequency Synthesizer

PLL Frequency synthesizer is composed with X2 which is crystal oscillator, VCO which is voltage control oscillator, Phase Comparer, Pre-scaler, U1 (PLL IC) which is embedded programmable divider, and RC LPF(low-pass filter). This PLL Frequency synthesizer is designed to generate the setting frequency according to the control of CPU.

1-1) X-TAL Oscillator

The frequency of X2(X-TAL Oscillator) is used for the reference frequency of U1(PLL IC), also is used for the local frequency of U2(IF IC).

1-2) PLL IC

PLL IC(U1) is controlled by CPU, and receives the transmitting/receiving frequency data per each channel which is memorized to EEPROM through CPU.

U1 divide the VCO oscillation frequency which is received in Pin 16 of U1 by Prescaler and Programmable Divider, and then compares the phase with reference frequency, at this time the frequency is determined. The output detected from the internal Phase Comparer, via Pin14 of U1, is transmitted to the "C53, R35, C54, R36, and C55"that is PLL LPF, and finally generates DC voltage to adjust the VCO output frequency wanted.

1-3) PLL Lock Detector

Internal Phase Comparer of PLL IC(U1) compares the frequency and phase which is loaded from the Reference signal and the signal from VCO, and via the Pin14 of U1, output the differential DC voltage which is the difference of two signal. This DC voltage is loaded to the VCO, and finally the VCO frequency is changed. Above series of operation is repeated continuously and the frequency is to be set to the frequency wanted.

The frequency stability at this time, is to be same with the stability of X2, and this status is called as "Locked".

1-4) Voltage Control Oscillator (VCO)

VCO has the "transmitting/receiving Voltage Control Oscillator" which is adjusted by the DC voltage that comes from PLL LPF.

Local Oscillation Frequency is determined by C58, C60, L16, C65, C66, D8, and VC2, and transmitting / receiving is switched by Q10.

The frequency is oscillated and amplified at Q8, and Q9, when receiving, the receiving local oscillation frequency is loaded to the Mixer Q6, and when transmitting, the transmitting return frequency is loaded to the Q4 (TX amplification Driver)

2. Receiving Part

2-1. Transmitting/Receiving change switching circuit

The signal received from the antenna, via the LPF(low pass filter) composed with L1~L3, C1, C2, C3, C4 and C5, is loaded to the "Transmitting/Receiving change switching circuit". By the D1 (transmitting change switching Diode) is to be off, via L19, received signal is transmitted to the foregoing Band-Pass-Filter which is located before the receiving part.

2-2. Front-End

Front-End is composed two SAW (Surface Acoustic Wave) Filter and one LNA (Low Noise Amplifier).

2-3**. 1st Mixer**

Mixer Q6 is "RF AMP TR", add the VCO local signal with the received signal which is received from input BASE, load the added signal to the EMITTER, enforce the non-linear operation of amplifier, generate co-modulation frequency between the receiving signal frequency of COLLECTOR and Local signal frequency, and the one of them is the 1st medium frequency signal (21.7 MHz).

2-4. MCF (Monolithic Crystal Filter)

MCF is a input/output matching circuit of FL3, is the BPF which have high selectivity. MCF has very narrow band-pass width of 3.75, and the function that eliminating the ripple among the band-pass width, also MCF meet the attenuation characteristic of Stop Band.

Among various signal generated from 1st Mixer, MCF select IF 21.7 MHz signal, and suppress other signal unwanted.

2-5**. IF Amp**

Q7 amplifies the amount that the loss of MCF and the Gain which is needed afterward circuit, and load the 21.7 MHz IF Signal to the Mixer Input Pin16 of the narrow-band Fm IF IC U2.

2-6. IF IC

2nd Mixer, IF AMP, Osc., FM Detection, Noise Squelch, and RSSI circuit is embedded on the IF IC U2. By the mixing with "1st IF signal 21.7 MHz of internal 2nd Mixer in IF IC" and "2nd local frequency 21.25 MHz of X2 that is connected to Pin1", IF IC generates 2nd IF signal 450 kHz.

