Design of Corporate Feed Network Using Wilkinson Power Divider

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***Abstract* - A four port corporate feed network by using Wilkinson power divider is described which splits a signal into 'n' equal phase and equal amplitude parts where n can be odd or even. The feed network provides isolation between output terminals and approximately matched terminal impedances over desired frequency. A schematic of feed network is given which satisfies the necessary design parameters, and an experimental model is described at 1176.45 MHz, which has a minimum return loss at each port is about -35dB, isolation of -57 dB between outputs, Insertion loss -6.344and all output port are in-phase (<0.5degree) .**

Keywords - Wilkinson power divider, corporate feed network, In-phase, Isolation.

I. Introduction

The power dividers [5] are especially used for antenna array [1,4] systems that utilize a power-splitting network, such as corporate or parallel feed system. The corporate feed is simply a device that splits power between 'n' outputs ports with a certain distribution while maintaining equal path lengths from input to output ports. It can be implemented with n-way power splitters where three-port power dividers are commonly used. The flexibility of the two-way divider's feed structure allows use of multiple stepped-sections to achieve power division with the capability of wideband operation. The bandwidth is primarily limited by the matching of the radiating elements, although, using high-isolation power divider reduces the dependence on the match of the loads. In this particular domain, the power dividers should satisfy several critical requirements, which include high isolation, low insertion loss and usually multiport outputs. Conventional waveguide-type power dividers are used for high power application generally at the transmitter side. At receiver side, due to low power, a suitable type of micro strip line and strip line power divider is used, however, when multiport are needed, it is necessary to make a cascade, and therefore number of ports are increased.. Feed network [8-10] is always located inside of the circuit topology.

Micro strip antenna arrays are often used in modern telecommunication and radar systems. A common approach for realization of antenna feeding networks is dependent on utilization of a corporate connection of Wilkinson power divider [5, 8, 9]. Such a solution allows for in-phase excitation of all radiating elements in a broad frequency range.

II. Wilkinson power divider

At higher frequencies (above 500 MHz) these devices are usually realized as a micro strip or strip line Wilkinson design. All Broad wave reactive power dividers are Wilkinson types.

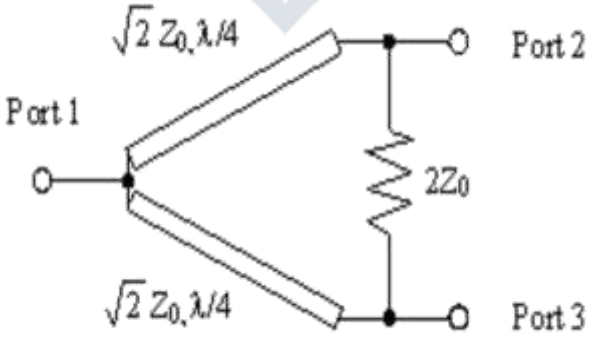

Figure: 1 Two ports Wilkinson power divider [9]

Figure.1 shows a simple 2-Way Wilkinson power divider. Being a Lossless reciprocal three port network, it inherits all its properties which state that, this type of network cannot have all the ports matched simultaneously. To solve this isolating resistor is placed between the two output ports, since no current flows through the resistor (i.e. there is no potential difference between the output ports), this resistor does not contribute to any resistive loss. This makes it an ideal Wilkinson and a 100% efficient device.

This resistor also provides excellent isolation even when the device is used as a combiner. Another property of the Wilkinson divider is that, it can be broken down into quarter wavelength (λ/4) sections.

III. Tools to be used for Simulation

Advanced Design System (ADS) is the world's leading electronic design automation software for RF, microwave, and high speed digital applications. It is a powerful tool and user friendly interface, ADS pioneers the most innovative and commercially successful technologies, such as S-parameters and 3D EM simulators, used by leading companies in the wireless communication & networking and aerospace & defense industries.

IV. Schematic design using ADS

For the present design, we will be using the following defined parameters:

1. Relative dielectric constant ε_r = 4.6,
2. Substrate thickness H = 1.5mm,
3. Dielectric loss tangent is 0.001,
4. Conductor thickness T=0.020 mm and
5. Conductor conductivity= 5.8e7 S/m (for copper).

