APPENDIX B: PRODUCT DESCRIPTION

7. THEORY OF OPERATIONS

Circuit Composition and Operation Theory

The basic explanation for the circuit composition the one board controlling the analog circuit parts and the digital circuit parts for the other control.

Receiver

Receive parts is composed in the double conversion system, which has the 1st IF Frequency of 21.4 MHz And 2nd Frequency of 455 KHz The 2 pole MCF used in the 1st IF, and the sensitivity repression are reduced for the more stable reception.

RF Front end

The signal received by the antenna will be transmitted to the band pass filter through the antenna switching circuit consisted of C44, L7 The front RF amplifier transistor Q1 consists of the L301, C302 input band pass filter and L307, C209, saw filter output band pass filter primarily diminishes the other signal rather then the 1st IF image and other signal within the reception band amplifier only the necessary signal within the RF

1st Mixer

The receiver which has been amplifier in the RF frontend is provided to the base of the 1st mixer Q2. The 1st L/O signal provide from the VCO is supplied to the emitter of Q2 and Converted to the 1st IF 21.4 MHz

1st IF Filter and 1st IF Amplifier

The signal converted by Q2 to 21.4 MHz, the 1st frequency, change its impedance through C61,
L14 and then is infused to the fundamental MCF which has the center frequency of 21.4 MHz and the width of +/- 3.75 KHz. Here, the signal reduces the image and other unwanted signal for the 2nd IF , and changes its Impedance again through the R9. Then the signal is infused to the Q3, the 1st IF amplifier. The signal infused to the Q3 is amplifier approximately by 20 dB in other to acquire the required reception sensitivity, and infused to the IC1 which functions as the 2nd mixer, the 2nd IF amplifier, and the FM detector.

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

The receiver IF signal of 21.4 MHz, which has been infuse to IC1 is mixed with the 2nd L/O signal of 20.945 MHz, and converted to 455 KHz, the 2nd IF frequency. The receiver signal converted to the 2nd IF signal frequency passed through the CF1, the ceramic filter of 455 MHz again. After the limiting inside the IC1 and the FM demodulating by the quadrature detector inside the IC1, the signal offers the output through the 9th pin of IC1.The 2nd L/O signal of 20.945 MHz which infused to the IC1 filter and uses directly the crystal of 20.945 MHz. The squelch circuit is composed to detect the noised from the

received signal demodulate in the 9th pin of the IC1. For this purpose, the noise filter is using the OP amplifier inside the IC1.

De-Emphasis and 300 Hz (IC103)

The audio signal which has been FM demodulate in the IC1 is supplies to the IC103 which function as the De-emphasis and 300 Hz HPF. Since the IC103A has the 300 Hz HPF with the 1st characteristics and the De-emphasis characteristics with the center frequency of approximately 200 Hz, the IC103B, and the IC103C has the 300 Hz HPF with the 6th characteristics, they function as a normal De-emphasis and also reduce the signal such as CTCSS to unwanted noised from the speaker. Audio Power Amplifier (IC101) The receiver audio signal which has been automatic adjusted to the appropriate volume in by Q5,Q104,Q105 are supplied to the 2nd pin of the IC101 amplifier approximately by 20 dB. Then, it turns up the speaker with the maximum output of 0.3 watts. The 7th pin of the IC101 is the audio mute terminal. If a voltage supply to the 6th pin of IC101 is supplied to this terminal, the IC101 stops functioning as the audio power amplifier regardless of the signal supplied to the 2nd pin of the IC101. And there is no sound from the speaker.

WX Radio

RF Amp (Q4)

The weather signal amplified by Q4.

1st Mixer (Q7)

The weather receiver signal which has been amplified in the RF front end is provided to base of 1st MIX Q7. The 1st local signal provided from the PLL module is supplied to the emitter of Q7 and converted to the 1st IF21.4 MHz.

Transmitter

The transmitter parts of the TK-514 is designed to amplify the RF signal oscillated and modulated by the synthesizer to approximately 500 mW by the power transistor of Q701.

