International Journal of Applied Engineering Research ISSN 0973-4562 Volume 9, Number 24 (2014) pp. 31010-31014


# Performance Analysis of Patch Antenna Feeding Methods

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**Abstract**
This research presents the performance analysis of patch antenna fed using microstrip line and fed by using coaxial line. Performance parameters that are evaluated includes Gain of antenna, Bandwidth of antenna and VSWR of antenna, Structure of patch antenna is designed and analyzed by using High frequency structure simulator.
Index Terms — Patch antenna, microstrip line, coaxial line.

**Introduction**
Out of many popular methods to feed patch antenna microstrip line feeding and coaxial line feeding is among the most popular methods. Fig (1) illustrates the feeding of patch by using microstrip line and Fig (2) illustrates the feeding of patch by using coaxial line. Inset Distance $y_o$ and inset gap decide the Matching characteristics of inset feed technique.

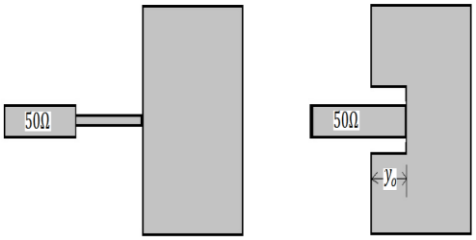

**Figure 1** Microstrip fed Patch antenna

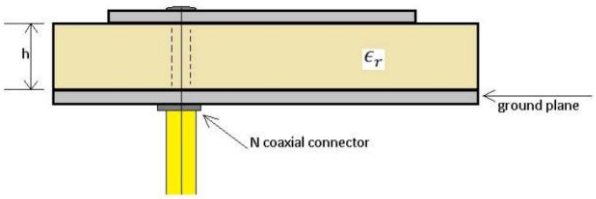

**Figure 2** Coaxial fed Patch antenna

The most important factor in feeding is to match input impedance of source with patch. In microstrip line fed patch antenna a quarter wave impedance transformer is required to match microstrip line impedance with patch. In coaxial fed microstrip line the position of feed on patch must be selected where patch input impedance matches with impedance of coaxial line.

In this research first a patch antenna is designed for 2.4 GHz. by using design equations mentioned in reference [1-12]. High frequency structure simulator is used to simulate the antennas. This patch antenna is fed by using microstrip and coaxial line. Microstrip line feeding is achieved by using quarter wave transformer and inset feed techniques. The gain, VSWR and efficiency of designed antennas are computed and compared. The Dimensions and parameters of, patch antenna, feeding line and substrate in designing Patch antenna are presented in Table 1, Table 2 and Table3.

**Table 1** Rectangular Patch antenna design
Using quarter wave transformer

| S. No. | Name of Parameter | Value |
|---|---|---|
| 1 | Resonant Frequency | 2.4 GHz |
| 2 | Patch Length | 5 Cm |
| 3 | Patch width | 4.15 cm |
| 4 | Substrate Material | Duriod |
| 5 | Substrate height | .16 cm |
| 6 | Quarter wave transformer width | .193 cm |
| 7 | Quarter wave transformer Length | 2.34 cm |
| 8 | Microstrip line width | .493 cm |
| 9 | Microstrip line length | 3.808 |

**Table 2** Rectangular Patch antenna design
Using inset feed techniques

| S. No. | Name of Parameter | Value |
|---|---|---|
| 1 | Resonant Frequency | 2.4 GHz |
| 2 | Patch Length | 5 Cm |
| 3 | Patch width | 4.15 cm |
| 4 | Substrate Material | Duriod |
| 5 | Substrate Height | .16 cm |
| 6 | Inset distance | 1.263 cm |
| 7 | Inset Gap | .247 cm |
| 8 | Feed width | .493 cm |
| 9 | Feed Length | 3.808 cm |

**Table 3** Rectangular Patch antenna design
Using Coaxial line

| S. No. | Name of Parameter | Value |
|---|---|---|
| 1 | Resonant Frequency | 2.4 GHz |
| 2 | Patch Length | 5 Cm |
| 3 | Patch width | 4.15 cm |
| 4 | Substrate Material | Duriod |
| 5 | Substrate height | .16 cm |
| 6 | Coaxial inner radius | .104 cm |
| 7 | Coaxial outer radius | .354 cm |
| 8 | Coaxial feed length | 2.08 cm |

**Results and Discussion**

The structure of quarter wave transformer rectangular patch antenna designed using High Frequency Structure Simulator for 2.4 GHz is shown in Fig (3).

