

# UHF Digital (License free band radio) Handheld Trans-receivers

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## 1 Introduction

The history of railway transport in India began in the mid-nineteenth century. The core of the pressure for building railways in India came from London. In 1848, there was not a single kilometer of railway line in India. The country's first railway, built by the Great Indian Peninsula Railway (GIPR), opened in 1853, between Bombay and Thane. In 1900, the GIPR became a government owned company. The network spread to the modern-day states of Assam, Rajputana and Madras Presidency and soon various autonomous kingdoms began to have their own rail systems. In 1905, an early Railway Board was constituted, but the powers were formally vested under Lord Curzon. The Board served under the Department of Commerce and Industry and had a government railway official serving as Chairman, a railway manager from England and an agent of one of the company railways as the other two members. In 1951 the systems were nationalized as one unit, the Indian Railways, becoming one of the largest networks in the world. Indian Railways is divided into 16 zones<sup>1</sup>, which are further subdivided into divisions. The number of zones in Indian Railways increased from six to eight in 1951, nine in 1966 and sixteen in 2003. Each zonal railway is made up of a certain number of divisions, each having a divisional headquarters. There are a total of sixty-eight divisions.

For communication related to its train operation, Indian Railways has its own telecommunication network. Earlier it was overhead telephone wire, running on telephone poles along the railway lines. Now all the overhead lines have been replaced with cables and optic fibers. For station-to-station and the station-to-railway-control-center communication there are the dedicated communication channels. Also, for train operation there are dedicated channels.

Further, if train stops in mid-section, there is emergency telephone points provided at fixed interval. The loco pilot and the guard are equipped with emergency telephone sets and in emergency they can walk to the nearest emergency telephone point and using the Portable control phones can contact the railway

control.

For communication between the train and the stations, the train loco pilot and the guard of the train are provided with VHF walkie-talkie sets which are functioning through VHF towers. The loco pilot and the guard in the train can contact the station master in their range.

## 2 Radio Communication

Communication by Radio means the transfer of intelligence from one point to another through space using radiated electromagnetic energy (Radio Waves) (in the frequency spectrum of from about 10 KHz to about 30,000 KHz.)

Class	Freq. Range	Wave Length
VLF	10-30 KHz	30,000 -10,000 m
LF	30-300kHz	10000-1000 m
MF	300-3000kHz	1000-100 m
HF	3-30 MHz	100-10 m
VHF	30-300 MHz	10-1 m
UHF	300-3000MHz	100-10 cm
MW	3 to 30 GHz	10-1 cm

Table 1: Radio frequency spectrum

The objective of any communication is to pass information from one place to other. Radio Communication consists of generation, propagation and reception of electromagnetic waves. HF, VHF, UHF & M/W Communication Modes are used in Indian Railways.

### 2.1 Very High Frequency (VHF) Communication

The frequency band of VHF Communication is 30 MHz to 300 MHz. The frequency allotted by Wireless Planning and Coordination (WPC) wing of ministry of communication in VHF for Indian Railways are in the band

a) 85.5 to 86.5 MHz

b) 146.2 to 167.95 MHz

<sup>1</sup>not counting Kolkata Metro

Communication in this range of frequencies is mainly due to line of sight, reflection and scattering of waves.

### 2.1.1 Uses of VHF

VHF Communication is used (now a days) for many applications as Traffic Control, Police Duties, Mobile Communication, Point to point communication, Multy Rural Radio ( MARR) Application and Disaster management.

Possible uses of VHF Communication on Indian Railways are :

- Communication during Maintenance and Constructional Blocks.
- Yard communication.
- Communication in the train in between Guard & Driver .
- Mobile Communication in between moving train/vehicle with fixed location(Station) or another moving train/ vehicle.
- ART equipped with hand held and base station VHF sets.
- Duplex VHF Sets are utilised for extension of exchange number to distant place. control working.( Train Traffic Control )/Patching.
- Universal Emergency Communication for communication between driver, guard, station master and cabin.

### 2.1.2 VHF 25 Watt Communication

VHF set 25-watt equipment is installed in each Railway Station to work as the base station for emergency communication system. The equipment VHF Set 25 W is fixed permanently in suitable location inside the station master room. The VHF set is primarily meant for emergency communication between the station and the train. However, in exceptional cases the equipment is also used for communication between two adjacent stations.