Pre-emphasis and 300 Hz HPF. Limiter (IC104A, 104C)

The voice signal input from the microphone is pre-emphasized at the same time, the components below 300 Hz are reduce to minimize the interference to the CTCSS tone.
The signal which comes out of the IC104C is limited to a certain amplitude at the IC104A for the voice signal not to exceed the allowable band width assigned for transmission.

3 KHz LPF (IC104D, IC104B)

After passing the IC104A limiter, the signal is combined with the CTCSS tone at the digital circuits, passes the RV102, and is supplied to the 6 KHz LPF has the 4^{th} characteristics and adjust the assigned frequency band width not to exceed the allowable rang.

Tx Power (Q701)

The transmitted signal of approximately 7 mW, combined at the driver TR is supplied to the base of the Q701 amplifier. The transmitted signal amplifier to 0.47 W here passes the TX LPF of the 2^{nd} characteristics of the L702 and the L703, and RX/TX switching takes place by the D701. After this, The signal is provided to the antenna the TX LPF of the 1^{st} characteristics, consisted of the L700 and L701.

VOX Module

Pressing the PTT switch or turning on the VOX control switch changes unit operation from receive mode to transmit mode. At transmit mode if modulation frequency is inputted to the mic. The mic will convert the sound pressure into varying electrical signals. This signal will then go to pin 7 of the VOX Module. The central part of this module is IC501 which is a Hexagonal Inverter IC . The six inverters are as MIC/AMP and VOX AMP Circuit. At PTT mode only the MIC/AMP of this IC is being utilized.

VOX Mode of Operation

At VOX mode condition, whenever the modulating frequency is present, unit goes on TX Mode or is transmitting automatically for hands-free operation. As discussed above whenever the speech or modulating signal is convert into electrical signal by the microphone pin 2 of IC501 is always low due to inverter's electrical characteristic. At VOX Mode, this low signal then goes to R87 and R88 which is the VOX gain control (control the sensitivity or amount of voice level to trigger VOX operation).

"FRS" Frequency Synthesizer

Voltage Control Oscillator (VCO)

The VCO of oscillates 462.5625 MHz to 467.7125 MHz under the transmission condition and 441.1625 MHz to 446.3125 MHz under the reception condition. The VCO consist of the clip
oscillator of the Q705, and contains the oscillator frequency of approximately 21.4 MHz during the transmission/reception conversion. That is since the VCO should oscillate relatively low frequency during reception compared to transmission, the D707 is biased by the Q706.

Therefore as a result, the C729 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 D707 is adversely biased by the Q706, and as a result , The C729 which is added unparallel to the circuit of the VCO is removed to oscillate the desired transmission frequency. The VCO is controlled by the IC701 PLL IC in order to oscillate accurate frequency. The output frequency of the VCO is supplied to the IC701 PLL IC immediately. At the IC701, TCXO (12.8MHz) by the TCXO(M701) is compared to the output frequency of the VCO. The VCO is controlled the loop filter consisted of the R720, R721 and the C732, C733, C734 in order to oscillate the stable frequency wanted for the radio. The VCO controlled voltage which as passed the loop filter is supplies to the D731 varactor diode, and the VCO an oscillate the PLL programmed frequency by the capacity variance in the D731. In addition, the L714 on the VCO circuit function as frequency for the VCO to be properly controlled by the IC701 PLL IC.

RX/TX Buffer Amplifier (Q704)

The RF signal oscillate at the VCO is provide to the Q2 RX 1st mixer through the Q704 during the reception, and is provide to the Q702 power driver amplifier through the Q704 during the transmission.

PLL Frequency Synthesizer (IC701)

The PLL synthesizer of the signal loop PLL circuit with the reference of 6.25 KHz. The IC701 PLL IC includes all the function such as the reference oscillator, the driver, the phase detector, the lock detector, and the programmable divider. At the reference oscillator, the 12.8 MHz TCXO of the TCXO(M701) is connected to the pin 11 of the IC701 to oscillate the frequency of 12.8 MHz. The TCXO (12.8 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error rang even under a low temperature of -30° C. The phase detector send out the output power to the loop filter through 3rd pin of the IC701. If the oscillation frequency of the VCO is low compared to the reference frequency, the phase detector sends out output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send put can maintain the frequency set. The programmable divider maintain the desired frequency with control from the CPU. The dividing ratio, “N” to oscillate the desired frequency is as below :

