H-Shaped Dielectric Resonator Antenna for UWB application

P .Mahender
Department of Electronics and Communication
National Institute of Technology
Rourkela, India.
mahender1985@gmail.com

S.Natarajamani
Department of Electronics and Communication
National Institute of Technology
Rourkela, India.
natarajamani@gmail.com

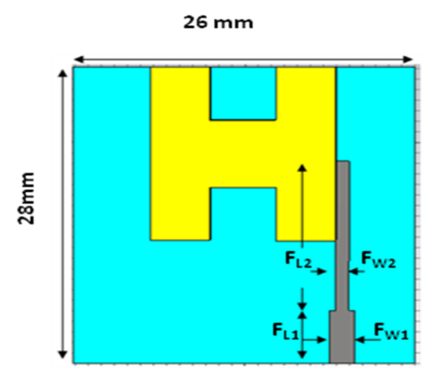
S.K.Behera.
Department of Electronics and Communication
National Institute of Technology
Rourkela, India.
skbehera@ieee.org

ABSTRACT
The design of Ultra wideband dielectric resonator antenna with low dielectric constant is presented in this article. The antenna consists of H-Shape dielectric resonator (DR) fed by Microstrip line and a slotted ground. Parametric studies, time domain analysis of the antenna are presented. The parameters are designed and simulated using CST Microwave studio. The constant group delay, path loss and the calculated correlation factor shows that the antenna is well suited for UWB applications.

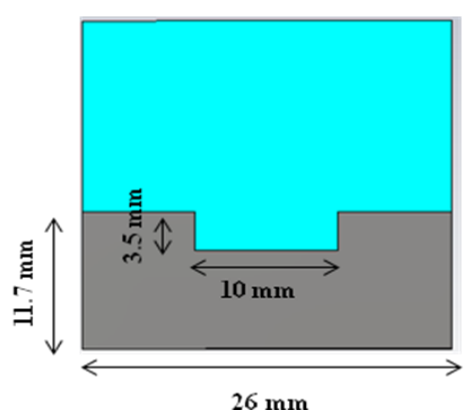
Keywords
Dielectric resonator antenna (DRA), UWB antenna

1. INTRODUCTION
The extremely wide spectrum of 3.1 to 10.6 GHz with 15 bands of bandwidth greater than 500 MHz and power limit less than -41.3 dBm/MHz announced by FCC for Ultra wide band. The release of this Spectrum has rapidly increased the research in UWB technology for communications, radar imaging, and localization applications [1]. Radio systems based on UWB technology offer opportunities for transmission of high data rate signals, coding for security and low probability of intercept, especially in multi user network applications [2]-[5]. UWB communication systems have the promise of very high bandwidth, reduced fading from multipath in mobile communication and low power requirements. In general, UWB radio systems transmit and receive temporally short pulses without carriers or modulated short pulses with carriers. Carrier free UWB radio systems usually employ very short pulses in the order of sub nanosecond (ns) as opposed traditional communication schemes which send sinusoidal waves. Antenna plays a major role in UWB applications because these antennas have to transmit short duration pulses without any pulse spread and as accurately as possible.DRA is one of the best antennas for UWB applications due to its attractive features like high radiation efficiency, low dissipation loss, small size, light weight, and low profile [6]. Moreover, DRAs which posses a high degree of design flexibility, have emerged as an ideal candidate for wide band, high efficiency, and cost-effective applications. Recently more and more Ultra wideband antenna designs have been proposed especially Stacking of two DRAs, DRAs separated by wall, Antenna mounted on a vertical ground plane.

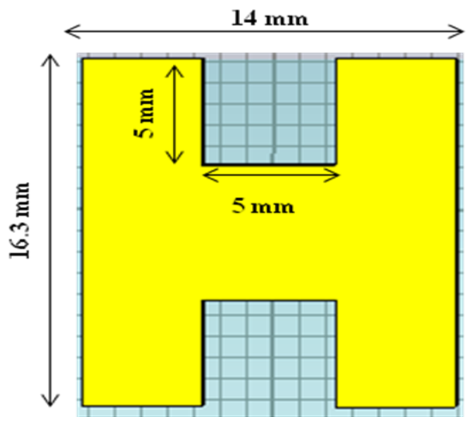
2. CONFIGURATION OF ANTENNA
Fig1. Shows the proposed DRA. The size of DRA is 14mm length and 16.3 mm width and 6 mm thickness with dielectric constant 10.2, and it is placed on 26 × 28 mm^2 substrate with dielectric constant 1.06 and thickness of 0.7 mm. The ground plane is partially printed below the substrate.



(a)



(b)



(c)

Fig. 1. Geometry of Antenna (a) Front View (b) Back View (c) DR.

3. RESULT AND DISCUSSION

The commercial 3D full wave electromagnetic (EM) simulation software CST Microwave studio is used for simulation. Fig. 2. Compares return loss with and without ground slot. With ground slot total ultra wide band is covered. The slot in the ground plane is affecting the lower frequencies.

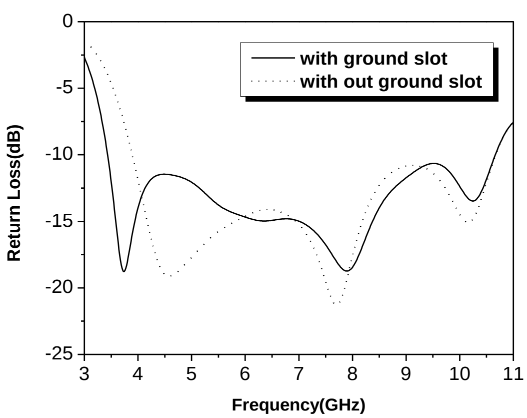


Fig. 2 Variation of Return Loss with and without ground slot.

