THEORY OF OPERATION

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This PLL controlled FRS/GMRS transceiver provides accurate and stable operation.
The basic functions consist of 9 main sections:

① Power
② FRS/GMRS Receive Stage
③ Weather Receiver Stage
④ Squelch Control
⑤ Transmit Stage
⑥ VCO and PLL
⑦ Microcontroller
⑧ CTCSS
⑨ Vibration Circuit
⑩ VOX Circuit

POWER

The unit is powered with 6.0V (4×AA type) Alkaline type or 4.8V (4×1.2V) Ni-Cd type batteries. The power is spread into four sections.

① The power for the low battery detect circuitry. This circuit is used to detect the battery capacity and turn on the low battery icon accordingly.
② The power for the RF-power amplifier.
③ The power for the Audio amplifier section.
④ The 6.0V or 4.8V is regulated to 3 V by IC7 XC6201302 for the power supply to the MCU and its related circuitry. Under the MCU control, Q20, Q30 composes as a power switch for transmit and receive circuitry. For power saving purpose, Q21 and Q30 are turned on and off in a ratio of 1:3, That is 250msec on and 750msec off.

Receive Stage

RF signal is received through the antenna and is passed onto a low pass filter network and amplified by Q3. This allows only the required band signal to pass through the band pass filter (BPF). The mixer Q4 converts the incoming signal down to 21.4 MHz. These signals again pass to a 21.4 MHz XTAL band pass filter F1. This gives a better channel selectivity. The selected 21.4 MHz XTAL signal is amplified by IF amplifier Q18 before it is passed to the second converter IC1 BA4116. IC1 BA4116 is the second converter with a 20.95MHz local oscillator. This converts the 21.4 MHz signal down to 450 kHz. This 450 kHz signal is sent to discriminator after passed through F2 filter. The signal is demodulated, and outputs an audio signal. The detected audio signal passes through Audio Amplifier unit IC3 LM324, the 300Hz high pass filter, a final audio amplifier IC2 SL386D, and then to the speaker. When a call signal is received, the signal is extracted by IC3 LM324 when a call signal is detected. MCU then generates a buzz sound to alert

the user.

Squelch Control

Squelch control circuitry consists of IC1 BA4116 and its related circuit. The squelch signal output from IC1 pin 9 pass through filter amplifier circuit composed by pin 7 and pin 8. The voltage of pin 13 is detected by CPU pin 60 to determine squelch is on or off.

Transmit Stage

When the PTT switch is pressed, the transceiver is switched into transmit mode through the TX/RX exchange control Q20 and Q30. MCU turns on the power to the transmitter. The voice is picked up by the condenser MIC and passes through the band pass filter IC3C LM324 and is amplified by IC3B LM324 MIC amplifier circuit, and adjusted by VR1 to obtain a proper audio frequency response. 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 Q25, a driver amplifier Q12 and the RF power amplifier Q19. The signal then is finally radiated out through antenna. The unit will also be switched into transmit mode when the CALL button is pressed. A dual tone signal of 1.2 kHz and 600Hz will be fed into the transmitter for transmission.

VCO and PLL

PLL circuitry is composed by IC5 KB8825, the frequency synthesizer PLL and VCO. The channel information from the MCU is sent to the shift register in IC5 from pin 7. A control voltage is generated through the low pass filter to the VCO from pin 3 and is used to control RF frequency from Q1. Q6 is the RX/TX exchange switch. RF signal from the VCO passes through the buffer amplifier Q2 and then is fed back into PLL pin 1 of IC5. In receive mode, the signal is fed to the receiver first mixer Q4, and generate the first intermediate frequency (IF). In transmit mode, this signal modulation with the audio signal or call signal and is passed through to transmit power amplifier unit for transmission.

Microcontroller

The Microcontroller μPD789405 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, and low battery indication. The MCU scans the keypad to detect key pressed and released, then execute the function accordingly.