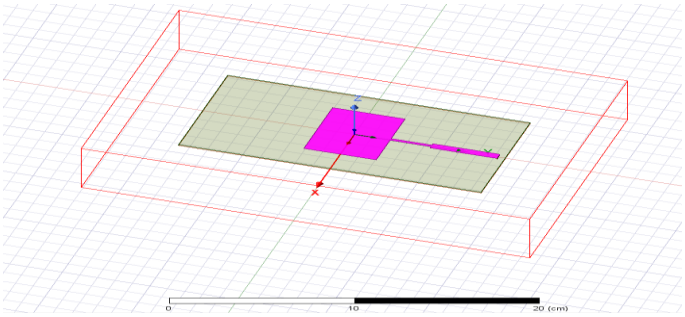

**Figure 3.** Structure of quarter wave transformer fed rectangular Patch antenna

Input Impedance of designed antenna is shown in Fig (4). Obtained Input impedance is 42.1 Ω.

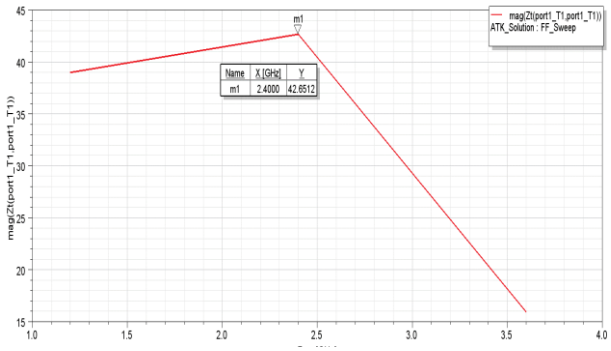


**Figure 4.** Input impedance of quarter wave transformer fed rectangular Patch antenna

The scattering parameter at Port 1 is measured to be – 2.9db. and is shown in Fig (5). This indicates a good matching between source and antenna.

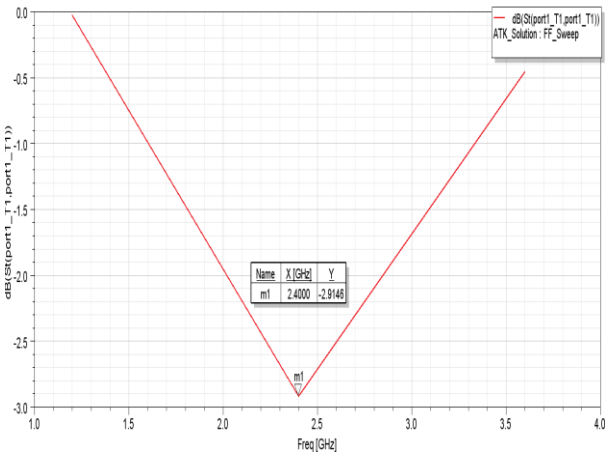


**Figure 5.** $S_{11}$ graph of quarter wave transformer fed rectangular Patch antenna.

VSWR of designed quarter wave fed transformer rectangular Patch antenna is shown in Fig (6). Obtained VSWR is 6 which indicate good matching between source and load.

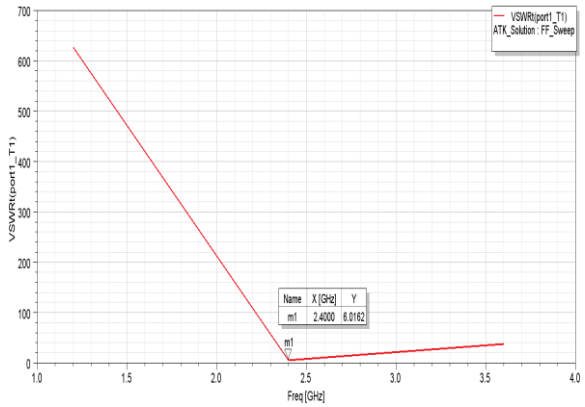


**Figure 6.**VSWR graph of quarter wave transformer fed rectangular Patch antenna

The Radiation Pattrn of designed quarter wave transformer fed rectangular Patch antenna is shown in Fig (7). A gain of 5.16 dB is achievable from designed dipole antenna.

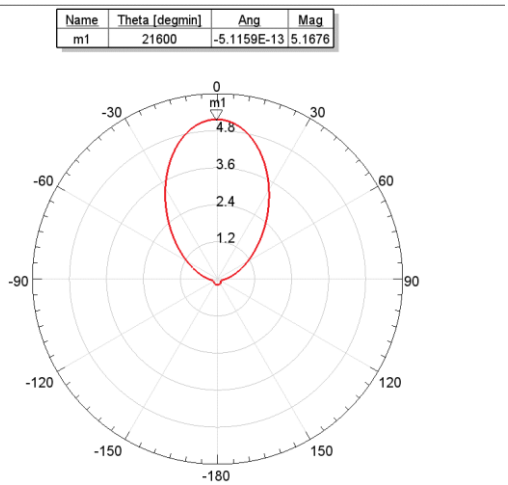


**Figure 7.**Radiation Pattern of quarter wave transformer fed rectangular Patch antenna

The structure of inset feed rectangular Patch antenna designed using High Frequency Structure Simulator for 2.4 GHz is shown in Fig (8).