An omni directional ground plane antenna fixed at a suitable height, mounted on a GI pipe or a lightweight mast is erected by the side of the station building. Low loss coaxial VHF cable connects this antenna to the VHF equipment. The VHF set is mounted on the top of the table or fixed on the wall adjacent to the station master on duty. The VHF set is provided with speaker & handheld microphone with press to talk switch having flexible connecting

cord. The power supply is provided through a 12-volt battery of minimum 40AH capacity. There is an interface unit at each base station for manual patching with control circuit.

## 2.2 Limitation of VHF Communication

- Short distance coverage.
- Blank Zones occur due to terrain, high rise buildings & other structures, so area must be surveyed for blank zones from where communication is not possible.
- Simplex mode of working.
- Maintenance of rechargeable batteries.
- AC power supply is required for charging of batteries which may not be available at the sight of use. Charging also needs about 4 to 6 hours. Thus the set requires more than one battery set for continuous operation.
- Interference due to other user having adjacent frequencies .
- Effect of prevailing noise in the surrounding.
- Licence fee and royalty charges are to be paid to the WPC.

## 2.3 Ultra high frequency (UHF) Communication

The frequency band of UHF Communication is 300 MHz to 3000 MHz. The wavelengths corresponding to these limit frequencies are 1 meter and 10 centimeters.

## 2.4 What is the difference between VHF and UHF?

- UHF uses higher frequencies than VHF.
- VHF band (with a length of 270MHz) is much narrower than the UHF band (which has a frequency range of 2700MHz).
- Usually channels of UHF have a higher bandwidths than VHF, therefore, carries more information.
- UHF waves are more affected by attenuation than VHF waves. Therefore, VHF waves can travel longer distances than UHF.

- UHF antennas are smaller than VHF antennas as their wavelength are smaller than VHF.

transmitter power, 4 watts effective radiated power and 200 KHz carrier band width.

### 3 Laws Governing the Use of Walkie Talkie in India

Wireless Planning & Coordination (WPC) Wing of the Ministry of Communications, created in 1952, is the National Radio Regulatory Authority responsible for Frequency Spectrum Management, including licensing and caters for the needs of all wireless users (Government and Private) in the country. It exercises the statutory functions of the Central Government and issues licenses to establish, maintain and operate wireless stations. WPC is divided into major sections like Licensing and Regulation (LR), New Technology Group (NTG) and Standing Advisory Committee on Radio Frequency Allocation (SACFA). SACFA makes the recommendations on major frequency allocation issues, formulation of the frequency allocation plan, making recommendations on the various issues related to International Telecom Union (ITU), to sort out problems referred to the committee by various wireless users, Siting clearance of all wireless installations in the country.

Indian Railways pays huge sum of amount to WPC annually to retain and use of walkie talkies and radios no matter the equipments are used for short distance or longer distance. Even if the equipment are defective and not in use, Indian Railways have to pay a fee towards licensing fee & royalty to WPC.

Digital UHF license free walkie talkie have undergone a test at National Accreditation Board for Testing and Calibration Laboratories (NABL) and the equipment has been awarded an ETA (Equipment Type Approval) from WPC.

### 4 Digital UHF License-Free Walkie-Talkie

Railway board has issued a letter to test Digital UHF license free walkie talkie with the intention to reduce the cost of incurring licensing & royalty fees.

Ministry of Communication & IT (Wireless Planning & Coordination Wing) vide the Gazette Notification has amended rules for the use of Low Power Equipment in the frequency band 865-867 MHz. As per the amended rules no license shall be required to establish, maintain, work or deal in lower power wireless devices or equipments on non-interference, non-protection and shared (non exclusive basis) in the frequency band 865-867 MHz with maximum 1 watt

### 5 Features and Benefits of License-Free UHF W/T sets

- No Need to apply for a license for this.
- Privacy guaranteed with encryption.
- No loss of voice and cross talks.
- Superior quality of sound.
- Operates in both analog and digital mode.
- Front facing speaker and Microphone.
- Inbuilt facility private call, group call & broadcast call.
- Offices with multiple locations can be connected using IP.
- Seamlessly connects between Telephone, GSM & Other Network using RoIP and GSM Modems.



Figure 1: UHF license-free walkie-talkie

### 6 Application of License-Free UHF W/T sets

- Communication between different offices / locations.
- Communication between multiple locations at a central location.

- Remotely Monitoring communication of a particular radio channel by either Laptop/PC or through a fixed RoIP unit.
  - Communication between basement, minus 2, ground and top floors in a shopping mall, office, hotel, parking place.
  - Communication inside a long tunnel.
  - Communication on a long highway.
7. Loudspeaker.
  8. LCD display: Shows channel number, remaining battery life, and so on.
  9. Alpha Numeric keypad to send SMS (Short Message Service) to another walkie talkie.
  10. LED indicator light shows when channels are busy.

