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# Fabrication of Ultra Wideband Antenna Array

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**Abstract:** Wireless technology is one of the main areas of research in the world of communication systems today and a study of communication systems is incomplete without an understanding of the operation and fabrication of antennas. In modern communication devices over conventional antenna, ultra wide band antennas are commonly used due to their ultra wide frequency bandwidth, low power transmission level and secure and reliable communication solutions. Here three Ultra Wideband antennae are designed. The first designed antenna is a single pentagonal patch antenna. The second proposed UWB antenna has two pentagon patches with each having separate feeds designed to cover the frequency band from 6.3 GHz to 40 GHz. The UWB capability of antenna is achieved with the help of array of pentagon antenna. The simulated results give return loss lower than -10dBi over the entire range. The third proposed antenna also has two pentagon patches but a common feed designed to cover the frequency range of 8 GHz to 12.5 GHZ. It is achieving return loss lower than -15 dBi over the entire range reaching -40 dBi at 10.6 GHz and 11.5 GHz.
**Keywords:** Antenna, Antenna Array, Multi Frequency, Single and Dual Feed, Ultra Wideband Antenna.

## I. INTRODUCTION

An antenna is an electrical device which converts electric power into radio waves and vice versa. We can find applications of antenna everywhere around us. In the era of next generation networks we require a single antenna that can cover multiband frequencies. With the evolution of microstrip antenna, it is possible to approach applications requiring different frequencies can be operated simultaneously with only one antenna, which significantly reduces the size also. A UWB antenna is an antenna capable of transmitting as well receiving signal over the specified range of frequencies. UWB is rapidly evolving as a high data rate wireless communication technology. As is the case in conventional wireless communication systems, an antenna also plays a very crucial role in UWB systems. However, there are more challenges in designing a UWB antenna than a narrow band one. Pentagonal microstrip patch gives better performance than the rectangular patch antenna [1]. It also supports both linear and circular polarization. UWB transmission is defined as the emission from an antenna for which the radiated signal bandwidth exceeds the lesser of 500 MHz or 20% of the center frequency [2]. Antennas having small size, light weight, low profile, flexibility and excellent rejection ratio in the transmitting band are preferred from a designer's point of view [3]. Also, as the operating standards/ frequencies changes, the size of the antenna also changes accordingly, which need to be resolved for the sake of portability of devices. The main idea behind UWB radio systems is that they transmit signal pulses of very short duration, as compared to traditional communication schemes. The role that UWB antennas play in all of this is that they have to be able to transmit these pulses as accurately and efficiently as possible. The UWB technology has a great potential in future in the field of short range data and voice transmissions.

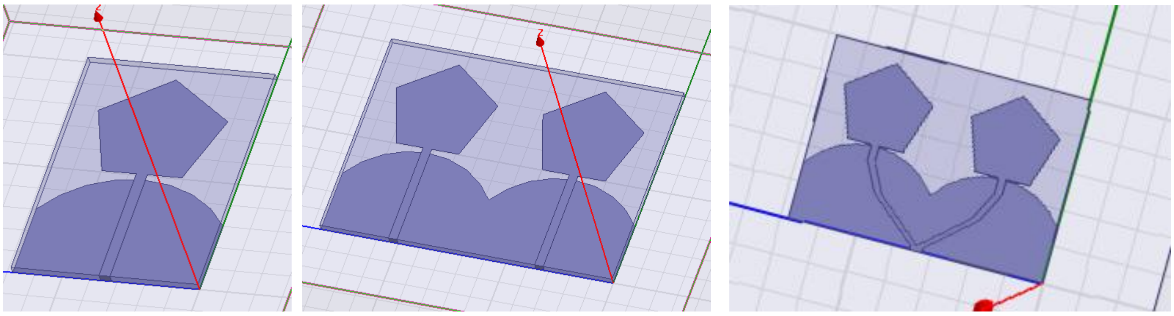
For this design, we had few parameters that we had to satisfy. Those parameters were the bandwidth of the antenna, gain and the radiation pattern of the antenna. The first parameter that we had to consider for our design is the bandwidth. The bandwidth is basically the frequency (or range of frequencies) that the antenna is designed to radiate. In narrowband systems, the bandwidth for which an antenna is designed is very small because there is just one frequency at which the antenna should radiate. In our case, this design is able to radiate signals over the frequency range between 6.3 GHz and 40 GHz. The second parameter that we had to consider for our design is overall gain (i.e. throughout the bandwidth). The gain should be high enough in order to allow the signal to propagate efficiently. If the gain of an antenna is very low then the signals will fade away after travelling a short distance. So we have achieved gain of -10 dBi over the bandwidth and achieving the peak of -35 dBi for dual feed array antenna and -39 dBi for the single feed antenna array.