Calculate the physical parameters can be synthesized using LineCalc of the ADS. The physical parameters of the micro strip line for the 50Ω (Z0) and quarter wave transformer for the 70.7Ω ($\sqrt{2} * Z_0$) are as follows.

1. For 50Ω line width W=2.748750mm Line length L=34.285900mm and
2. For 70.7Ω line Conductor width W=1.426250mm, Radius (measured to strip centerline) R = 23.25 mm.

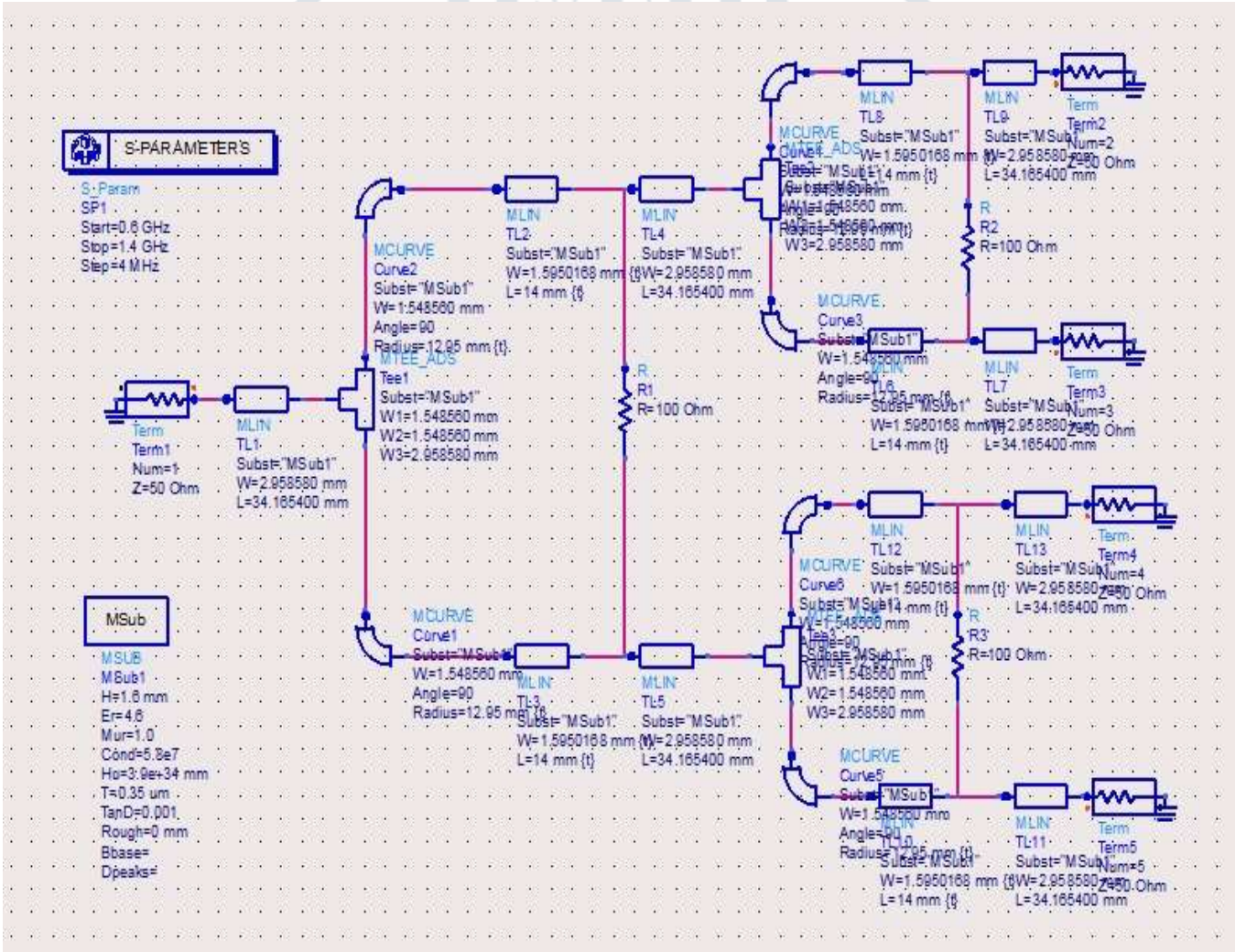

Figure: 2 Schematics circuit of 1*4 corporate feed network

V. Results

Table: 1 Return loss

Parameter	Value (dB)
S11	-35.521
S22	-45.681
S33	-45.681
S44	-45.681
S55	-45.681

Table: 2 Insertion loss

Parameter	Value(dB)
S21	-6.344
S31	-6.344
S41	-6.344
S51	-6.344

Table: 3 Isolation

Parameter	Value (dB)
S23	-57.694
S24	-58.774
S25	-58.774
S34	-58.774
S35	-58.774
S45	-57.694