## 7 Communication between Different Offices / Locations

A walkie-talkie is a hand-held portable radio which communicates wirelessly using the radio wave signals on single and shared frequency bands. Each of the battery-powered units of the device contains an antenna and transmitter/receiver for sending and receiving of the radio waves. It also contains a loudspeaker that doubles up as a microphone when someone talks into it. There is also a push-to-talk or PTT button for this purpose. The radio waves are a part of the electromagnetic spectrum. They travel at the speed of sound. The high-speed sound waves are very easily picked up by the other handsets. The radio waves are converted back into electric currents and are used by the loudspeakers to reproduce the sound of the voice of the person who is talking. The digital walkie-talkie is a simple, robust and easy to use device for indoor as well outdoors. These devices are also very much suitable as these are very light and easy to carry and handle. Various parts of the digital walkie-talkie include antenna, LCD displays, select buttons, monitor, menu buttons, loudspeaker, PTT button, volume control, on/off switch, microphones, LED indicators, etc.

### 7.1 Description of a Digital UHF Licence Free walkie-talkie

1. Antenna: Sends and receives radio waves.
2. Channel knob: To change the channels.
3. On/off switch and volume control.
4. Emergency button: It is during an emergency. Without using Push-to-talk (PTT) button communication between walkie talkie to another walkie talkie can happen.
5. Push-to-talk (PTT) button.
6. Provision to connect programming cable.

## 8 Trials over SCR

A trial was conducted in Hyderabad, Secunderabad & Vijayawada divisions of S.C.Railway, using Digital UHF set - model NX 420 K3 (licence free band radio) of Kenwood make. The observation of the divisions are given below.

1. In Secunderabad division using these sets, they could communicate with a satisfactory voice quality upto the range of 1.8 Kms for low power equipment (1 W) and 2.3 Kms for high power equipment (4 W).
2. In Vijayawada division using these sets, they could communicate with a loud and clear voice quality up to the range of 2.2 Kms for low power equipment (1 W) and 2.8 Kms for high power equipment (4 W).
3. In Hyderabad division using these sets, they could communicate with a good voice quality up to the range of 1.3 Kms for low power equipment (1 W) and 1.75 Kms for high power equipment (4 W).

From the above observation it is understood that this Digital radio licence free walkie talkie can work up to the maximum range of 2.2 KMs for low power and 2.8 Kms for high power equipment. But VHF5 W walkie talkie sets can work up to the range of 5 KMs.

Present scenario in Indian Railways, 25W VHF sets is available as a base station which can establish the communication with 5W walkie talkie sets which are available with Drivers, Guards, Shunting Masters and Maintenance staff etc., where as in UHF communications there is no 25 W sets available for communicating with 1W/4W UHF Digital walkie talkie sets.

However, the distance communication using UHF digital radio licence free walkie talkie can be established through Radio Over Internet Protocol (RoIP).

## 9 Radio over Internet Protocol (RoIP)

RoIP is the integration of VoIP technology in two-way radio. Rather than transmitting voice data through traditional means, signals are sent through a network of transmission towers and expensive copper lines. RoIP harnesses the power of the internet to send live voice from one user to another instantly.

### 9.1 Communication between multiple locations / offices via RoIP

RoIP Modem has a Radio and IP Interface Port on which the radio would be connected over the IP Network. RoIP modem can be connected in any IP Backbone supporting IPv4 such as Internet, Local Area Network.

#### 9.1.1 In Transmitting Side

The RF radio connected to a Modem receives the RF Signal, it converts RF Signal to Audio and fed to the modem to convert the Audio signals to IP Audio packets, then the modem Passes the audio packets with the size lesser than 64KBPS through IP to the assigned destinations.

#### 9.1.2 In the Receiving End

The RoIP modem will unpack the audio packets as voice received through IP and fed to the radio to transmit the audio signal as RF Signals. The communication is thus possible irrespective of the distance between the Communication centers through IP beyond line of sight.

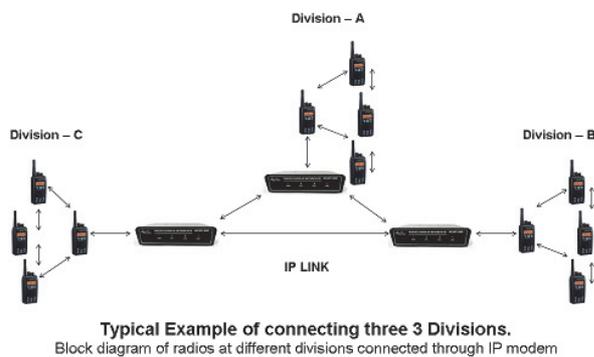


Figure 2: UHF Walkie-Talkie working through IP network

## 9.2 Radio Communication with GSM / Telephone line using RoIP



Figure 3: UHF Walkie-Talkie working through GSM network

Radio over IP GSM Gateway has been designed as a gateway between the Conventional Analog and Digital Two Way Radios with the IP Protocol and the GSM 2G/3G/4G Networks.

