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# Implementation and Applications of Various Feeding Techniques Using CST Microwave Studio

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***Abstract--***The study of microstrip patch antennas has made great progress in recent years. Compared with conventional antennas, microstrip patch antennas have more advantages and better prospects. The main concern is to study the bandwidth improvement of the microstrip antenna using different slots. The construction of different microstrip antennas on a dielectric substrate operating on 1.8 GHz is proposed. The article presents four models of single layer microstrip antenna operating on the same 1.8 GHz frequency. Each of antennas was fed in other ways. Each of the antenna models are designed using parameters such as VSWR, input resistance, input reactance and radiation pattern . Bandwidth of the patch antenna is increased by using multiple layer dielectric substrates. Some effect of disadvantages can be minimized. Lower gain and low power handling capacity can be overcome through an array configuration. Some factors are involved in the selection of feeding technique.

***Keywords***- *Feeding, bandwidth, return loss, radiation pattern*

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## 1. Introduction

A microstrip patch antenna (MPA) consists of a conducting patch of any planar or nonplanar geometry on one side of a dielectric substrate with a ground plane on other side. It is a popular printed resonant antenna for narrow-band microwave wireless links that require semi hemispherical coverage. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been heavily studied and is often used as elements for an array. A large number of microstrip patch antennas have been studied to date. The rectangular and circular patches are the basic and most commonly used microstrip antennas. These patches are used for the simplest and the most demanding applications. Rectangular geometries are separable in nature and their analysis is also simple. The circular patch antenna has the advantage of their radiation pattern being symmetric.

### 1.1 Feeding Techniques

A feed line is used to excite to radiate by direct or indirect contact. There are many different techniques of feeding and four most popular techniques are coaxial probe feed, micro-strip line, aperture coupling and proximity coupling.

Coaxial probe feeding is feeding method in which that the inner conductor of the coaxial is attached to the radiation patch of the antenna while the outer conductor is connected to the ground plane. Advantages of coaxial feeding is ease of fabrication, easy to match, low spurious radiation and its disadvantages is narrow bandwidth, difficult to model specially for thick substrate.

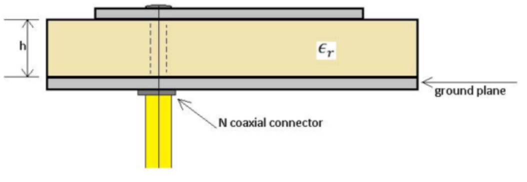


Fig 1.1

Micro-strip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. However the disadvantage of this method is that as substrate thickness increases, surface wave and spurious feed radiation increases which limit the bandwidth.

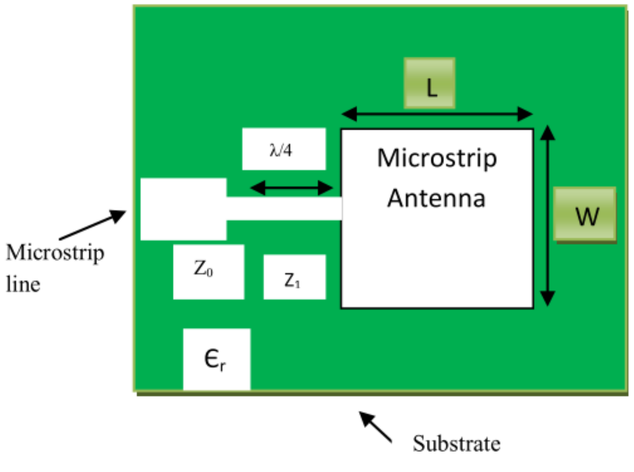


*Fig 1.2 Microstrip line feed*

Aperture coupled feed consists of two different substrate separated by a ground plane. On the bottom side of lower substrate there is a microstrip feed line whose energy is coupled to the patch through a slot on the ground plane separating two substrates. This arrangement allows independent optimization of the feed mechanism and the radiating element. Normally top substrate uses a thick low dielectric constant substrate while for the bottom substrate; it is the high dielectric substrate. The ground plane, which is in the middle, isolates the feed from radiation element and minimizes interference of spurious radiation for pattern formation and polarization purity. Advantage is that it allows independent optimization of feed mechanism element.

