Design of Wilkinson Power Divider Using Micro-Strip Antenna

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Abstract:*A microstrip array antenna is proposed with a three-layer mono-feed layer for communication purposes. In the field of microwave engineering and circuit design, Wilkinson Power Divider is a specific class of power divider circuit that can achieve insulation between output ports while maintaining a matching state on all ports. Wilkinson's design can also be used as a compound of power because it consists of negative components and then is reciprocal. The proposed microstrip antenna was designed using an electromagnetic analyzer based on MoM, IE3D. A comprehensive analysis of return loss, radiation pattern, absolute gain (dBi) and VSWR for the proposed array antenna is presented in this project. In the era of modern communication, the micro-bar antenna is suitable for simple configuration, low lighting and easy manufacturing in nature. There are four types of feeding techniques used for small tape antenna. In this project we use Transmission line feed technique. In this project we also compare the different types of feed technique. Wilkinson power divider uses quarterwave transformers, which can be easily fabricated as quarter wave lines on printed circuit boards. It is also possible to use other forms of transmission line (e.g. coaxial cable) or lumped circuit elements (inductors and capacitors). There is a great cdivider we achieve more output power than directional couplers.*

***Key Words* - Feed, Absolute gain, Wilkinson Power Divider, Beam-width.**

1. INTRODUCTION

To talk about a new era of communication, the microstrip design of the small antenna evokes much interest among young engineers and especially microwave engineers [1]. For microwave transitions, we need a small, lightweight antenna. On this basis, the Microstrip Antenna is the most suitable device. For microwave communication as well as for wireless communication, more than one operating frequency is required per day for many reasons. Operating frequencies are required mainly because most microwave and wireless engineers use different communication bands and engineers use different frequency bands. Therefore, engineers recently designed antennas with multiple properties. Another standard required for antenna design is to reduce the size. Reducing size is the new method. In this way, the size of the antenna is the same as for the conventional antenna. To reduce size, the most useful technique is to cut different structures in the correct position on a traditional microstrip antenna [2-5]. Reducing the size of the antenna means a very low resonance frequency for the cleaved antenna compared to the traditional antenna [6-8]. Unlike slotted antennas, there are other antennas such as DRA (aerial resonance buffer), fractional antenna, etc. to reduce antenna size [15-20].

Hard to design fractal antennas and DRA need to high substrate substrates are not readily available. Today, microstrip micro size of the microstrip is very small and can be reduced to increase demand for applications in various communications, especially microwave and mobile communications [9-10]. In the field of microwave engineering and circuit design, Wilkinson Power Divider is a specific class of power divider circuit that can achieve isolation between output ports while maintaining a matching state on all ports.

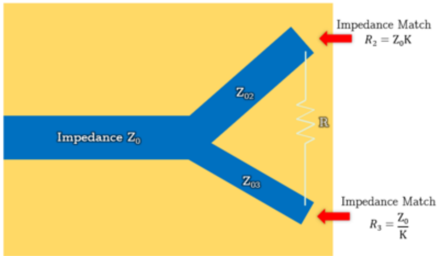
Wilkinson's design can also be used as a compound of power because it consists of negative components and then is reciprocal. This circuit was first found by Ernest J. Wilkinson in 1960, widely used in radio frequency communication systems using multiple channels since the high degree of isolation between output ports prevents crosstalk between individual channels. The scatter parameter is given to the common situation of the Wilkinson power divider at two times the design frequency by:

$$|S| = \frac{-j}{\sqrt{2}}\begin{vmatrix} 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{vmatrix}$$

The S-matrix test reveals that the network is reciprocal (Sij = Sji), that the terminals are identical (S11 = S22 = S33 = 0), that the output terminals are isolated (S23 = S32 = 0) and that the power is equal (S31 = S21). A non-unitary matrix produces the fact that the grid is missing. The ideal Wilkinson divider may lead to S21 = S31 = -3 dB.