It is an advanced version of ROIP modem with added feature of GSM Connectivity. It provides inter-connectivity of Wireless Radio over GSM Network/ IP Network.

It is very useful in case of emergency communication over the GSM Network. Using a mobile phone/ telephone, communication is possible with the radios. The modem is the much higher version than the one that supports IP communication. It has a provision to insert a Sim card for the communication to happen. If communication is needed with Radios then the number is to be dialed that has been inserted in the modem and then the communication happens.

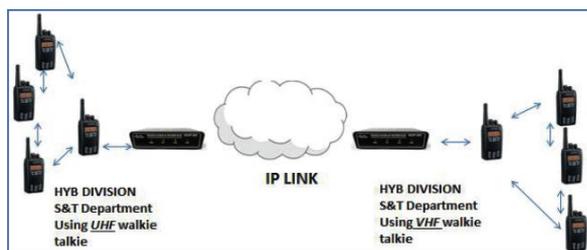
## 10 Communication between UHF & VHF Sets

There are two ways of connecting UHF & VHF:

1. Using a specialized modems with IPs to connect UHF & VHF
2. Using cross cable to connect UHF & VHF

### 10.1 Using a specialized modems with IPs to connect UHF & VHF

Communication is possible between the VHF & UHF sets as shown above using specialize modems for connecting the multiple locations. We will have to allocate IP address to the modems. One modem associated to the walkie talkie will have all UHF sets and second modem will have VHF sets associated.



As per the above picture left side modems associated with UHF sets and modem at the right hand side is VHF sets. The communication happens this way; the RF radio connected to a Modem receives the RF Signal, it converts RF Signal to Audio and fed to the modem to convert the Audio signals to IP Audio packets, then the modem Passes the audio packets with the size lesser than 64KBPS through IP to the assigned destinations. The RoIP modem will unpack the audio packets as voice received through IP and fed to the radio to transmit the audio signal as RF Signals. The communication is thus possible irrespective of the distance between the Communication centers through IP beyond line of sight.

### 10.2 Using cross cable to connect UHF & VHF sets

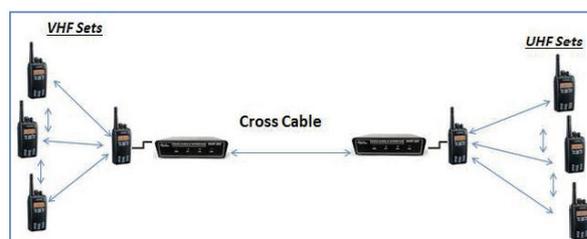


Figure 4: Connection of UHF & VHF set using cross cable

Both the modems are connected via cross cable. One modem is associated with UHF sets and another modem is associated with VHF sets. Instead of the IPs we are now connecting using a cable while all the other setup remains the same. Please refer to the figure 4.

- The communication happens from a UHF set to VHF set.
- Communication is passed on from one of the VHF set to another VHF set that is directly connected to the modem.

- From the modem the communication is again passed on through the cross cable.
- At the other end of the cross cable there is another modem that fetches the data and send it to the UHF set.
- The UHF set sends the voice data to the other UHF sets.
- Similarly the communication from UHF set to VHF set happens.
- Hence the communication happens between VHF & UHF sets are possible

## 11 Conclusion

Railway Board issued instructions to conduct a trial of Digital UHF licence free walkie-talkie in frequency band of 865 MHz 867 MHz with intention to reduce the cost of incurring licensing and royalty fees which are paid towards VHF sets. During the trail / testing of these UHF digital radio sets, it was observed that these sets can work only up to the range of maximum 2.8KMs for 4W UHF equipment. At present in UHF communication there are no 25 W sets available which are required as base station for establishing communication with portable UHF digital sets if they are provided to driver, guard, shunting master and other safety maintenance staff. For implementation of UHF digital radio sets, 25W base station is also required in Indian Railways.

*The information / views expressed in this paper is of the authors and are based on their experience. Comments / observations may be sent to the author at gopisingh123@rediffmail.com.*

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