Study and Analysis Linearly Polarized Microstrip Patch Antenna

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Abstract – A novel particle swarm optimization method based on IE3D is used to design an Inset Feed Linearly Polarized Rectangular Microstrip Patch Antenna. The aim of the thesis is to design and fabricate an inset fed rectangular Microstrip Antenna and study the effect of antenna dimensions Length (L), Width (W) and substrate parameters relative Dielectric constant (εr), substrate thickness on Radiation parameters of Band width. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configuration. Other configurations are complex to analyze and require heavy numerical.

Index Terms – Patch antenna, Swarm optimization algorithm, PSO/IE3D simulation setup.

1. INTRODUCTION

Communication between humans was first by sound through voice. With the desire for slightly more distance communication came, devices such as drums, then, visual methods such as signal flags and smoke signals were used. These optical communication devices, of course, utilized the light portion of the electromagnetic spectrum. It has been only very recent in human history that the electro- magnetic spectrum, outside the visible region, has been employed for communication, through the use of radio. One of humankind's greatest natural resources is the electromagnetic spectrum and the antenna has been instrumental in harnessing this resource.

2. ANTENNA DESIGN AND RESULTS

The three essential parameters for the design of a rectangular Microstrip Patch Antenna: • Frequency of operation (*fo*): The resonant frequency of the antenna must be selected appropriately. The Mobile Communication Systems uses the frequency range from 2100-5600 MHz. Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for my design is 2.4GHz. : • Dielectric constant of the substrate (*εr*):The dielectric material selected for our design is RT Duroid which has a dielectric constant of 2.45. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

• Height of dielectric substrate (*h*): For the microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.58 mm.

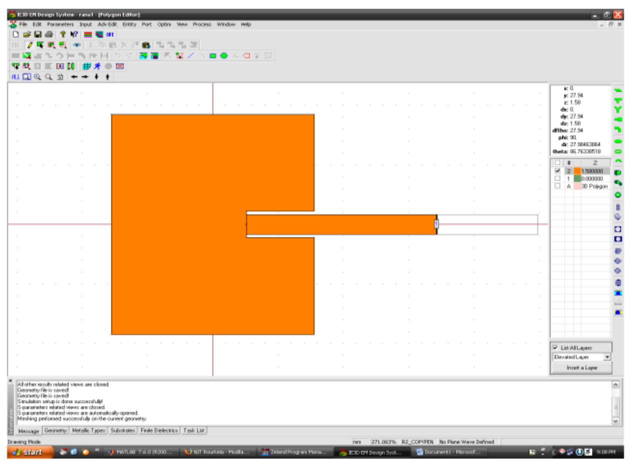

Figure 4.1: Microstrip patch antenna designed using IE3D

The inset feed used is designed to have an inset depth of 13.2mm, feed-line width of 5.6mm and feed path length of 37mm. A frequency range of 2.2-3.5 GHz is selected and 151frequency points are selected over this range to obtain accurate results. The center frequency is selected as the one at which the return loss is minimum. As described in chapter 2, the bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna can be said to be those range of frequencies over which the RL is greater than -9.5 dB (-9.5 dB corresponds to a VSWR of 2 which is an acceptable figure). Using PSO, the optimum feed depth is found to be at Yo= 13.2mm where a RL of -27 dB is obtained. The bandwidth of the antenna for this feed point location is calculated (as shown below in Figure 4.4) to be 23.28 MHz and a center frequency of 1.9120 GHz is obtained which is very close to the desired design frequency of 1.9 GHz.

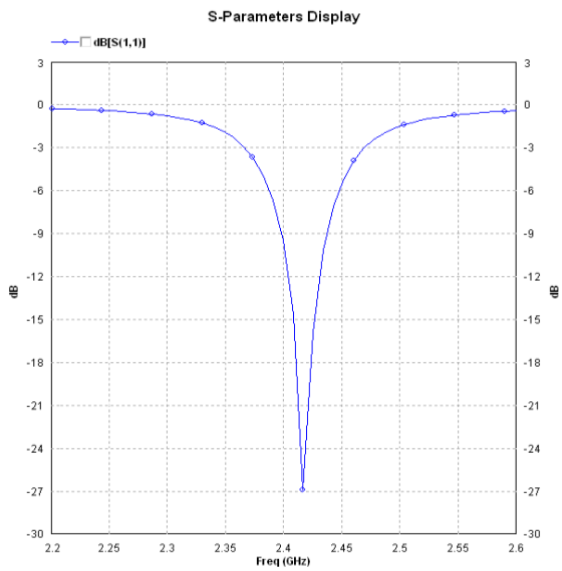

Figure 4.2: S-parameter plot for Return loss v/s frequency

The **Smith Chart**, invented by Phillip H. Smith (1905-1987), is a graphical aid or nomogram specializing in radio frequency (RF) engineering to assist in solving problems with transmission lines and matching circuits. The Smith Chart is plotted on the complex reflection coefficient plane in two dimensions and is scaled in normalized impedance (the most common), normalized admittance or both, using different colours to distinguish between them. These are often known as the Z, Y and YZ Smith Charts respectively. Normalized scaling allows the Smith Chart to be used for problems involving any characteristic impedance or system impedance, although by far the most commonly used is 50 ohms. As such, figures 4.3 and 4.4 show that the input impedance of the port was matched with the normalized ZC value of 50 Ω at the frequency 2.408 GHz, which is near the operating frequency of 2.4 GHz.

3. CONCLUSION

The optimization of the Microstrip Patch is partially realized which concludes that the PSO code was functioning correctly. The future scope of work revolves around increasing the efficiency and decreasing the run time of the PSO code by using a distributive computing platform. Realization of results by the modified PSO would be concluded with the fabrication of the patch of the Microstrip Patch Antenna. The investigation has been limited mostly to theoretical study due to lack of distributive computing platform. Detailed experimental studies can be taken up at a later stage to find out a design procedure for balanced amplifying antennas.

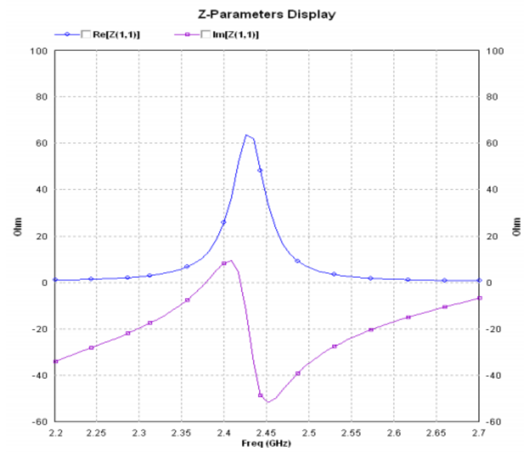

Figure 4.3: Z-parameter plot for Input impedance (ZC)

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