Design of Dual Band Microstrip Patch Antenna for Wireless Applications

A Sanjana, S Sindhu, Rajendra S Soloni, H S Rajappa and D N Chandrappa

May 29, 2022

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Ms. Sanjana A
8th Semester student
Dept. of E&CE
GMIT, Davangere
Davangere, India
sanjanaajay628@gmail.com

Ms. Sindhu S
8th Semester student
Dept. of E&CE
GMIT, Davangere
Davangere, India
sindhus842000@gmail.com

Mr. Rajendra Soloni
Asst. Professor
Dept. of E&CE
GMIT, Davangere
Davangere, India
rajendrass@gmit.ac.in

Mr. Rajappa H S
Asst. Professor
Dept. of E&CE
GMIT, Davangere
Davangere, India
rajappahs@gmit.ac.in

Dr. Chandrappa D N
Associate professor
Dept. of E&CE
East West College of Engineeirng
Bengaluru, India
karanthdc@gmail.com

Abstract*— In this research, a rectangular shape microstrip patch antenna for wireless applications has been built and analyzed at 5.8 GHz using a quarter-wave transformer feeding approach. Microstrip patch antennas are gaining popularity due to their numerous appealing characteristics, including their tiny size, light weight, ease of fabrication, and low cost. The CST microwave studio simulation programme is used to compute and optimize the physical characteristics of the building, as well as the patch and ground plane. The results reveal that the antenna is capable of operating in two frequency bands. The first frequency band resonates at 3.65 GHz with a return loss of -20.6dB, a gain of 0.9025dBi, and a bandwidth of 79.79MHz, whereas the second frequency band resonates at 4.47 GHz with a return loss of -46dB, a gain of 0.9025dBi, and a bandwidth of 79.79MHz.

***Keywords*— Return loss, Voltage standing wave ratio (VSWR), Microstrip patch antenna, Gain**

*Introduction (***Heading 1***)*

Wireless technologies have increasingly piqued developers' interest in conventional applications due to their enticing characteristics. Excellent reading compass, lightning-fast data transfer, and a possibly low price Near-field and far-field wireless scheme applications are divided into two groups. Depending on the reading range necessary. UHF near field systems have received a lot of interest because to their significant advantages in commodity level applications, notably for desktop approaches. The reader's contact with the transponder antennae is critical. It is a short-range wireless transmission and receiving technique.[1].

Antennas play an increasingly important part in Wireless systems, and their performance has a significant impact on the system's overall performance. The antenna for the Wireless system that is designed is highly important. LF (125 KHz), HF (13.56 MHz), UHF (860-960 MHZ), and microwave bands are all used in contemporary RFID systems (2.45 GHz and 5.8GHz). These frequency ranges are the focus of the antenna model. The antenna under discussion here is limited to systems that operate in the microwave spectrum. In general, the antenna's gauge is related to its operating frequency. The antenna size will be increased and the tag's dimensions will be increased for devalued frequencies. When the antenna size is fixed, great gain for higher frequencies may be attained. When the antenna size is firmed excellent gain will be achieved for larger frequency.

In the best-case scenario, antenna size becomes a bottleneck for tag downsizing. As a result, the Wireless system's operating periodicity should be carefully selected. We should look into a variety of factors at the same time. That is, the return loss, gain, and tag size. Numerous Wireless antenna features, such as antenna configuration, aerial size, bandwidth, radiation pattern, polarisation, and return loss, are depicted in various contests. [2].

Microstrip antennas come in a variety of shapes and sizes in wireless communication systems, with the patch antenna being the most common. Patch antennas have a conducting patch on one side of the dielectric material and a ground plane on the other. Small size, simplicity of manufacture, cheap cost, and light weight compatibility with printed board circuit technology are key benefits of the patch antenna [3]. Linear, dual, and circular polarizations are available with the patch antenna. Probe fed, aperture linked, proximity, and insert feed are some of the feeding strategies utilised to feed patch antennas [4]. Inset feeding and quarter wave transformer feeding are the easiest to construct of all the strategies.

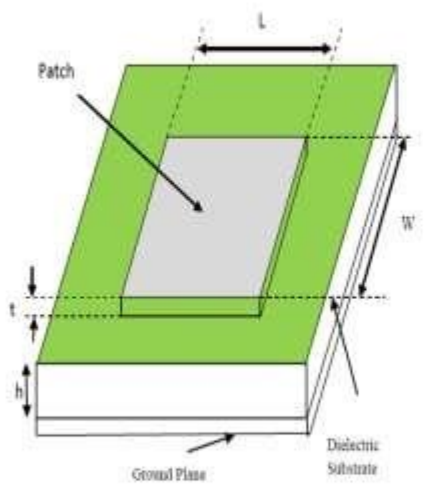

Fig.1: Structure of Rectangular Microstrip Patch Antenna

Patch antenna has some drawback of reduced gain, small bandwidth, these disadvantages can overcome by some quantity by taking care in design of antenna there are different factor effect the radiating character of antenna [5].