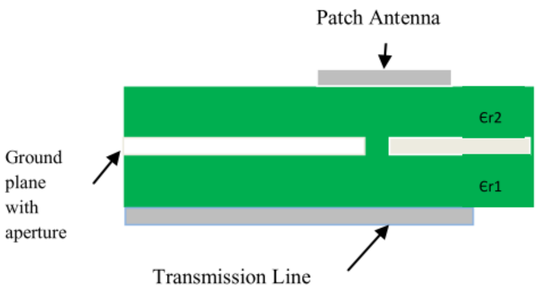


Fig 1.3 Aperture coupled feed

Proximity coupling has the largest bandwidth, has low spurious radiation. However fabrication is difficult. Length of feeding stub and width-to-length ratio of patch is used to control the match. Its coupling mechanism is capacitive in nature.

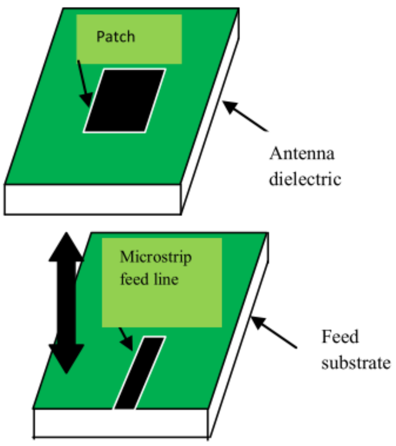


*Fig 1.4 Proximity coupled feed*

The major disadvantage of this feeding technique is that it is difficult to fabricate because of the two dielectric layers that need proper alignment. Also there is increase in overall thickness of the antenna. In the wide range of antenna models there are different structures of Microstrip antennas, but on the whole we have four basic parts in the antenna. They are the patch, dielectric substrate, ground plane and feed line

Comparison of different feeding techniques

| Characteristics | Micro strip line feed | Coaxial feed | Aperture coupled feed | Proximity coupled feed |
|---|---|---|---|---|
| Spurious feed radiation | More | More | Less | Minimum |
| Reliability | Better | Poor due to soldering | Good | Good |
| Ease of fabrication | Easy | Soldering and drilling needed | Alignment Required | Alignment Required |
| Impedance Matching | Easy | Easy | Easy | Easy |
| Bandwidth | 2-5% | 2-5% | 21% | 13% |

**1.2 Design and Simulation of various feeding techniques using CST microwave Studio**

First we design the coaxial fed micro strip patch antenna at 5 GHz application. The first stage is to design square shaped patch antenna and feeding is done with the coaxial feed to match the impedance of 50 ohm. The parametric changes provide the result for 5 GHz applications. Figure 1.5 shows its design.

**1.2.1 Coaxial Fed Antenna For 5 GHz**

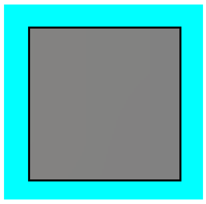

*Fig 1.5 CST design of Coaxial Fed Antenna*

The square patch antenna resonates at 5 GHz. Since the antenna length controls the antenna operating frequency, tweaking the antenna length until the antenna operates at 5 GHz. The antenna length and the frequency are inversely proportional, so the length has to be decreased till the resonance frequency is 5 GHz.

This paper focuses on comparison done in terms of the axial ratio, return loss |S11|dB and radiation patterns at phi=0 and phi=90 resulting from the use of these feeding and patch antenna dimensions. Hence the return loss parameter, axial ratio and radiation patterns for the design seen in Figure 1.5 are shown in Figure 1.6, figure 1.7 and figure 1.8 , figure 1.9, figure 1.10.