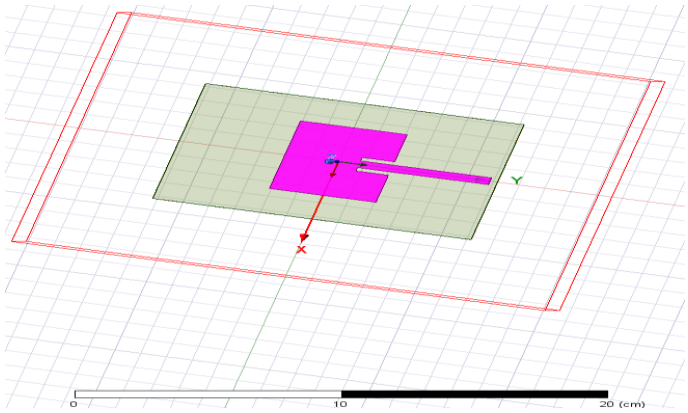

**Figure 8.** Structure of inset feed rectangular Patch antenna

Input Impedance of designed inset feed rectangular Patch antenna is shown in Fig (9). Obtained Input impedance is around 40. 59 Ω.

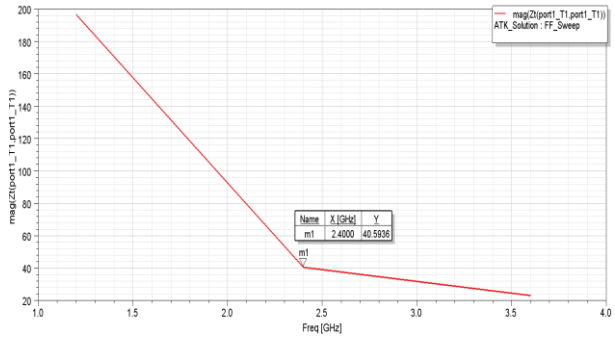


**Figure 9.** Input impedance of inset feed rectangular Patch antenna

The scattering parameter at Port 1 is measured to be – 15 dB. and is shown in Fig (10). This indicates a good matching between source and antenna.

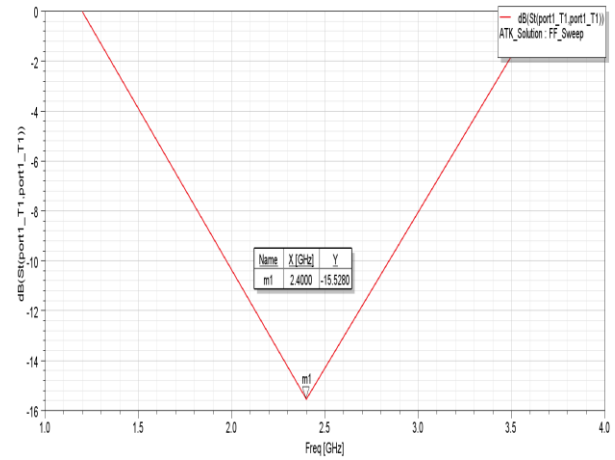


**Figure 10.** $S_{11}$ graph of inset feed rectangular Patch antenna.

VSWR of designed inset feed rectangular Patch antenna is shown in Fig (11). Obtained VSWR is 1.41 which indicate good matching between source and load.

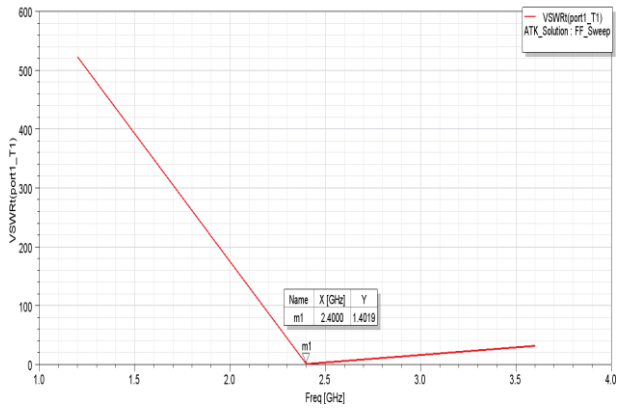


**Figure 11.**VSWR graph of inset feed rectangular Patch antenna

The Radiation Pattrn of designed inset feed rectangular Patch antenna is shown in Fig (12). A gain of 8.120 dB is achievable from designed inset feed rectangular Patch antenna