The UWB antenna has a great scope in future in applications like location detecting inside a building, WPAN, peripheral connectivity through cable less connections to applications like wireless storage, I/O devices and USB. Sensors of all types also offer an opportunity for UWB to flourish. The key requirements for sensor networks include low cost, low power and multi functionality which can be well met by using UWB technology. Also it can be implemented in vehicle collision detection using data packet transmission system.

The advantage of this design is that it can be used to transmit omnidirectional signal for a short range as used in WPAN applications and can transmit long range signal on particular frequencies achieving a gain of -39 dBi.

## II. ANTENNA DESIGNS

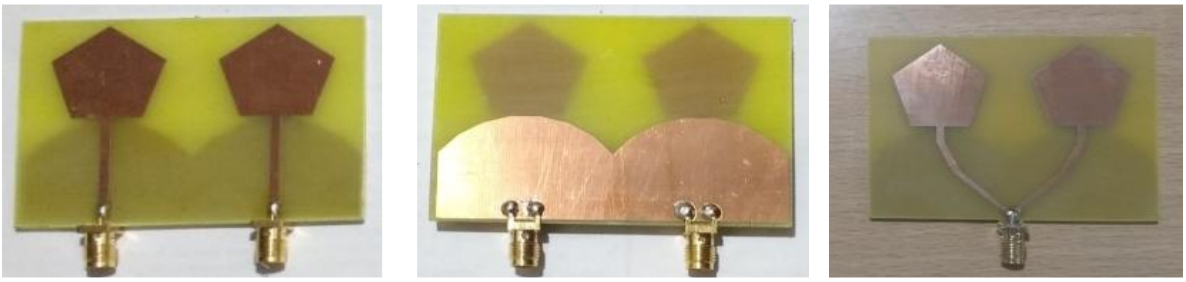
The geometry of the proposed UWB antenna for wide range wireless applications is depicted in Fig.1. This antenna was printed using FR4 as substrate with the dielectric constant = 4.4 and the substrate thickness of 1.6 mm. The software used to model and simulate the proposed antenna was Ansoft HFSS 13, which performs 3D full-wave electromagnetic field simulation and provides the analysis of various parameters of the antenna. The HFSS is an industry standard tool for simulating the antenna with respect to real time environment.



(a) (b) (c)

Fig 1 shows the simulated designs (a) Single Pentagonal Patch, (b) Separate feed Pentagonal Antenna Array, (c) Single feed Pentagonal Antenna Array.