Via Pin3, this 450 kHz signal is loaded to 450 kHz Ceramic Filter FL4, filtered, and then is loaded again to the 2nd IF AMP(450 kHz) PIN 5, and then finally this 450 KHz signal is amplified.

450 KHz IF AMP transmit the signal that have sufficient Gain to the internal Detector circuit, and demodulate the signal. The demodulation type is a quadrature detector type, the demodulation is conducted by Resonator X3 that is connected to the IC Pin8, and the Audio Signal is transmitted to the Pin9 through internal LPF.

Among the detected output, first the noise ingredient is loaded to the Pin8 (which is Internal Filter input terminal) of U2.

By R29, R28, R27, C38, C39, and C37, this loaded Noise is amplified and frequency bandwidth is limited. The Squelch Operation is controlled by the changing of noise quantity in "Noise Comparer Section" of U2.

If the Squelch is in open status, SQ Detector terminal Pin13 of U2 is loaded to CPU with the Logic High State, and make the CPU output the signal that release the Signal Mute and Audio Mute.

If the Squelch is in close status, SQ Detector terminal Pin13 of U2 is loaded to CPU with the Logic Low State, and make the CPU can not output the signal that release the Signal Mute and Audio Mute.

2-7. **Audio High-pass Bandwidth Filter and Audio Amplifier**

Demodulated Audio signal is passed the De-Emphasis circuit which has –6 dB/OCT characteristic, and the high-pass bandwidth is attenuated that is emphasized at TX, and finally the signal is changed to flat frequency response characteristic.

The Audio Signal is loaded to Pin17 of U5, and is adjusted with appropriate level, and is transmitted to the Audio last AMP U7 Pin 2. The amplified Audio signal is outputted to U7 Pin5, and then via External Speaker Jack J2A, and drive the internal Speaker. (Nominal output is larger than 0.25)

Belonging to the varying of the voltage of Pin6 in U7 by Q19, and Q20, the Audio Mute is controlled. That is, if the voltage of Pin6 in U7 is High, the Audio signal is passed, but if the voltage of Pin6 in U7 is Low, the Audio signal is muted. Audio output is controlled by VOLUME UP/DOWN KEY.

3. Transmission Part

Transmission Part is composed with Driver AMP High-Frequency RF Power IC. When starting the transmission by pressing the PTT SW, the output of VCO is amplified through Q4,Q3,Q2,and Q1, and via LPF, the output is transmitted to the ANT.

3-1) **PTT Detector and CPU Control**

By pressing the PTT SW1, the Pin46 of U3 is changed with LOW, then the CPU starts the transmission. When in VOX MODE status, the value of MIC Level is amplified by Q23, depending on the Setting Value of VOX Level, U1 recognize the PTT.

The CPU that recognized the PTT signal, decodes the Frequency Data of that channel and other Option Data which is registered in EEPROM, controls the other Option control circuit, and transmit the Data to the PLL IC, also send the Low signal to TX Enable(U3 pin38) that controls the TX voltage.

The CPU monitor the Lock Port of PLL, and once find that if the PLL is stable, send the Low signal to the TX LED(U3 pin22) control terminal. These operations are maintained while pressing the PTT SW.

3-2)**. Mic AMP and modulation**

The Audio signal which is made by internal condenser MIC or external MIC, is amplified by U5 and U6, and have the characteristic of Pre Emphasis 6dB/OCT.

U5 has the -36dB/OCT for frequency more than 3.6 kHz, the Audio signal which is filtered through Limiting circuit, is transmitted to the Maximum deviation adjuster VR1, and limits the maximum modulation deviation, and finally the audio signal is loaded to VCO, and then the Audio signal FM modulated.

3-3) **Power AMP and LPF**

TX RF signal that generated at TX VCO, is loaded to Drive AMP Q4, Q3, and Q2, and is amplified by the input level that Q1 requires, and then is loaded to Q1, finally is changed to the output of more than 0.5W. This signal is supplied to the LPF and ANT Connector, and is radiated via ANT.

If there isn't enough size of input or Bias voltage, the output isn't made. The LPF is designed with 3rd stage for the purpose that eliminating the High-Frequency ingredient and making better the TX Spurious characteristic.