

## Design of the H-Shape U- Slotted Microstrip Patch Antenna

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### Abstract

An H-shaped Microstrip patch antenna with U slot and capacitive feed is presented here. To overcome the various problems in the feeding, a capacitive feeding scheme has used which consist of a radiator patch and a small coplanar feed strip very near to it. The design of antenna incorporates the capacitive feed strip which is fed by a coaxial probe by using equivalent approach. Two slots are used in the radiating patch of the proposed Micro strip antenna to increase fringing field results the improved bandwidth. U slot is made at the centre of radiating patch to increase the radiating edges which will help in increasing the bandwidth. This antenna operates at 5.1 GHz frequency. This antenna mainly designed for satellite communication.

**Keywords:** H-Shape, U- Slotted, Microstrip, Patch, Antenna, Frequency, Parameter, Communication, Satellite, Bandwidth.

### INTRODUCTION:

We Designed a H Shape U slotted patch antenna and Compare the Result with rectangular Patch antenna and also show the comparison between capacitive feed and without capacitive feed technique. We do parametric study such as air gap between the substrate and the ground plane, the separation distance between the radiator patch and feed strip, probe diameter and dimensions of the feed strip on the performance of the antenna are studied and discussed in the paper and finally designed an optimized antenna.

#### 1. Basic Antenna Geometry

Figure 1 shows the basic geometry of the antenna in which the larger patch act as radiator and small one serves as a feed strip which couples the energy to the radiators by capacitive means. The antenna substrate is placed above the ground plane at an air gap  $g$  RO3003 is used as a substrate with dielectric constant=3 and thickness  $h=1.56\text{mm}$ . The design of antenna is used for the operational frequencies of 5.1 GHz. Specification of the antenna for 5.1 GHz are length 15.5mm, width 13.12mm, length of feed strip 3.7mm, width of feed strip 1.8 mm, length of first slot 8.2, width of first slot 1.55mm, length of second slot 6mm, width of second slot along width 1mm. Separation distance of feed strip and radiating patch 0.75mm, air gap 6mm. Probe diameter 0.8 mm, relative dielectric constant 3.0 and thickness of the substrate 1.56 mm.

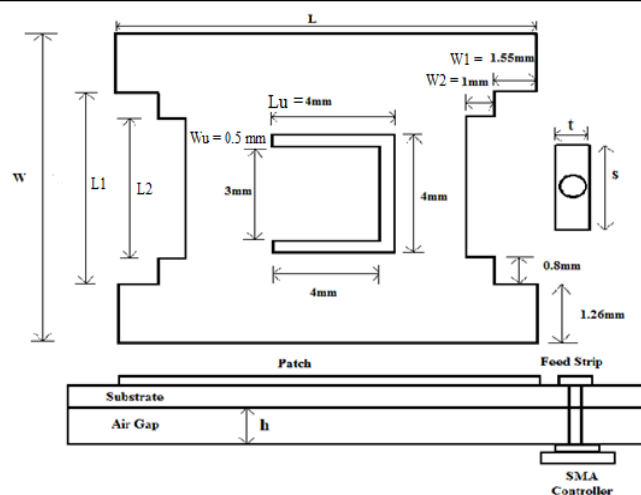


Figure 1: Slotted Patch Configurations

#### 2. Effects of Patch Shape on Antenna Performance

In this section we will study the effect of patch shape on antenna performance and comparison between Rectangular Patch, H shape Patch and U slotted H shape patch antenna.

##### 2.1 Design A Rectangular Patch Antenna :

To design a rectangular antenna for 5.1 GHz are length 15.5mm, width 13.12mm, length of feed strip 3.7mm, width of feed strip 1.8 mm. Separation distance of feed strip and radiating patch 0.75mm, air substrate height 6mm. Probe diameter 0.8 mm, relative dielectric constant 3.0 and thickness of the substrate 1.56 mm.

