THEORY OF OPERATION

TM886-USA

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

The transceiver consists of 6 main sections:

- **Transmitter**
- **Receiver**
- **Low voltage detection**
- **Weather alert**
- **Local oscillator PLL (Phase Lock Loop) Circuit**
- **Memory backup**

- **Transmitter**

  The audio is picked up from the internal MIC, the audio signal is then amplified by Audio Amplifier, IC7 LM324 (4/4), IC7 (3/4) and filtered by a low pass filter IC7 (2/4). The audio is adjusted with VR3 to obtain a suitable Audio frequency response, and then modulated with the carrier by VCO, through Varicap (D8).

  The modulated signal output from the VCO is pre-amplified by Q3, Q4 and Q2. Then it is amplified by Q20, Q19 .The amplified signal then passes through a low -pass filter network which consists of L3, C98, C19, L6, C91 filters out spurious emission, and the antenna switching circuit, D2, D1. The signal is filtered by another low-pass filter circuit which is consists of C16, L2, C5, C11, L1, C4, C1. These low pass filters are necessary to suppress the second and third harmonics. The signal is then fed into the antenna input and radiated out. The signal is also fed into another path consisting of C88, D5, R47 for sampling, and is converted into a direct current voltage for the Automatic power control (APC) circuit IC1, Q6, VR5, VR1,Q9.

  When the unit is transmitting, the audio signal is added to the TX VCO Varicap D8. The capacitance of D8 is varied following the audio signal and when mixed with the carrier to form the modulated signal.

- **Receiver**

  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 C1, L1, C4, C11, L2, C5, C16, L5, C10 to filter out the unwanted signals, the antenna switching circuit D1 switching circuit to receive. The received RF signal then passes through a SAW filter F4. And is amplified by RF amplifier Q5. The amplified RF signal passes through another SAW filter F5. The RF signal then is mixed with the local oscillation frequency by the mixer Q18. A first IF (Immediate Frequency) 21.4 MHz is produced. The IF

is passed through a pair of crystal filter F1 (1/2), F2 (2/2) to further filter other unwanted signals. The first IF then is amplified by Q1 and the IF amplifier IC3 (BA4116). IC3 is a integrated RF amplifier which is consists of a local oscillator, a demodulator, a second mixer, squelch control circuit, and RF 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 F3 to filter out the residue unwanted signal at pin 5 of IC4 (BA4116) output this final IF signal and the Audio signal is output at pin 9 of IC3 (BA4116).

The audio signal is fed through a volume control VR6 and finally amplified by Audio amplifier IC2 (NJM2070) and heard in the speaker.

The squelch control is also controlled by IC3 (BA4116). The second IF passes through IC3 (BA4116) internal squelch control R114, C164, C165 form as a squelch amplifier. The ceramic filter produces a squelch signal (RF noise). Pin 14 of IC3 sends the digital squelch control signal to the CPU mute the audio speaker path. Pin 12 of IC3 output a RSSI level to the CPU.

- **Low Voltage Detection**

  The battery voltage, divided by R21, R22 is input to IC5 Pin 41 for voltage level sample.

- **Weather alert**

  The weather signal pass through a band pass filter which is consist of IC8(B,C,D) LM324, and is reshaped by IC8A LM324, then is detected by IC5 UPD789407.

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

  The receiver and transmitter both share the same PLL (Phase Lock Loop) Circuit to produce the carrier or the receive frequency. The local oscillator consists of a fundamental frequency oscillator X1 20.95MHz and IC4 (KB8825). A phase Lock Loop (PLL) IC4 (KB8825), TX VCO Q17 and RX VCO Q16. The fundamental frequency is frequency divided by IC4 and a 25 kHz signal is produced. When the VCO frequency applied to and frequency divided by IC4 produces a frequency comparable to 25 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. The PLL also will output a lock indication to CPU to indicate the PLL is in frequency lock state.

- **Memory Backup**

  IC10 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 CPU will reset the system, clear the RAM, and recall in the memory from the EEPROM to refresh the RAM in MCU .