Unequal/Asymmetric Division through Wilkinson Divider

If the arms of ports 2 and 3 are connected to unequal resistance, an asymmetrical division of power can be achieved. When the characteristic impedance is Z0, one wants to divide energy as P_2, P_3, and $P_2 \neq P_3$, thenthe design can be created following the equations where new constant K is defined for ease of expression, where $K^2 = P_2/P_3$



Impedances are different in two branches to achieve unequal splitting of power. The output impedances of the two branches are also different. Then the design guideline is:

$$Z_{02} = Z_0\sqrt{\frac{1+K^2}{K^3}}$$

$$Z_{03} = Z_0\sqrt{K(1+K^2)} = K^2 Z_{02}$$

$$R = Z_0(K + \frac{1}{K})$$

2. ANTENNA STRUCTURE

Designed antenna configurations in Figure 1 are shown with PTFE substrate. We designed a conical shape with rectangular holes added with two rectangular equal slits to achieve all the properties of the Wilkinson power divider that were discussed earlier using feed line transmission. The specific insulation material for this design is FR4 substrate epoxy with constant electrical insulation (r) = 4.4 and substrate height (h) = 1.6 mm. Feeding the transmission line probe is used for the proposed structure.

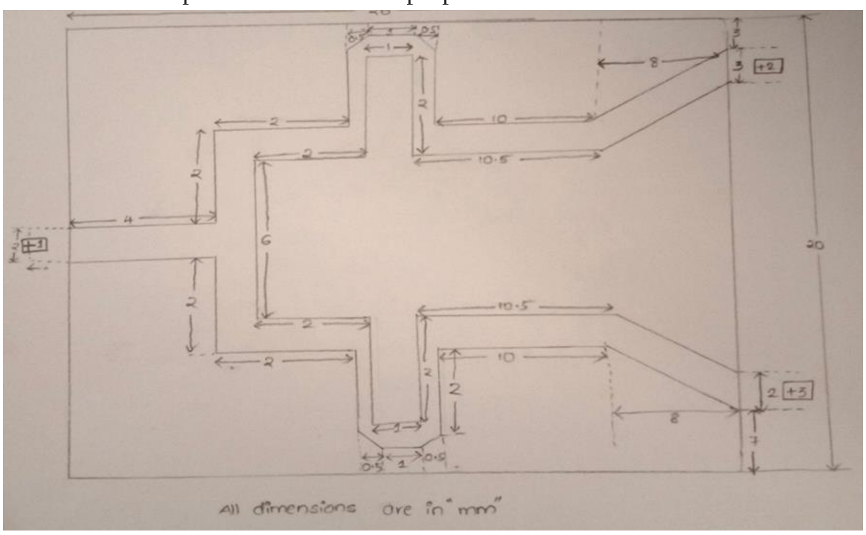


Figure 1: proposed Antenna configuration

3. SIMULATED RESULTS AND ANALYSIS

Parametric analysis of the designed antenna is performed and displayed in this section. The parameters of designed antenna have been investigated for improved bandwidth and gain and return loss of antenna. The simulated return loss of the designed antenna is illustrated in Figure 2, Figure-3 and Figure 4.

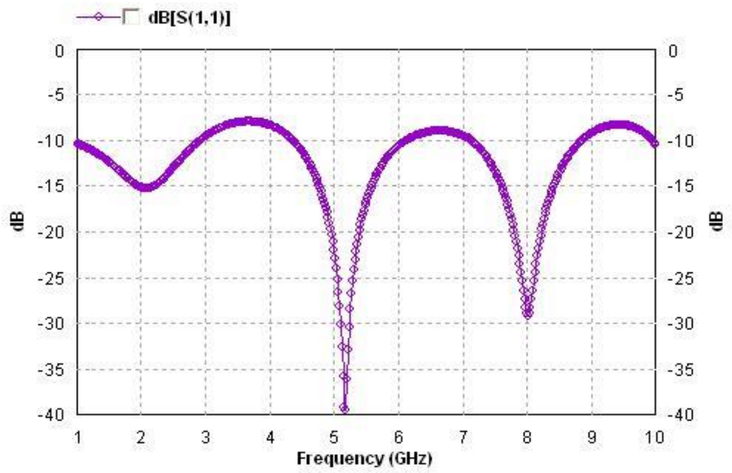


Fig 3: Return Loss Pattern (when input port active)