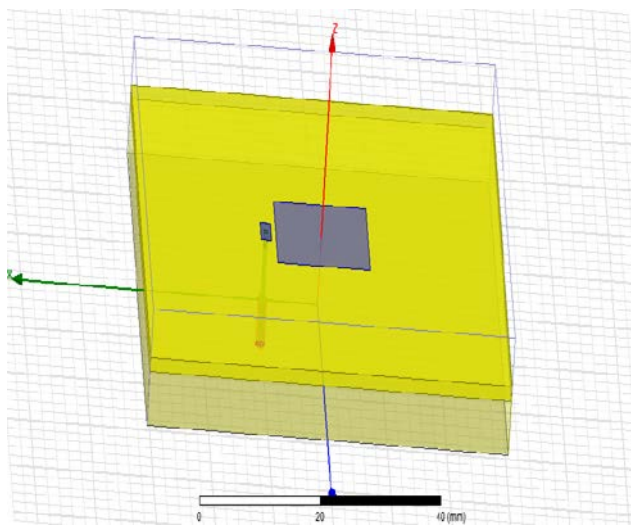


Figure 2: HFSS deigned Rectangular shape Microstrip antenna

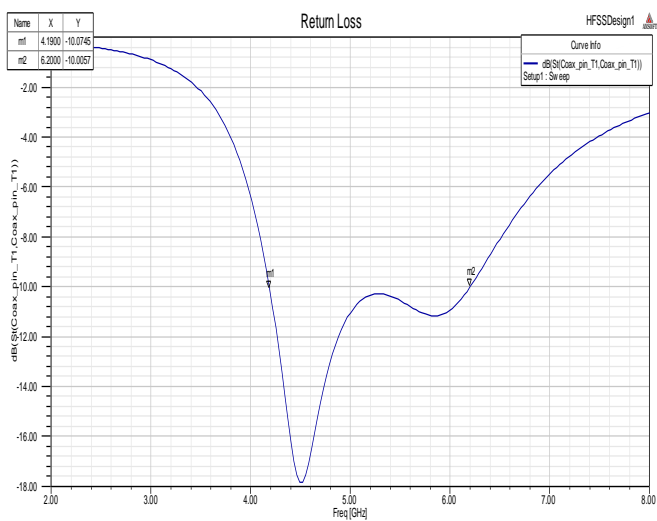


Figure 3: S11 Parameter display

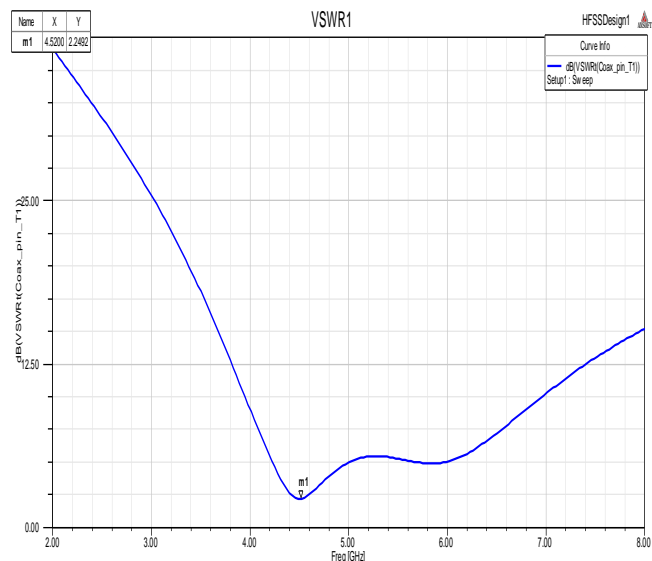


Figure 4: VSWR

In this simulation Rectangular Microstrip patch antenna was designed. And the designed antenna was shown in Figure 2 using HFSS software .S parameter of Rectangular Patch antenna also shown in Figure 3 and VSWR shown in Figure 4. This antenna has 4.5 GHz Resonance Frequency and Bandwidth is 2.01 GHz which is good But VSWR of this antenna is 2.24 dB it indicates that it is not an efficient antenna because for efficient antenna VSWR must be less than 2.

**2.2 Designing of H-Shape Microstrip patch antenna :**

To obtain H shape antenna cut four slots in radiating patch. The length of first slot 8.2, width of first slot 1.55mm, length of second slot 6mm,width of second slot along width 1mm.