CTCSS

The CTCSS consists of transmitter and receiver section. In CTCSS transmission, a CTCSS signal is added to the audio and modulated for transmission. MCU pin OUT1, OUT2, OUT3 and OUT4 output a 16-stage of the digital values. These digital values then are passed through a digital to analog converters R134 and R135. The output is a step waveform, and then is filtered by a low pass filter and mixed with the audio. The receiver section consists of

a CTCSS decoder circuit which is used to separate the audio signal and the CTCSS signal for the existing CTCSS signal. The CTCSS signal is filtered and amplified by IC4(A, D) and reshaped as a square wave by IC4 LM324. The signal then is input to the MCU and is determined the CTCSS signal value for the valid CTCSS receive.

CALL

When the CALL button is pressed, the transceiver is switched into transmit mode through the MCU control. A dual tone signal of 1.2 kHz and 600Hz is generated by MCU. This dual tone signal of 1.2 kHz and 600Hz signal is amplified in the MIC amplifier unit and modulated for transmission.

Weather Receive Stage

Weather Receive Stage consists of Q22 and Q23. Weather signal is amplified by Q22 and Q23 is converted into 21.4M by mixer Q23. VCO of weather signal consists of Q5 and its related circuit.

Vibrating Circuit

Mcu generates a high level. M2 will vibrate by Q11. Mcu generates a low level and M2 will stop vibrating.

VOX Circuit

Audio signal picked up is filtered by IC3C LM324, then is amplified through IC3B LM324. The AC signal is detected by Mcu. When the AC level is matched with the level which Mcu sets. The unit will switch to transmit.

TROUBLESHOOTING

Before troubleshooting, prepare your unit as follows:

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

No.	Symptom	Cause/Remedy
1	LCD No Display	● Check batteries to see if the voltage is lower than 3.9V DC.
2	No sound	● Check to see if Q13, IC3 and IC4 is defective.
3	No sound	● Check to see if speaker is defective. ● Check to see if the external speaker jack is defective.
4	No RX or audio distorted	● Check to see if the VCO and LPF circuit are defective. ● Check to see if Q3, F1 or Q4 are defective.
5	No squelch control	● Check to see if IC1 is defective.
6	No LED back light	● Check to see if LED1, LED2 and Q8 are defective.
7	Transmit with low modulation	● Check to see if VR1 is defective.
8	No function of CALL switch	● Check to see if IC8 is defective. ● Check to see if SW3 is defective.
9	No TX	● Check to see if Q12, Q19 and Q25 are defective. ● Check to see if Q20 is defective.
10	No function of PTT switch	● Check to see if IC8 is defective. ● Check to see if switch SW6 is defective.
11	No modulation with transmitting with CTCSS ON	● Check to see if R124 and R135 are defective.
12	No RX with CTCSS on	● Check to see if IC4 is defective.

ADJUSTMENT PROCEDURE

Step	Adjustment	Procedure
1	VC1	Adjust VC1 to obtain demanded TX frequency.
2	L1 L3 L6 L15	Adjust L1, L3, L15 to obtain demanded TX power.
3	VR1	1. Inject an audio frequency (AF) –20dBm. 2. Adjust VR1 to obtain maximum TX deviation ≤2.5 kHz. 3. Check MIC modulation sensitivity, and it should be 2.5~10mV.
4	VR1	1. Set CTCSS 01, CTCSS 12 or CTCSS 38. 2. Adjust VR1 to obtain TX deviation with 0.55~0.8 kHz.
5	L1	Adjust L1 to obtain demanded receive sensitivity.
6	L1	Adjust L1 to obtain demanded image frequency.

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-adjusting radiotelephone. Tampering with the radiotelephone may upset the alignment and lower its performance.

Test Equipment Required:
The following equipments required for the alignment.

- Regulated DC power supply, 0~12V, 1A or higher; or 8.4V, 1A
- Audio signal generator, 10Hz~20 kHz
- Digital multimeter
- Deviation meter
- Frequency counter, 0~500 MHz high impedance
- Oscilloscope
- RF power meter, 5W
- High frequency standard generator, >160 MHz
- Tracking generator, >160 MHz
- Distortion analyzer
- Audio level meter
- T-coupler
- Alignment drivers, etc.

DISASSEMBLY INSTRUCTIONS
To remove the front and rear panel from the main chassis:

- Remove the four screws from the rear panel of the unit and remove the battery compartment.
- Remove the two screws from the PCB board.