

## THEORY OF OPERATION ON HL SERIES

The HL Series Handheld Radio Transceivers are comprised of one main PCB. The main PCB contains the transmitter, receiver, and control circuits.

### Receiver

The receiver circuit adopts dual conversion super heterodyne with 1<sup>st</sup> IF 43.655MHz and 2<sup>nd</sup> IF 455kHz.

#### Front-end

Front-end consists of per-selector filter, RF Amplifier, Post-selector filter. The receive signal is routed through C111 and selected by D105~D108, D110~D113 and L106, L107, L110, L111 to amplified around 13dB at RF amp Q101. Front-end adjusts bandwidth by varicap diode tuning. This circuit removes unnecessarily spurious 1<sup>st</sup> image.

#### First Mixer

The signal from front-end is input to Q103 gate1 of 1<sup>st</sup> mixer. Local signal generated from VCO is input to Q103, gate2. These two signals are mixed at Mixer into 1<sup>st</sup> IF signal 43.655MHz, which is resonated in parallel at C155, L120, R131 and inputted to XF1, pair crystal filter.

#### IF Amplifier

1<sup>st</sup> IF signal from XF1 is amplified about 20dB at IF amp Q105 and imputed to U1, IF DEMOD IC. 2<sup>nd</sup> Local oscillator is 43.2MHz. The signal from 2<sup>nd</sup> Mixer is refined removing unnecessary spurious signal and detected through high gain linear amp. This detected signal is inputted to U1 pin.

#### AF Amplifier

300Hz high pass filter U606 removes the signal under 300Hz of the demodulated signal U1 so that noise under sub tone use is removed.

De-emphasis functions to get 6dB/Oct by R641, C638 and this signal controls volume of sound by SW701. IC603 can operate a speaker as audio current amplifier amplifying the signal. The operating current can be reduced by mute signal.

#### Squelch

The demodulated signal from U1 is coupled of noise to C173. The noise is filtered and amplified by C176, 177, R147 and used internal amplifier of U1. This noise signal is used as the signal to mute CPU[IC801] D/A .

#### Audio Amp

After Sub-tone signal is removed at 300Hz High pass filter and de-emphasized to 6dB/Oct at R641, C638 the volume of sound is controlled by SW701.

IC603 is doing low frequency current amplify as audio amplifier to operate a speaker.

IC603 ha mute function and if pin4, mute port is Low, it's on mute. If it is High, it's unmated.

### Transmitter

The transmitter consists of buffer, power amplifier, low-pass filter, antenna switch, auto-power control.

#### 2-1) Buffer

+2dBm TX RF signal from VCO is amplified to around +15dBm by buffer Q205, Q202 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 from buffer Amp. Gains 6 Watt output by final Amp Q201.

Collect impedance of Q201 states in low so that it is matching to 50ohm by C203, 205, 206, L202, 203 and imputed to 5<sup>th</sup> low pass filter[L101~103, C101~106].

## 2-3) Low Pass Filter

5<sup>th</sup> Low pass filter reduces the unwanted spurious for TX output power from final amp.

L101~103, C101~106 are chebishev 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 D101, 102.

Flow of the signal in RX is designed to minimize the loss of the signal using the character of series resonance of L105, C111.

## 2-5) Auto-Power Control

This circuit control TX power by detection on the current through R505.

The voltage difference from these resistors is amplified by IC501-A and gets the voltage comparing the this signal with the reference voltage from R510, 511 at IC501-B.

This voltage difference is kept to stable value by D/A1 changing gate voltage of final Amp.

## PLL Synthesizer

Reference frequency is 14.4MHz 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 IC1 pin5 port. HL series consists of internal charge pump at IC1.

Charge pump output turns into DC by PLL LPF R403, 404, 406, C407, 406, 405, so that is can vary VCO control voltage to have set frequency.

For TX and RX switch, Q305 and Q306 base switch to control voltage. (TX\_EN)

## Audio and Control circuit

IC801 controls all factions of the radio as Microprocessor.

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

IC606 consists of 250Hz LPF to function Sub-tone decoding correctly and he output of this filter is amplified at IC606. Then, it goes to IC606 to be changed to logic signal so that Sub-tone decoding is enabled.

IC901-A,B, C, 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 RV301 for the volume.

IC509-C,D is 3kHz LPF and has the character that reduces to 18dB/Oct.

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

## **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 7.4V 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 L304 at RX channel 0.7 to be 1.0V.  
    Confirm if it is below 2.3V at RX high channel.  
    Adjust L307 at TX channel 0.7 to be 1.0V.  
    Confirm if is below 3.2 at TX high channel.
- 3) Confirm if channel 1 is in 0.7+/-0.2 in RX

### **5-3) Adjustment of transmitter [Up+Down+Power on]**

- 1) Adjust to tune the set frequency.[D/A]
- 2) Adjust to tune the set power.[D/A]
- 3) Set audio generator to be 1kHz 80mVrms and connect to radio external jack.
- 4) Adjust RV301 to tune desired modulation.
- 5) If a channel is set with Sub-tone the modulation of Sub-tone 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 SSG RF level and confirm if 12dB SINAD is below -119dBm.
- 3) Adjust D/A to open audio at 12dB SINAD.
- 4) Set tone frequency to SSG when there is channel set with Sub-tone and then set deviation to 10% peak Dev. Then check if GREEN LED is on.
- 5) Repeat the above in other channels.