VHF ANTENNA FOR FIRE STATION

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Abstract - Wireless technology is one of the main areas of research in the world of communication system today & a study of communication system is incomplete without an understanding of the operation & fabrication of antennas. This was the main reason to select a project which focuses on this field.

The field of antenna study is an exteremely vast one,so,to grasp the fundamentals we focused on the testing of VHF antenna.

Introduction

Our research paper focuses on the hardware fabrication & software simulation of several antennas. In order to completely understand the above it is necessary to start off by understanding purpose of voice radio communication for fire station.

The past few decennaries have seen great advancements in the communications industry. Movable communicating devices have gone from being used mainly in public safety and business applications to a situation where they are in every home and in the hands of almost every American man, woman and child. As users are added, there is more pressure on the system, and there is only so much room on the radio spectrum. The communications industry and the government have responded by making changes to the system that direct additional efficiency.

These advancements have improved radio frequency (RF) spectrum efficiency but have added complexity to the expansion of existing systems and the design of new systems. Some of these advances in technology are directed by the Federal Communications Commission (FCC), while others are optional. Many users of public safety spectrum have survived the time, effort and costs associated with narrowbanding. This attempt created additional capacity in the existing spectrum, but performance of some existing systems was degraded when converted from 25 kilohertz (kHz) to 12.5 kHz. Even with narrowbanding, the hunger for RF spectrum continues to grow, necessitating continued efforts for spectral efficiency. "The migration to 12.5 kHz efficiency technology will require licensees to operate more efficiently, either on narrower channel bandwidths or increased voice paths on existing channels. This will give permission to create additional channels within the same spectrum, thereby supporting more users." The costs and operational effects of these changes are significant. The actual RF physics associated with moving to narrowband with no other system changes resulted in loss of range. Finding the way through the complex technological and legal options of public safety communications led to the development of this guide to assist the fire service in the decision-making process.

Fire Service Communications Model --- The fire service operates in a staged state with assets located in fire stations. Calls are dispatched to specific parts based on their location in relation to the incident. When more than one unit responds to an incident, an on-scene Command structure is established to coordinate fire attack, provide safety and accountability, and manage resources. The elements assigned to these incidents work for the local Incident Commander (IC) who is the focal point of communications on the fireground. During the first attack, fireground communications are fast-paced and chaotic to the untrained listener. The dispatch center assumes a support role and simultaneously documents specific fireground events, handles requests for additional resources, and may record fireground tactical radio traffic.

Antenna parameters --- An antenna is an electrical conductor or system of conductors transmitter which radiates electromagnetic energy into space receiver-collects electromagnetic energy from space. The IEEE defination of an antenna as given by stutzman & thiele is "That part of a transmitting or receiving system i.e designed to radiate or receive electromagnetic waves". The major parameters associated with an antenna are defined in the following section.

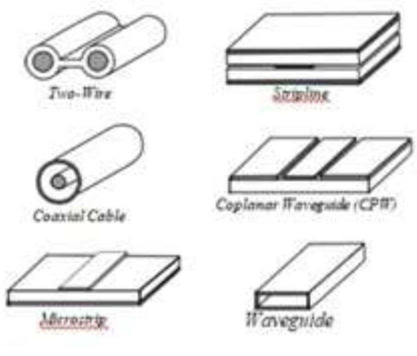
Types of antenna --- Antenna can be classified in several ways. One way is the frequency band of operation. Others include physical structure & electrical/electromagnetic design. Most simple, non-directional antennas are basis dipoles or monopoles. More complex, directional antennas consist of arrays of elements such as dipoles or use one active & several passive element, as in the yagi antenna. New antenna technologies are being developed that allow an antenna to antenna to rapidly change its pattern in response to changes in direction of arrival of the received signal. These antennas and the supporting technology are called adaptive or "smart" antennas & may be used for the higher frequency bands in the future.

SYSTEM DEVELOPMENT

Circuit concepts --- In this chapter we are going to review the very basics of circuit concepts & distinguish the lumped element system from the distributed elememnt system. The focus will be on the fundamentals of transmission lines, including the basics model, the characteristics impedence. Input impedence, reflection coefficient, return loss & voltage standing wave ratio of a transmission line. The smith chart, impedence-matching techniques, Qfactor & bandwidth will also be addressed. A comparison of various transmission lines & associated connectors will be made at the end of this chapter.

Transmission line theory --- A transmission line is the structure that forms all or part of a path from one place to another for directing the transmission of energy. Such as electrical power transmission & optical waves. Examples of transmission lines include conducting wires, electrical power lines, coxial cables, dielectric slabs, optical fibers & waveguides. In this book we are only intrested in the transmission lines for RF engineering & antenna application. Thus dielectric transmission lines like optical fibers are not considered.

