WAVEGUIDE DIPLEXER DESIGN AND IMPLEMENTATION IN COMMUNICATION SYSTEMS

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***Abstract*—diplexers circuits are recurrently used for the satellite systems and mobile communications to separate the high power wide-band of transmission band from the error prone reception frequency range. Various telecommunication services like navigation system or television systems are based on satellite communication. This paper presents the introduction and design considerations of waveguide diplexer. Design parameter includes T junction analysis and conventional waveguide diplexer.**

Keywords—Multiplexing, Electromagnetic waveguides, Insertion loss, Band pass filters, Arm, Electromagnetic analysis, Electromagnetic scattering, Circuits, Waveguide junctions.

I. INTRODUCTION

The fast growing millimeter-wave (mmW) and use of microwaves provides the big promotion for the enhancements in the diplexer designs[6] and in microwaves filter [1–5] over previous three decades. Mostly all types of communication as well as electronic systems such as base stations for mobile communications uses diplexer circuits. Diplexers are used within the systems so as to differentiate between required and unrequired signal frequencies.

Microwave diplexer already attracted a tons of interest because of its capability to permit two different devices to share and use over single communication medium. The necessity for miniaturisation, furthermore decreasing in the complexity of design in Milimeter wave (mmW) and microwave components, whereas also maintaining or improving the condition of such components. this design has recently got a lot of attention from the side of researchers in this particular area of research. The aforesaid pros makes the design of diplexer cost efficient and compact in size replacement to communicating via different channels. A range of diplexer applications are present that is why, the researchers are developing more efficient design method and novel methods to go in line with efficient and the increasing demands in modern communication systems.

Diplexers are basically the devices used for either breaking/splitting single frequency band in two bands (sub bands) or they can be used for combining two bands(sub bands) into the single band which can be wide band [7]. They are most commonly utilized in the communication systems in satellite to mix the transmitted and the received signal on antennas. This can scale the volume as well as mass of space craft to a substantial value [8]. The diplexers for microwave are employed for mixing two totally distinct networks with distinctive operational frequencies to one port. Microwave diplexer is usually employed in front end of cellular radio (base stations) to differentiate transmitted and received signal in the Radio Frequency (RF) as shown in Fig.1

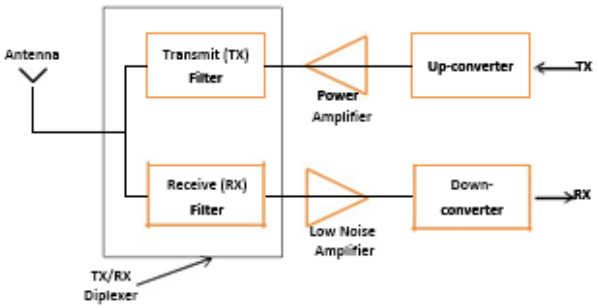

Fig. 1.Front end of a Base Station

II. DESIGN PARAMETERS

A. Design Parameters

The diplexer can be designed using, two methods, with the use external waveguide H-plane T-junction, with the use waveguide H-plane manifold structures.both are briefly discussed as

B. Waveguide T-Junction

The Waveguide junctions are mostly used once power in given waveguide has to be distributed or need to be partially extracted. The different types of waveguide junction are there which can be used and each type is having specific properties. The various type of the waveguide junctions effects energy which is enclosed within the particular waveguide in numerous ways [9] The major types are discussed below in article [9]

H-Plane Tee(T) Junction: In this category of the waveguide junction. It gained its name as its top is of the "T". The T-junction is parallel to the plane of the magnetic field (H lines) in the waveguide. Fig 2 Shows H- Plane T Junction.

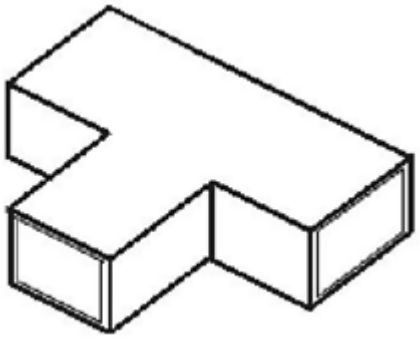

Fig 2. Waveguide H-Type Junction

E-Plane Tee (T)-Junction: This type of waveguide junction got its name as of the top of the "T" exceeds from the foremost waveguide in the same plane as of the electric field within the waveguide. Fig 3 shows E Plane T junction.

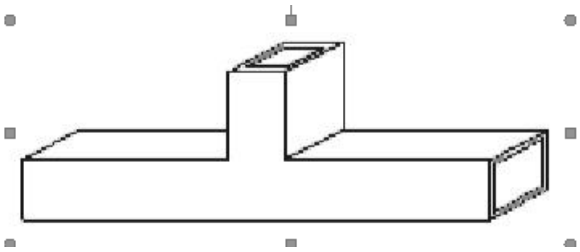

Fig 3. Waveguide E-Type Junction

Waveguide T-junctions are vital components in several microwave applications, T-junctions are usually utilized in diplexer configurations, and it has been continuously felt that the T-junction requires some specific dimensional parameters to attain an appropriable match within the relevant frequency ranges. Therefore, The optimized T-junctions are utilized in the design of a low loss, wide bandwidth and high power diplexer [10].