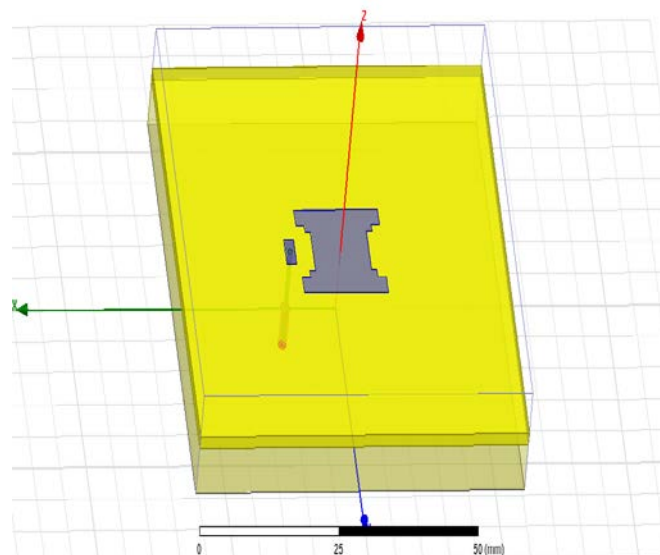


Figure 5: HFSS deigned H shape Microstrip antenna

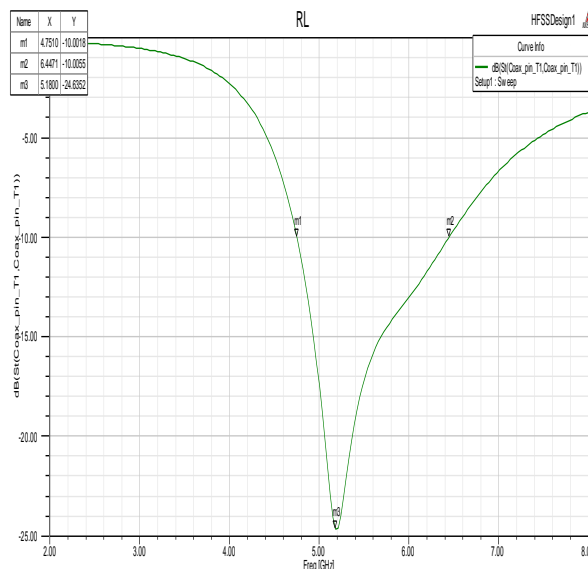


Figure 6: Return loss graph

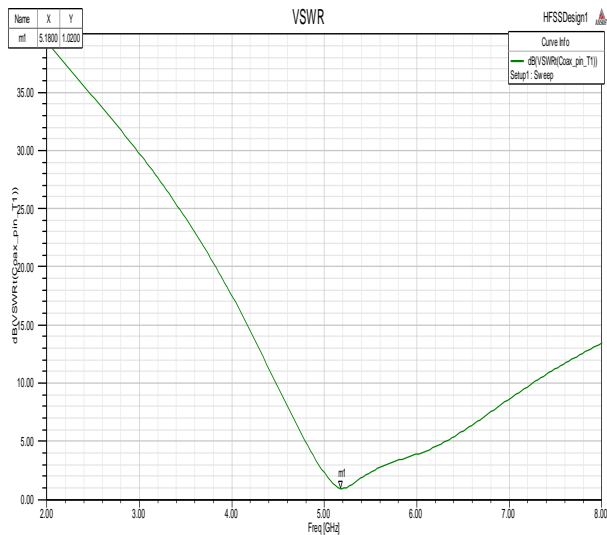


Figure 7: VSWR

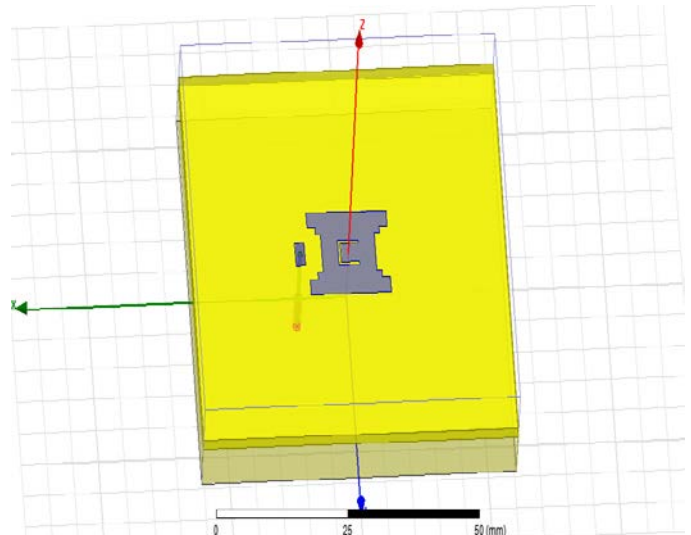


Figure 9: U Slot H- Shape patch antenna with capacitive feed

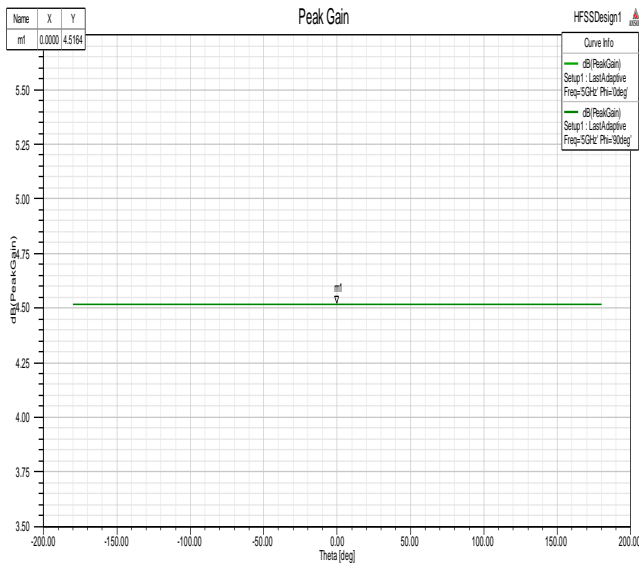


Figure 8: Peak Gain

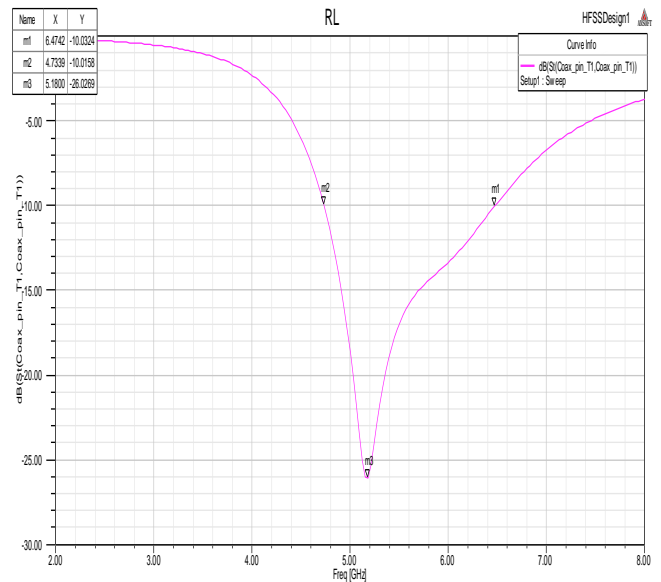


Figure 10: Return loss

In this simulation H shape Microstrip patch antenna was designed. And the designed antenna was shown in Figure 5 using HFSS software .S parameter of H- shape MSPA also shown in Figure 6, VSWR shown in Figure 7 and Gain of this antenna is 4.51 dB i.e. shown in Figure 8 This antenna has 5.1 GHz Resonance Frequency and Bandwidth is 1.69 GHz and VSWR of this antenna is 1.02 dB It indicates that it is an efficient antenna.

### 2.3 U slot H- Shape MSPA with Capacitive feed:

To obtain H shape U slotted antenna cut U slot in H shape Microstrip patch antenna. To obtain U slots in H shape patch cut three slots of length 4mm and width 0.5 mm.