Various transmission lines --- There are many transmission lines developed for various application. The most popular ones are shown in fig. They are two-wire transmiission line, the coxial cable, the microstrip, the stripline, the coplaner waveguide & the waveguide. We are going to examine these transmission lines in terms of their characteristics impedance, basic mode, frequency bandwidth, loss characteristics & costs.



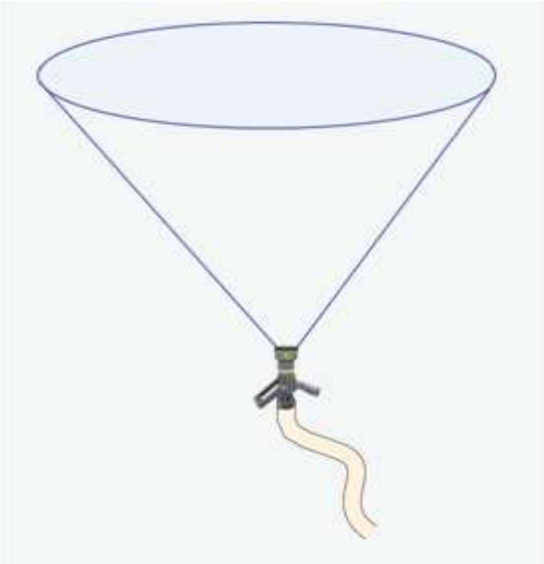
Coxial cable --- The coxial cable consist of a central, insulated wire (inner conductor) mounted inside a tubular outer conductor as shown in fig. In some applications the internal conductor is also tubular. The inner conductor is insulated from the outer conductor by insulating material.

Antenna manufacturing & measurements --- Once an antenna is designed. It should be made & tested. The construction of an antenna may be a complex process since the antenna has to meet the electrical & mechanical specification as well as some other requirements(such as costs).

Fixed-Site Antennas --- Fixed-site antennas are placed on towers or buildings to provide the dispatch or repeater coverage throughout the service area. The antennas used must be designed to work in the system's frequency band and, for best power coupling, should have a center frequency as close as possible to the actual operating frequency.

The radiation pattern for the antenna should be selected to provide a signal in the wanted sections of the coverage area and have minimal coverage outside the desired coverage area. This will help to confirm that the system is not interfering with other systems unnecessarily. The basic practical antennas are omnidirectional and have approximately equal coverage for 360 degrees around the antenna. In fire service terms, a nozzle set to a wide angle fog would be equal to an omnidirectional antenna.
Below fig. Shows fixed antenna

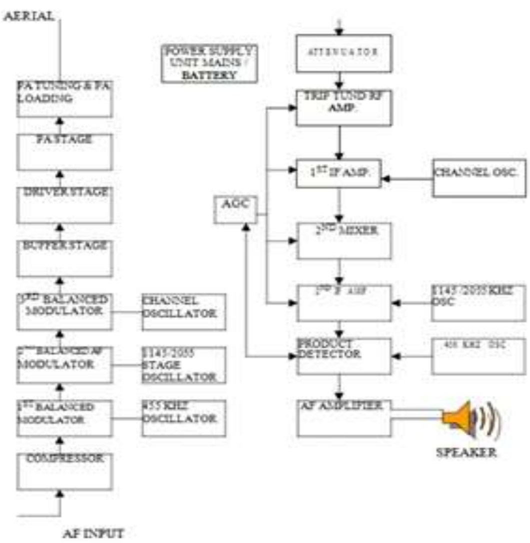
Below fig. Shows omnidirectional antenna

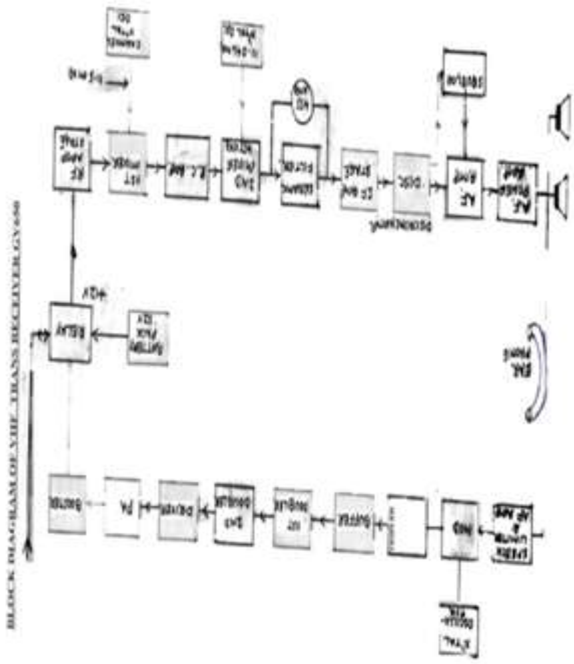


Wave propogation --- Any radiated power escaping into frr space is in the shape of electromagnetic waves. These waves are oscillated & propogated through free space with the velocity of light of 3*10^8 Mt/sec or 1,86,000 miles/sec. Electromagnetic waves are transverse oscillation perpendicular to the directiob of propogation. For H.F communication the mode of propogation through the sky wave & VHF communication through space wave.