## III. FABRICATED ANTENNAE

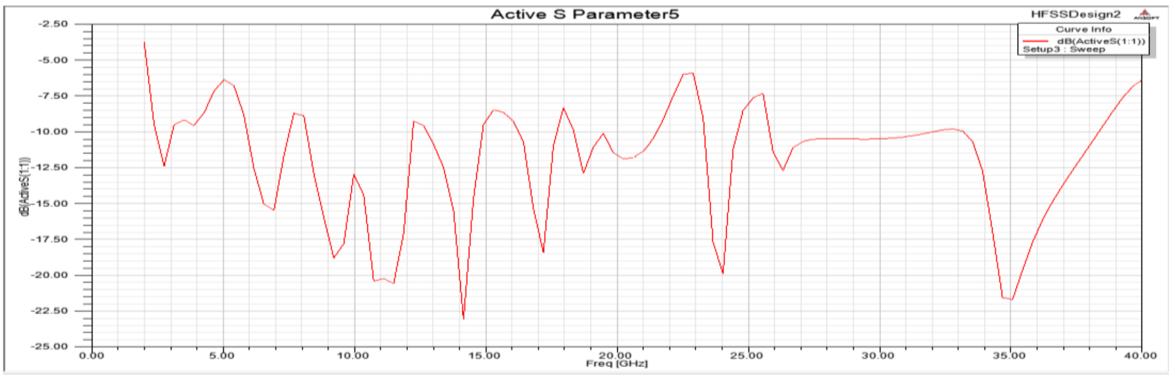


(a) (b) (c)

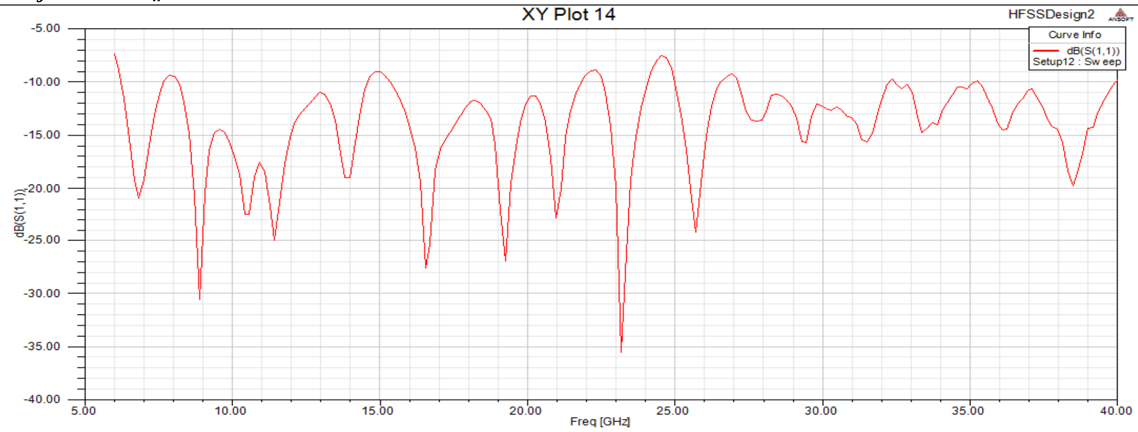
Fig 2 shows the fabricated antenna designs (a) Separate feed Pentagonal Antenna Array Patch,(b) Common Ground Plane, (c) Single feed Pentagonal Antenna Array Patch.

The fabrication of this antenna is done using masking and etching the unmasked area using $FeCl_3$ solution. The masking was done by printing the design using carbon and then transferring the mask on to the copper board.