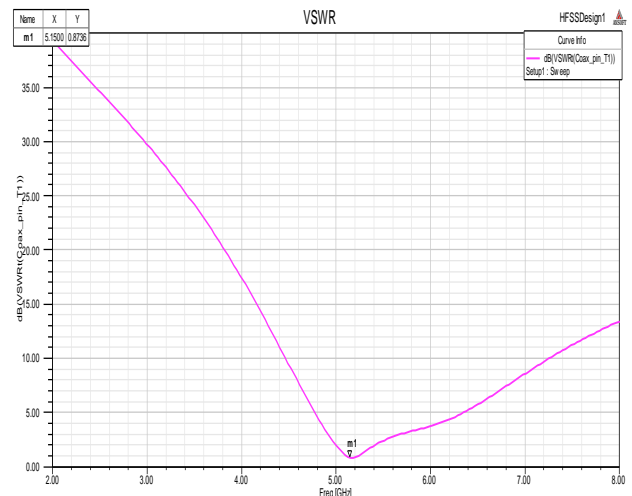


Figure 11: VSWR

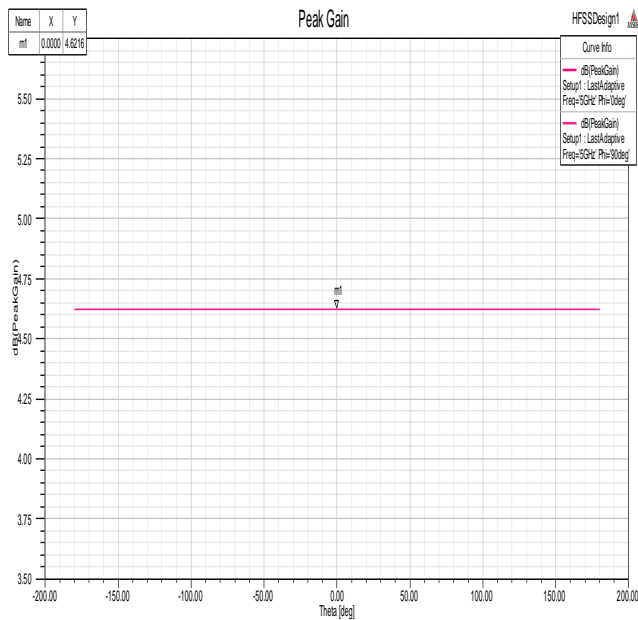


Figure 12: Gain

In this simulation U slot H shape Microstrip patch antenna with capacitive feed was designed. And the designed antenna was shown in Figure 9 using HFSS software .S parameter of U slotted H- shape MSPA also shown in Figure 10, VSWR shown in Figure 11 and Gain of this antenna is 4.62 dB i.e. shown in Figure 12. This antenna has 5.1 GHz Resonance Frequency and Bandwidth is 1.74 GHz and VSWR of this antenna is 0.87 dB.

**3. Formula to obtain Percent Bandwidth**

$$f_2 = \text{Max Frequency}$$

$$f_1 = \text{Min Frequency}$$

$$BW = \frac{f_2 - f_1}{f_c} * 100$$

$$f_c = \frac{f_2 - f_1}{2} + f_1$$

$$f_2 = 6.47 \text{ GHz} \quad f_1 = 4.73 \text{ GHz}$$

$$f_c = 5.6 \text{ GHz}$$

$$BW = 31.07 \%$$

**3.1 Comparison between Patch shapes:**

Figure 13 Shows the Comparison between Rectangular Patch, H-Shape Microstrip patch antenna and U slotted H-Shape MSPA with capacitive feed and table 4.1 shows the comparison of Bandwidth and VSWR.

