

# **TECHNICAL SPECIFICATION FOR**

**SP-220/240**

**PORTABLE RADIO**

**ISSUE 1.0**

**LMR DIVISION**

**MAXON KOREA**

<b>MAXON DIVISION</b>	<b>SIGNATURE</b>	<b>DATE</b>
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## **Introduction**

The SP-230/250 is a small, lightweight handportable for applications where small size is the primary requirement. The SP-230/250 used a BCD Encoder SW and the current RF circuit of SP-210 and applied a new LMR ASIC in stead of Analog circuit, which is capable of Automatic Adjustment by a PC and test equipments. Both the VHF and UHF models are controlled by PLL / microprocessor

## **Content**

- Unit
- ANT
- Metal-Hydride Battery Pack(7.5V/1350mAh)
- Drop in Charger
- Adaptor

## Features

- On/Off & Volume Switch

- PTT Switch
- Monitor Switch
- External One Jack
- 4/16 channels /with CTCSS and DCS
- 12.5 KHz /20 KHz/ 25KHz Programmable
- 1/5 Watts Switchable

### **Main Function**

- Wideband
- Standard/Non-Standard CTCSS signaling
- Transmit Time-Out-timer/TX Inhibit
- Low Battery Indication
- Memory Protect
- Battery save Circuitry
- 4/16 Channels

### **Wideband**

This software is made to work and control the wide band receiver/transmitter board.

### **Marked Idle Enable**

If this function is enabled, the unit will transmit provided that the correct programmed CTCSS tone has been decoded. This function is essential for repeater operation.

### **Standard/Non-Standard CTCSS**

When programming a channel with CTCSS, any frequency from 55 to 250 Hz can be selected in 0.1 Hz increments. The radio will be capable of encoding and decoding two non-standard CTCSS tones.

### **Transmit Time-Out-Timer (TOT)/TX Inhibit**

The time-out-timer is system programmable for 10 seconds to 990 seconds, in 10 second increments and can also be selected as disabled. The default value is 10 seconds. The addition to this feature is a programmable lock-out-timer that inhibits the radio transmitter for a specified time after the time-out-timer expires.

When the time-out-timer function is enabled, and the TX inhibit function is disabled, the radio will transmit after the time-out-timer has expired and the PTT button is released and again depressed. With the TOT and TX enabled, the radio will not transmit after the time-out-timer has expired, even if the PTT is released and depressed again. Transmission will not be allowed until the TX inhibit time has expired. TX inhibit time is system programmable from 5 to 60 seconds in 5 second increments. The default value for the TX inhibit is 5 seconds. The radio will beep one time, 5 seconds before the TOT time expires. This will indicate to the user that the transmitter is about to be locked out. If the PTT is released and depressed again anytime before the TOT has expired, the TOT time will be reset. If the beep tone enable /disable is set to disable, the one beep will not be issued. The radio will beep 4 times when the TOT time expires. After the TX inhibit time passes, the radio will beep one final time.

## **VCO Lock Time**

The micro will allow more lock time for the VCO before the indication of out-of-lock beep.

## **Low Battery Indication**

Low Battery Indication will be changed so that it does not inhibit RX and will allow one transmission after low cell is indicated. Low cell will not be indicated during transmit mode. If the battery goes below specified limits during the TX mode, low cell will be indicated immediately after releasing the PTT button.

After the low cell indication is issued, the transmitter can only be used one time. When the PTT is pushed again and then released, the transmitter is locked out until the unit is powered down and then powered back up.

## **Memory Protect**

The software is such that if the radio is inadvertently put into program mode it will not lose the contents of the EEPROM memory. Data will only move in and out of the memory when the programmer is attached.

## **External Option Detect**

An input to the microprocessor will be available that will indicate to the microprocessor that the external option has been selected. This input should be connected to the external option connector. External option should be selected for each channel. If a channel is selected during programming for external option, this input should be active when the channel is selected during operation of the unit.

# **THEORY OF OPERATION**

The VHF and UHF handheld radios are comprised of a RF PCB and a Digital PCB. The RF PCB contains the transmitter, receiver circuits and the Digital PCB, control circuits respectively. The control circuits contain the micro controller, ASIC (Audio signal processor) and associated digital circuits.

## **DIGITAL CIRCUIT**

### **ASIC**

is comprised of Analog signal path, SAT signal path, miscellaneous signals and controller as follows

### **Analog signal path**

A1 : is a BUFFER AMP to generate discriminator audio from Pin9 to ASW1.