FREQUENCY RANGES OF THE HF & VHF
HF high freq -- 3 MHZ to 30 MHZ VHF
very high frequency -- 30 to 300 MHZ.

Block diagram of the hf 100W SSB transmitter & receiver

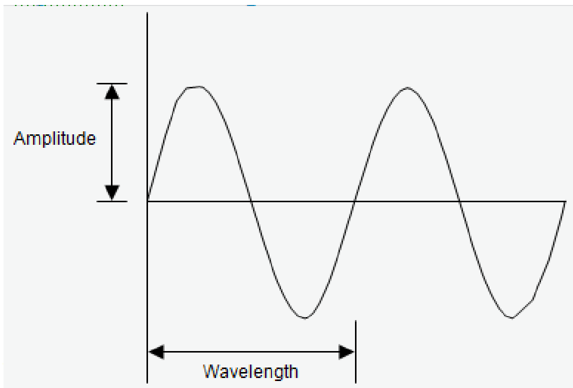




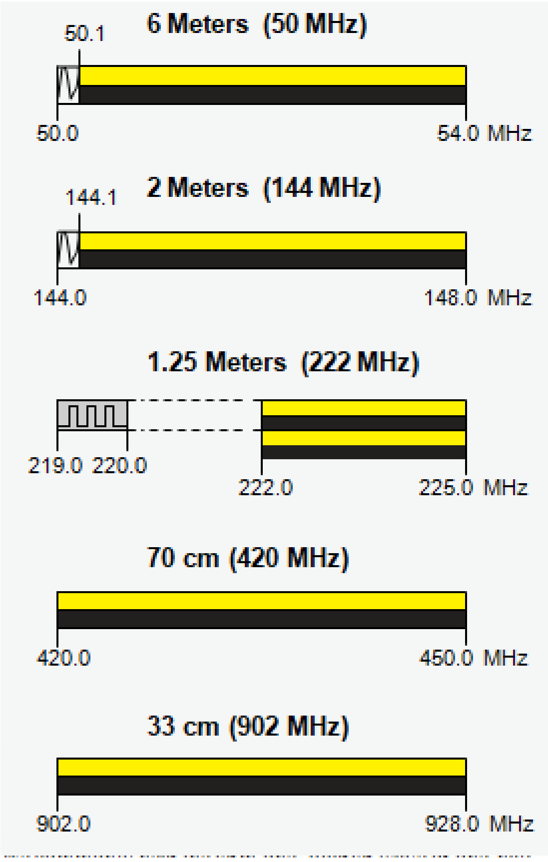
Block diagram of transreceiver

Radio Spectrum --- The wavelength is the distance between two crests of the wave. The frequency and wavelength are inversely related so that as the frequency of the wave increases, the wavelength decreases as shown below figure.

Below fig. Shows Electromagnetic wave.



The wavelength of the radio signal is a establishing factor in the size and design of the antenna. Wave length is an actual distance that is usually measured in meters. Ham radio operators often do not refer to frequency band of the radio but use the wavelength to classify the radio. A VHF radio would be mentioned to as a 2 meter rig and a UHF radio would be a 70 centimeter (cm) radio



Simulation of VHF antenna radiation pattern --- in the last several years we are witness of increasing marine trafic density especially considering the

recreational marine trafic. Most of these ships are equipped with marine VHF radio working in frequency range from 156 MHZ to 176 MHZ. Recreational vessels can be divided into two groups: saliboats & motorboats. These two groups have completely different characteristics considering antenna mounting & vessel behaviour on the sea. Saliboat antennas are always vertically mounted & slanting appears due to saliboat heeling. Motorboat antennas are usually mounted with backwards tilt for esthetic reasons. Expression "heeling" is characteristics for saliboats & refers to specific slanting towards one side during sailing.

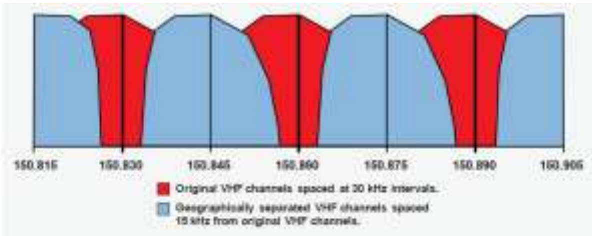
$$number\ of\ lobes = \frac{2h}{\lambda} + 1 \qquad (1)$$

Antenna used in simulation was a marine VHF half-wavelength end-fed dipole antenna. All models were simulated at 156.8 Mhz which commonly serves as the refrence frequency for marine VHF antenna characteristics.

