

# THEORY OF OPERATION

## 21-1845

This FRS transceiver provides accurate and stable operation.

The basic functions consist of 8 main sections :

- Power Supply Unit
- Receiver Stage
- Squelch Control
- Transmit Stage
- VCO and PLL
- Micro-controller
- CTCSS(QUIET)
- CALL

### Power

The unit is powered with an AC 117V adapter with output 9V DC.

1. 9V voltage is regulated to 5.0V by IC6 a low drop regulator LM2930 for the VCO & PLL power, as well as for CPU power, TX and RX power control circuitry. Q15 as a power switch for RX and TX. They are controlled by RX and TX CTL from CPU.
2. The power for the RF-power amplifier, is directly driven by 9V.
3. The power for the Audio amplifier section.

### Receive Stage

RF signal is received through the antenna and is passed onto a low pass filter network and amplified by Q4. This allows only the required band signal to pass through to the SAW band pass filter (BPF) F1. The mixer Q5 converts the incoming signal down to 21.7MHz. This signal again passes to a 21.7MHz XTAL band pass filter F2. This gives a better channel selectivity. The selected 21.7MHz signal is amplified by IF amplifier Q6 before it is passed to the second converter IC2 MC3361. IC2 MC3361 is the second converter. This converts the 21.7MHz signal down to 450KHz. This 450KHz signal is sent to discriminator. The detected audio signal passes through Audio Amplifier unit IC8 LM324, the 300Hz high pass filter and volume control. The audio signal then is amplified by audio amplifier IC10 LM368, and then fled to the speaker.

### Squelch Control

Squelch control circuitry consists of IC2 MC3361 and its related circuit. The squelch signal output from IC2 pin 9 pass through filter amplifier circuit composed by pin 10 and pin 11. The signal is amplified and detected by IC2 and generate a control voltage at pin 13 of IC2 for CPU to detect. VR1 is used to control the threshold of the squelch (squelch sensitivity). Pin 13 of IC2 is output a Lo to MCU IC5 pin 51 to indicate an incoming signal is detected.

### Transmit Stage

When the PTT switch goes down, the transceiver is switched into transmit mode through the TX/RX exchange control. Q15 is turned on for the power to the transmitter. The voice is picked up by the

condenser MIC and passes through the 300Hz high pass filter IC3 NJM3403 and is amplified by IC4 LM324 MIC amplifier circuit. The signal modulates with the carrier in the form of FM modulation. The modulated signal from the VCO goes into the power amplifier unit which consists of a buffer amplifier Q8, a driver amplifier Q7 and the RF power amplifier Q3. The signal then is finally radiated out through antenna.

### **VCO and PLL**

PLL circuitry is composed of IC1 M64082 the high frequency PLL and VCO. The channel information from the CPU is sent to the shift register in IC1 from pin 2. A control voltage is generated through the low pass filter to the VCO from pin 8 and is used to control RF frequency from Q1. Q9 is the RX/TX exchange switch. RF signal from the VCO passes through the buffer amplifier Q2 and then is fed into PLL IC1. In receive mode, the signal is fed to the receiver first mixer Q5 to convert the received signal to 21.7MHz. In transmit mode, this signal modulations with the audio signal and is passed through to the transmit power amplifier unit for transmission.

### **Microcontroller**

The Microcontroller MPD789405 is the main control of the whole transceiver unit. It is also used to drive the LCD to show the status of the unit. On the LCD, there is current working channel display, transmit indication, receive indication, QUIET indication, and low battery indication. The MCU scans the keypad to detect key pressed and released, then execute the function accordingly.

### **CTCSS(QUIET)**

The CTCSS consists of transmit and receive section. In CTCSS transmit, a CTCSS signal is added to the audio and modulated for transmission. CPU pin OUT1, OUT2, OUT3 and OUT4 output a 16 stage of digital values. These digital values then are passed through a digital to analog converter R164 to R171. The output is a step waveform, and then is filtered by a low pass filter and mixed with the audio. The receive section consists of a CTCSS decoder circuit which is used to separate the audio signal and a CTCSS signal for the existing of a CTCSS signal. The CTCSS signal is filtered and amplified by IC2 MC3361 and reshaped as a square wave by IC9 LM324. The signal then is input to the CPU and is determined the CTCSS signal value for the valid CTCSS received. The unit CTCSS (QUIET) code is selected by the combination of CTCSS switches P40,P41,P42,P43,P44 and P45 input to MCU IC5.

### **CALL**

When the CALL button is pressed, the transceiver is switched into transmit mode through the CPU control. IC306 MC14001 generates a ringer audio signal which is controlled by CPU. This 1.6KHz signal is amplified in the MIC amplifier unit and modulated for transmission.

## ADJUSTMENT PROCEDURE

STEP	ITEM	ADJUSTMENT	PROCEDURE
1	TX Frequency	VC1	Adjust VC1 to obtain demanded TX frequency.
2	TX	L11 L12 L13	Adjust L11, L12, L13 to obtain demanded TX power.
3	TX. Dev.	VR3	<ol style="list-style-type: none"> <li>1. Inject an audio frequency (AF) -20dBm.</li> <li>2. Adjust VR3 to obtain maximum TX deviation <math>\leq 2.5\text{KHz}</math>.</li> <li>3. Check MIC modulation sensitivity, and it should be 2.5~10mV.</li> </ol>
4	CTCSS Dev.		Check CTCSS deviation if it is normal.
5	RX		Check RX sensitivity if it is normal.
6	RX	L5 L1	Adjust L5 and L104 to obtain Max. Sensitivity.
7	RX	VR1	Adjust VR1 to obtain demanded squelch sensitivity.

## ALIGNMENT PROCEDURES

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

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

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

### **Test Equipment Required**

The following equipment is required for the alignment.

Regulated DC power supply, 0~12V, 1A or higher.

Audio signal generator, 10Hz~3KHz

Digital multimeter

Deviation meter

Frequency counter, 0~500MHz high impedance

Oscilloscope

RF power meter, 0.5W

High frequency standard generator, >500MHz

Tracking generator, >500MHz

Distortion analyzer

Audio level meter

T-coupler

Alignment drivers, etc.

## **DISASSEMBLY INSTRUCTIONS**

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

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