And its gain 1

A2 : amplifies analog signal which was received from IN2(Mic input terminal) by 10dB.  
And then output signal goes ASW1.

ASW1 : is 2 way switch. It generates one of analog signals which was applied from A1 and A2. The control signal should be controlled by 1 bit signal. Default value is <0> and A1 is selected

INTRIM : compensates the deviation for the input analog signal sensitivity. The control range of the signal is +3.5/-4dB and is controlled by 16 steps. And the control signal is handled by 4 bit signal. Default value is <1000> and gain is 0dB.

HPF : was composed of the 8th order or more and the cut-off frequency is 300Hz. As for the attenuation characteristic of filter, the signal diggerence must at least over 30dB at the cut-off frequency 300Hz and the first 250Hz of attenuation bandwith.

ASW2 : is 4 way switch. It receives analog signals from HPF and its output goes one of De-Emphasys, RXVOL or AMP(with 6dB/oct Pre-Emphasys), AMP(without Pre-Emphasys)by the control instruction. The control signal must be controlled by 2 bit signal. Default value is <00> and De-Emphasys is selected.

DEMPHA : has a characteristic of +6dB/oct De-Emphasys. The gain for 1KHz Analog Signal which is appllied from ASW2 is 1.

PREMPHA : has a characteristic of +6dB/oct Pre-Emphasys. The gain for 1KHz Analog Signal which is appllied from ASW2 is 1.

RXVOL : controls the magnitude of input analog signal to generate to the speaker. The analog signal must be able to be controlled as 16 stages within the range of maximum 0dB to minimum -37.5dB.

AMP : is amplifier which generates analog signal is applied by ASW2 to Limitter. And it also has to have the characteristic of +6dB/oct Pre-Emphasys before the amplifying stage. And the minimum gain of the amplifier is +20dB at the minimum level of the control signal. The control instruction should be controlled as 8 stages from minimum +20dB to +41dB by 3bit signal

LIMITER : has the function of limiting the signal at the definite magnitude for modulation Limiter input level must be limited at 0dB(2800mVp-p)and Liniter output signal must be controlled at 4 stages from 0dB to -5.4dB by 2 bit signal. Also output signal of Limiter go to the LMOUT terminal.

ASW3 : is 2 way switch. It selects signal from either Limiter or SATRIM and its output goes VSLP.

VSLP : is low pass filter of at least 6th order or more and its cut-off frequency must be elected either 2.55KHz or 3KHz by 1 bit signal. Filter attenuation characteristics must be at least over 21dB/oct. But unlike VSCBPF, the cut-off frequency of VLPF should be changed by switching of device. That is to prevent reducing of S/N ratio due to the harmonic by the internal clock.

TXTRIM1 : to compensate deviation for the magnitude of analog input signal, within the Gain range of +3.5dB to -4dB, TXTRIM1 controls as 16 stages by 4bit signal.

TXSUM : mixes the signal from TXTRIM1 with the other signal which is applied by TDIN 4 bit signal , or selects one of the signals. And it also must be able to mute two applied signal. When muting, attenuation factor must be at least over 50dB.

ATTN : attenuates the signal applied from TXSUM by 6dB. This should be able to select the attenuation of 0dB or 6dB by 1 bit control signal.

TXTRIM2/3 : control the deviation of final output signal for modulation, Within the range of +3.75 to -4dB. It can be controlled as 32 stages by 5 bit signal, respectively.

A3/A4/INV : is the final output Buffer AMP of TX Analog signal and Gain is 0dB, respectively. Output A3 and A4 is non-inverting signal. INV inverts the phase of the TXTRIM3 output of TXTRIM3 is INV.

## **SAT Signal Path**

SATRIM2 : is received DTMF or other tone signal and compensates the deviation of the input signal. The signal can be controlled by 4 bit control signal within the range of +2.5dB to -3dB and +13.5dB to +12dB.

ASW3 : Two way switch. selects one of the signals which is applied by RDIN and TDIN.

Both RDIN AND TDIN signals is DCS or CTCSS , and all of the paths from TDIN to FLTOUT and COMPON to MODOUT1/2/3 must be DC couple.

VSCLPF : is the Variable Switched Capacitor Low Pass Filter , which is variable the applied signal from ASW4 by signal instruction, at cut-off frequency, from 50Hz to 300Hz. It is composed of the 7th order elliptic Low Pass Filter or more. To make the decision of cut-off frequency , the clock which is applied to VSCLPF oscillates at internal controller by controller instruction and it must be supplied to VSCLPF.

