

Theory of Operation on SP-0402

The SP-0402 Handheld Radio Transceivers are comprised of one main PCB.

The main PCB contains the transmitter, receiver, and control circuits.

1) Receiver

The receiver circuit adopts dual conversion super heterodyne with 1st IF 45.1MHz and 2nd IF 455kHz

A. Front-end

Front-end consists of pre-selector filter, RF Amplifier, Post-selector filter. The receive signal is routed through C818 and selected by BPF to amplified around 13dB at RF Amp Q801.

This circuit removes unnecessarily spurious 1st Image.

B. First Mixer

The signal from Front-end is input to Q2 base of 1st mixer. 1st local signal generated from VCO is input to Q2, emitter. These two signals are mixed at Mixer into 1st IF signal 45.1Mhz, which is resonated in parallel at C61, L14 and inputted to XF1, Pair crystal filter.

C. IF Amplifier

1st IF signal from XF1 is amplified about 15dB at IF amp Q3 and inputted to IC1, IF IC.

2nd Local Oscillator is 44.645MHz. The signal from 2nd Mixer is refined removing unnecessary spurious signal and detected through high gain linear amp. This detected signal is inputted to U7 pin9.

D. AF Amplifier

300Hz High Pass Filter U3 removes the signal under 300Hz of the demodulated signal from U7 so that noise under sub tone use is removed.

De-emphasis functions to get 6dB/oct by R55, C91 and this signal controls volume of sound by SW4.

U9 can operate a speaker as audio current amplifier amplifying the signal. The operating current can be reduced by mute signal.

E. Squelch

The demodulated signal from U7 is coupled of noise to C144. The noise is filtered and amplified by C85,143, R178. This input signal is used as

the signal to mute VR3 audio.

F. Audio AMP

After CTCSS,DCS signal is removed at 300Hz High Pass Filter and de-emphasized to -6 dB/Oct at R55, C91, the volume of sound is controlled by SW4.

U9 is doing low frequency current amplify as audio amplifier to operate a speaker.

U9 has mute function and if Pin 2, mute port is low, it's on mute. If it is high, it's unmute.

2) Transmitter

The transmitter consists of Buffer, Power Amplifier, Low-Pass Filter, Antenna Switch, Auto-Power Control.

2-1) Buffer

-6 dBm TX RF signal from VCO is amplified to around $+25$ dBm by buffer Q7,8 to have desired output power at final Amp.

Pie style resister attenuator is used between VCO and Buffer Amp. To minimize the effect of load caused by transmit amplifier in TX.

2-2) Power Amplifier

TX RF Signal form buffer Amp. Gains 7Watt output by final Amp Q6.

Collect impedance of Q6 states in low so that it is matching to 50ohm by C198, 28, 75, 192, 47, L11, strip line and inputted to 5th Low Pass Filter.

2-3) Low Pass Filter

5th Low Pass Filter reduces the unwanted spurious for TX output power from final Amp.

L10, 9, C46, C53, 11 are Chebisheve Filter.

2-4) Antenna Switch

Ant. Switch is to share the antenna in TX and RX. It prevents TX sensitivity from degradation by LPF. Also, it protects receive circuit by blocking TX signal to receive end, turning on D5, 6.

Flow of the signal in RX is designed to minimize the loss of the signal using the character of series resonance of L7, C818.

2-5) **Auto-Power Control**

This circuit controls TX Power by detection on the current through R34.

The voltage difference from these resistors is amplified by U4-B and gets the voltage comparing the this signal with the reference voltage from R95, 100 at U4-A.

This voltage difference is kept to stable value by RV5 changing Gate voltage of Final Amp.

3) **PLL Synthesizer**

Reference frequency is 12.8Mhz and this oscillated frequency is compensated in temperature.

The frequency from VCO is inputted to PLL IC and this inputted signal is divided by the ratio set by data and compared with reference step frequency.

Then, the difference comes to IC641 pin15,16 Port. SP-0402 consists of external charge pump.

Charge pump output turns into DC by PLL LPF R28, 29, 168, C33, 41, 68, 160 so that it can vary VCO control voltage to have set frequency.

For TX and RX switch, Q36 and Q40 base switch to control voltage.(TX_EN1)

4) **Audio and Control circuit**

IC1 controls all functions of the radio as Microprocessor.

It detects outer condition such as function data on frequency, Power supply switching and make it operate correctly.

IC U1 consists of 250Hz LPF to function CTCSS,DCS decoding correctly and the output of this filter is amplified at U1-A. Then, it goes to Q24 to be changed to logic signal so that CTCSS, DCS decoding is enabled.

U10-A,B is CTCSS, DCS encode Filter. It mixes the signals from 3 ports and

this mixed signal goes through this filter to get clear CTCSS, DCS signal.

U5-A, B and D is TX Audio Amp and limiter. It amplifies the voice signal from C-MIC and has the character of 6dB/Oct Pre-Emphasis.

This voice signal is controlled by U5-A for the volume.

U5-B is 3KHz LPF and has the character that reduces to 18dB/Oct.

This character minimizes the interference of adjacent channel by voice signal.

5) Alignment Procedure

This radio is adjusted to meet all condition in production except special case.

Readjustment is not requirement.

5-1) The preparation before adjustment.

- 1) Set the Power Supply voltage to 7.5V and then connect to the radio.
- 2) Connect the connector to Radio Antenna terminal.
- 3) Connect the radio to test equipment.

5-2) PLL Synthesizer

- 1) Measure the voltage of TP1 with High impedance voltage meter.
- 2) Adjust TC3 at RX channel 1 to be 2.0V.
Confirm if it is below 10V at RX high channel.
Adjust TC2 at TX channel 1 to be 4.0V.
Confirm if it is below 11V at TX high channel.

5-3) Adjustment of Transmitter

- 1) Adjust RV1 to tune the set frequency.
- 2) Adjust RV5 to tune the set power.
- 3) Set Audio Generator to be 1kHz 120mVrms and connect to Radio External Jack.
- 4) Adjust RV4 to tune desired modulation.
- 5) If a channel is set with CTCSS, DCS the modulation of CTCSS, DCS varies based on the size of the modulation.

5-4) Adjustment of Receiver

- 1) Set SSG RF level to -47dBm @1kHz 60% Dev.
- 2) Adjust T1 to maximize Audio.
- 3) Adjust SSG RF Level and confirm if 12dB Sinad is below -119dBm .
- 4) Adjust VR3 to open Audio at 12dB Sinad.
- 5) Set tone frequency to SSG when there is channel set with CTCSS, DCS and then set deviation to 10% Peak Dev. Then check if green LED is on.
- 6) Repeat the above in other channels.