**Return Loss**

Return loss is an important parameter when connecting an antenna. It is related to impedance matching and the

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maximum transfer of power theory. It is also a measure of the effectiveness of an antenna to deliver power from the source to the antenna.

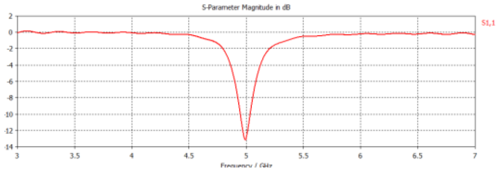

*Fig 1.6 Return loss (in dB) for coaxial fed antenna at 5 GHz. Return loss for the proposed antenna reaches −13.113 dB, it has the bandwidth of 98 MHz.*

**.Radiation Pattern**

The radiation pattern is usually a graphical representation of the radiation properties including power flux density, radiation intensity, field strength and polarization as a function of angle. Among these patterns, the power pattern which represents the spatial distribution of radiated power is usually of most interest.

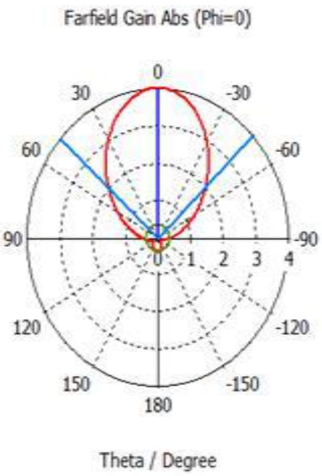


*Fig 1.7 Radiation pattern for coaxial fed antenna at H-plane, $\phi$=0. The main lobe magnitude (gain) is found to be 3.998 dB.*

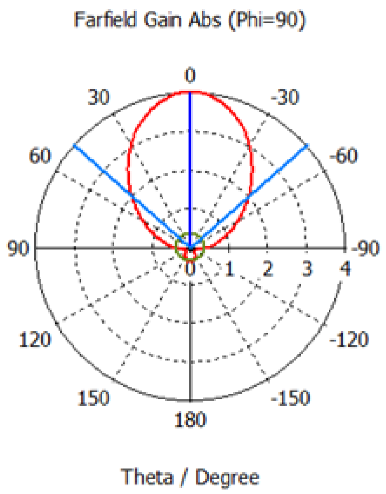


*Fig 1.8 Radiation pattern for coaxial fed antenna at E-plane, $\phi$=90. 25*

**Axial Ratio**

Axial Ratio is a property of an elliptically polarized field. AR is the ratio of major and minor axes of the polarization ellipse.

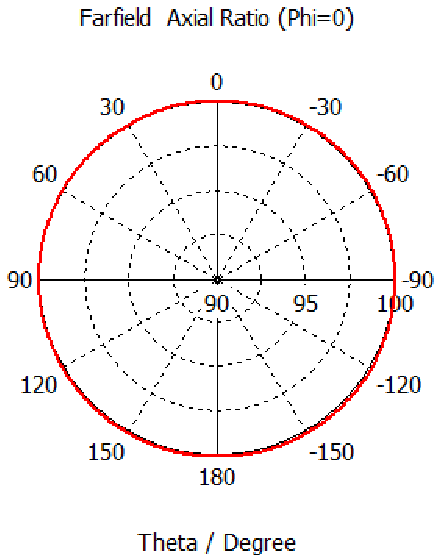


*Fig 1.9 Axial Ratio for coaxial fed antenna at H-plane, $\phi$=0. The axial ratio obtained is 100 dB. It is perfectly linearly polarized.*

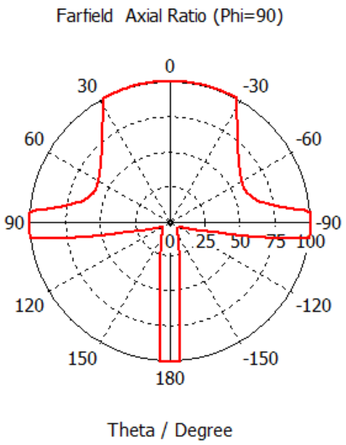


*Fig 1.10 Axial Ratio for coaxial fed antenna at E-plane, $\phi$=90. . The axial ratio obtained is 100 dB. It is perfectly linearly polarized.*

**1.2.2 APMSA Fed Antenna For 5GHz**

First we design the APMSA fed micro strip patch antenna at 5 GHz application. The first stage is to design square shaped patch antenna and feeding is done with the APMSA feed to match the impedance of 50 ohm. The parametric changes provide the result for 5 GHz applications. Figure 1.11 shows its design.