SATRIM : to compensate the deviation of input SAT signal, it controls the amplitude as 16 stages within the range of +3.5dB to -4dB by 4 bit signal.

COM : comparing external reference voltage(COMPP)with the applied SAT signal which is from FLTOUT to COMPIN and it goes to Logic High and Logic Low at this point. The reference voltage goes to Vref.

## **Miscellaneous signals and controller**

ADC/ DAC : 8 bit Analog to Digital Converter/ 8 bit Digital to Analog Converter

CTRL : transferring its mutual data passing through 3 pin to external controller by Serial Communication. And execute the relevant instructions

DATA : transferring all the instructions with external controller. It operates as output terminal by READ instruction and it operates as input terminal by WRITE instruction.

CLOCK : is synchronous input terminal for communication with external controller. Clock is supplied from external controller and data transfer is modulated at CLK down edge.

ENBL : In data communication , it determines effective timing. At Active Low, Data Read and Write can be effective.

AGND,DGND : Reference voltage of internal Analog paths. Classified Digital's Analog's GND.

### **CTCSS/ DCS Decoding Processing**

Discriminator audio from pin 9 IC5 is applied to the 7th order elliptic Low Pass Filter through Pin 3 IC406 where the signal of the voice band affecting the processing of CTCSS or DCS decoding is diminished sufficiently. The deviation of the signal passed through the 7th order LPF is controlled by SATRIM2 and the applied signal which is from FLTOUT to COMPIN is compared with external reference voltage (COMPP) and then it goes to Logic High and Logic Low. The signal is output from Pin 21(IC406) and fed into IC403(micro) where it is matched with a programmed frequency. If successful, a Decode occurs, which is shown by a green L.E.D on the top side of the VHF and UHF handheld and audio is heard. If valid Decode was not seen , the busy L.E.D.(Yellow) would be shown.

### **CTCSS Encoding Processing**

During TX encode the tone squelch digital signal is produced as a 3bit parallel word at pins 48,49 and 50 of the micro controller (IC403). The 3bit digital signal is converted to an analog signal by resistors R420, 421 and 423. The analog signal is fed into IC406 pin4 and filtered by 7th order elliptic LPF. The filtered signal is output on pin 23 (IC406) and fed into pin22 of IC406 . The filtered encode signal is mixed with the audio signal from TXTRIM1 by TXSUM. Via ATTN , the mixed signals applied to TXTRIM2/TXTRIM3, which control for modulation.

### **External Mic/PTT Control circuit**

The external microphone is connected via 3.5mm stereo connector on the right side of the handheld. The internal mic and speaker are disabled by SPK/MIC Jack.

### **LOW Battery Indicator Circuit**

When the battery voltage drops below 5.6 VDC, D403 and Q405 turn on. The micro controller disables the transmitter and at the same time enables the red LER and sends an alert tone to warn the user. The battery should be replaced or charged at this time (one tx allowed after low battery).

### **EEPROM**

RX/TX channels, and CTCS/DCS as well as other data from the programmer are stored in the EEPROM. The data stored is retained without power supplied. This is a non-volatile memory. The EEPROM may have information re-programmed or erased. IC404 is an EEPROM with 25C32S capacity and data is written and read serially

### **Mute (squelch) Circuit**

The mute circuit which is controlled by the output of IC403(micro) pin13(3837) is connected to Q415,414 via R446 which mutes the H8/3837IC on the Digital circuits.

### **Monitor**

The unit contains a switch mounted on the PTT assembly for monitor function. This is enabled or disabled by programming software.



## **RF CIRCUITS**

### **Transmitter**

The transmitter is comprised of:

1. Buffer
2. Power AMP
3. Low Pass Filter
4. Antenna Switch
5. A.P.C Circuits

### **Buffer**

VCO output level is 0dBm and amplified to +17dBm (UHF)/(VHF). The buffer consists of Q16, Q17 and Q3 for isolation and gain.

### **Power AMP**

The P.A Module consists of 2-stage amplifier and amplifies the TX signal from +16dBm to +37dBm. The input and the output terminal of the P.A Module are matched 50 OHM.

### **Low Pass Filter**

L7, L8, L11, C73, C74, C75 and C76 are the 7th order Chebyshev low pass filter. Unwanted harmonic are reduced by -65 dBc.

### **Antenna Switch**

When transmitting, the diodes D5 and D6 are forward biased enabling the RF signal passage to the antenna. D6 is shorted to ground inhibiting the RF signal to front-end. In receive the diodes D5 and D6 are reversed biased passing the signal from the antenna through L13 and C83 to the front-end without signal loss.

