4 DETAILED FUNCTIONAL DESCRIPTION

4.1 UHF Transmit

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 Q2, 12,13 for isolation and gain.

Power AMP

The P.A Module(Q28) consists of 3-stage(Q18,Q39,Q28) amplifier and amplifies the TX signal from +37dBm to (+46~47)dBm. The input and the output terminal of the P.A Module are matcued 50 OHM.

Low Pass Filter

L21,25,,C296,96,98,100,297,110,99 are Chebyshev low pass filter. Unwanted harmonic are reduced by -65 dBc.

Antenna Switch

When transmitting, the diodes D15 and D2 are forward biased enabling the RF signal passage to the antenna. D15,D2 is shorted to ground inhibiting the RF signal to front-end. In receive the diodes D1 and D15/2 are reversed biased passing the signal from the antenna through L24 and C111 to the front-end without signal loss.

Automatic Power Control Circuit

The APC circuit consists of the R109, variable resistor RV1,5, U11, and Transistor Q34, Q37, and Q14,Q15,Q16. The supply current is monitored by difference voltage on R249 which is through for it. If the current is varied by RF power output or other reasons, it produces some bias voltage by U11 and Q34. The differential signal at the output of U11 is passed to Q14 and Q15that produces a constant power output to the antenna. RV5 is used to adjust the RF power level.

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 -30c to +60c.

PLL IC Dual Modules Prescaler

Input frequency of 12.8 MHz to U1 MB15E03SL pin 16 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 U1, Divided by A and N counter in IU1 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 U1.

Level Shifter & Charge Pump

The charge pump is used for changing output signals Fr, Fv at PLL IC from 0-5v to 16v necessary for controlling vco.

DC to DC Converter

The DC to DC converter converts the 8v to 15-16v to supply the necessary voltage for wide range frequency in vco.

VCO

The TX and RX VCO generates RF carrier and local frequency and each VCO is switched by a TX/RX power source. It is configured as a Colpitts oscillator and connected to the buffer as a cascade, the bias circuit is a cascade configuration to save power. The varicap diode D201/D202 are low-resistance elements and have different capacitance for reverse bias voltage.
Using the change of reverse bias voltage(2v – 14v), the wanted frequency for each channel can be obtained.
L203 are resonant coils and L303 are used to change the control voltage by the tunning core.
D201 modulation diode modulates the audio signal. C208,C308 compensates the non-linearity of the VCO due to the VCO due to the modulation diode and maintains a constant modulation regardless of frequency.

Microphone Audio Circuit

Microphone audio is fed through the front panel PCB onto the main PCB, where it is amplified, pre-emphasised and limited before being applied to the VCO and TCXO (via pin 1 on TCXO module).

Frequency synthesiser circuit

With data received from the EEPROM (U6) the frequency synthesiser circuit controls and produces the RF carrier frequency for the transmitter during transmit and the local oscillator frequency for the receiver. The frequency synthesiser circuit is comprised of:

- Rx/Tx Voltage Controlled Oscillator (VCO)
- Charge Pump and Loop Filter
- Dual Modulus Prescaler

Voltage Controlled Oscillator

Contains two VCOs. One for producing carrier frequencies during transmit and one for producing the local oscillator frequency during receive. The module also has Rx and Tx power line filters.

RX/TX VCO

The VCO consist of an RX VCO and a TX VCO. It is switched RX/TX by the power source .
It is connected to the buffer as a cascade bise in order to save power . The varicap diode D201,D202,D301 are low-resistance elements and produce a change in frequency With a change in reverse bias voltage(1.2~14v) .L203,L303 are resonant coils,which change the control voltage by the tuning core. D201modulation diode, modulates the audio signal.

Charge Pump and Loop Filter

Transistors Q903 to Q904 and associated resistors and capacitors form the charge pump and loop filter. The phase detector output from U1 pins 7 and 8 are combined by the charge pump to produce a 0 – 16 tuning volt signal. The signal is filtered by the loop filter to remove any residual reference frequency harmonics from the signal. After filtering, the signal is applied to the voltage controlled oscillator module.

Dual Modulus Prescaler

The prescaler divides the VCO frequency by 64 or 65.

Power Amplifier and Harmonic Filter

The power amplifier contains transistors Q12, Q13, Q18, Q39, Q28 and associated inductors, capacitors and resistors. When the radio is in transmit mode the diode D1,D15 is forward biased enabling the modulated RF signal from the VCO (amplified by the first stage amplifier / buffer Q12 and Q13) to pass to the pre-driver Q18 via Q39. The output signal is passed from Q39 to Q28 where it is then amplified for transmission. The amplified RF signal is passed through stripline coupler and is fed to the harmonic low pass filter, comprising L21, L25, C296,C96,C297, C99, C100, C110 and then to the antenna connector (ANT). The stripline coupler provides a sample of the RF signal for the automatic power control. During transmit D1,D15 is forward biased which connects the power amp to the antenna. D2,D15 is forward biased inhibiting transmit signal power from being fed to the receiver circuitry.