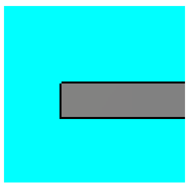

*Fig 1.11 CST design of APMSA Fed* Antenna

**Return Loss**

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The return loss obtained from Figure 1.12 is equal to -37.318 dB ($\leq -10\ dB$), which shows the s-parameter for port 1.

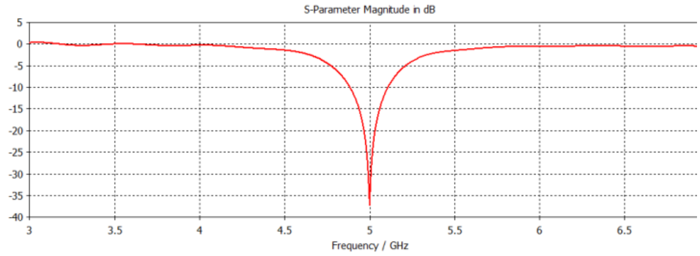


*Fig 1.12 Return loss (in dB) for APMSA fed antenna at 5GHz. Return loss for the proposed antenna reaches -37.318 dB, it has the bandwidth of 248 MHz.*

**Radiation Pattern**

Radiation patterns are also taken at phi=0 and phi=90 values related to object direction.

The plot of gain as a function of direction is known as radiation pattern is shown in figure 1.13 and figure 1.14.

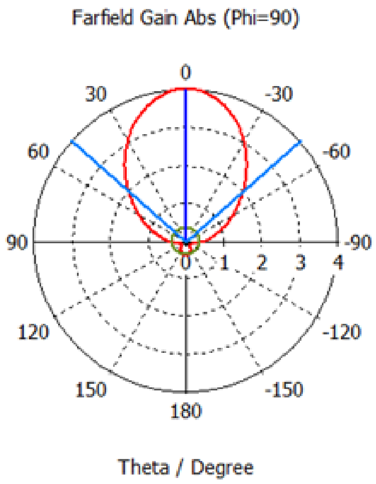


*Fig 1.13 Radiation pattern for APMSA fed antenna at E-plane, $\phi$=90.*

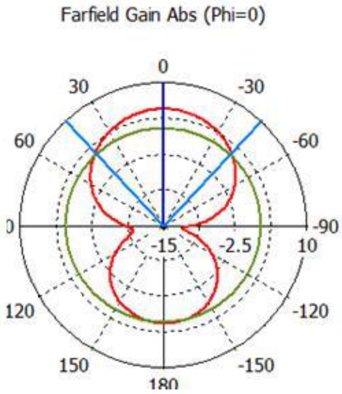


*Fig 1.14 Radiation pattern for APMSA fed antenna at H-plane, $\phi$=0. The main lobe magnitude (gain) is found to be 5.278 dB.*

**Axial Ratio**

For polarization axial ratio is taken at theta =0 and phi=0 values and this shows that the antenna is linearly polarized as it is 40 dB. AR is shown in figure 1.15 and figure 1.16.

