

# THEORY OF OPERATION

TM366-USA  
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This PLL controlled VHF marine mobile transceiver provides an accurate and stable multi-channel operation.

The transceiver consists of 14 main sections

- Transmitting stage
- Receiving stage
- Local oscillator PLL (Phase Lock Loop) Circuit
- Memory backup
- Low voltage detection
- Large LCD
- Local/distance Circuit
- 2nd Receiver
- WX Alert Circuit
- PC Program
- DSC Feature
- GPS Message
- MPU

- **Transmitter Stage**

Voice audio is picked up from the internal Mic. The audio signal after passing through the MIC mute switch, a pre-emphasis network are then amplified and limited (IDC: instantaneous deviation control) by Audio IC205C, IC205B and filtered by a low pass filter IC10C, IC10D. The audio that is adjusted by VR3 to obtain suitable the frequency deviation, modulates the carrier of VCO, through Varicap (VD2).

The modulated signal output from the VCO is pre-amplified by Q2, When the supply voltage is 13.6V, this signal will be amplified by IC1 up to 1W or 25W RF power. Then the signal is filtered by low-pass filter circuit of which consists of L1, L2, L4, C1, C2, C3, C5, C6, C14, C47. These low pass filters are necessary to suppress the second and the third harmonics as higher. The signal is then fed into the antenna terminator 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 IC12, Q5, Q14, Q15, Q24 to control the voltage of IC1 Pin 2 to maintain the output power stability. Q15 is used control Hi/Lo power

When the unit is transmitting, the channel control voltage is added to the TX VCO varactor diode VD6. The capacitance of VD2 is varied following the audio signal, therefore the carrier is modulated to form the modulated signal.

- **Receiver Stage**

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

The RF signal is received by the antenna, and passes through a low-pass filter network L1, L2, L3, L9, C1, C2, C3, C5, C6, C14, C47 to filter out unwanted signal. 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 signal from Q10 by the mixer D22, D23. The first IF (Immediate Frequency) 21.4 MHz is produced. This IF is passed through a coil T2 and 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 IC7. (IC7 is an integrated IF amplifier which consists of a local oscillator, a demodulator, a second mixer, squelch control circuit, and IF amplifier). The 21.4 MHz IF then is mixed by the 21.950 MHz signal from the pin9 of IC16 here with second mixer and converted into 2nd Immediate Frequency (IF) 450 kHz. The 2nd IF passes through a ceramic filter F4 to filter out the residue unwanted signal at pin 5 of IC7 output this final IF signal and The demodulated AF signal is output at pin 9 of IC7.

The demodulated AF signal pass through IC15 then passes through a volume control VR201 through de-emphasis circuit feeding IC10A, IC10B. and finally amplified by Audio amplifier IC11 and heard in the speaker.

The squelch control signal also produced by IC7, the rectified noise signal is output by Pin 14 of the IC7. Pass through the network by composition of C170, R44 are sends the digital squelch control signal to the MCU to mute the audio speaker path and to indicate the RX station on LCD, R214, R217 and VR203 form a variable resistor, which correspond to the squelch level.

- **PLL synthesizer**

The receiver and transmitter both share the same PLL synthesizer to produce the stability carrier frequency or the 1st local oscillation frequency.

The RX VCO is comprised of Q301 and VD1, when Rx 5Vvoltage is supply, the VCO will produce local oscillator frequency which at 21.4MHz below. The TX VCO is comprised of Q303 and VD2 when TX 5Vvoltage is supply it oscillates at the fundamental frequency, with direct frequency-modulation using varactor diode VD6 The high stability frequency is determined by crystal X2 (20.950 MHz) and as the PLL reference oscillator. This signal is frequency-divided by IC16 and a 12.5 kHz signal is produced. When the VCO frequency applied to IC16 pin1 and frequency-divided by IC2 produces a frequency comparable to 12.5 kHz, PLL IC pin 3 will output a PD voltage to 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 IC pin 5 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 AT24C64, 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.

- **Low Voltage Detection**

The battery voltage divided by R250 and R251 through R254 is input to IC203 for voltage level detection. If the battery voltage drops below 10 V, LCD will indicate the battery is in low state.

- **Large LCD**

All message through series way from MCU to display driver IC401 and will be displayed through a 38×26mm 4×12 characters dot matrix LCD display.

- **Local/distance circuit**

Local/distance circuits are composed of D15, and R35. When local SW is on high level, receiver sensitive is high otherwise is low.

- **2nd Receiver**

2nd receiver circuit is a dedicated channel 70 watchkeeping receiver for DSC decoder. RF input is from C101 of main PCB, the received RF signal then passes through a high RF transformer L505 and is amplified by RF amplifier Q501, L506, L507, L508, C15, C18, C20 form the band pass filter. Then passes through a high RF transformer L509 is mixed with the first local oscillation frequency by the mixer D501, D502,. The first IF (Immediate Frequency) 17.9 MHz is produced. This IF signal is passed through a transformer coil L510 and a pair of crystal filter F1, F2 to further filter. The first IF then is amplified by Q503 and the IF amplifier IC501. IC501 is an integrated IF amplifier which consists of a 2<sup>nd</sup> local oscillator (18.355Mhz), a demodulator, a second mixer, squelch control circuit, and IF amplifier circuits). The 17.9MHz 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 F503 to filter out the residue unwanted signal at pin 5 of IC501 output this final IF signal and The demodulated FSK signal is output at pin 9 of IC501 through R517 C543 pass J501.J4 fed in IC15 pin 13 of the main PCB.

The squelch control is also controlled by IC501. The audio signal passes through the low pass filter R514, R515, C541 and IC501 internal squelch control R516, and C542 that form as a squelch amplifier to produce a squelch signal (noise) from pin11 of IC501 output, this signal is then amplified by Q505 and regulated by D505 to produce a direct current voltage as a control voltage then it is fed through R526 and pin14 to IC501 from pin13 output the busy signal.

- **WX Alert function**

The 1050Hz tone of receiver through IC6A composed band-pass filter and IC6B amplifier form square wave signal. To feed IC203 pin 97, then produce weather alert from IC203 pin2.

- **PC Program**

J203 on CPU board is connected with the outside cabinet through a cable with a round pin5 plug. Software upgrade and clone can be functioned when an exclusive interface control box is connected with RS-232 interface of computer.

When the light on control box is green, J203 pin4 is high level (5v), CPU programming is performed, and the software is upgraded. When the light on control box is red, clone function is performed.

- **DSC Feature**

- DSC TX Encoded by MCU IC203, through RP1, R237, R234, produces D/A convert, and IC205D low pass filter forms FSK signal. This signal is amplified by IC205A and filtered by IC10C, IC10D to modulate VCO frequency from the DSC signal transmit output.

DSC RX decode: DSC signal from 2nd receiver is Send to IC15 pin13 on the RF unit from pin 14 of IC15 output, then the signal passes through IC6C high-pass filter and IC6D low-pass filter form FSK signal. This FSK is signal decoded by IC609. The DSC is restored by IC203 [MCU] with RX data from pin1 Of IC609

- **GPS Message**

External GPS Message is input to MCU through phototransistor IC207 LCD will display the ship current location and time message.

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- **MPU**

Operation is controlled by 16-bit MPU IC U203 (HD64F3062).The system clock uses a 14.7456MHz crystal for a time base. IC U202 reset the MPU when the power is supplied by the DC power supply, and monitors the voltage of the regulated 5V power supply line.