THEORY OF OPERATION

TP-329

February 25, 2004

This PLL – controlled FRS (Family Radio Service) transceiver provides an accurate and stable multi-channels operation.

The transceiver consists of 7 main sections:

- **Transmitting Stage**
- **Receiving Stage**
- **Squelch Control**
- **Low Voltage Detection**
- **VCO and PLL**
- **Memory Backup**
- **VOX**

- **Transmitter**

The audio is picked up either from the internal or external MIC, the audio signal is then amplified by Audio Amplifier, IC4 LM324V (A.C), and filtered by a band pass filter IC4 (C.D) . The audio is adjusted by VR1 to obtain a suitable Audio frequency response, and then modulated with the carrier by VCO, through Varicap (D2).

The modulated signal output from the VCO is pre-amplified by Q12 2SC4901, Q13 2SC4901 and Q14 DRF1401. The RF output power is 0.5W. The amplified signal then passes through a low pass filter network, which consists of L12, C37 and C64 to be filtered out spurious emission, then arrive at the antenna switching circuit D4. The signal is filtered by another low pass filter circuit, which consists of L15, C62, L2, C66,NOTE2. These low pass filters are necessary to suppress the second and third harmonics. The signal is then fed into the antenna and is radiated out.

When the unit is transmitting, the audio signal is added to the TX VCO varicap D2. The capacitance of D2 is varied following the audio signal so as when mixed with the carrier to form the modulated signal.

- **Receiver**

The receiver uses a double frequency super-heterodyne circuit. The first Intermediate Frequency (IF) is 21.4MHz and the second is 450kHz.

The RF signal is received by the antenna, and passes through a low pass filter network, L2, C66, C65,L14, C81, C6, L19 and C4 to filter out the unwanted signals. The RF signal is amplified by Q1. This allows only the required band signal to pass through the SAW band pass filter (BPF) F101. Then the RF signal is mixed with the local oscillation frequency by the mixer Q2. A first IF (Intermediate Frequency) 21.4MHz is produced therefore. This IF passes through ceramic filter F102 to be further filtered from other unwanted signals. The first IF then is amplified by Q3 and the IF amplifier IC7 (DBL5018V). IC7 is an integrated RF amplifier which consists of a local oscillator, a demodulator, the second mixer, squelch control circuit, and RF amplifier. The 21.4MHz IF goes to IC7 pin16, and is mixed here within the second mixer and converted to second IF, which then passes through a ceramic filter F103 to filter out the unwanted signal at pin 5 of IC7 (DBL5018V). It is the

final IF signal and the audio signal is output from pin9 of IC7 (DBL5018V).

IC2 LM324(A,D) is the CTCSS processing circuit, from pin 14 of which, CTCSS signal is output. The amplified audio is output from IC2(B,C) LM324 pin 8, then passes through a volume control circuit, MCU pin 28,29,30 and 31. Finally it is amplified by Audio amplifier IC3 (NJM2070) and heard from the speaker.

- **Squelch Control**

The squelch control is also fulfilled by IC7 (DBL5018V). The audio signal passes through IC7 (DBL5018V) internal squelch control Q4,D7, C5, R19,R25,R24,R23 and C53 that form as a squelch amplifier. The filter produces a squelch signal (RF noise).

The Squelch signal is converted to DC signal by Q4 and is output to IC8 MCU pin 42 from IC7 pin 13. Mute signal is produced by MCU to control the audio amplifier circuit.

- **Low Voltage Detection**

The battery voltage divided by R79, R78 is input to IC8 pin 22 for voltage level comparison. If the battery voltage drops below 3.2 V, the low voltage symbol is to be displayed on LCD.

- **VCO and PLL**

Both signal reception and transmission share the same PLL (Phase Lock Loop) Circuit to produce the carrier or the receiving frequency. The local oscillator consists of a fundamental frequency oscillator X1 and a Phase Lock Loop (PLL) IC1 (KB8825). The fundamental frequency is determined by X1 (20.950 MHz) that is regarded as the PLL reference oscillator. This signal frequency is divided by IC1 and a 12.5 kHz signal is produced. When the frequency of VCO divided by IC1 is comparable to 12.5 kHz, PLL will control the VCO. When these two frequencies are matched, a constant control voltage is output from PLL to lock VCO in desired frequency.

- **Memory Backup**

IC5 is an EEPROM AT24C02, which acts as memory backup for the working channel code and the system parameters. Every time when the unit is switched on, the MCU will reset the system, clear the RAM, and recall the memory from the EEPROM to refresh the RAM in MCU IC8.

- **VOX**

The MIC signal is amplified and filtered by IC4 LM324V(A,D). The amplified signal is detected through a AD converter of MCU and is compared to DC level that can be detected by MCU. When the DC level matches the setting level. MCU then switches the unit into TX mode. VOX sensitivity can be adjusted by selecting MENU button for different environmental condition.

ADJUSTMENT PROCEDURE

Step	Item	Adjustment	Procedure
1	TX Frequency	VC1	Adjust VC1 to obtain demanded TX frequency.
2	TX	L12,L15,L2	Adjust L12,L15,L2 to obtain demanded TX power.
3	TX. Dev.	VR1	1. Inject an audio frequency (AF) -20dBm. 2. Adjust VR1 to obtain maximum TX deviation ≤2.5kHz. Check MIC modulation sensitivity, and it should be 2.5~10mV.
4	RX	L2	Adjust L2 to obtain demanded receiving sensitivity.
5	RX	L2	Adjust L2 to obtain demanded image frequency.

ALIGNMENT PROCEDURES

Important: The FCC requires that any frequency adjustment on a radiophone must be □□done by an authorized person, who is the holder of a current first or second class radiotelephone license.

This unit has been fully aligned at factory before shipment and does not normally require further adjustment. When necessary, however, the unit may be aligned as indited below.

Do not adjust any circuit in this radiophone unless you understand the circuit operation and have experience in adjusting radiophone. Tampering with the radiophone may upset the alignment and lower its performance.

Test Equipment Required:

Regulated DC power supply, 4.5V, 1A or higher; or3XAAA
Digital multimeter
Deviation meter
Frequency counter, 0~500MHz high impedance
Oscilloscope
RF power meter, 5W
Tracking generator, >160MHz
Distortion analyzer
Audio level meter
T-coupler
Alignment drivers, etc.

TROUBLE SHOOTING

Before troubleshooting, prepare your unit as follows:

- Install the batteries into your unit.
- Turn volume control fully clockwise so that it is all the way up.

Item.	Symptom	Cause/Remedy
1	LCD No Display	● Check batteries to see if the voltage is lower than 3V DC.
2	No sound	● Check to see if Q7, Q8, Q17or IC3 is defective.
3	No sound	● Check to see if the speaker is defective. ● Check to see if the external speaker jack is defective. ● Check to see if IC3 is defective.
4	No RX or audio distorted	● Check to see if the VCO and LPF circuits are defective. ● Check to see if T100 is defective.
5	No LED back light	● Check to see if LED or Q9 is defective.
6	Transmission with low modulation	● Check to see if VR1 is defective.
7	No TX	● Check to see if Q15 or Q18 is defective.
8	No function of PTT switch	● Check to see if Q18 is defective. ● Check to see if switch SW2 is defective.
9	No modulation when transmitting with CTCSS on	● Check to see if IC4 or VR1 is defective.
10	No RX with CTCSSS on	● Check to see if IC2 is defective. ● Check to see if IC7 is defective.

DISASSEMBLY INSTRUCTIONS

To remove the front and rear panels from the main chassis:

1. Remove the four screws from the bottom of the unit.