

THEORY OF OPERATION

(19-1210)

This PLL-controlled VHF mobile business transceiver provides an accurate and stable 2-channel and mobile function operation. It is also implemented with the CTCSS feature that helps to reduce interference from other systems in the area operating on the same frequency.

The basic functions of the transceiver consist of seven main sections:

- Voltage regulator
- Transmitter
- Receiver
- LED indicator
- Local oscillator PLL(Phase Lock Loop) Circuit
- Memory backup
- CTCSS

1. VOLTAGE REGULATOR

The 13.8V power from the mobile battery is directly supply to the transmitter power amplifier Q8 and Q9. It is also regulated to 5 V by IC204 LM7805. The regulated 5V supplies to most of the main circuit of the unit, such as PLL, VCO and microcontroller circuit.

The regulated 5V is also controlled by the Microcontroller IC201 MC68HC05C4, either to current supply power to receive circuit or transmit circuit. At receive, the microcontroller turns Q202 and Q204 off, Q203 is on and the regulated 5 V supplies power to the receiver circuit through Q203. When the microcontroller detected the PTT, the unit then is switched to transmit mode and turns Q202 and Q204 on, and Q203 off, the regulated current supplies power to the transmit circuit.

2. TRANSMITTER STAGE

When PTT is pressed, Q207 is turned on for the MCU PTT detect, the unit then is switched to transmit mode. The audio signal is picked up from the external microphone. The audio signal then is amplified and filtered by a low pass filter NJM3403 IC207 and followed by a high pass filter LM324 IC208 to eliminate the unwanted signals. The audio signal is adjusted with VR201 to obtain a suitable audio frequency response, and then modulated with the carrier by VCO, through varicap (VD1).

When the unit is in transmit mode, the MCU IC1 also detects the CTCSS switch, if the CTCSS is on, the MCU sends out the assigned CTCSS codes corresponding binary data via pin 3-6. These codes are D/A by an R, 2R network and reshaped to become a CTCSS waveform and mixed with audio signal for

transmission.

The modulated signal output will be amplified by Q12. Q4, Q7, Q8, Q9 are the power amplifier section and boost the power to 5W. The amplified signal then passes through a low pass filter network that consists of L17, C50, L3, C51 to filter out the unwanted signals and the antenna switching circuit, D1, D2. The signal finally is filtered by another low pass filter circuit that consists of L1, L2, C1, C2, C3, C4 and C5. These low pass filters that are necessary to suppress the second and third harmonics.

3. RECEIVER

The RF signal is received by the antenna, and passes through a low pass filter network, which consists of L1, L2, L4, C1, C2, C3, C4, C5, C7, to filter out the unwanted signals and the antenna switching circuit of D1, D2 switching circuit to receive. The received RF signal then passes through a RF transformer L120, and is amplified by RF amplifier Q1. L6, L7, L8, C12, C14, C15, C16 and C17 are formed as the band pass filter. The RF signal then is mixed with the local oscillation frequency by the mixer Q2. A first IF 21.6MHz is produced. This 1st IF is passed through a crystal filter F1 to further filter other unwanted signals and have a better channel selectivity. The first IF then is amplified by Q3 and then input to a 2nd converter, IF amplifier IC209. The IF amplifier IC209 (MC3361) is an integrated IF amplifier which consists of a local oscillator, a demodulator, a second mixer, squelch control circuit, and IF amplifier.

IC209 MC3361 is the second converter which has its own local oscillator with a 21.145MHz Crystal oscillator. This converts the 21.6MHz signal down to 455KHz. This 455KHz signal is then amplified and detected. The signal consists of the audio signal and the CTCSS code. These detected outputs split into two paths - the audio and the CTCSS paths.

The audio path goes to the high pass (300Hz) filter, and it attenuates the CTCSS tone (67Hz ~ 251Hz), only allowing the speech signal (300Hz ~ 3KHz) to appear at the volume control. The audio signal then passed through the output amplifier IC205 (TDA2003) and then onto the speaker.

The CTCSS path goes to the CTCSS unit. IC202 is a lowpass filter and only allow the CTCSS tone to pass through. IC202 LM324 reshape the CTCSS to forms a square waveform input to MCU. The MCU built-in counter counts the internal signal. The obtained pulse reading compares to the assigned CTCSS code on the pre-programmed CTCSS chart. If they match within acceptable tolerance, MCU will turn on the audio amp.

The squelch control is also controlled by IC209 (MC3361). The second IF is passed through low pass filter R244 and C223, IC209 internal squelch control circuit, R246, C225 and C226 form as a squelch amplifier. The ceramic filter C223 produces a squelch signal (RF noise) which is amplified by Q208 regulated by D202 to produce a direct current voltage as a control voltage. The control voltage then is input to pin 12 of IC209, and pin 13 of IC209 output a digital squelch control signal to MCU for MCU to determine mute or unmute the audio speaker path.

4. LED INDICATOR

Two LED indicators - a red LED for transmission and a green LED for reception.

The green LED indicator lights up when the unit receives a signal.

The red LED indicator lights up when the PTT switch is pressed down and transmission starts.

A 7 segment LED display (red) will display channel number, which show number 1 when channel switch is selected to frequency 1; will show number 2 when channel switch is selected to frequency 2.

5. PLL (Phase Lock Loop) CIRCUIT

The receive and transmit are using a PLL Circuit to produce a carrier or the receive PLL Circuit frequency. The oscillator consists of a fundamental frequency oscillator X1, a PLL IC1 (LMX1511), VCO Q11. The frequency of the fundamental frequency oscillator is determined by Crystal X1 a 12.8MHz is chosen and as a PLL the reference oscillator. This signal is frequency divided inside IC1 and a 5KHz signal is produced. When the frequency from VCO is applied to IC1 and also frequency divided by IC1 to produce a frequency to compare with the PLL 5KHz, PLL will output a control voltage to VCO. When these two frequencies are matched a constant control voltage is output from PLL to lock VCO in desired frequency. The PLL also will output a lock indication to MCU to indicate the PLL is in frequency lock state.

6. MEMORY BACKUP

IC203 is an EEPROM AT93C46 that allows to store unit information. This acts as a memory backup for the working channel code and the system parameter. Every time when the unit is switched on, the MCU will reset the system, clear the RAM, and recall in the memory from the EEPROM to refresh the RAM in MCU. The EEPROM is Electrical Erasable and provides memory backup even the unit is not battery backup.

7. CTCSS

This is a subsonic selecting calling system named "CONTINUOUS TONE SQUELCH SYSTEM" used for eliminating interference for users operating on the same frequency in the same area. When the CTCSS function is enabled, the unit will also decode a CTCSS signal and mute/unmute the audio path accordingly.

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