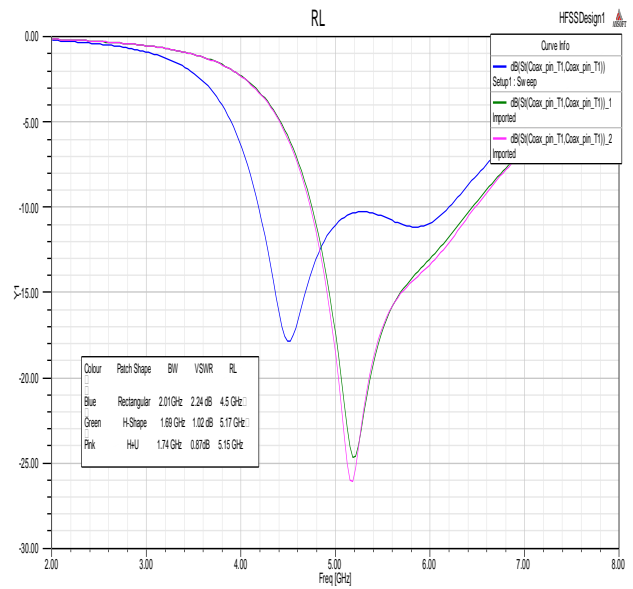


Figure 13: Return Loss Comparison

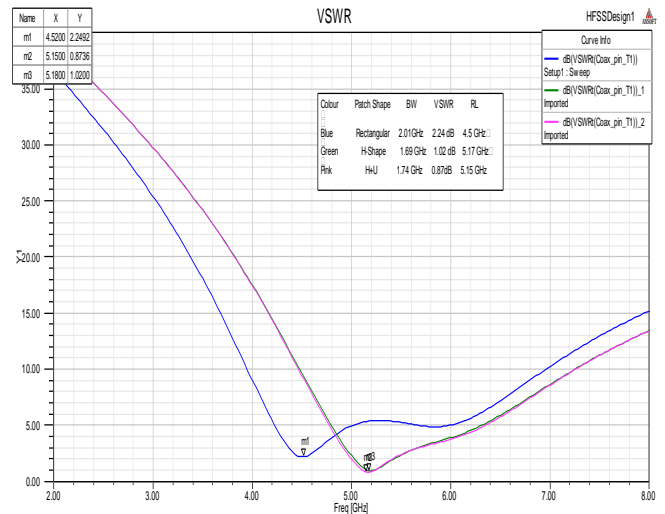


Figure 14: VSWR comparison

Table 1: Comparison between Patch Shapes

Patch Shape	Graph Colour	BW (GHz)	VSWR (dB)	RF
Rectangular	Blue	2.01 GHz	2.24 dB	4.5
H shape	Green	1.69 GHz	1.02 dB	5.17
H-shape U slotted	Pink	1.74 GHz	0.87 dB	5.15

**4. U slot H-shape MSPA without Capacitive Feed Patch Antenna**

In this simulation U slot H shape Microstrip patch antenna without capacitive feed was designed. And the designed antenna was shown in Figure 14 using HFSS

software .S parameter of U slotted H- shape MSPA also shown in Figure 15 and VSWR shown in Figure 16 This antenna has 5.7 GHz Resonance Frequency and we didn't get any Bandwidth and VSWR of this antenna is 17.44 dB that is why this antenna is not efficient.