### **Automatic Power Control Circuit**

The APC circuit consists of the R109, variable resistor RV1, IC3, and Transistor Q19, Q21, and Q22. The supply current is monitored by difference voltage on R109(0.1 Ohm) which is through for it. If the current is varied by RF power output or other reasons, it produces some bias voltage by IC3A and Q19. The differential signal at the output of IC3 is passed to Q21 and Q22 that produces a constant power output to the antenna. RV1 is used to adjust the RF power level.

## **RF CIRCUITS PLL SYNTHESIZER**

### **12.8 MHz TCXO**

The TCXO contains the 2-stage thermistor network compensation and crystal oscillator and modulation ports. Compensation is +/-2.5 PPM or less from -30°C to +60°C.

### **PLL IC Dual Modules Prescaler**

Input frequency of 12.8 MHz to IC2 MB15E03SL pin 1 is divided to 6.25 KHz or 5 KHz by the reference

counter, and then supplied to comparator. RF signal input from VCO is divided to 1/64 at prescaler in IC2, Divided by A and N counter in IC2 to determine frequency steps, and then supplied to the comparator. PLL comparison frequency is 6.25/5KHz so that minimum programmable frequency step is 5/6.25 KHz. A and N counter is programmed to obtain the desired frequency by serial data in CPU. In comparator, the phase difference between reference and VCO signal is compared. When the phase of reference frequency is leading, Fv is output, but when VCO frequency is leading, Fr is the output. When Fv=Fr, phase detector out is very small 0v pulse. 64/65 modulus prescaler is comprised in IC2.

### **Level Shifter & Charge Pump**

The charge pump is used for changing output signals Fr, Fv at PLL IC from 0-5v to 0-12v necessary for controlling vco.

### **Reference Frequency LPF**

The Loop Filter contains R12, C21 and C22. LPF settling time is 12mS with 1 KHz frequency. This also reduces the residual side-band noise for the best signal-to-noise ratio.

### **DC to DC Converter**

The DC to DC converter converts the 5v to 14-16v to supply the necessary voltage for wide range frequency in vco.

### **VCO**

The VCO consist of one VCO. Is switched TX/RX by switching TR Q201. It is configured as colpits oscillator and connected to buffer as cascade bias in order to save power. The varicap diodes D201 and D202 are low-resistance elements and produce a change in frequency with a change in reverse bias voltage (2-11v). L203 and C220 are resonant coil and capacitor, which change the control voltage by the turning core and capacitor. D202 modulation diode, modulates the audio signal. C204 compensate for the non-linearity of the vco due to modulation diode, and maintain a constant modulation regardless of frequency .

## **RECEIVER**

### **Front End**

The receive signal is routed backward through the low pass filter, then onward to Pin 1 of the Hybrid Receiver Front End Module to a matchig circuit consisting of C603 through C601 ,L602 through L601 is coupled to the base of Q601 which serves as an RF amplifier. Diode D601 serves as protection from static RF overload from nearby transmitters. The output of Q601 is then coupled to a bandpass filter consisting of C604 through C615 and L603 through L607).The output of Pin 6 is then couples to the doubly balanced mixer D4. The receiver Front End module is factory pre-turned and requires no adjustment. Repair is effected by replacement of the entire module of the proper banded module. These are VHF 138MHz to 162 MHz and UHF 440 MHz to 470 MHz. The receiver Front End module signal pins are as follows:

1. RF Input
2. Input Ground
3. N/A
4. Receive +5V
5. Ground
6. Output

### **First Mixer**

D9, T1 and T2 are double balanced mixers which provide the 45.1 MHz intermediate frequency output. The filtered frequency from the Front End module is coupled to T1. The 45.1 MHz IF output is matched to the input of the 2-pole monolithic filter by L14, L15, C93 and C92. The crystal filter provides a bandwidth of  $\pm 7.2$  KHz from the operating frequency providing a high degree of spurious and intermodulation protection. Additionally, a 90 MHz trap (XF1) is also placed at the filter output to provide additional attenuation of the second order IMD. The output of the filter is impedance matched by C90 and C43 to the base of the post of filter IF amplifier Q25.

### **Second Oscillator Mixer Limiter And FM Detector**

The output of the post filter amplifier, Q25, is coupled, via C98 to the input of IC5 (TA31136FN). IC5 is a monolithic single conversion FM transceiver, containing a mixer, the second local oscillator, limiter and quadrature detector. Crystal X1 44.645 MHz is used to provide resultant 455KHz signal from the output of the second mixer. The mixer output is then routed to CF1 or CF2. These ceramic filters provide the adjacent channel selectivity of 25KHz or 12.5 KHz bandwidth.

