Four Tubing Duplexer Using Band Pass and Reject

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Abstract **- A band pass Duplexer for simultaneous operation of a mobile relay station is essential in the world of army communication system. A new method of designing the band pass duplexer is proposed in this paper. The main structure of the band pass duplexer is a parallel coupled line connected with a capacitor. The duplexer are designed in order to improve communication system and radio amateur. It can be implemented by attaching at the army vehicles such as land rover as repeater at operation area. It also can be used with radio amateur as a mobile repeater. The band pass duplexer works as a band pass filter which allows user to communicate with each other within a frequency range of 140 MHz to 150 MHz VHF. Therefore, the duplexer is capable to minimize loses in transmitting and receiving a signal within that frequency range.**

Keywords- band pass duplexer, repeater,

I. INTRODUCTION

Due to the demand for land mobile radio, the problem caused by frequency congestion, receiver desensitization and intermodulation. The selective cavity can solve these problems. To transmit and receive a signal on the same antenna at the same time, reject unwanted signals and in the case of the duplexer feed two different signals to the same antenna. The duplexer separates and isolates the incoming signal from the outgoing and vice versa. It is still needed because ever been in a place where there's lots of RF activity, and noticed the receive performance of your radio degrades to some degree. Duplexer will prevents the receiver and transmitter from 'hearing' one another by the isolation it provides.

It also a device that is referred to by several different names like cavities or cans. There is some loss to the system because of the duplexer however the advantage of being able to use a single antenna usually outweighs the drawbacks. The major objective of this project is to develop the band pass duplexer system for frequency range 130 - 170 MHz VHF.

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II. CONCEPT OF DESIGN

A. General Design

Generally design of cavity filter with each cavity coupled to an arbitrary number of other cavities is presented [3]. In this paper, a general approach for designing multiple coupled cavity filter, which overcomes the aforesaid drawback; this approach, applicable to a large class of specific filter structure, is based on the introduction of suitable equivalent cavities which include the effect of the coupling elements. Duplexers can be constructed in several ways. There are many ways to combine filters to perform duplex operation such as band-pass duplexers, band-reject or notch duplexers.

B. BR- Band Reject

Band Reject, also known as 'Notch Duplexer' built using tuned or resonant elements that 'notch' out one particular frequency in the receive and transmit legs. A Band Reject (BR) type duplexer means that deep attenuation 'notches' are provided for receiver protection (from the transmitter's output) as well as and transmitter noise (at the receive frequency). The attenuation of 'out of band' signals is less with a BR design than that achievable with a BP design (although there is some attenuation of 'out of band' signals with a BR design).

C. BP- Band Pass

BP - Band Pass, built using tuned or resonant elements which 'pass' one particular frequency in the transmit and receive legs. BP duplexers are especially suitable in frequency crowded areas and provide additional rejection of in-band and out-of-band signals. BP duplexers generally have a slightly higher IL than BR style duplexers often times it is worth the slight 'cost' of the additional IL for the protection afforded the receiver and the filtering done to the transmitter; sometimes the 'path' into the transmitter is a source of transmitter intermodulation with other nearby transmitters so the benefit of a BP extends there as well.

C. Cavity Deplaning Filters

A cavity is a single resonator, usually in the form of an electrical quarter Wavelength [1]. A resonant cavity filter is typically a two port device and the Response characteristic depends on the filter type (band-pass, band-reject, notch or vary-notch). Most resonant cavity filters are made of seamless aluminum and finished with a passivity anodized finish [2]. Cavity resonator filters are usually implemented with helical, coaxial, or waveguide resonators. Coaxial filters are available in frequencies from 30MHz to over 10GHz and helical filters from below 10MHz to 2GHz [4].

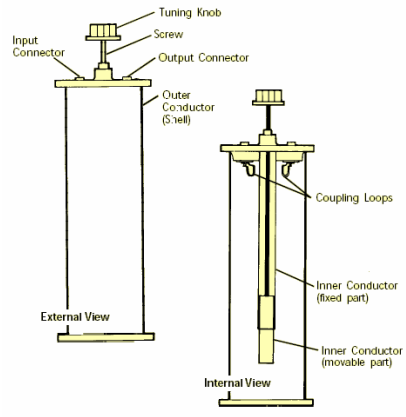

Figure 1: Design for Band Pass Filter

III. DEVELOPMENT OF DUPLEXERS

A. Materials

Prior to constructing the duplexer, choosing the type of metal tubing came. Commercial manufacturers use aluminums, but they have heli-arc welding and machine shop facilities. The aluminum it can't solder easily. Steel also is unsatisfactory due to its low conductivity and because it rusts. Some commercial manufacturers have successfully used copper-plated steel, but this is difficult for the home builder. The only real choice is copper or brass. Starting with copper as the construction material, again have two choices, tubing made for the metal working industry or from army sources. Copper from cannonball 105mm is best for several reasons. This is because in the army a used cannonball for training and war, so that tubing will be disposed or be recycled. Due to ease of obtaining it, it will save money and hand made with craftman workship. That alone makes copper tube from cannonball cartridge 105mm is the only choice.

B. Design

Many researches had been done to identify the availability of the product in the market. It is available in a variety of model and several of them appear to meet radio amateur requirement, several duplexer models will meet their requirement, so the particular model selected becomes a matter of preference. There are two distinct types of duplexers used in the two way radio communication: the band pass duplexer and band reject duplexer. The duplexer selected must provide certain function if optimum system performance is to be achieved. A duplexer must be designed for operating in the frequency band in which our duplex system operates, capable of handling the output power of the transmitter and designed to separate transmit frequency and receive frequency.