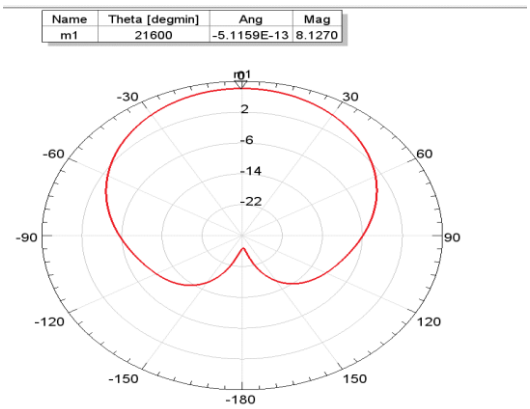


**Figure 12.**Radiation Pattern of inset feed rectangular Patch antenna

The structure of Coaxial fed Patch antenna designed using High Frequency Structure Simulator for 2.4 GHz is shown in Fig (13).

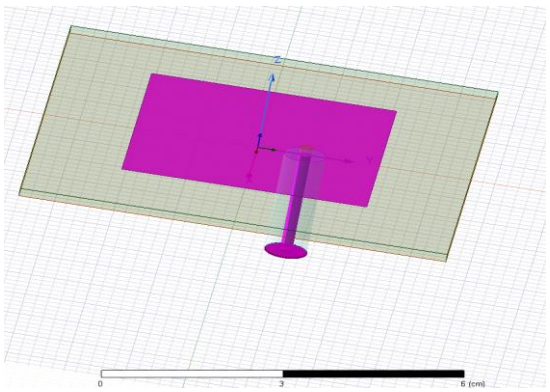

**Figure 13.** Structure of Coaxial fed Patch antenna

Input Impedance of designed antenna is shown in Fig (14). Obtained Input impedance is 225 Ω.

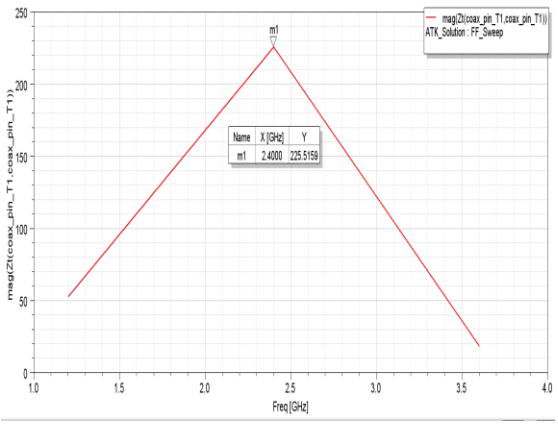


**Figure 14.** Input impedance of Coaxial fed Patch antenna

The scattering parameter at Port 1 is measured to be db. and is shown in Fig (15). This indicates a good matching between source and antenna.

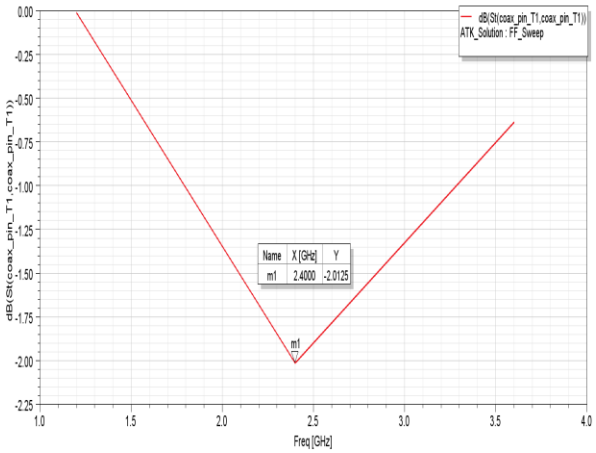


**Figure 15.** $S_{11}$ graph of Coaxial fed Patch antenna

VSWR of designed coaxial fed rectangular patch antenna is shown in Fig (16). Obtained VSWR is 8.6 which indicate good matching between source and load.

