Bandwidth Improvement of S-Shape Microstrip Patch Antenna

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***Abstract*-A survey of S-shape microstrip antenna elements is presented, with emphasis on theoretical and practical design techniques. The bandwidth of S-shape microstrip antenna is increased by using a tuning stub. The S-shape antenna is first studied by a modal-expansion (cavity) technique and then is fully analyzed with bandwidth equations. This paper presents the analysis of the bandwidth & its improvement with the help of the numerical method. And results expressed that there is no energy loss in the propagation of wave.**

I. INTRODUCTION

Microstrip antennas are being increasingly used for aerospace applications because of their low weight, low volume and conformal nature. The most commonly used microstrip antennas are rectangular and circular disc antennas. However, other microstrip antennas are also being considered, depending on the application [1].

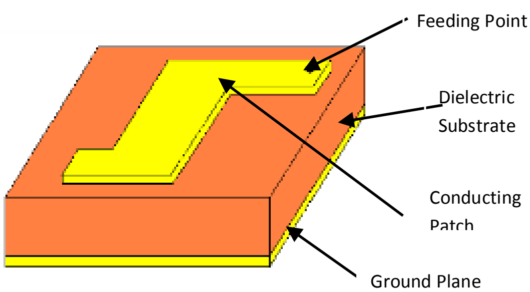


Fig. 1. S-shape microstrip antenna

In order to meet the requirement for mobile or personal communication systems, microstrip antennas with reduced size and broadband operation are of particular interest. Among various feeding mechanisms, the compact broadband microstrip antennas directly matched to a 50Ω coaxial line is also of importance, for its usefulness in integration with microwave integrated circuits. For this purpose, we present in this paper several related designs of microstrip antennas to broaden the operating bandwidth and reduce the overall size of the antenna. Here we discuss the S-shaped patch antenna. The S-shaped patch antenna reported here has a size about half that of the rectangular patch, with larger beamwidth but smaller bandwidth [2] shown in Fig.1.

II. BANDWIDTH OF S-SHAPE ANTENNA

The bandwidth of an antenna is defined as "the range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard." The bandwidth can be considered to be the range of frequencies, on either side of a center frequency (usually the resonance frequency for a dipole), where the antenna characteristics (such as input impedance, pattern, beamwidth, polarization, side lobe level, gain, beam direction, radiation efficiency) are within an acceptable value of those at the center frequency [3].Bandwidth as referred to S-shape microstrip antennas may take one of several meanings. The usual definition of the bandwidth, $\Delta f = Q/f_o$ is not extremely useful by itself. There is usually an impedance matching network between the antenna radiating element and its input port which must be considered. A more meaningful measure of bandwidth is that band of frequencies where the input VSWR is less than a specified value, usually 2:1, assuming that a unity VSWR is obtained at the design frequency. The bandwidth may then be expressed in terms of Q [4].

$$BW = \frac{VSWR - 1}{Q\sqrt{VSWR}} \qquad (1)$$

As now we have simulated the antenna parameters in the IE3D software [6] and the response is shown in Fig. 2., we shall study the radiation parameters. After this response from the range of the frequencies we can see that the operation point is at 2.1GHz for this design. The antenna is well matched to 50Ω at 2.1 GHz. In the Fig. 2. shown the VSWR which are less the value of 2.

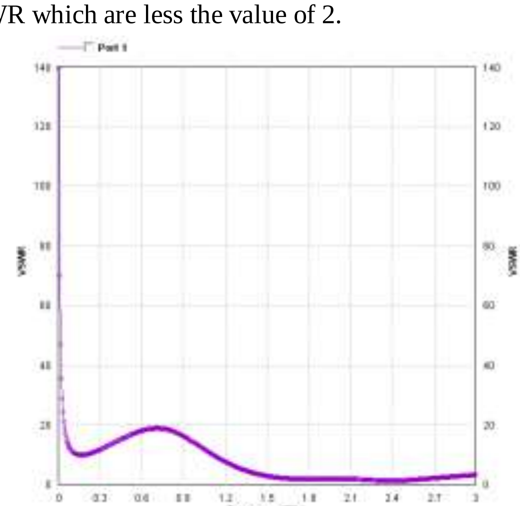


Fig. 2. VSWR of S-shape microstrip antenna

he simulation is run and is completed which gives the S-Parameters of the simulated structure. The S-parameters can be seen in the Fig. 3.

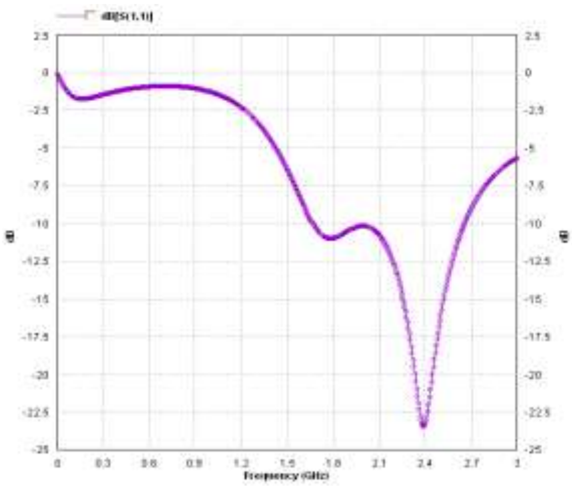


Fig.3. Return loss for the feed located

We can observe from the above Fig.3. the return loss is -10.6dB at 2.1GHz. The negative return loss here depicts that the antenna have not many losses during the transmission

