



# **Maintenance Manual**

**PZ-S series Portable Radio**

**Circuit Analysis**

**PZ-S400, PZ-S100**



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## **FRONT ASSEMBLY**

The Front Assembly includes the speaker, PTT key button, Monitor button.

### **Microphone and Speaker**

The microphone mounts directly onto the main PCB board. The microphone receives audio through the hole in the front housing.

The speaker mounted onto the front housing, and connects to the main PCB board through the solder wire.

## **REAR ASSEMBLY**

The Rear Assembly provides a die-casting frame for main board and sub-board. The antenna connects to a SMA type connector that is mounted to the top of the frame.

The circuit of MAIN board of PZ-S series radio consists of the Audio/Logic circuitry (which controls the functions of Radio) and the RF circuitry.(which decides the communication quality and performance) The circuit of sub board consists of battery connectors and fuse for protected the main circuit.

## **CIRCUIT ANALYSIS**

### **AUDIO/LOGIC SECTION**

The Audio/Logic circuit consists of logic circuitry and audio receiver/transmitter circuitry. The Audio/Logic circuit is common to UHF and VHF models. A single microprocessor on the board controls the operation of the radio. The processor scans the control switch and issues commands to the RF board. The Audio/Logic circuitry consists of primarily of the followings.

- Microprocessor
- Personality EEPROM
- Audio signal processor

The schematic diagram is described in Fig . The first sheet contains all input/output connection for the board. And the second sheet contains logic circuitry and audio signal circuitry.

### **Microprocessor U100**

A single microprocessor controls the all operation of the PZ-S series radio. All lines connect to the analog portion of the board are first RF bypassed by RC circuits. Most of these RC circuits are physically located as close as possible to each microprocessor pin of the board.

The microprocessor contains internal flash memory. The microprocessor normally executes the radio software code in this Flash memory.

The Reset circuit consists of voltage detector (Q102), R101 and C117. If the input level of voltage detector (Q102) is less than DC+2.7V, the reset circuit generates a reset signal automatically.

### **3.3 Volt Regulator U50**

A single 3.3volt regulator U50 supplies all circuitry on the board. The regulator receives input voltage from the battery (nominally 7.5Vdc) and fuse F50 provides protection for the main circuit.

And also the 3.3 volts for RF section and VCO can be controlled separately by microprocessor.

### **Personality EEPROM**

A 2048 X 8 bit EEPROM U103 stores all customer frequencies, tones and option information. Tune data aligned with the RF section is stored for transmit high power level, transmit low power level, audio deviation, data deviation and squelch.



**CAUTION**

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If replacement of U103 personality EEPROM, contact UNIMO Technology Co., Ltd. Customer Service to obtain programming information.

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The microprocessor serially communicates with the EEPROM on the IIC\_CLK AND IIC\_DATA lines (or the Inter Integrated Circuit Bus) Programming of the EEPROM is accomplished without opening the radio by communication with the microprocessor through the Phone jack connector.

### **Low Battery Sense**

The low battery sense circuit (R119, R121, R112, C108) monitors the current voltage state of the battery. This low battery sense voltage is sent to microprocessor U100 pin 63. This pin is analog-to-digital conversion port and the microprocessor measure the voltage level.. When the battery voltage drops below approximately 6.3Vdc, generates a low battery alert sound.

### **Liquid Crystal Display (LCD)**

The LCD assembly is on the Board. It consists of a diffuser, zebra strips, the LCD and a lens. The primary function of the board is to drive a 112 x 16 graphic display and to drive the individual segment lines of the LCD.

Serial display data from the microprocessor is sent to the LCD driver on the LCD panel. IIC DATA and IIC CLK lines (Inter Integrated Circuit BUS) are pass through the zebra strips on the LCD driver. Another function is to provide back lighting of the LCD module using for LED devices (D102). The diffuser placed immediately above the LED evenly distributes the light.

### **Audio Processor**

The Audio Processor U101 handles nearly all the audio functions in the PZ-S series radio. It has the audio filter that operates the basic functions of radio, the Limiter, the Splatter Filter, the Comander and the Scrambler. It can be controlled by microprocessor.