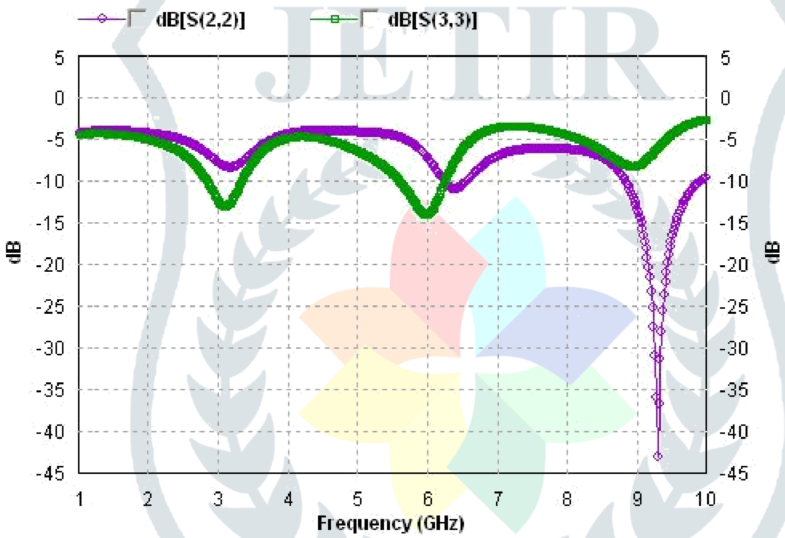


Fig 4: Return Loss Pattern (when output port active)

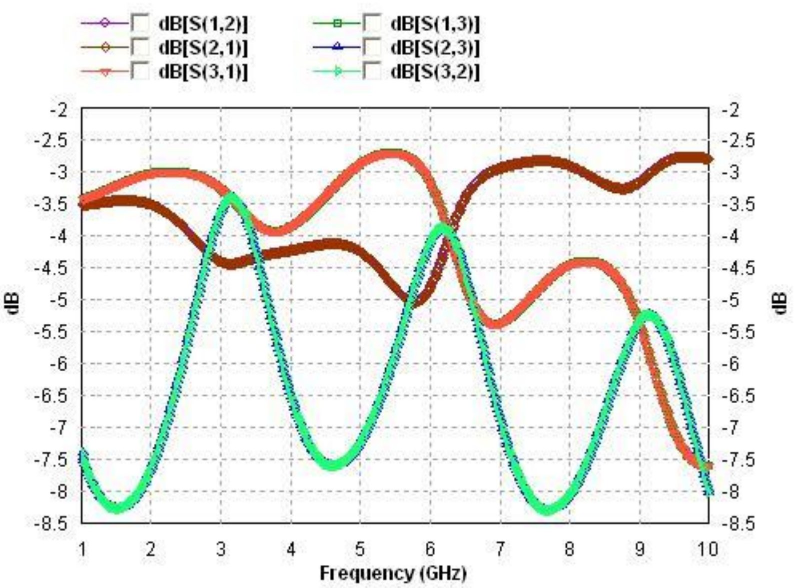


Fig 5: Return Loss Pattern (when output port active)

Because the slot is cut in the correct position of the antenna, the resonance frequency operation is obtained with large values of the frequency ratio with a large return loss of antenna.

Case 1: (When input port [PORT-1] active) The first resonance frequency of a proposed antenna isobtained at f_1 = 2.04 GHz with a return loss of about -15.2 dB. The second resonance frequency is obtained at f_2 = 5.19 GHz with a return loss of -39.3 dB and third resonance frequency is obtained at f_3 = 8.03 GHz with a return loss of -29 dB. The 10 dB corresponding bandwidth obtained for the proposed antenna in f_1 and f_2 is 178.88 MHz and 169.9 MHz, respectively.