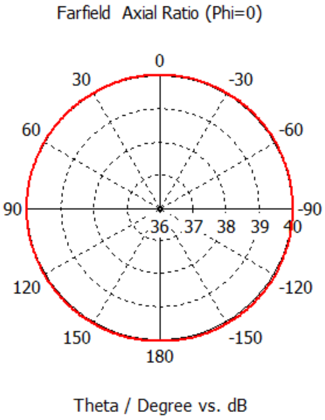


*Fig 1.15 Axial Ratio for APMSA fed antenna at H-plane, $\phi$=0. The axial ratio obtained is 40 dB.*

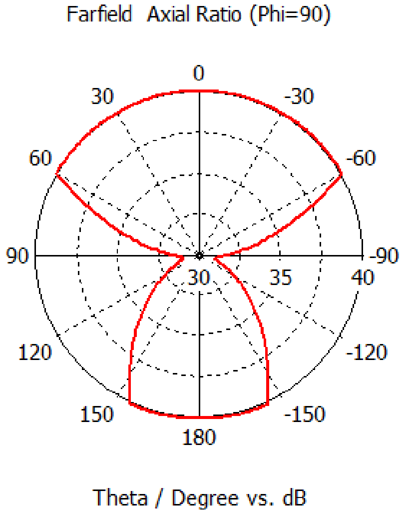


*Fig 1.16 Axial Ratio for APMSA fed antenna at E-plane, $\phi$=90. The axial ratio obtained is 40 dB.*

**1.2.3 QWT Fed Antenna For 5 GHz**

First we design the QWT fed micro strip patch antenna at 5 GHz application. The first stage is to design square shaped patch Antenna and feeding is done with the QWT feed to match the impedance of 50 ohm. The parametric changes provide the result for 5 GHz applications. Figure 1.17 shows its design.

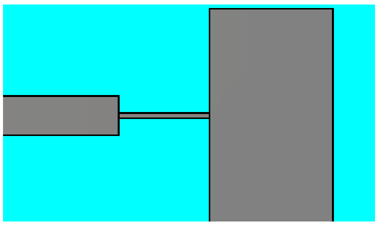

*Fig 1.17 CST design of QWT Fed Antenna*

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**Return Loss**

It is also a measure of the effectiveness of an antenna to deliver power from the source to the antenna is a property of an elliptically polarized field. The return loss obtained from Figure 4.18 is equal to -27 dB ($\leq -10\ dB$), which shows the s-parameter for port 1.

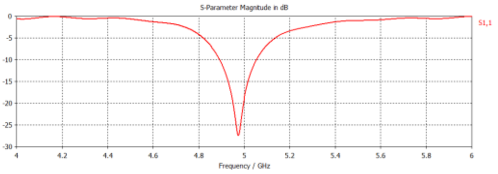


*Fig 1.18 Return loss (in dB) for QWT fed antenna at 5 GHz. Return loss for the proposed antenna reaches -27 dB. Bandwidth obtained is 169 MHz.*

**Radiation Pattern**

The plot of gain as a function of direction is known as radiation pattern is shown in figure 1.19 and figure 1.20. Gain obtained is 6.667 dB.

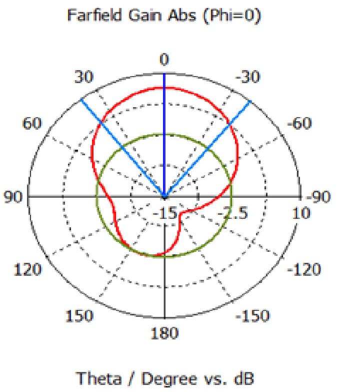


*Fig 1.19 Radiation pattern for QWT fed antenna at H-plane, $\phi$=0.*

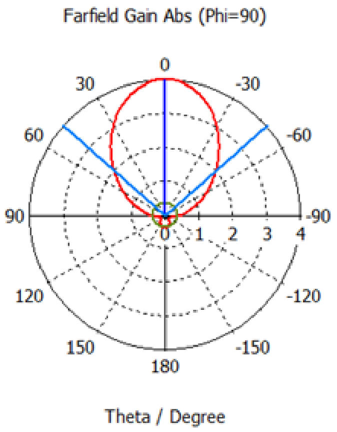


*Fig 1.20 Radiation pattern for QWT fed antenna at E-plane, $\phi$=90.*

**Axial Ratio**

For polarization axial ratio is taken at theta =0 and phi=0 values and this shows that the antenna is linearly polarized as it is 30 dB. AR is shown in figure 1.21 and figure 1.22.