III. TRADITIONAL WAVEGUIDE

Diplexers are usually utilized to connect the Receiver and Transmitter filters of a transceiver to one antenna through a suitable three port junction [11]. This can be conventionally achieved by utilizing a two of divider and band pass filters. Channel filters passes the range of frequencies in a given required range and rejects the frequencies that lies outside the given required range, and divider splits the signal that is going into the filters, or combines the signals that is coming from the filters [12]. The mostly employed configurations of distribution are E-plane or H-plane 2-furcated power dividers [13,14], manifold structures [16-19], circulators [15], T -junction [21] and Y- junction [20]

Fig.4 shows the arrangement of two-channel diplexer with a 1:2 ratio divider diplexer network and Fig. 5 shows a H-Plane Diplexer circulator configuration, in which every particular channel consists of a band pass filter and a channel dropping circulator [15].

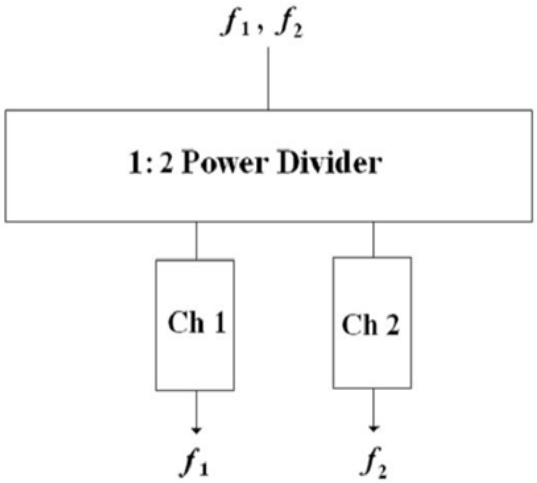

Fig 4. Configuration of Diplexer with a 1:2 divider network

In various arrangements, the connections of channel filters are by coaxial, waveguide, transmission lines Micro strip etc. and Tee (T)-junctions[16] and it consists of a two of waveguide filters connected to a short-circuited length of waveguide (the manifold).

,.L

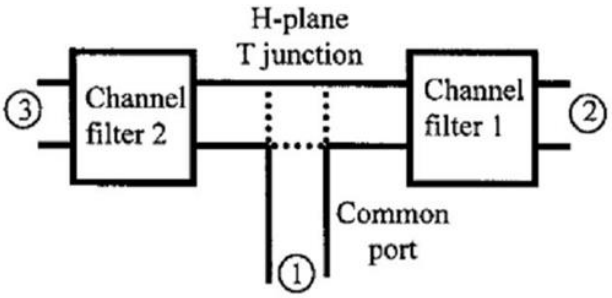

Fig 5. Block Diagram of H-plane diplexer

IV. CONFIGURATION OF A CONVENTIONAL DIPLEXER

This part provides equivalent design equation and a circuit of a conventional diplexer, The equivalent circuit of a conventional diplexer is made up of two band pass filters connected with a rectangular waveguide (H-Plane) Tee (T)-junction which is shown in Fig 6 [20], the transformer ratio "n "and susceptance b0 can be formulated using [21].

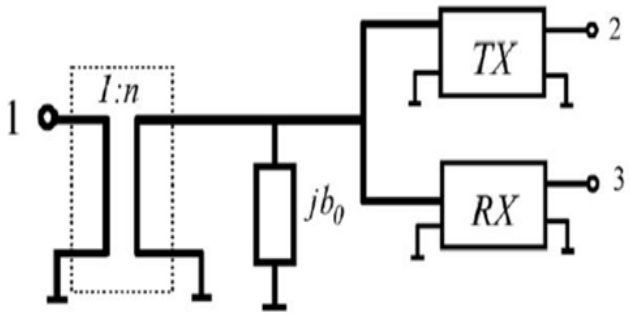

Fig. 6. Diplexer with waveguide(H-Plane) Tee (T)-junction.

The input admittance at input port 1 can be formulated as in figure 3.8 as follows [21],

$$y_{in} = n^2 (jb_0 + y_{in}^{TX} + y_{in}^{RX})$$

here y is the admittance at input (port 1) port of the filter with the other port terminator with the reference load, similarly y in RX is the admittance at the input port of the (Receiver) RX filter with the other port matched. These admittances are expressed in terms of S11 parameters of the individual TX and RX filters as follows

$$y_{in}^{TX} = \frac{1 - s_{11}^{TX}}{1 + s_{11}^{TX}}$$

$$y_{in}^{RX} = \frac{1 - s_{11}^{RX}}{1 + s_{11}^{RX}}$$

The S11 parameter are expressed as of the input admittance of diplexer y_{in} as follows

$$S_{11} = \frac{1 - y_{in}}{1 + y_{in}}$$

The transmission parameters S_{21} and s_{31} of the diplex

$$s_{21} = \frac{s_{21}^{TX}(1 + y_{in}^{TX})}{\frac{1}{n} + jnb_0 + n.y_{in}^{TX} + n.y_{in}^{RX}}$$

$$s_{31} = \frac{s_{21}^{RX}(1 + y_{in}^{RX})}{\frac{1}{n} + jnb_0 + n.y_{in}^{TX} + n.y_{in}^{RX}}$$

V. CONCLUSION

Paper includes the various types for the waveguide diplexer. Also it provides analysis and design equations for different diplexer categories. Configuration of conventional diplexer can be useful for making the diplexer design, which can provide the key for making diplexer design for various types of applications which includes satellite communication, telecommunication, mobile communication and navigation.

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