### **Mute (squellch) Circuit**

The mute circuit switches off the power amplifier when no audio signal is present. The squellch circuit consists of IC5 and RV2 (RV4) and thier associated components. The noise signal foom pin 9 of IC5 is amplified by internal amp of IC5 and then fed into RV2(RV4). RV2(RV4) is used to adjust the squellch circuit sensitivity and is normally adjusted to produc anoise squellch opening sensitivity of 10dB to 12dB SINAD

### **Speaker Audio Amplifier**

After signal detection and audio filtering, Via VR5 on the RF board, the low level audio is returned to the digital board. This is then routed to Pin2 of IC408 to provide speaker audio. IC408 is enable by a logic low applied to Q415 which in turn enable Q414, appiying GND to pin 9 of IC408.

## **MAINTENANCE AND REPAIR**

### **GENERAL**

#### **UHF**

The UHF hand portable radio covers the UHF band from 400 to 500 MHz. The radio have been factory aligned for operation within frequency band.

Any repair or adjustment should only be made by or under the supervision of a qualified radio service technician.

### **REMOVING AND REPLACING**

When removing or fitting, use the Exploded View and Parts List in conjunction with the following procedures:

### **Removing And Replacing Battery**

To remove the battery

1. Hold the radio chassis in one hand, press and hold the battery release catch on the top side.
2. Using the other hand, slide the battery toward the bottom side and off the battery guide rail.

To replace the battery

1. With the slides of the battery positioned in line with the radio battery rail guides, slide the battery into position until a click is heard.

## **ALIGNMENT PROCEDURE**

The SP230/250 U2 Receiver is designed for broad band covering UHF(440-470MHz) and should require no special alignment, unless repairs are performed on the receiver portion.

The only alignment normally required is to squelch circuit, Apply a signal that produces 10dB SINAD, reduce the input to -130dBm, close the squelch control(RV2,RV4) until the receiver mutes.

Increase the signal to 10dB SINAD reading reference level and adjust RV2 or RV4 until the squelch opens. In high noise environment, some users may prefer to have the squelch opening set somewhat tighter, e.g.:12 to 14dB SINAD.

Should repairs be required, the following procedures should be applied:

### **VCO**

1. Set the unit to the lowest transmitter frequency, 440MHz(UHF), 138MHz(VHF) and adjust the VCO L203 to 2.5V and 1.0V respectively.
2. Set the unit to the highest transmitter frequency, 470MHz(UHF), 162MHz(VHF) and check that the VCO voltage is below 11 volts.
3. Set the unit to the lowest receiver frequency, 440MHz(UHF), and adjust the VCO C208 to 1.5V.

4. Set the unit to the highest receiver frequency 470MHz(UHF), 162(VHF) and check that the VCO voltage is below 11 volts.

\* Note : use TP1 to measure the voltage.

## **Transmitter**

Connect the unit to a Service Monitor with the power meter setting to the 5 W scale (or autorange)

## **TCXO**

Set the channel selector to the mid-range frequency 455 MHz, adjust CT1, for a reading of 445 MHz +/- 200Hz. For the VHF data radio, adjust the CT1 and set the frequency within the required range.

## **APC**

1. Adjust RV1 for fixing up High Power(5W)
2. Adjust RV3 for fixing up Low Power(1W)

# **COMPONENT REPLACEMENT**

## **Surface Mount Components**

Surface mount components should always be replaced using a temperature controlled soldering system. The soldering tools may be either a temperature controlled soldering iron or a temperature controlled hot-air soldering station. A hot-air system is recommended for the removal of components on these boards. With either soldering system, a temperature of 700 F(371 C) should be maintained.

The following procedures outline the removal and replacement of surface mount components. If a hot-air soldering system is employed. See the manufacture's operating instructions for detailed information on the use of your system.

\* CAUTION : Avoid applying heat to the body of any surface mount component using standard soldering methods. Heat should be applied only to the metalized terminals of the components. Hot-air systems do not

damage the components since the heat is quickly and evenly distributed to the external surface of the component.

\* CAUTION : The CMOS Integrated Circuit devices used in this equipment can be destroyed by static discharges. Before handling one of these devices, service technicians should discharge themselves by touching the case of a bench test instrument that has a 3-prong power cord connected to an outlet with a known good earth ground. When soldering or desoldering a CMOS device, the soldering equipment should have a known good earth ground.