Table: 4 Phase

Parameter	Value (degree)
S21	-85.410
S31	-85.410
S41	-85.410
S51	-85.410

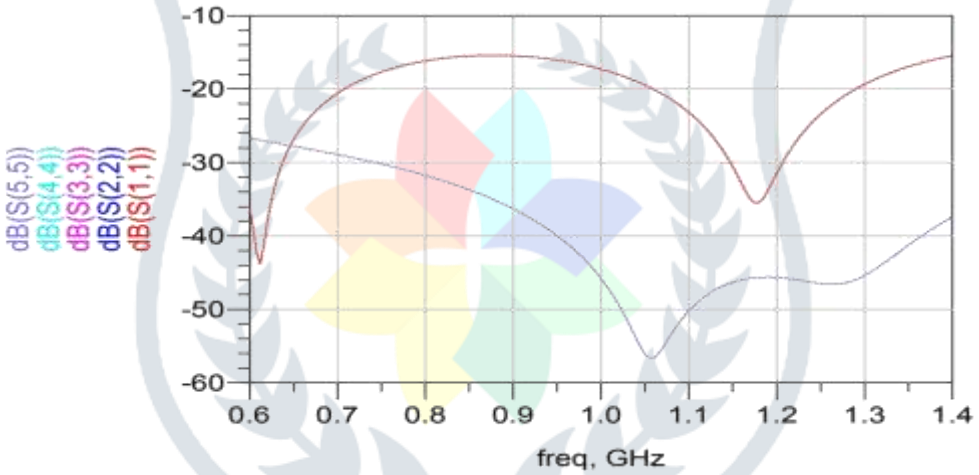

Figure:3 Return loss S-parameters for all ports

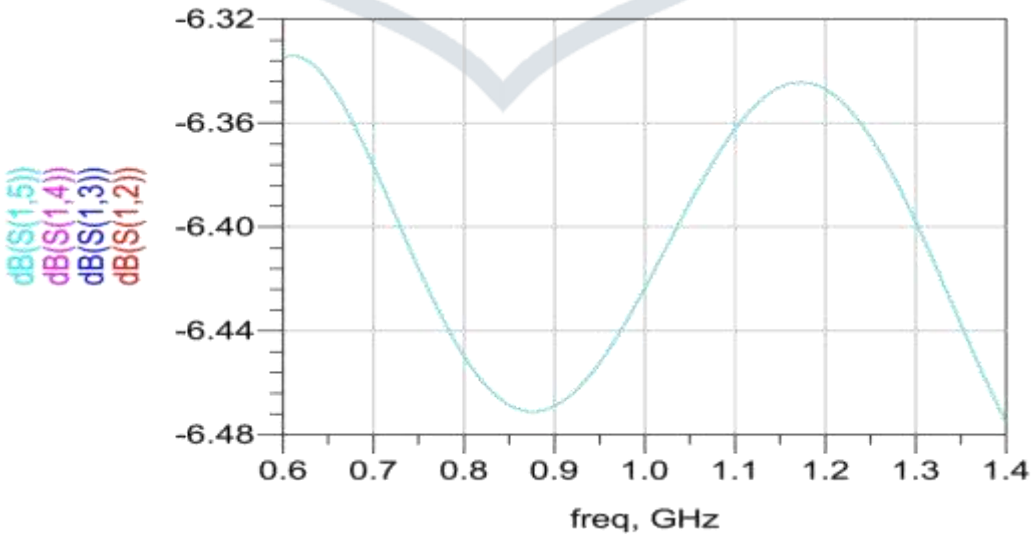

Figure: 4 Insertion loss S-parameters

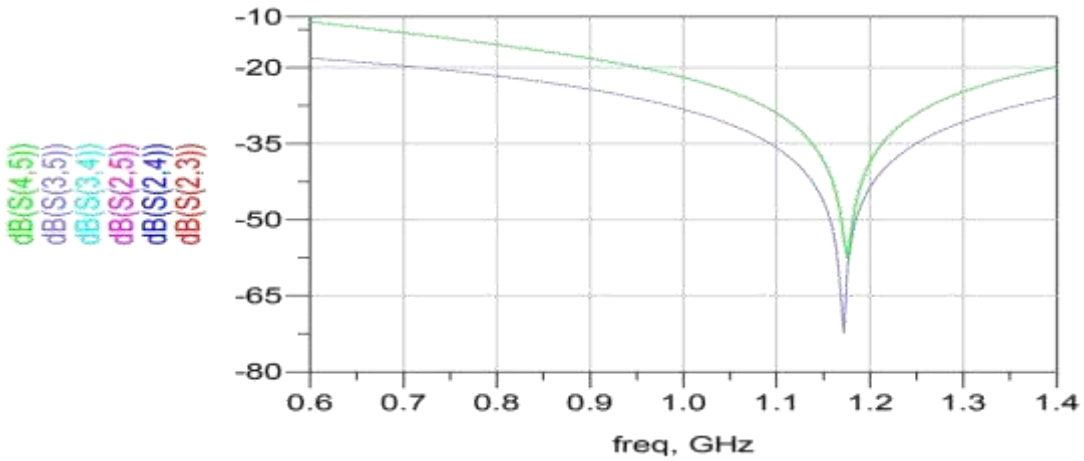

Figure: 5 Isolation at output ports S-parameters

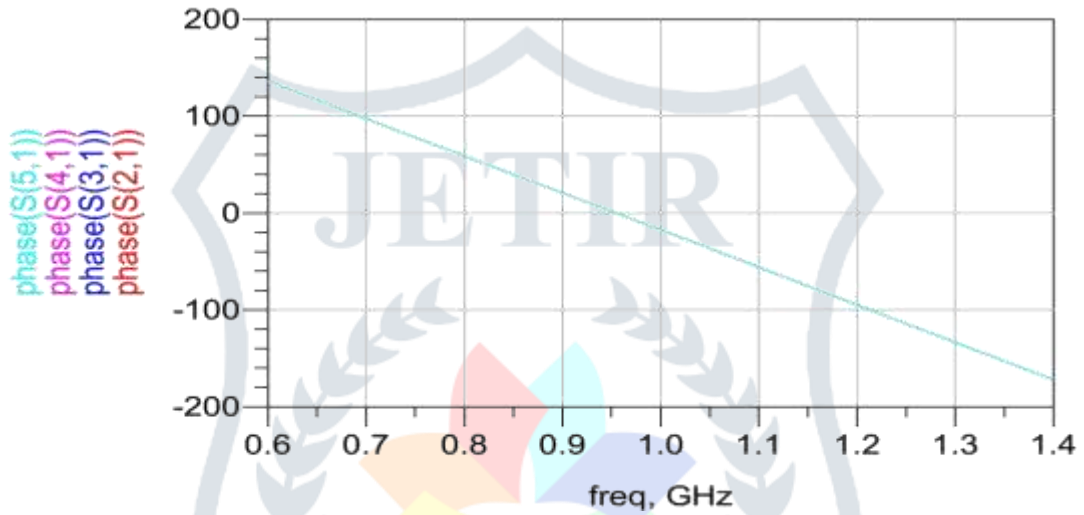

Figure: 6 Phase difference between all output ports

VI. Conclusion

The schematic of 1x4 corporate type feed network using Wilkinson power divider has been designed and simulated at frequency 1176.45MHz for four element array antenna for navigation which has a minimum return loss at each port is about -35dB, isolation of -57 dB between outputs, Insertion loss -6.344and all output port are in-phase (<0.5degree) .

VII. REFERENCES

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