III. BANDWIDTH IMPROVEMENT OF S-SHAPE ANTENNA

In [5] an expression relating the bandwidth B and the resonator quality factor Q of a simple RLC circuit was derived. This relationship is dependent on the degree of matching desired, as given by $R_{norm} = R_{\max} / Z_o$, where $R_{\max}$ is the maximum (resonant) resistance for a parallel RLC with a system impedance Z_o of and the acceptable mismatch as given by the maximum standing wave ratio S and is written as

$$Q = \frac{1}{B}\sqrt{\frac{(SR_{norm}-1)(S-R_{norm})}{S}} \qquad (2)$$

The bandwidth B is defined as $(f_2 - f_1)/f_r$ where f_1 and f_2 are the frequencies where VSWR (f_1) =VSWR (f_2)=S and f_r is the resonant frequency. An expression for the impedance of a parallel RLC resonance about a narrow band of frequencies can be approximated as

$$Z_{pric}(f_r + \Delta f) = R_{pric} - jX_{pric}$$

$$\cong \frac{R_{norm} - 2jR_{norm}Q\left(\frac{\Delta f}{f_r}\right)}{1 + 4Q^2\left(\frac{\Delta f}{f_r}\right)^2} \qquad (3)$$

where $\Delta f = f - f_r$ or the frequency shift from resonance.In (2) and in the following expressions, it is assumed that the antenna input impedance is close to the system impedance such that additional matching to the input feed line is not necessary. This requirement is not overly restrictive when considering EM coupled antennas since the input impedance can be made near 50 (for a 50- system) through proper choice of substrate thickness and feed height or slot size.Therefore, an antenna at resonance results in $1/S < R_{norm} < S$ and the frequency for which $R_e(Z_{pric}) = 1/S$ gives the maximum possible band edge $\Delta f_{\max}$, which is found (3) to be

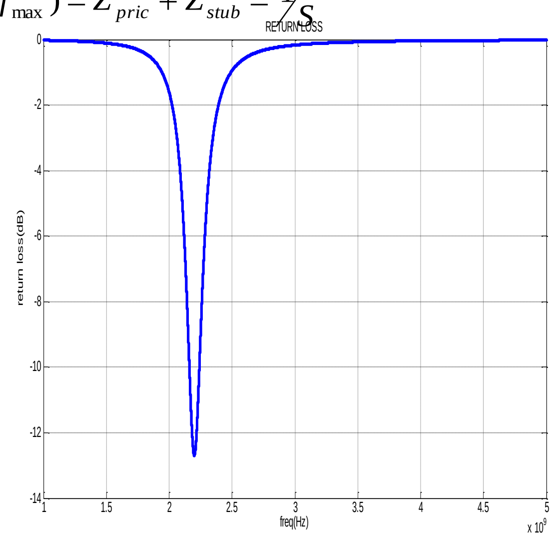
$$\frac{\Delta f_{\max}}{f_r} = \frac{1}{2Q}\sqrt{SR_{norm} - 1} \qquad (4)$$

At this band edge, if a reactive matching network were to present the conjugate reactance of (3) so that

$$Z_{stub}(f_r + \Delta f_{\max}) = jX_{pric} \qquad (5)$$

then the total input impedance of the parallel RLC network and a reactive load would be

$$Z_{Total}(f_r + \Delta f_{\max}) = Z_{pric} + Z_{stub} = 1/S \qquad (6)$$



In (5) and (6), an assumption that a symmetric impedance locus is obtained about f_r such that a solution for one band edge is adequate. Therefore, (4) represents half the achievable bandwidth and the total new bandwidth is

$$B_{new} \cong 2\frac{\Delta f_{\max}}{f_r} > B \qquad (7)$$

This improvement in bandwidth can be found using (2), (4), and (7).

IV. COMPARISON BETWEEN THEORETICAL EXPERIMENTAL RESULTS

We have designed the S-shaped microstrip patch antenna at frequency 2.1 GHz. This patch antenna is simulated by IE3D software, version 12.6. [6] We have observed that from following Fig. 3. shows that Return loss with frequency of antenna is found to be -23.33 dB at resonant frequency 2.4 GHz.Bandwidth of these antenna is 0.20db.At all centre frequencies value of VSWR 1.15 at 2.4 GHz which is less than 2 is shown in Fig. 4. Smith chart which is a polar plot of the of the complex reflection coefficient determine the input impedance of the designed antenna in our simulated result it is closed to 50 ohms.

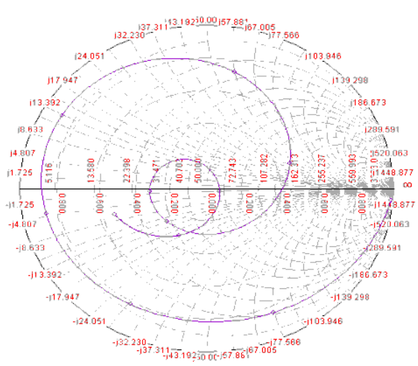


Fig. 4. Smith chart of the proposed antenna

In the theoretical analysis that patch antenna is gives the -13db return loss at 2.1GHz operating frequency shown in Fig. 5. and bandwidth is 0.19db. But in simulated result that return loss is decreases shown in Fig. 3. So that results presented that bandwidth is increases without losses. Table.1. shows the comparative value of bandwidth.

Fig.5. Return Loss by matlab

Table.1. Comparison between theoretical & simulated result

Configuration	Theoretical (db)	Simulated (db)
S-shape	0.19	0.20

V. CONCLUSION

The bandwidth of S-shape microstrip antenna is increased by using a tuning stub. Basic design equations were derived to aid in the optimization using EM simulation. This basic procedure of enhancing the bandwidth of EM coupled antennas from proper design of the stub is shown to achieve better performance due to efficient utilization of the available circuit structures.Experimental results gives the better response such as return loss, VSWR, smith chart & bandwidth. These parameters presented that the losses are minimum during the transmission. And its bandwidth is improved by using the bandwidth equation.

VI. REFERENCES

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