For designing the suggested rectangular microstrip patch antenna below equations are used to calculate the dimensions of antenna. The preferred antenna is resonating at 3.65 GHz and 4.47 GHz and simulated using CST software.

ESTIMATION OF WIDTH:

$$W = \frac{Co}{2fr}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where, *W* is the width of patch, *C* is the velocity of light, $f_r$is the resonant frequency.

Calculation of dielectric constant:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\left(\frac{h}{w}\right)\right]^{-0.5}$$

Length is calculated by:

$$\Delta L = 0.412h\left[\frac{(\varepsilon_{reff} + 0.3)(\frac{w}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{w}{h} + 0.8)}\right]$$

$$L = \frac{Co}{2fr}\sqrt{\frac{2}{\varepsilon_{reff}}} - 2\Delta L$$

The basis patch antenna is depicted in figure 2. The patch antenna is fabricated on glass epoxy substrate is 4.3, substrate height (h_t) is 1.6 mm, width of patch (w) is 40 mm and length (L) is 31mm. Then power is fed to the antenna using quarter wave transformer feeding technique. Table2 shows the parameters with the dimensions used to implement the basic patch antenna. The return loss of basic path antenna is shown in figure 3.

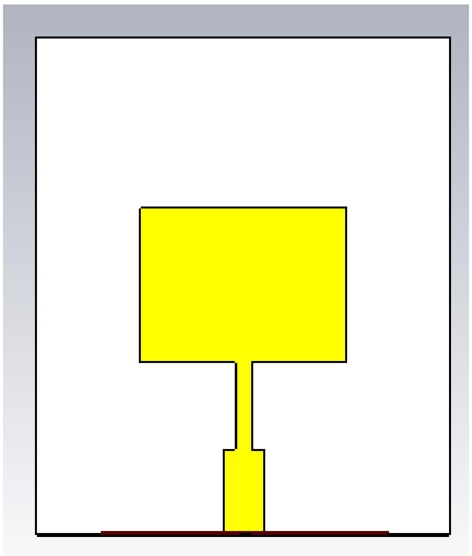

Fig.2: Patch antenna

Table 1: Design parameters

Parameter	**Units in mm**
Width(W)	15.8869
Length(L)	11.8848
Width of the feed line (W_f)	3.1144
Length of the feed line (L_f)	6.5801
Length of the transmission line (L_t)	6.6358
Width of the transmission line (W_t)	1.2001
Height of substrate (h_s)	1.6

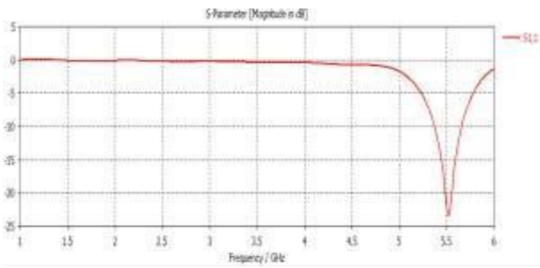

Fig.3: Return loss of basic patch antenna

The slots are created on the patch as shown in figure 4.

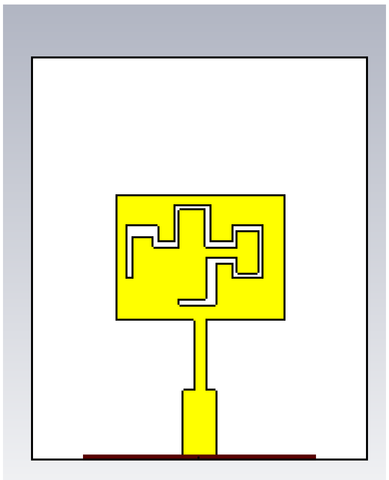

FIG.4: DESIGNED PATCH ANTENNA WITH SLOT

RESULTS

Return loss, VSWR, Radiation pattern and gain are simulated and presented in this paper. The patch antenna designed by considering number of parameters. The return loss graph of the proposed antenna as shown in figure 5 depicts the return loss of dual frequencies namely -20.6 dB at 3.65 GHz, -46 dB at 4.4 GHz. The VSWR graph is shown in figure 6.

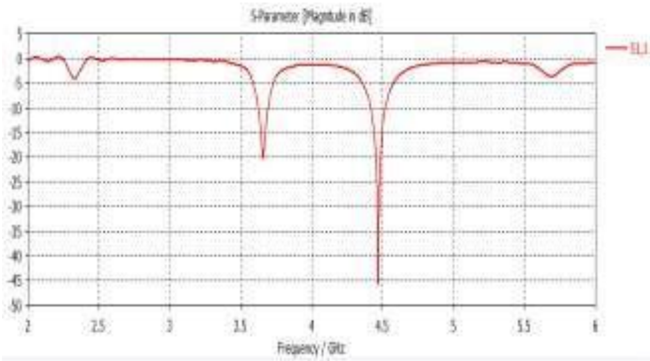

Fig.5: Return loss of the proposed slotted antenna

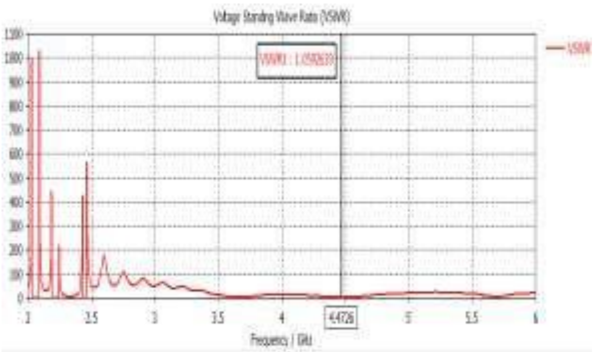

Fig .6: VSWR with slot designed antenna

The radiation patterns of the proposed antenna are shown in figure 8 to figure 11.