4.2 UHF Receive

The receiver is comprised of:

- RF amplifier
- First mixer and first IF amplifier
- Second mixer, second IF amplifier and FM detector
- Receiver audio circuit
- Mute (Squelch) circuit

RF amplifier

The receiver Front End module contains two stages of filtering and an amplifier, Q601. The module filters out the unwanted frequencies and provides a gain of typically 12dB for the wanted frequencies. The wanted RF signal at the operating frequency is passed to the first mixer.

The signal received from the antenna is routed through the 7^{th} order Chebyshev low-pass filters contained C601, C603, C604, CL603, C605,C608 and L601, L602, L604 and passed through Front End Module (RF amplifier) via pin 1. The front-end module contains D601 to Q601, the front end module is configured to enable the RF signal at the operating frequency to pass to the first mixer.

First Mixer and First IF Amplifier

The VCO local oscillator signal routed through buffer transistors Q2 is filtered by C14, C15, C16,C17 and L2and L4. D4 produces a difference frequency IF of 45.1MHz from pin 6 of front end module and the filtered VCO local oscillator signal at pin 4. The 45.1MHz difference frequency is filtered by the 2-pole crystal filter FL4,5. The tuned circuit T1 and T2 and associated components provide matching of the crystal filter to ensure good pass-band response and selectivity. The IF signal is amplified by Q3 and passed to the second mixer, second IF and FM detector U2.

Second Mixer, Second IF, FM Detector

U2 is a single conversion FM receiver integrated chip and contains the second mixer, second IF amplifier and FM detector. The second local oscillator frequency is determined by the crystal Y6 connected to pin 1 of U2. The first IF signal is received at pin 16 of U2 and applied to the mixer. The output of the second mixer, a frequency of 455kHz, is the difference between the IF signal and the second local oscillator. The 455kHz passes via pin 5 and is applied to a 455kHz bandpass filter, FL2, (12.5/25kHz channel spacing) or FL3 (12.5kHz channel spacing). The selection of the filters is accomplished by diodes D11 (input) and D12 (output) whose bias is controlled by software and applied to the diodes from pin 98 of the microprocessor (U18). The output of FL2/FL3 is passed via pin 11 to a high gain amplifier coupled to the adjustable quadrature detector Y1 (pin 10). Any detected signal is produced at pin 96 of U18 and applied to the Receiver Audio Circuit and the Mute (Squelch) circuit.

Receiver Audio and Sub-audio Circuit

The receiver audio circuit has been fully controlled by Baseband Process, CMX881 supported by CML using internal software program.

Frequency and CTCSS/DCS data storage

EEPROM

Rx/Tx channels, CTCSS/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. U6 is an EEPROM with 32Kbite capacity and data is written and read serially

Mute (squelch) Circuit

The mute circuit switches off the power amplifier when no audio signal is present. The squelch circuit consists of U2 and RV2,RV3 and their associated components. The noise signal form pin 9 of U2 is amplified by internal amp of U2and then fed into RV2, RV3. RV2,RV3 is used to adjust the squelch circuit sensitivity and is normally adjusted to produce noise squelch opening sensitivity of 10dB to 12dB SINAD

Speaker Audio Amplifier

After signal detection and audio filtering , Via U14on the RF board, the low level audio is returned to the digital board. This is then routed to Pin22 of U13 to provide speaker audio.

MAINTENANCE AND REPAIR

GENERAL

UHF

The UHF hand portable radio covers the UHF band from 440 to 470MHz. 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.

ALIGNMENT PROCEDURE

The PM-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 produes 10dB SINAD, reduce the input to -130dBm, close the squelch control(RV2,RV3,) until the receiver mutes.

Increase the signal to 10dB SINAD reading reference level and adjust RV2 or RV3 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), and adjust the VCO L203 to 2.5V and 1.0V respectively.
2. Set the unit to the highest transmitter frequency, 470MHz(UHF), and check that the VCO voltage is below 14 volts.
3. Set the unit to the lowest receiver frequency, 440MHz(UHF), and adjust the VCO 302 to 1.5V.
4. Set the unit to the highest receiver frequency 470MHz(UHF),) and check that the VCO voltage is below 14 volts.

* Note : use L203,L303 to measure the voltage.

Transmitter

Connect the unit to a Service Monitor with the power meter setting to the 45 W scale (or autorange)

TCXO

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

APC

1. Adjust RV5 for fixing up High Power(45W)
2. Adjust RV1 for fixing up Low Power(5W)

Surface Mount Components

Surface mount components should always be replaced using a temperature controlled soldering system. The soldering tools may be ether 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.

* CAUSION : Avoid applying heat to the body of any surface mount component using standard soldering methods. Heat should be applied only to the metailzed 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.

* CAUSION : 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 know 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 plies.
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 silder using a vacuum de-soldering tool or Solder wick. Again, us 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 the PCB. Use as little solder as possible.
2. Please 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 too 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

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