## **Surface Mount Removal**

1. Grip the component with tweezers or small needle nose pliers.
2. Alternately heat the metalized terminal ends of the surface mount component with the soldering iron. If a hot-air system is used, direct the heat to the terminals of the component. Use extreme care with the soldering equipment to prevent damage to the printed circuit board (PCB) and the surrounding components.
3. When the soldering on all terminals is liquefied, gently remove the component. Excessive force may cause the PCB pads to separate from the board if all solder is not completely liquefied.
4. It may be necessary to remove excess solder using a vacuum de-soldering tool or Solder wick. Again, use great care when de-soldering or soldering on the printed circuit board. It may also be necessary to remove the epoxy adhesive that was under the surface mount component and any flux on the printed circuit board.

## **Surface Mount Component Replacement**

1. "Tin" one terminal end of the new component and the corresponding pad of one of the PCB. Use as little solder as possible.
2. Place the component on the PCB pads, observing proper polarity for capacitors, diodes, transistors, etc.
3. Simultaneously touch the "tinned" terminal end and the "tinned" pad with the soldering iron. Slightly press the components down on the board as the solder liquefies. Solder all terminals, allowing the component time to cool between each application of heat. Do not apply heat for an excessive length of time and do not use excessive solder.

With a hot-air system, apply hot air until all "tinned" areas are melted and the component is seated in place. It may be necessary to slightly press the component down on the board. Touch-up the soldered connections with a standard soldering iron if needed. Do not use excessive solder.

\* CAUTION: Some chemicals may damage the internal and external plastic parts of the radio.

4. Allow the component and the board to cool and then remove all flux from the area using alcohol or another approved flux remover.

## **Surface Mounted Integrated Circuit Replacement**

Soldering and de-soldering techniques of the surface mounted IC's are similar to the above outlined procedures for the surface mounted chip components. Use extreme care and observe static precautions when removing or replacing the defective (or suspect) IC's. This will prevent any damage to the printed circuit board or the surrounding circuitry.

The hot-air soldering system is the best method of replacing surface mount IC's. The IC's can easily be removed and installed using the hot-air system. See the manufacturer's instructions for complete details on tip selection and other operating instructions unique to your system.

If a hot-air system is not available, the service technician may wish to clip the pins near the body of the defective IC and remove it. The pins can then be removed from the PCB with standard soldering iron and tweezers, and the new IC installed following the Surface Mount Component Replacement procedures. It may

not be necessary to "tin" all ( or any) of the IC pins before the installation process.

## TROUBLESHOOTING      GUIDE

SYMPTOMS	CAUSES	COUNTERMEASURES
<b>Unit does not Work</b>	1. Complete discharge of battery (7.5+/-10%) 2. Fuse blown up 3. 5v voltage source	1. Replace battery. 2. Replace fuse 3. IC5 (5v+/-0.2v)
<b>Warning tone&amp; No Work</b>	1. PLL error 2. Filtering Error 3. EEPROM Fail 4. Low battery (lower then 5.6V)	1. Check TCXO/VCO/PLL IC 2. Check LPF 3. Re-programming 4. Replace or charge battery
<b>Bad RX Sensitivity (-10 to -60dB)</b>	1. Defective ANT sw 2. defective front-end 3. Defective DBM 4. IF IC 5. VCO level drop 6. Change of 1'st local frequency	1. check D5,D6 2. Check Q601 3. Check D9,T1,T2 4. Replace IC5 5. RX VCO level >2dBm 6. Retune TCXO
<b>Defective RX</b>	1. VCO frequency change or level drop 2. Defective voltage Source	1. Repair VCO Defective IF IC (IC1) 2. IC5, Q1,Q3
<b>PLL Error</b>	1. Defective 12.8 MHz TCXO 2. Voltage source for RX VCO/ TX VCO 3. Defective PLL IC	1. Replace TCXO. 2. Check RX VCO/TX VCO 3. Replace IC2
<b>NO TX Power</b>	1. Tx buffer APC 2. Power module 3. APC control	1. Check Q3,16,17 2. Replace Power module 3. Check Q19,21,22
<b>Low TX power output</b>	1. APC	1. Re-adjust RV1
<b>No modulation</b>	1. SW IC & mic amp IC	1. Check IC401, IC406
<b>No programming</b>	1. short protector VCC	1. Defective programming lead
<b>NO S.A.T</b>	1. IC406	1. Check IC406