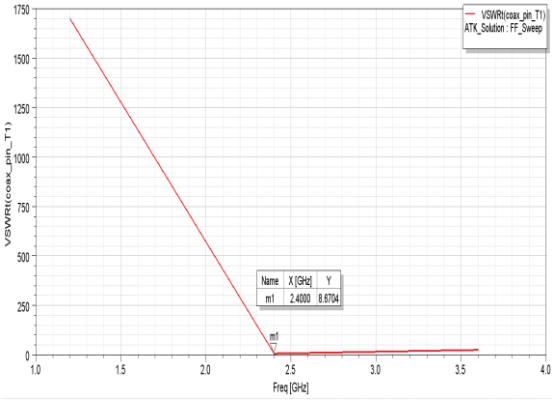


**Figure 16.**VSWR graph of Coaxial fed Patch antenna

The Radiation Pattrn of designed Coaxial fed Patch antenna is shown in Fig (17). A gain of 7.8 dB is achievable from designed dipole antenna.

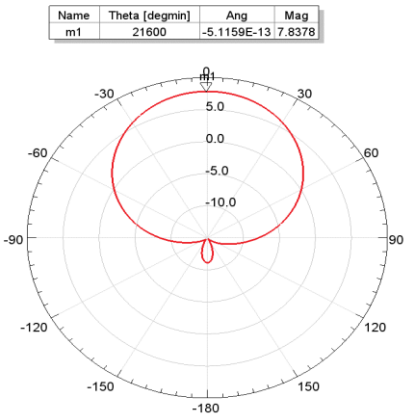


**Figure 17.**Radiation Pattern of Coaxial fed Patch antenna

## Conclusion

A Rectangular and Circular Patch antenna are designed in this research. A comparison of these antennas is presented below

| S.No. | Performance Parameters | Inset fed rectangular Patch antenna | Coaxial fed Patch antenna | Quarter wave fed transformer rectangular Patch antenna |
|---|---|---|---|---|
| 1 | Input Impedance | 40. 59 Ω | 225 Ω | 42.1 Ω |
| 2 | VSWR | 1.41 | 8.6 | 6 |
| 3 | $S_{11}$ | – 15 dB | -2 dB | -2.9 dB |
| 4 | Gain | 8.120 dB | 7.8 dB | 5.16 dB |

From the results it is evident that Inset fed rectangular Patch antenna provides the best gain among three

## References

[1] K. Carver and J. Mink, "Microstrip antenna technology," in IEEE Transactions on Antennas and Propagation, vol. 29, no. 1, pp. 2-24, January 1981, doi: 10.1109/TAP.1981.1142523.

[2] C. Garvin, R. Munson, L. Ostwald and K. Schroeder, "Low profile, electrically small missile base mounted microstrip antennas," 1975 Antennas and Propagation Society International Symposium, Urbana, IL, USA, 1975, pp. 244-247, doi: 10.1109/APS.1975.1147458.

[3] Xiao, S., Wang, B. & Wang, G. Design of Reconfigurable Millimeter-Wave Patch Antenna. International Journal of Infrared and Millimeter Waves 23, 1091–1099 (2002).

[4] G. Sanford, "Conformal microstrip phased array for aircraft tests with ATS-6," in IEEE Transactions on Antennas and Propagation, vol. 26, no. 5, pp. 642-646, September 1978, doi: 10.1109/TAP.1978.1141909.

[5] Balanis, C. A. (1989). Advanced engineering electromagnetics. New York: Wiley.

[6] I. J. Bahl and P. Bhartia, "Microstrip Antennas," Chapter 2, pp. 31-83, Artech House, Dedham, MA, 1980.

[7] R. K. Mishra and A. Patnaik, "Designing rectangular patch antenna using the neurospectral method," in IEEE Transactions on Antennas and Propagation, vol. 51, no. 8, pp. 1914-1921, Aug. 2003, doi: 10.1109/TAP.2003.814748.

[8] E.O.Hammerstard and O.Jensen, "Accurate Models for Microstrip Computer-aided design" IEEE MTT-S, 1980, Digest, pp.407-409.

[9] E. O. Hammerstad, "Equations for Microstrip Circuit Design," 1975 5th European Microwave Conference, Hamburg, Germany, 1975, pp. 268-272, doi: 10.1109/EUMA.1975.332206.

[10] M. Kahrizi, K. Sarkar and Zoran A. Maricevic, "Dynamic Analysis of a Microstrip Line Over a Perforated Ground Plane", IEEE Transaction on Microwave Theory and Techniques, Vol. 42, No. 5, May 1994.

[11] E. Tunier. Lee B. T., M. Islam and D. P. Nickirk, "Quasi-Static Conductor Loss Calculations in Transmission Theory and Techniques, Vol. 42, PP. 1807-1815, 1994.

[12] E. Yamshita, "Variational Method for the Analysis of Microstrip Like Transmission Lines", IEEE Transaction on Microwave Theory and Techniques, Vol. 16 No. 8, Aug, 1968.