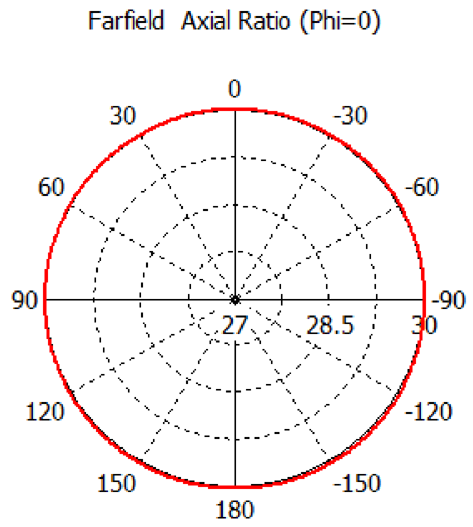


*Fig 1.21 Axial Ratio for QWT fed antenna at H-plane, $\phi$=0. The Axial Ratio obtained is 30 dB.*

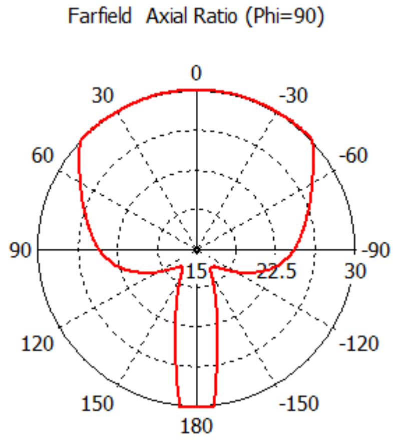


*Fig 1.22 Axial Ratio for QWT fed antenna at E-plane, $\phi$=90. The Axial Ratio obtained is 30 dB.*

**1.2.4 Proximity Fed Antenna For 5 GHz**

First we design the proximity fed micro strip patch antenna at 5 GHz application. The first stage is to design square shaped patch antenna and feeding is done with the proximity feed to match the impedance of 50 ohm. The parametric changes provide the result for 5 GHz applications. Figure 1.23 shows its design.

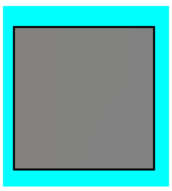

*Fig 1.23 CST design of Proximity Fed Antenna*

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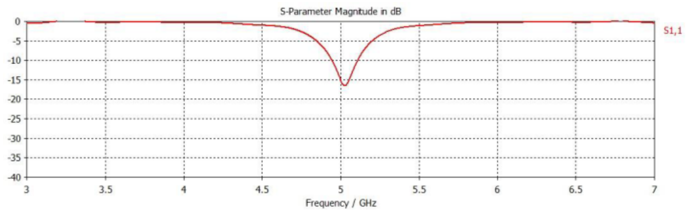


***Return Loss***

*Fig 1.24 Return loss (in dB) for QWT fed antenna at 5 GHz. Return loss for the proposed antenna reaches -17.697 dB. Bandwidth obtained is 160 MHz.*

**Radiation Pattern**

Radiation patterns are also taken at phi=0 and phi=90 values related to object direction.

The plot of gain as a function of direction is known as radiation pattern is shown in figure 1.25 and figure 1.26. Gain obtained is 5.054 dB.