Case 2: (When output port [PORT-2] active) The first frequency of a proposed antenna is obtained at f_1=9.30 GHz with a return loss of -42.78 and corresponding bandwidth obtained is 1.09 MHz

Case 3: (When output port [PORT-3] active) The first frequency of a proposed antenna is obtained atf_1=3.12 GHz with a return loss of -13.04.The second resonance frequency is obtained at f_2=5.97 GHz with a return loss of -14 and corresponding bandwidth obtained is 654.26 MHz.

Network theory controls that the separator cannot meet the three conditions (matching, reciprocal and lost) at the same time. The Wilkinson divider divides the first two (identical and reciprocal), and cannot satisfy the latter (be less loss). Thus, there is some loss in the network. The loss does not occur when the signals in ports 2 and 3 are in a phase and have the same size. If noise is entered into ports 2 and 3, the noise level in port 1 does not increase, and half the noise energy of the resistor is dissipated. By cascading, input energy may be divided into any number of outputs.

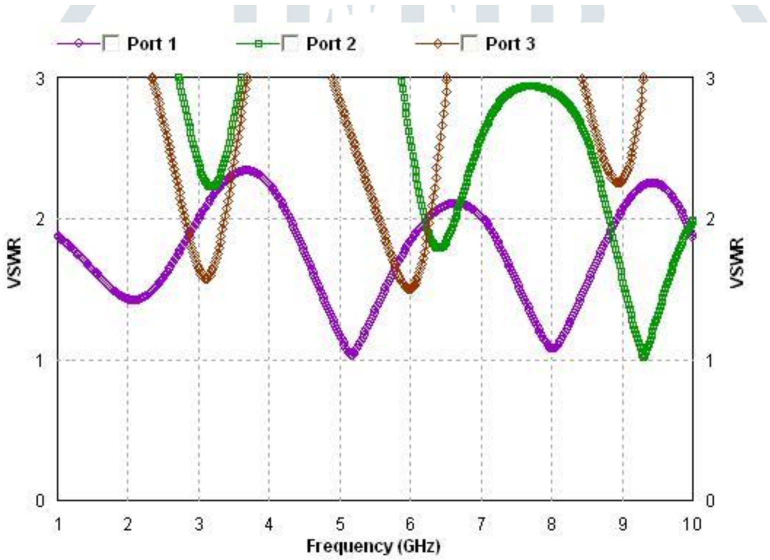


Fig 6: VSWR vs. Frequency Plot for Proposed Antenna

VSWR vs. the resonance frequencies are shown in Fig. 6. All VSWR values are within a 2: 1 range.

Cumulative results displays in Table I and Table II which is discussed below:

TABLE I: ***GAIN AND BEAMWIDTH OF DIFFERENT RESONANT FREQUENCY***

RESONANT FREQUENCY	FREQUENCY RATIO	GAIN(dbi)	BEAM WIDTH(deg)
f_1=2.04	1	-25.91	106.6^0
f_2=3.12	-1.52	-16.43	73.77^0
f_3=5.19	2.54	-9.71	160.68^0
f_4=5.97	2.92	9.28	88.811^0
f_5=8.03	3.93	-10.35	142.29^0
f_6=9.30	4.55	-9.28	114.04^0

TABLE II: ***SIMULATED RESULTS FOR PROPOSED ANTENNAwith respect to Return Loss***

INPUT PORT	RESONANT FREQUENCY (GHZ)	RETURN LOSS (dB)	10 DB BANDWIDTH (Hz)
S_{11}	f_1=2.04	- 15.2	1.93 G
	f_2=5.19	- 39.3	1.77 G
	f_3=8.03	- 29	1.72 G
S_{22}	f_1=9.30	- 42.78	1.09 G
S_{33}	f_1=3.12	- 13.04	502.9 M
	f_2=5.97	- 14	654.2 M

4. CONCLUSION

One layer, a three-feed transport line feeding a small patch antenna that performed theoretical investigations using the immediate program of IE3D. When the Wilkinson power divider is designed using an electromagnetic analyzer, the maximum improvement shows a maximum loss of yield of about -42.78 dB. The VSWR value is also within the range of 2: 1. Another result is also observed. For the proposed antenna,160.68^0 beam wide enough for the intended applications.

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