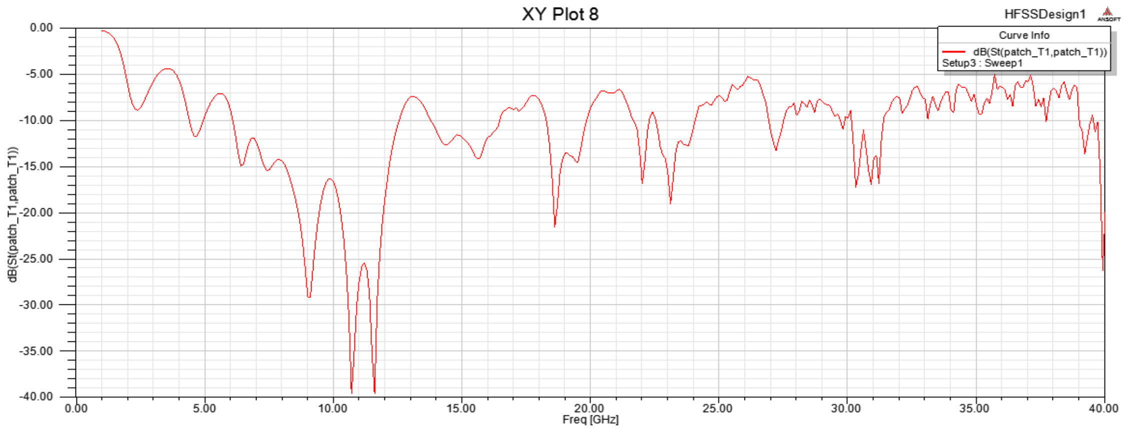
## IV. RESULTS




*(a)*




*(b)*

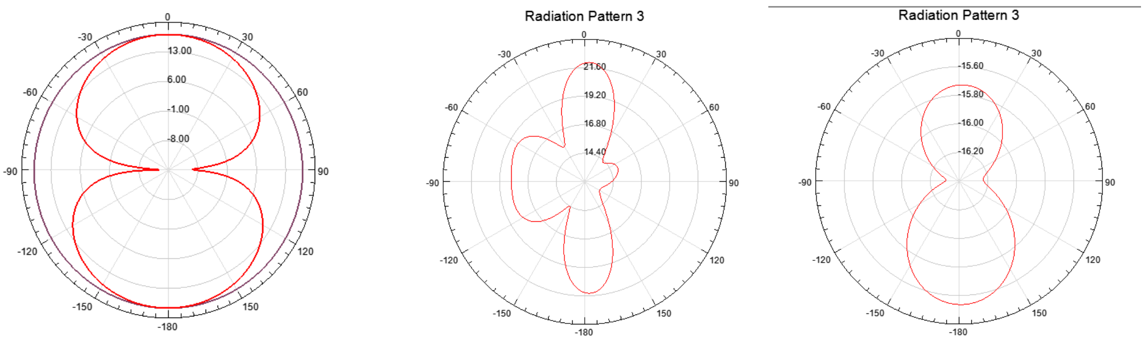



*(c)*

Fig 3 shows the simulated S11 graph for the antenna (a) Single Pentagonal Patch, (b) Separate feed Pentagonal Antenna Array, (c) Single feed Pentagonal Antenna Array.

The performance of proposed antenna is characterized by its return loss. The proposed antenna is giving return loss of -10 dB as shown in fig. 3.

It is observed that the gain across the whole bandwidth of 6-40GHz in the Dual feed pentagon microstrip array antenna is higher than that of Single pentagon microstrip antenna. That is, the maximum gain achieved in Fig. 3 (a) is -23.5dB but in Fig. 3 (b) is -35dB. This shows that the increase in array is directly proportional to the increase in gain of the antenna. Whereas in Single feed dual patch pentagon microstrip antenna the bandwidth is decreased to 8-12.5GHz with relatively much higher gain of -39dB.




(a) (b) (c)

Fig 4 shows the simulated 2D Radiation Pattern (a) Single Pentagonal Patch, (b) Separate feed Pentagonal Antenna Array, (c) Single feed Pentagonal Antenna Array

The radiation pattern of single pentagon is more uniform then the array of pentagon antenna with separate feed as shown in fig 4 (a) and (b). Again the radiation pattern of single feed pentagon array antenna is similar to the pattern of single pentagon antenna. So the radiation of antenna gets distributed if we are using different feeds.

## V. CONCLUSION

The ultra-wideband antennas were simulated in 3 different fashions namely, Single pentagon microstrip antenna, Dual feed pentagon microstrip antenna array and Single feed dual patch pentagon microstrip antenna. It was investigated that the gain of an ultra wideband antenna can be increased by adding arrays without affecting the bandwidth which is from 6GHz to 40GHz. The peak gain was increased from 23.5dB to 35dB. Also investigations were carried by increasing the array but giving a single feed, the bandwidth got narrowed down to 8GHz to 12.5GHz bandwidth. The gain achieved was boosted to 39dB. The gain and directivity can be varied using parametric analysis like changing the ground plane, feed point and type of feed. The directivity and gain can be improved using array of the same design and by reducing the ground plane [5]. But after certain number of elements in an array the radiation gain will start decreasing due to the resonating affect. Also the ground can be reduced to a certain ratio. After that it will degrade the radiation gain

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