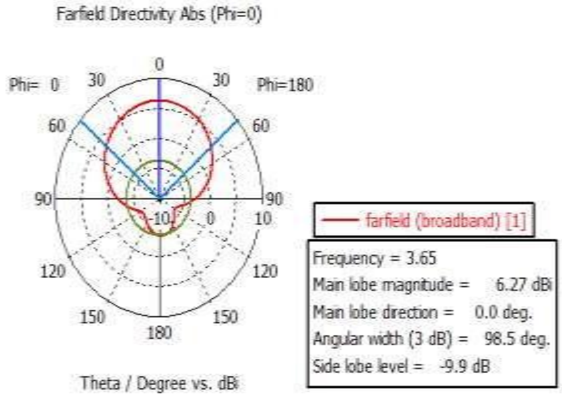

Fig.8: Radiation pattern at frequency 3.65 GHz E-field

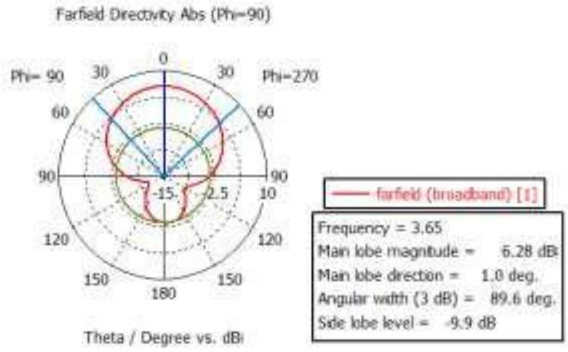

Fig.9: Radiation pattern at frequency 3.65 GHz H-field

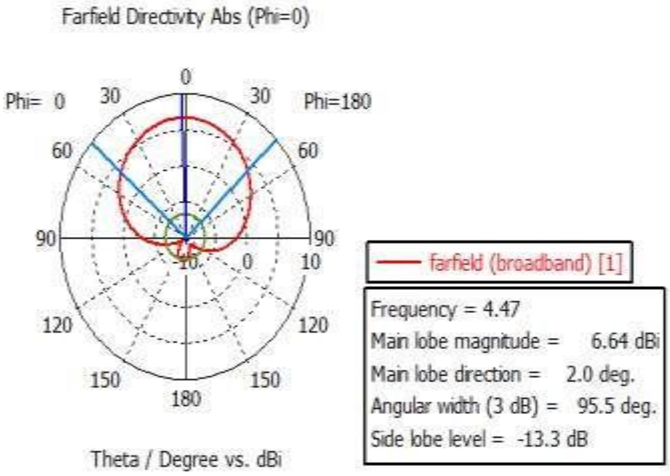

Fig.10: Radiation pattern at frequency 4.47 GHz E-field

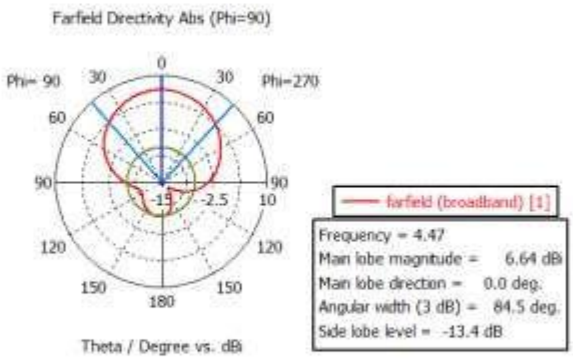

Fig.11: Radiation pattern at frequency 4.47 GHz H-field

The results of the proposed antenna are summarized in table2.

Table-2: Results

Frequency (GHz)	3.65 GHz	4.4 GHz
Return loss (dB)	-20.6	-46
VSWR	1.2	1.05
Bandwidth (MHz)	79.797	110.26
Directivity (dBi)	6.36	6.6
Gain (dBi)	0.9	2.57

CONCLUSION

Microstrip patch antenna designed and simulated in CST microwave studio software. The designed antenna shows high gain, low return loss and enhanced bandwidth. The antenna resonates at 3.65 GHz with a return loss of -20.6dB and at 4.4 GHz with a return loss -46dB.The gain of first and second bands is 0.902 dB and 2.57 dB respectively and bandwidth of first and second bands are 79.79MHz and 110.26 MHz. The designed antenna can be used for various RFID applications.

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