THEORY OF OPERATION

TM-338 (US Version)

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This PLL - controlled VHF marine mobile transceiver provides an accurate and stable multi-channel operation.

The transceiver consists of 8 main sections:
- **Transmitting stage**
- **Receiving stage**
- **Low voltage detection**
- **Local oscillator PLL (Phase Lock Loop) Circuit**
- **Memory backup**
- **DSC Feature**
- **Large LCD**
- **GPS Message**
- **WX Alert**

- **Transmitter Stage**

    The audio is picked up from the internal Mic. The audio signal is then amplified by Audio Amplifier, IC205 NJM3403 (1/4), IC205 NJM3403 (2/4) and filtered by a low pass filter IC10 NJM3403 (3/4), IC10 NJM3403 (4/4). The audio that is adjusted by VR3 to obtain a suitable RF frequency deviation, modulates the carrier of VCO, through Varicap (VD302).

    The modulated signal output from the VCO is pre-amplified by Q2, Q1 and IC1. When the supply voltage is 13.8V, this signal will be amplified up to 1W or 25W. The signal is filtered by low-pass filter circuit which consists of L1, L2, C3, C1, C2, C5 and C6. These low pass filters are necessary to suppress the second and the third harmonics. The signal is then fed into the antenna input and radiated out. The signal is also fed into another path consisting of C9, C10, D3, D4 for sampling, and is converted into a direct current voltage for the Automatic Power Control (APC) circuit Q6, Q4, Q3 collector current used to maintain the output power stability.

    When the unit is transmitting, the channel control voltage is added to the TX VCO varicap VD301. The capacitance of VD302 is varied following the audio signal, therefore the carrier is modulated to form the modulated signal.

- **Receiver**

    The receiver uses a double frequency super-heterodyne circuit. The first Immediate Frequency (IF) is 21.6 MHz and the second is 455 KHz.

    The RF signal is received by the antenna, and passes through a low-pass filter network L1, L2, L3, C1, C2, C5, C6 to filter out the unwanted signals. The received RF signal then passes through a high RF transformer L10 and is amplified by RF amplifier Q9. L11, L12, L13, C15, C18, C20 form the band pass filter. The RF signal then is mixed with the local oscillation frequency by the mixer T1,T2,D1,D18,D20,D21. The first IF (Immediate Frequency) 21.6 MHz is produced. This IF is passed through a pair of crystal filter F1, F2 to further filter out other unwanted signals. The first IF then is amplified by Q11 and the IF amplifier IC4 (MC3361). IC4 is an integrated RF amplifier which consists of a local oscillator, a demodulator, a second mixer, squelch control circuit, and RF amplifier. The 21.6 MHz IF then is mixed here with second mixer and converted into 2nd Immediate Frequency (IF) 455 kHz. The 2nd IF passes through a ceramic filter F3 to filter out the residue unwanted signal at pin 5 of IC4 (MC3361) output this final IF signal and the

Audio signal is output at pin 9 of IC4 (MC3361).

The audio signal is amplified by IC6B feeding through de-emphasis circuit IC10A, IC10B.   The amplified audio then passes through a volume control VR201 and finally amplified by Audio amplifier IC11 (LA4629) and heard in the speaker.

The squelch control is also controlled by IC4 (MC3361).   The audio signal passes through the high pass filter R55 and C33 and IC4 (MC3361) internal squelch control R75, C38, C36 and R77 that form as a squelch amplifier to produce a squelch signal (RF noise).   This signal is amplified by Q12 and regulated by D2 to produce a direct current voltage as a control voltage. The control voltage then is input to pin 12 of IC4 (MC3361).   Pin 13 of IC4 sends the digital squelch control signal to the MCU to mute the audio speaker path and indicate the RX state through LCD.   R37 and VR203 form a variable resistor, which correspond to the squelch level.

- **Low Voltage Detection**

  The battery voltage divided by R216 and R251 is input to IC203 for voltage level detection. If the battery voltage drops below 9.5 V, LCD will indicate the battery is in low state.

- **Local oscillator PLL (Phase Lock Loop) Circuit:**

  The receiver and transmitter both share the same PLL (Phase Lock Loop) Circuitry to produce the carrier or the receive frequency. The local oscillator consists of a fundamental frequency oscillator Q20 and A phase Lock Loop (PLL) IC2 (LMX1511) When Q303 switch to saturation, the VCO will produce receiver local oscillator frequency.   The fundamental frequency is determined by X3 (12.8 MHz) and as the PLL reference oscillator.   This signal is frequency-divided by IC2 and a 12.5 kHz signal is produced. When the VCO frequency applied to IC2 pin10 and frequency-divided by IC2 produces a frequency 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. Otherwise the PLL will also output a unlock indication to MCU to indicate that the PLL is in the frequency unlock state.

- **Memory Backup**

  IC201 is an EEPROM AT24C16, which acts as a 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 IC203.

- **DSC Feature**

  DSC TX Encoded by MCU IC203, through R226, R237, R234, R223 produces D/A convert, and IC205B low pass filter forms FSK signal.   This signal is amplified by IC205 and filtered by IC10C, IC10D to modulate VCO frequency from the DSC signal transmit output.   Demodulate signal of receiver through IC6C high-pass filter and IC6D low-pass filter form FSK signal.   This FSK is signal decoded by IC9.   The DSC is restored by MCU IC203 with RX data from IC9 pin7.

- **Large LCD**

  All message through series bus from MCU to display driver IC204 and will be displayed through a 1″×1.5″ in 4×12 characters dot matrix LCD display.

- **GPS Message**

  External GPS Message is input to MCU through phototransistor IC13 SPC714M.   LCD will display the machine current location and time message in idle state.

- **WX Alert**

WX receiver gets message from demodulator IC4 (DBL5018) and selected by a band pass filter IC6A (NJM3403). Then decoded by IC407 (NJM2211). The output message sent to MCU IC203 to processing data. Then give out alarm and display.