The main functions are as followings;

- The amplifier and attenuator functions for Transmitting and Receiving signals
- The Pre/De-emphasis circuitry is built-in.
- The Compressor and Expander are built-in.
- The Scrambler and De-scrambler of frequency inversion type (3.388 KHz) are built-in.
- Max Deviation level adjustment is available.
- The 12.5 / 25 KHz filter is built-in.
- The CTCSS and DCS filter is built-in and the level adjustment is available.

#### EDACS & Conventional Modes RX Audio (sheet4)

For transmitting of PZ-S series radio, the microphone bias can be supplied to microphone through Q109, R183 and R184 when pressing the PTT key button. When the VOX mode is activated, the bias can be supplied automatically. The voice signal made through microphone is entered into audio processor chip. (U101) In case of external speaker-microphone, the bias also can be supplied and generate EXT\_PTT signal to microprocessor.

The audio modulation signal is connect to the mod input of the VCO and sub-audible modulation signal is connected to the reference oscillator. The sub-tone signal (CTCSS, DCS) also can be added in the audio processor.

For receiving PZ-S series radio, the IF signal put into audio processor chip. The audio signal is on the output pin of the audio processor. The audio signal can be amplified by Audio amplifier chip.

The CTCSS tone and DCS codes are decoded on the audio processor and pass through the microprocessor,

### **Audio Amplifier (U59)**

The audio amplifier (U104) operates speaker and the maximum power output is 1.5 Watts with 16  $\Omega$  speaker. The earphone jack (J100, J102) is for using an external speaker microphone.

## **R/F SECTION**

The RF section consists of the following circuits;

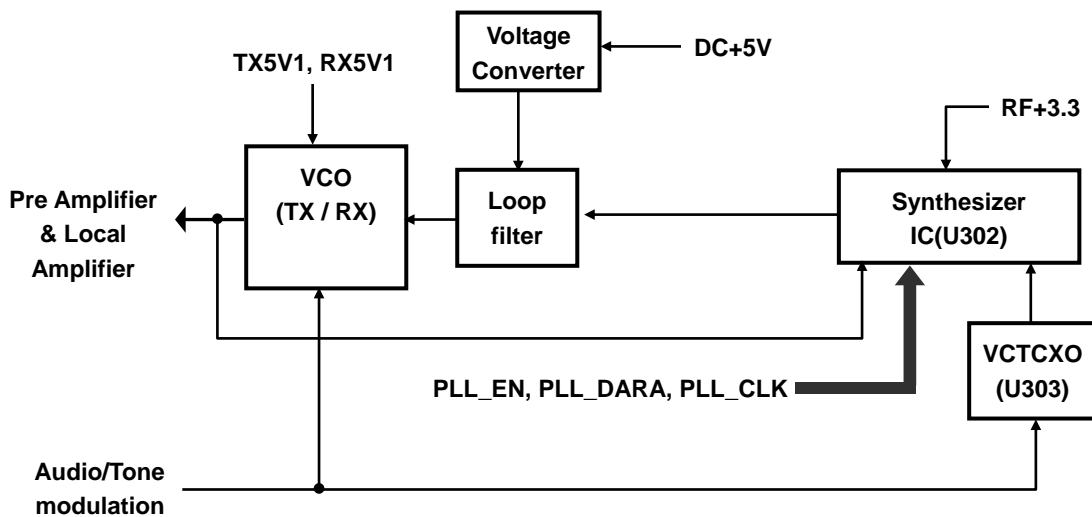
- A frequency synthesizer for generating the transmit carrier frequency and the first mixer injection frequency for the receive circuitry.
- Transmit circuits
- Receive circuits
- DC voltage regulator circuits and TX/RX switch circuits

### **SYNTHESIZER CIRCUIT**

The synthesizer circuit consists of the reference oscillator (VCTCXO, U303), PLL IC (U302), Loop-Filter, and VCO.

The microprocessor controlled frequency synthesizer circuit generates all transmit and receive RF frequencies for the PZ-S series radio. This circuit uses a Voltage Controlled Oscillator (VCO) operating on the actual transmit frequency of 400 ~ 470 MHz (136~ 174 MHz for VHF model) during transmit and 45.3 MHz (21.4 MHz for VHF band) below the actual receive frequency during the receive.

The PLL IC (U302) consists of the internal 19bit reference counter and the 19bit program divider, and is controlled by MPU program. The PLL\_EN, PLL\_DATA and PLL\_CLK signals program the synthesizer circuit.