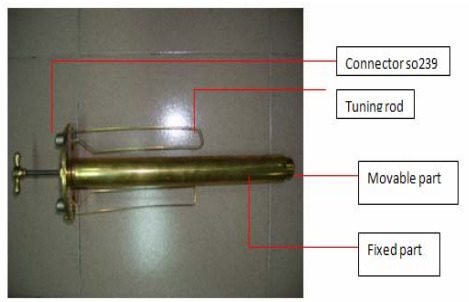

Figure 2: Fabrication of Duplexer

C. Selective Cavity

A selective cavity is a rather simple device that serves as a filter for radio frequencies. It ability to get a narrow band of frequencies pass through while frequencies outside this narrowband are attenuated. The narrow bands of frequencies pass through the cavity are within a few thousand hertz of the cavity's resonant frequency. The selective cavity, with this filtering action is important in the land mobile radio. As new

station go on the air, cause the interference to other station. The two most common forms of interference are receiver degradation and intermodulation. Receiver desensitization occurs when a nearby transmitter over power a receiver. Intermodulations occur when two or more nearby transmitters mix within the RF stages of a receiver and generate new frequency. In both cases, selectivity can be used to help solve the problem.

D. Experiment

After the planning phases, lastly this cavity filter had been completed and successfully tested. Analysis regarding to the system had been done to verify whether the completed hardware is functioning properly. The analysis can be divided into three sections they are tuning, transmit and receive signal and troubleshoot.

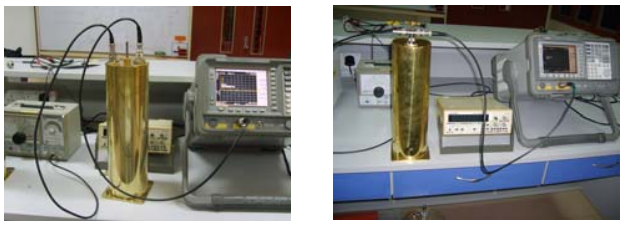

Figure 3: Tuning Process

i) Tuning

The important part after complete the construction is tuning. Tuning process must be doing one at one time for each cavity filter. The loop tuning, is connected to a spectrum analyzer with a tracking signal generator. The objective of optimization is to adjust for insertion loss in the band pass cavities and separation of notch and bump in the notch cavities. The duplexer provides enough attenuation of the transmitter signal, and transmitter parasitic, to prevent overloading or defenses of the receiver. A duplexer is divided into a transmit and receive section. The duplexer has three ports; they are the Antenna port, TX port and RX port.

ii) Tuning the Duplexer

Transmitter Section - Once choosing a particular method it is usually good to stick to that one. First terminate the RX port with the 50 ohm terminator. Second connect the generator to the TX port. Third connect the analyzer to the Antenna Port. Look at screen and observe position of the band pass curve appear and frequency is 148.050MHz. TX adjustment is complete for the moment.

Receiver Section - Removed the termination from the RX port, then remove generator from TX port and connect to RX port . Connect the termination to the TX port and adjust the notch so that it is on the TX frequency, but on this part a notch curve is not appear. This problem occurs because of cavity filter for notch part need adjustment at tuning coil and cavity size.

iii) Signal and Troubleshoot.

Band Pass Curve - During tuning section of all the duplexer, the sections of cavity filter for pass band at first not show wave form is wanted. After make changes with increase trimmer capacitor series with tuning rod. New wave form get acquired shown at Figure 4, this show cavity filter this too high impedance. This action is to get pure resistive.

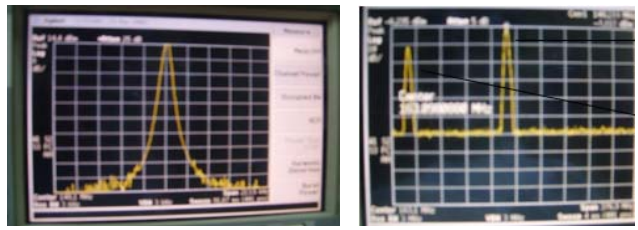

Figure 4: Band Pass Curve

Self Resonance - During the tuning process, self resonance appear at 70 MHz when RF generators inject a signal to the cavity filter. Self resonances occur because high insertion loss in cavity filters, it generates a frequency itself because of hand made construction of cavity. This problem can be solving by increase the size of cavity, vacuum and silver plating inside the cavity. Silver plated can be done by electrolysis process.

Band Pass versus Notch - At the band pass bump, both notch and band pass cavities perform in the same way. The low-loss peak or bump is tuned to the frequency that we want to pass, receive or transmit. At that frequency the filter is essentially transparent to the energy on the transmission line. That is, the line does not know that the filter is there. Other frequencies, however, are blocked. The key issue in deciding which type of filter to use is how much a band pass cavity blocks everything except the small band near where it's tuned. A notch cavity blocks only a small band where it is tuned. It lets everything else pass.

A band pass cavity does exactly what its name implies; it passes a band of frequency of 145MHz to 148MHz, not just a single frequency. If it were good enough, if its bandwidth were small enough, it would be the universal answer to duplexer filters.

IV. CONCLUSION

Wavelength, λ is important and need to make a best performance for duplexer. The filters in a band pass duplexer are working at frequency range 140MHz to 150MHz. Band pass filter is allows, or passes, a band, (or a narrow range) of frequencies. A four tubing are made to be a duplexer; two for band pass and other for band reject and the size for duplexer is 4 inches diameter and 16 inches length.

V. ACKNOWLEDGEMENT

In the future project, cavity filter will modify to get a duplexer with band pass and band reject. A number of cavities are cascaded to form a duplexer. Duplexer isolation can be adjusted by changing the number and size of the cavities and do are silver plating of the internal components of cavity. These duplexers have very high Q factors and also their resonant frequencies are determined by mechanical components, especially by the tuning rod.

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