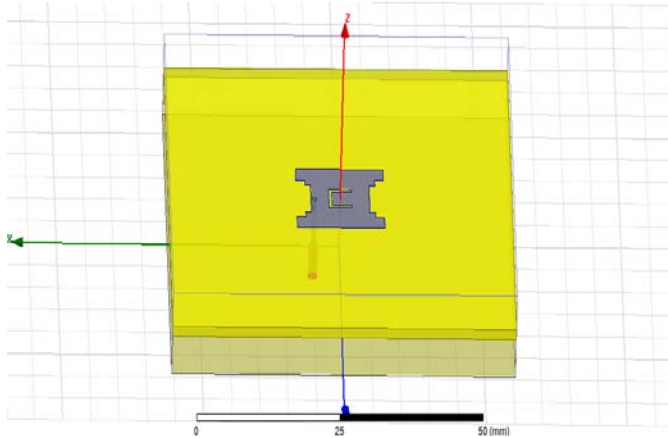


Figure 15: U slot H-shape MSPA without Capacitive Feed

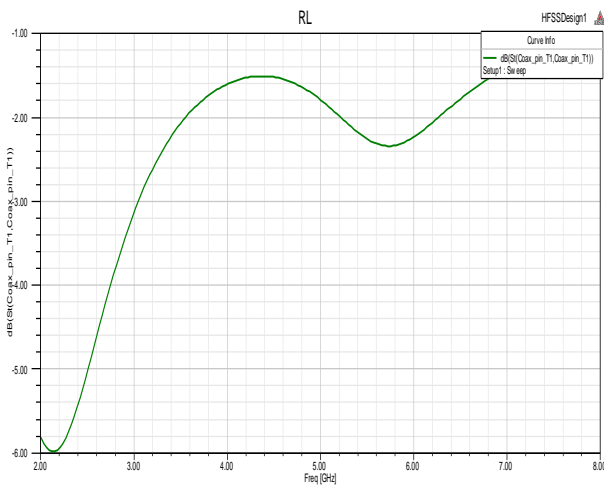


Figure 4.16: Return Loss

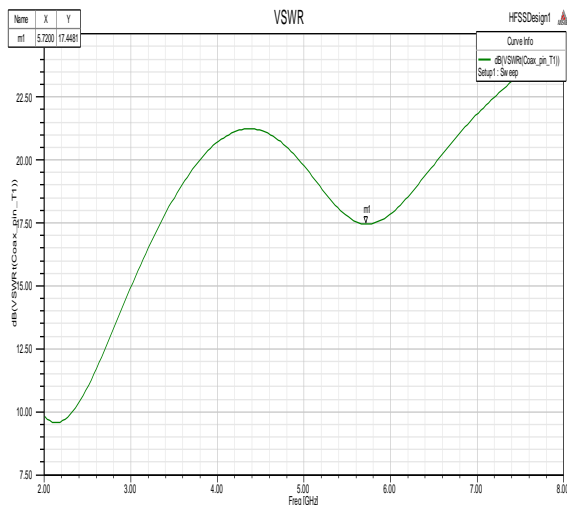


Figure 17: VSWR

### 5. Comparison Between with capacitive feed and without capacitive feed:

Figure 17 and 18 shows the Comparison between U slotted H-Shape Microstrip patch antenna with capacitive feed and without capacitive feed. Table 2 shows the comparison of BW and RL.

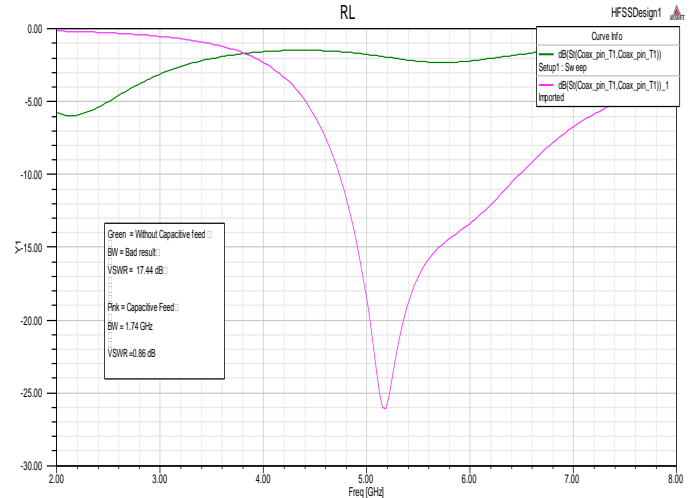


Figure 18: Return loss Comparison

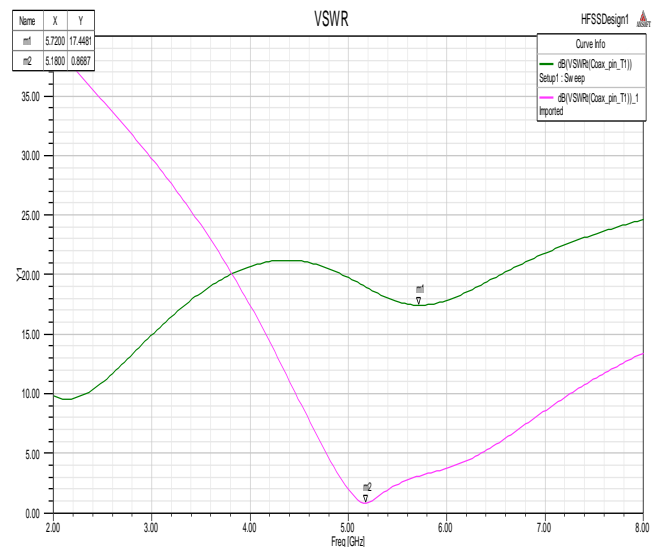


Figure 19: VSWR Comparison

Table 2: Comparison between without capacitive feed and with Capacitive feed

Green Graph = Without Capacitive Feed	Pink Graph = Capacitive Feed
Resonance Frequency = 5.7 GHz	Resonance Frequency = 5.15 GHz
BW = Bad result	BW = 1.74 GHz
VSWR = 17.44 dB	VSWR = 0.86 Db

## 6. References

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