ALIGNMENT AND ADJUSTMENT

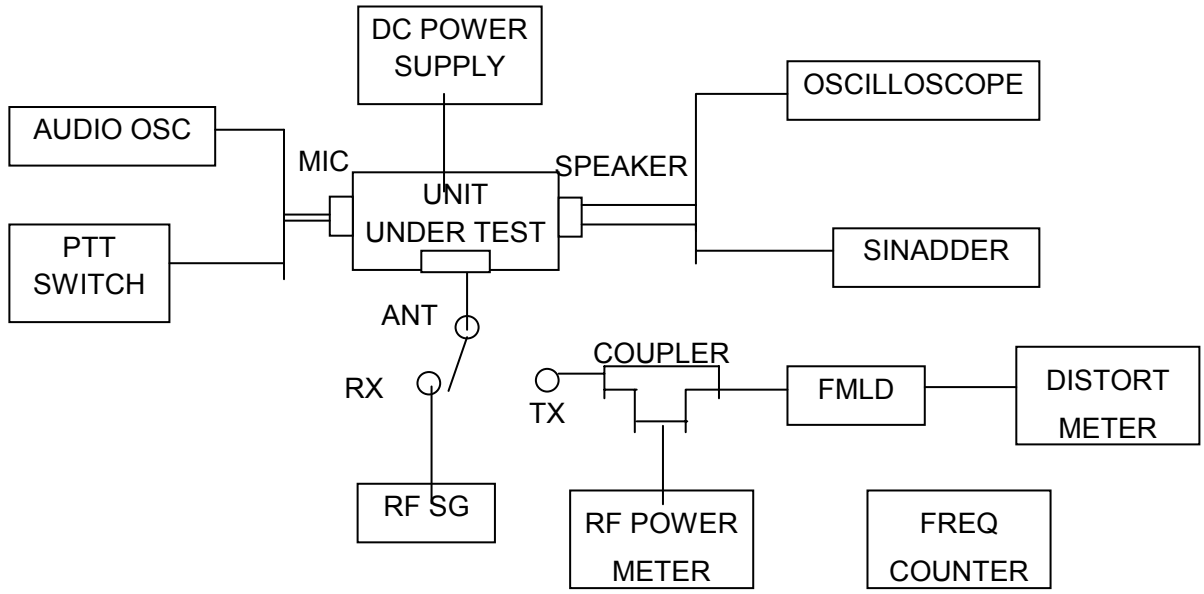
This transceiver is completely aligned at the factory and does not require any adjustments for installation. However it is considered as good practice to verify that none of the adjustments have changed.

The test equipment listed below are used for the test setup shown in Fig. 3.1.
This test setup used either partially or totally during the following adjustmentslibr.

A.TEST EQUIPMENT

1)	DC Power Supply (7.2V DC)	0 - 15V 3A max.
2)	RF Power Meter	10 W 50 Ohm 100-200 MHz
3)	RF Signal Generator	100-200 MHz, 50 ohm termination
4)	FM Linear Detector (FMLD)	100-200 MHz
5)	Frequency Counter	1-500 MHz
6)	Oscilloscope	20 MHz
7)	Distortion Meter	
8)	SINADDER (Trademark of Helper Instruments Co.)	
9)	Audio Oscillator	
10)	Toggle Switch (for use as PTT switch).	

Fig. 3.1



ADJUSTMENT PROCEDURE

Step	Adjustment	Test Point	Procedure
1	L16 Receive	TP1	1. Connect digital voltmeter to TP1 on RF PCB. 2. Set CH16. 3. Adjust L16. 4. TP1 voltage 1.2~1.6V DC.
2	L17 Transmit	TP1	1. Connect a digital voltmeter to TP1 on RF PCB. 2. Set CH01 INT. 3. Adjust L17. 4. TP1 voltage 1.8~2.2V DC.
3	VC1		1. Connect the antenna coupler output to a frequency counter. 2. Set channel to CH16 (156.800 MHz). 3. Adjust VC1 to obtain a frequency reading 156.800 MHz ± 200 Hz.
4	VR3 Modulation		1. Connect the antenna coupler output to an FM linear detector. 2. Connect Audio Oscillator to Microphone Jack. 3. Set unit to transmit mode. 4. Set audio oscillator output to -23dBm 1 kHz. 5. Adjust VR3 to obtain ±4.5 kHz deviation.
5	VR5, VR1 RF power output		1. Connect a RF power meter to antenna connector through antenna coupler. 2. Set unit to transmit mode. 3. Adjust VR5 to obtain: High power 4.5~5.5W. 4. Adjust VR1 to obtain: Low power 0.8~1.2W
6	T1		1. Connect a VHF signal generator to the antenna connector. 2. Connect a SINADDER to speaker jack. 3. Set signal generator to output 1 kHz with ± 3 kHz deviation. 4. At frequency 156.800 MHz, adjust T1 to get maximum voltage and minimum distortion.

TROUBLESHOOTING

Item	Symptom	Possible Cause
1	Unit does not turn on.	● Defective power switch VR6. ● Check the battery voltage. ● Defective regulator IC6.
2	Speaker no sound with AF signal applied to volume control	● Defective volume control. ● Defective speaker. ● Defective IC2 and/or associated components.
3	Squelch circuit inoperative	● Check squelch control. ● Defective IC3 and/or associated circuitry between pin 9, 10 and 11.
4	No receive (RX)	● Defective regulator IC6. ● Check TP1 voltage 0.5 – 3.5V. ● Check second OSC 20.95MHz, pin1 of IC3. ● Defective Q21, Q24, Q7. ● Check IC3 audio output voltage at pin 9. ● Defective audio signal buffer Q12. ● Defective F1 and F2.
5	Low receiver sensitivity	● Check antenna and connector for possible corrosion or bad connection. ● Failure of the output from Q5, Q18, Q1, IC3 ● Check the output level of local OSC.
6	No transmit (TX)	● Defective PTT switch. ● Defective regulator IC7. ● Check TP1 voltage 0.5 – 3.5V; ● Check power transmits circuit Q19, Q20, D2 and D1; ● Defective D11, Q4, Q2. ● Check power control circuit IC1, Q6, VR6, VR1, Q9 and D5;
7	Low RF power output	● Check RF power output from Q19, If it checks good, then check and antenna switching diode D2, D1.If not good then check the voltage level outputs of the drive amplifiers Q2 and Q4 as well as the associated circuitry.
8	Poor or no modulation	● Defective microphone. ● Defective IC7 and/or its associated components.
9	Deviation of transmit frequency	● Check crystal X1and VC1.