### Voltage Controlled Oscillator (VCO)

There are two kinds of Voltage Controlled Oscillator in the synthesizer circuit. One is the TX VCO which generates the actual transmit frequency of 400 ~ 470 MHz (136~ 470 MHz for VHF model) during transmit and the other is RX VCO which generates the 1<sup>st</sup> LO frequency of 354.7 ~ 414.7 MHz (114.6~ 152.6 MHz for VHF model) during the receive. These two VCO is selected by the VCO\_TX and VCO\_RX signal from the microprocessor.

When VCO\_TX signal is High, it turns transistor Q66 on and the TX5V1 (5Vdc) is supplied to the TX\_VCO. TX VCO oscillates transmit frequency by C463, C415, C418, C419, L85, D76, and Q62. The D77 (variable capacitor diode for modulation) and C412, C413, R452 play a role in maintain regular audio modulation within the using frequency range. The TX VCO generates the actual transmit frequency of 400 ~ 470 MHz for UHF model and 136 ~174 MHz for VHF model.

When VCO\_RX signal is High, it turns transistor Q67 on and the RX5V1 (5Vdc) is supplied to the RX\_VCO. RX VCO oscillates transmit frequency by C458, C402, C404, C405, L81, D74. The RX VCO generates the actual 1<sup>st</sup> local frequency of 354.7 ~ 414.7 MHz for UHF model and 114.6 ~152.6 MHz for VHF model.

Q63 operates as an amplifier which amplifies the output signal of the VCO and operates as a buffer amplifier which helps the stable operation of VCO. The output level from this amplifier is about -10dBm.

The output signal of the VCO fed through the local amplifier and TX pre amplifier. A control voltage from the Loop Filter is applied to L78 and L79 and is used to control VCO frequency. The feedback for the synthesizer circuit is taken from the C429. This signal connects though a band-pass Filter consisting

of capacitor C431, C434, C432 and inductor L75. The output signal fed into the synthesizer IC and the feedback signal level is  $-15\text{dBm}$ .

Transmitter modulation signal from Audio/Logic section is applied to R452, D77 and C413.

### **Reference Oscillator (U303)**

Reference Oscillator U303 provides a reference frequency of  $12.8\text{ MHz}$  at  $\pm 2.5\text{ppm}$  ( $-30^{\circ}\text{C}\sim+60^{\circ}\text{C}$ ) to Phase-Locked-Loop circuit. The oscillator has modulation capability. Frequency is adjusted by the FRE\_CON signal from the D/A converter section of U101. The voltage is controlled by PC Tune program.

### **Charge Pump and Loop Filter**

Synthesizer circuit outputs phase error signal between the desired frequency and feedback frequency from the VCO section. This phase error signal fed through the internal charge pump circuit.

The low pass filter is used for Loop filter circuit to reduce the side band noise of reference frequency and obtain a high signal-to-noise.

## **TRANSMITTER CIRCUIT**

The transmitter section consists of a driver amplifier, final amplifier, power control circuit and transmitter switch.

### **Driver Amplifier**

The driver amplifier consists of driver buffer amplifier (Q74, Q71) and drive amplifier (Q72). Transmit RF signal from the VCO feed to driver amplifier and amplified up to  $37\text{dB}$  by the driver amplifier section. The output signal fed through the final amplifier.

### **Final Amplifier**

The final amplifier (Q73) can amplify the power output up to more than  $5\text{W}$ . The Final Amplifier (Q73) amplifies to make final power output of more than  $37\text{dBm}$ . The drain of final amplifier is connected into the battery voltage in order to obtain maximum power. The output signal is fed through D61 and low-pass Filter section.

### **Power Control**

The Power Control circuit allows the radio transmit power to be set between  $2\text{ watt}$  and  $4\text{ watts}$ . It keeps the output power close to the set value in spite of variations in transmit frequency, battery voltage,



temperature and load. To do this, the Power Control circuit maintains a steady power output level by APC. The transmit output power is controlled by varying the power control voltage (DA\_TXPOW). The output transmit power is monitored by D80 and produce a DC voltage. The Amplifier (U305) amplifies only the difference between the forward power level and DA\_TXPOW level. This signal play a role to gate voltage driver amplifier (Q72) and final amplifier (Q73).

