

# THEORY OF OPERATION

TM308EUL for Cobra  
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This PLL controlled VHF marine mobile transceiver provides an accurate and stable multi-channel operation.

The transceiver consists of 15 main sections

- Transmitting stage
- Receiving stage
- Local oscillator PLL (Phase Lock Loop) Circuit
- Memory backup
- High / Low voltage detection
- Large LCD
- Local/distance Circuit
- 2nd Receiver
- PC Program
- DSC Feature
- GPS Message
- ATIS Feature
- PA Feature
- Recorder Feature
  
- **Transmitter Stage**

The local mic signal is pre-emphasized and amplified via U12B, and recorded signal from the recorder IC U17. One of 2 signals is picked up by the electric switch U9, CPU coding DSC signal, one of them amplified via U12A, by pass filter U3, and VR4 deviation and is sent to VCO modulation carrier. 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 of which consists of L1, L2, L3, L4, C94, C95, C96, C5, C7 and C8. These low pass filters are necessary to suppress the second and the third harmonics as higher. The signal is then fed into the antenna input and radiated out. The signal is also fed into another path consisting of C4, C6, D1, D2 for sampling, and is converted into a direct current voltage for the Automatic Power Control (APC) circuit U5 (Q19 to control the voltage of U6 Pin 2 to maintain the output power stability. U10 pin54 is used control Hi/Lo power).

When the unit is transmitting, the channel control voltage is added to the TX VCO varicap VD4. The capacitance of VD3 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, L4, L5, L9, C94, C95, C96, C5, C7, C8, C9 C101 and C102 to filter out unwanted signal. The received RF signal then passes through band pass filter F1 and is amplified by RF amplifier Q5. The RF signal then passes through the band pass filter F2 and is mixed with the local oscillation frequency by the mixer T1, T2, Q11. The first IF (Immediate Frequency) 21.4 MHz is produced. This IF is passed through a pair of crystal filter F3, F4 to further filter out other unwanted signals. The first IF then is amplified by Q16 and the IF amplifier U1. U1 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 here with second mixer and converted into 2nd Immediate Frequency (IF) 450 kHz. The 2nd IF passes through a ceramic filter F5 to filter out the residue unwanted signal at pin 5 of U1 output this final IF signal and The demodulated AF signal is output at pin 9 of U1.

Demodulated audio signal is amplified and filtered by U2B and switched by U9, one part is for Volume switch to adjust the volume, the other is send to recorder IC U16, then U11B de-emphasis the audio signal from the volume switch, and U18 to amplify and send to 3W inside and outer speakers.

The squelch control signal also produced by U1, the rectified noise signal is output by Pin 14 of the U1. Pass through the network by composition of C28, R135 and U2A are sends the digital squelch control signal to the MCU to mute the audio speaker path and to indicate the RX station on LCD, R100 and VR1 form a variable resistor, which correspond to the squelch level.

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

The receiver and transmitter both share the same PLL (Phase Lock Loop) Circuitry to produce the carrier frequency or the receiver local oscillation frequency. The local oscillator consists of a fundamental frequency oscillator Q7 and A phase Lock Loop (PLL) U7. When Rx 5V voltage is supply, the VCO will produce receiver local oscillator frequency. The high stability frequency is determined by crystal X1 (20.950 MHz) and as the PLL reference oscillator. This signal is frequency-divided by U7 and a 12.5 kHz signal is produced. When the VCO frequency applied to U7 pin1 and frequency-divided by U7 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**

U4 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 U10.

- **High / Low Voltage Detection**

The battery voltage divided by R163 and R162 through R164 is input to U10 for voltage level detection. If the battery voltage drops below 9.5 V, LCD will indicate the battery is in low state. If the battery voltage is above 16V, LCD will indicate the battery is in excessive state and produce a high tone alert.

- **Large LCD**

All message through series bus from MCU to display driver IC401 and will be displayed through a 63×47mm, 35×72 characters dot matrix LCD display.

- **Local/distance circuit**

Local/distance circuits are composed of Q1, Q6, R110, R112 and D5. When local SW is on low level, receiver sensitive is high otherwise is on low.

- **2nd Receiver**

2nd receiver circuit is as figure. RF input is from C96 (0.5PF) 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 U501. U501 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 U501 output this final IF signal and The demodulated FSK signal is output at pin 9 of U501 (DBL5018) through R517 C543 pass J501. J5 fed in U20B pin6 of the main PCB.

The squelch control is also controlled by U501. The audio signal passes through the low pass filter R514, R515, C541 and U501 internal squelch control R516, and C542 that form as a squelch amplifier to produce a squelch signal (noise) from pin11 of U501 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 U501 (from pin13 output the busy signal).

- **PC Program**

J1 on CPU is connected with the outside cabinet through a cable with a round pin8 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, J2 pin2 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 U10, through R126, R69,C163, C165 filter and amplified by U12A and filtered by U3 to modulate VCO frequency from the DSC signal transmit output.

DSC signal is received from 2nd receiver, and passes through U20B filter form FSK signal, then the Demodulated signal is sent into pin12 of U10. This FSK signal is decoded by U10. The incoming DSC call message will be restored in U4.

- **GPS Message**

External GPS Message is input to MCU through phototransistor U9 and LCD will display the machine current location and time message in idle state.

- **ATIS Feature**

ATIS encoded by MCU (U10), through R126, R69, C163, C165 filter and amplified by U12A and filtered by U3 to modulate VCO frequency from the DSC signal transmit output.