Narrowbanding Below 512 Megahertz---The NPSPAC process provided additional frequency spectrum for new systems operating in the 800 MHz band, but most fire and police departments in the U.S. still operate in the VHF or UHF bands **(Figure.1).** To increase the available frequency spectrum for public safety in the VHF and UHF bands, the FCC began investigation into narrowing the bandwidth for frequencies in this band.

In the VHF band, channels were spaced 15 kHz apart, with transmitters operating with 25 kHz bandwidth. In addition, as shown in **Figure.1,** adjacent transmitters were separated geographically to minimize interference. It became apparent that as the population served by these departments grew, their spectrum needs would grow as well, and the existing band plan would become inadequate for the needs.

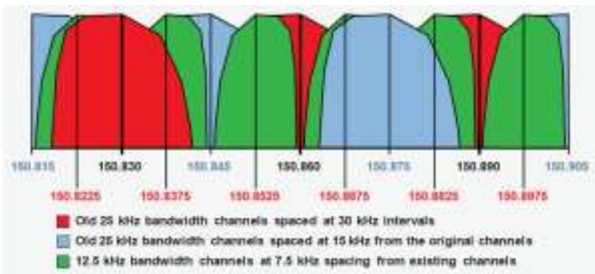
Below fig.1 Shows before narrowbanding



With no unused spectrum available in these bands, the FCC proposed narrowing the bandwidth of the existing frequency assignments, dividing each existing frequency channel in half.

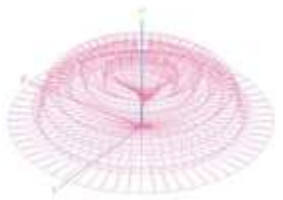
Each frequency in the new plan was spaced 7.5 kHz from the previous and had a bandwidth limited to 12.5 kHz.

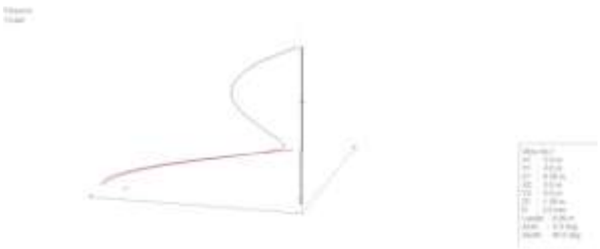
Below fig.2 shows after narrowbanding

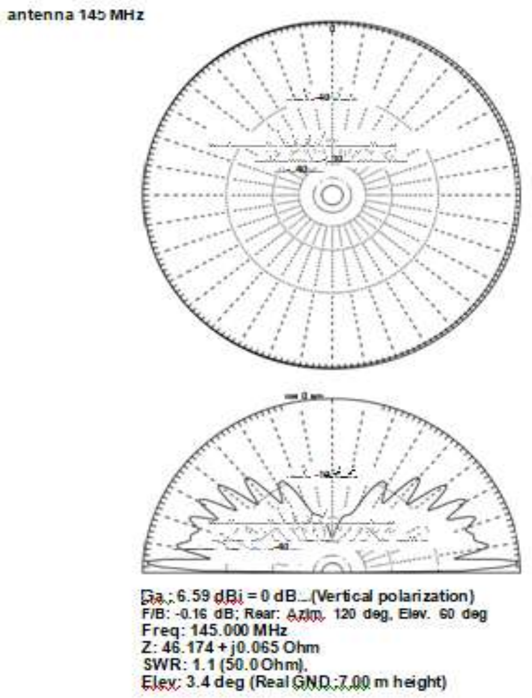


Further Narrowbanding --- The FCC has proposed further narrowing the bandwidth of channels below 512 MHz to 6.25 kHz bandwidth but has not issued rules related to a forced migration to this narrower bandwidth at the time of this publication. One of the reasons for this is the lack of FDMA subscriber equipment

Simulation Results







Conclusion

Upon the conclusion of our project we made the following assessment of our work. The overall working of antennas was understood. The major parameters that affect design & application were studied & their implication understood. The constructed slotted waveguide & biquad antennas operated at the desired frequency & power levels. It was concluded that the software results we obtained matched the theoretically predicted results.

It was observed that the antenna height played significant role in the frequency of the radiation pattern. Change in the antenna height change the number of lobes in the radiation pattern. The caused the redirection of maximum & nulls along the elevation angle however not affecting the envelope of the Pattern. Simulation showed that antenna slanting did not cause the slanting of the pattern itself. The pattern preserved most of its symmetry. These results present a good basis for further analyses concering different platforms various types of ground & more complex antenna structures.

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