### **TX Switches**

The antenna switch part separates TX from RX and when transmitting, it emits only the carrier through antenna and removes the Spurious and Harmonic. TX and RX switching is operated by pin diodes D60, D61 and D62. Regarding TX operation, if TX5V2V is supplied to D60, D61 and D62, the diodes will be turn on and the carrier is emitted to Antenna. The RX direction is blocked by D62, and it protects the RX part. When RX operation, TX5V2 will be OFF and D60 & D61 are blocked. The RX signal is entered into the RX direction.

The output signal passes through the low pass filter (L55, L56, C57, C58, C501, C502, C503, C504, C505, C506, C507, and C508) to remove of Spurious and Harmonic.

## **RECEIVER CIRCUIT**

The dual conversion receive circuit consists of a receiver front end, a 45.3 MHz 1<sup>st</sup> IF (UHF model), 21.4 MHz 1<sup>st</sup> IF (VHF model) and 455KHz 2<sup>nd</sup> IF and an FM detector. All audio processing and squelch functions are accomplished on the Audio/Logic section.

### **Front End**

The front-end circuit consists of low pass filter, tunable band-pass filter and low noise amplifier. A desired RF is coupled from antenna to the main board through antenna connector. The 400 ~ 470 MHz RF receive frequency is passed through a low-pass filter and passed the transmit switch and tunable band-pass filter (L61, L62, L67, L68, D64, D65, D68, D69). The frequency characteristic of tunable filter plays a role in making rejection of low frequency by DA\_BPF voltage.

### **RF Amplifier**

RF amplifier Q200 provides typically +15dB of gain to the RF signal. The output of the RF amplifier is coupled through tunable band-pass filter (U202). The center frequency of tunable band-pass filter is controlled by DA\_BPF. The output of band-pass filter connected to the input of mixer circuit (Q203).

### Local Oscillator Buffer

The injection frequency (354.7 ~ 414.7 MHz) from the synthesizer circuit is applied to the base of LO buffer transistor Q105. The output signal level is +3dBm and is connected to the input of mixer circuit (Q201).

### Mixer

The RF signal from the front-end and the injection frequency from the LO buffer is connected to the input of mixer(Q201), The mixer generates a 1<sup>st</sup> IF (UHF : 45.3 MHz, VHF : 21.4 MHz) signal on the output of the mixer circuit (Q201). The signal level of VCO local frequency is 2dBm±2dBm and at this time, the conversion gain is approximately 0dBm. The Mixer (Q13) uses n-channel dual gate MOS-FET in order to prevent spurious harmonics.

The signal on the output of the mixer is applied to the 1<sup>st</sup> IF band-pass filter. The Crystal filter (XF31) selects 1<sup>st</sup> IF frequency out of frequencies generated from the mixer part. The Crystal filter matching circuit consists of L73, C257, C223, C208, and R209.

The crystal filter output is amplified by bipolar IF amp transistor Q54. The output signal of IF amplifier connected through coupling capacitor C260 to the input of IF IC.

### IF Detector circuit

The IF IC (U301) consists of the 2<sup>nd</sup> Mixer, the 12.5 / 25KHz ceramic filter, the Discriminator, and the noise squelch circuit.

The 1<sup>st</sup> IF (UHF : 45.3 MHz, VHF : 21.4 MHz) signal is applied to an input of second mixer circuit (internal U301) through coupling capacitor C260. A second Local injection frequency of 44.845 MHz (VHF : 20.945 MHz) is internally applied to an other input of the mixer. This result in a second IF of 455 kHz on the output of the mixer. This signal pass through the 2nd IF filter (455 kHz) to the internal IF amplifier. The microprocessor selects the ceramic filter for the suitable channel spacing (12.5 kHz or 25 kHz) out of 2 ceramic filters. The W\_CON signal is high, 25 kHz ceramic filter is selected and N\_CON signal is high, 12.5 kHz ceramic filter is. Accordingly, the output of IF IC (pin#3) selects only the 12.5 kHz signal through F104 (25 kHz ceramic filter) and F103 (12.5 kHz ceramic filter).

When the channel spacing 12.5 kHz and 25 kHz are selected, Q55 and Q56 make the audio sound and the noise squelch in the same level. The squelch is adjusted in 10 steps by supplying the noise voltage of U301 (pin#14) to P2.6 A/D port of MPU (U51).