ATIS signal is received and demodulated by U1. Demodulated signal is sent into pin13 of U10, from pin 1 of U20A output. This FSK is signal decoded by U609. The incoming ATIS message will be restored in U4.

- **PA Feature**

The local mic signal is pre-emphasized and amplified via U10A, picked up by the electric switch U9, passes through the Volume switch, de-emphasized by U13B, and amplify via U14, and through the relay G1 send to outside PA speaker.

- **Recorder Feature**

The local mic signal is pre-emphasized and amplified via U10A,and receiver demodulated signal from U11, one of them is picked up by the electric switch U9, then send to Recorder IC U17 recording.

The recorded signal via the electric switch U9 to volume switch, de-emphasized by U13B, and amplify via U14 send to inside and outside speakers.

The recorded signal via the electric switch U9 can be sent to VCO modulation carrier.

## ALIGNMENT PROCDDURES

This transceiver is completely aligned at the factory and does not require any adjustments for installation. However it is considered as good practice to verify that none of the adjustments are changed.

Do not adjust any circuitry 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:

- Regulated DC power supply, 10 -16V adjustable, 7A
- Audio signal generator, 10Hz~3kHz
- Digital multimeter
- Deviation meter {linear detector}
- Frequency counter, 0~500MHz high impedance
- Oscilloscope
- RF power meter,  $\geq 30W$
- High frequency standard generator, >500MHz
- Tracking generator, >500MHz
- Distortion analyzer
- Audio level meter
- T-coupler
- Sinad meter
- Alignment drivers, etc.
- Or a radio communication test set 2955 (MARCONI INSTRUMENTS)

## ADJUSTMENT PROCEDURE

Step	Item	Adjustment	Procedure
1	TX Frequency	VC1	Adjust VC1 to obtain demanded TX frequency. $\pm 200\text{Hz}$
2	TX Power Hi	VR2	Adjust VR2 to obtain demanded TX power $22 \pm 1\text{W}$ .
3	TX. Deviation	VR4	<ol style="list-style-type: none"> <li>1. Inject an audio frequency (AF) <math>-20\text{dBm}</math>.</li> <li>2. Adjust VR4 to obtain maximum TX deviation <math>\leq 5\text{kHz}</math>.</li> <li>3. Check MIC modulation sensitivity, which should be <math>7 \sim 13\text{ mV}</math></li> </ol>
4	RX		<ol style="list-style-type: none"> <li>1. Check RX sensitivity if it is normal.</li> <li>2. Check RX S/N and Distortion</li> <li>3. Repeat step 1 to 2 at CH28 and CH3</li> </ol>
5	RX	VR1	Adjust VR1 to obtain Best Squelch response.
6	DSC test		Check Modulation index for DSC. Modulation index for DSC. Frequency error (demodulated DSC signal)
7	ATIS test		Check Modulation index for ATIS. Modulation index for ATIS. Frequency error (demodulated DSC signal)
8	PA test		Check PA function
9	Recorder test		Check mic recorder ,Rx recorder and recorded Tx

## 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.

Item	Symptom	Cause/Remedy
1	Unit is not able to turn on.	<ul style="list-style-type: none"> <li>● Check the power voltage and power switch.</li> <li>● Check to see if regulator U14 defective.</li> </ul>
2	No sound with AF signal applied to pin 4 of IC14.	<ul style="list-style-type: none"> <li>● Check to see if U18 and /or associated components is Defective.</li> <li>● Check to see if speaker on control circuit Volume switch, U13B, is defective.</li> </ul>
3	Squelch circuit inoperative.	<ul style="list-style-type: none"> <li>● Check to see if VR1 is defective.</li> <li>● Check to see if U1 is defective.</li> </ul>
4	No receiver (RX)	<ul style="list-style-type: none"> <li>● Check to see if U7 is defective.</li> <li>● Check to see if U1 audio output at pin 9 is defective.</li> <li>● Check Q5,F1,F2</li> <li>● Check 21.4MHz output of first mixer Q11.</li> <li>● Check 21.4MHz output of crystal filters F3, F4.</li> <li>● Check 21.4MHz output of first IF amplifier Q16.</li> <li>● Check 450kHz signal from ceramic filter F5.</li> <li>● Check to see if VCO circuit is defective.</li> <li>● Check to see MCU is defective.</li> </ul>
5	Low receiver sensitivity	<ul style="list-style-type: none"> <li>● Check to see if antenna is bad connecting.</li> <li>● Check to see if the output from Q5, Q11, Q16 and F3,F4 is defective.</li> </ul>
6	No transmission (TX)	<ul style="list-style-type: none"> <li>● Check to see if the PTT switch is defective.</li> <li>● Check to see if power transmit circuit Q17 are defective.</li> <li>● Check to see if VCO circuit is defective.</li> <li>● Check PLL control voltage if it reads <math>2 \pm 0.2V</math> at 156.05MHz.</li> </ul>
7	Poor or no modulation	<ul style="list-style-type: none"> <li>● Check to see if the microphone or MIC jack is defective.</li> <li>● Check to see if U12B and/or its associated components are defective.</li> </ul>
8	Deviation of transmit frequency	<ul style="list-style-type: none"> <li>● Check the frequency of 20.950MHz crystal X1.</li> <li>● Adjust VC1 and verify the transmit frequency.</li> </ul>

## DISASSEMBLY INSTRUCTIONS

To disassembly, follow the procedures below:

- A. Unscrew 6 screws for the bottom cabinet of the main unit.
- B. Unscrew the 4 screws of hand MIC.