N = VCO oscillation frequency / reference frequency

If the desired frequency is 462.5625 MHz

a) TX
   N = 462.5625 MHz / 0.00625 MHz = 74010

b) RX
   N = [462.5625 MHz – 21.4 MHz] / 0.00625 MHz = 70586

c) RX (WX)
   N = [161.650 MHz – 21.4 MHz] / 0.00625 MHz = 22440

CTCSS Processing

RX CTCSS Tone Processing

The received CTCSS tone is sent out through 9th pin of the IC1, and supplies to the IC107
switching capacitor filter through the IC102 analog switch. The voice signal which can effected the reception of the CTCSS tone is decreased enough at the IC107. The cut off frequency at the IC107 is adjusted by the IC301 CPU to suit the characteristice of the CTCSS tone.
The CTCSS tone received at the IC107 is supplies to the 10th pin of the IC301 CPU, and receives the desired CTCSS tone.

TX CTCSS Tone Processing

The TX CTCSS tone composed at the IC301 is properly reduce at the R182 and supplies to the IC107 switched capacitor filter reduce enough the components in the high frequency which can effect the voice communication. And then, the TX CTCSS tone is combined with the TX voice signal through the IC102 analog switch, and supplies to the RV102 TX deviation control volume.

CPU and Memory

Most of the control functions of the TK-514 are controlled by the IC301 CPU. The IC301 CPU has the internal ROM in the capacity of 16 K byte, and the program for the operation of the IC301. When the power of turned on, the IC301 reads the data necessity for the operation from the IC108 EEPROM, and decide the operation channel, frequency, etc. If the user alters any parameter of the radio, the IC301 updates the altered parameter to the IC108.

8. ALIGNMENT INSTRUCTIONS

WARNING

Any repairs or adjustment should be made under the supervision of a qualified radio-telephone technician.

TRANSMITTER

1. Power Supply Voltage

The power supply voltage should be set for 6.0 V DC measured at the radio during transmit.

Periodically check the supply voltage during the alignment procedure.

2. Frequency Setting
A. Connect a frequency counter or Communications Service Monitor to the antenna connector through an RF power attenuator (10 watt minimum rating, 20 dB minimum attenuation).
B. Depress the PTT switch.
C. Adjust the TCXO(M701) such that output frequency is equal to the channel Frequency with a maximum error of +/-300 Hz.
D. Release the PTT switch.

3. Output Power Alignment
A. Set the power supply voltage for 6.0 V Dc.
B. Connect a communications Service Monitor or a wattmeter and dummy load to the antenna connector
C. Depress the PTT switch.
D. To be convinced for 0.5 watt output power with a maximum error of +/-0.1 watt.
E. Release the PTT switch.

4. Deviation Adjustment
A. Connect an audio generator to the microphone use jack JIG. The audio frequency should be set at 1 KHz
B. Connect an FM deviation meter or communication Service Minitor to the antenna connector
Through an RF power attenuator (10 watt minimum rating, 20 dB minimum attenuator). Set the monitor to read peak diviation.
C. Depress the PTT switch.
D. Adjust the audio generator level 100 mV rms.
E. Adjust RV102 for 2.4 KHz maximum deviation (with CTCSS tone)
F. To be convinced 1.8 KHz without CTCSS tone (1 KHz dev. 20 dB up)
G. Release the PTT switch.

RECEIVER

Note : Insure that the proper channel has been selected before proceding with the alignment procedure.

1. Power Supply Voltage.
The proper voltage for testing is 6.0 V DC.

2. Receiver Alignment
A. Connect an RF signal generator or Communications Service Monitor to the antenna connect.
B. Connect a SINAD meter and oscilloscope across the speaker terminals.
C. Set the output level of the RF signal generator for - 47 dBm the generator should be set for
+/-1.5 KHz deviation of a 1 KHz tone.
D. Set the audio output level for 0.6 Vrms by adjusting volume.
E. Adjust T1 for maximum audio output.

F. Reduce the output level of the RF signal generator for produce a 12 dB SINAD indication.

9. SEMICONDUCTOR AND FUNCTIONS