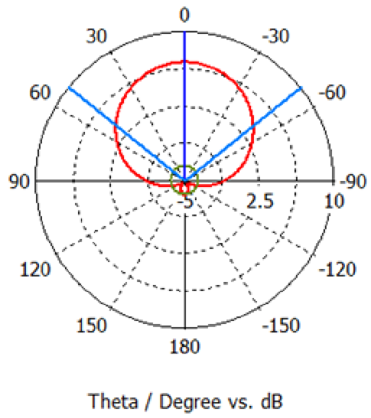


*Fig 1.25 Radiation pattern for QWT fed antenna at H-plane, $\phi$=0.*

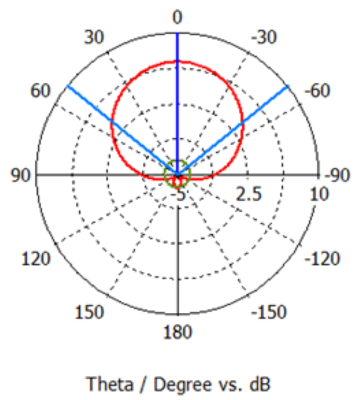


*Fig 1.26 Radiation pattern for QWT fed antenna at E-plane, $\phi$=90.*

**Axial Ratio**

Axial Ratio is a property of an elliptically polarized field. AR is the ratio of major and minor axes of the polarization ellipse.

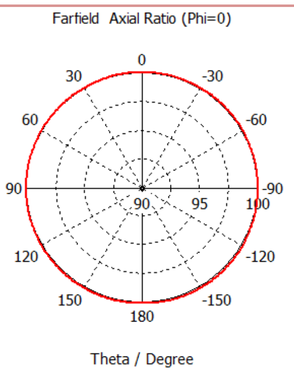


*Fig 1.27 Axial Ratio for QWT fed antenna at H-plane, $\phi$=0. The Axial Ratio obtained is 100 dB. It is perfectly linearly polarized.*

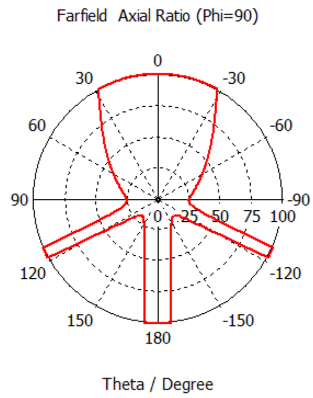


*Fig 1.28 Axial Ratio for QWT fed antenna at E-plane, $\phi$=90. The Axial Ratio obtained is 120 dB.*

## 2. Conclusion

The work analyzes the results of computer simulations and measurements, thereby demonstrating the advantages and disadvantages of microstrip antennas with different feeding techniques. The results demonstrate a wider bandwidth and higher gain than that of the conventional antenna without slots.

## 3. Acknowledgement

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## 4. References

[1] C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley and Sons, 3rd Edition, 2005.

[2] G. A. Deschamps, "Microstrip Microwave Antennas," symposium on Antennas, 1953.

[3] R. Kant and D. C. Dhubkarya, "Design & Analysis of H-Shape Microstrip Patch Antenna," publication in the Global Journal of Research in Engineering, vol. 10, no. 6, pp. 26-29, Nov. 2010.

[4] R. Kumar, J. P. Shinde and M. D. Uplane "Effect of Slots in Ground Plane and Patch on Microstrip Antenna Performance".

[5] X. Zhang and A. Zhao “Enhanced-bandwidth PIFA Antenna with a Slot on Ground Plane”,Research Center, Beijing 100176, China.

[6] G. P. Gauthier, A. Courtay, and G. H. Rebeiz “Microstrip antennas on synthesized low dilectric-constant substrate”, IEEE Trans. Microwave Theory Techn., vol. 45, pp. 1310-1314, Aug. 1997.

[7] K. F. Tong, K. M. Luk, K. F. Lee, R. Q. Lee, “A Broad-Band U-Slot Rectangular Patch Antenna on a Microwave Substrate,” IEEE Transactions on Antennas and Propagation, vol. 48, no. 6, June, 2000.

[8] R. Collin, “Field Theory of Guided Waves,” IEEE Press, 2nd Edition, New York 1991

[9] [9] Hall, P. S. Wood, C and Garrett, C, “Wide bandwidth microstrip antennas for circuit integration,” Electron.

[10] Bharatia, P. R. Garg, and I. Bahl, “Microstrip Antenna Design Handbook,” Artec House, 2001