Fig. 3. Shows the parametric study of the feed length when the optimum length of feed is achieved the impedance is perfectly matched which is shown in the Fig. 4. The gain vs. frequency curve which is shown in the Fig. 5. is increasing in the desired frequency range.

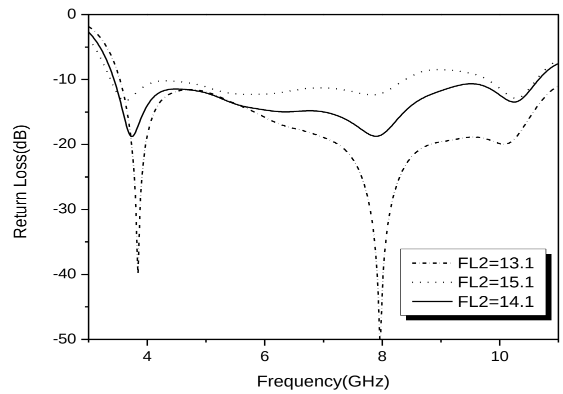


Fig. 3 Return Loss for various feed lengths.

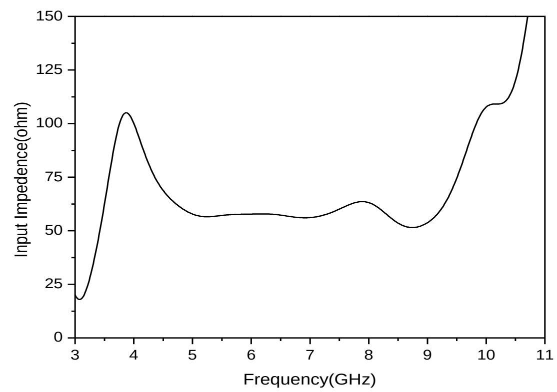


Fig. 4 Input impedance of the proposed antenna.

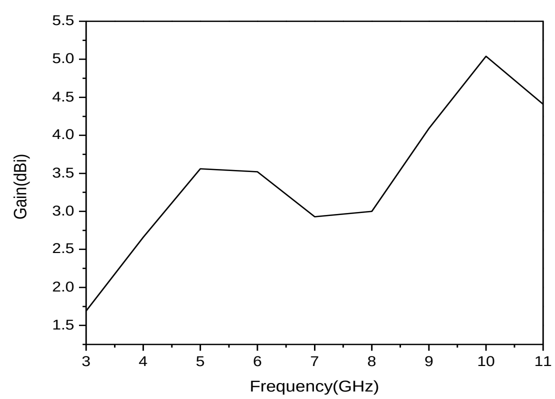
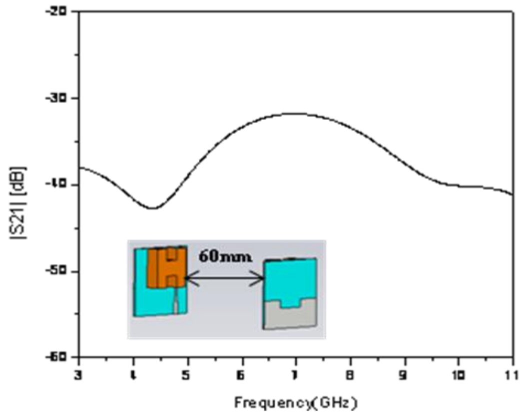
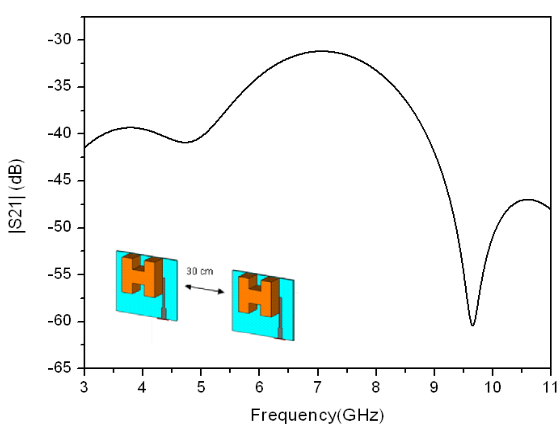


Fig. 5 Gain of the proposed antenna

The dispersion properties of the proposed antenna are presented in the Fig 6(a), 6(b). The path loss indicates the propagation performance. If this is not constant and its variation becomes large, the propagation performance between the transmitting and receiving UWB antennas are



(a)



(b)

Fig. 6 Path loss of antenna (a) Face to Face (b) Side by Side.

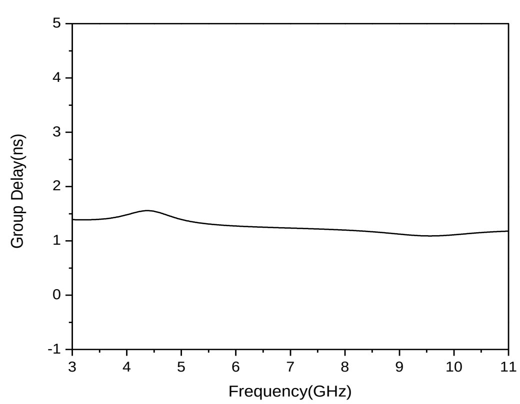


Fig. 7 Group delay of proposed antenna

affected adversely and pulse communication becomes impossible. We show that the path loss varies almost constant when the two antennas are face to face and slightly distorted when they are side by side. The Group delay indicating the pulse distortion is important in UWB radio technology because it transforms the digital coding information into the impulse signals whose pulse duration is less than 1 ns. From Fig. 7 it is clear that the variation of the Group delay is less than 1ns. in the operating frequency band. From the results we can expect that the characteristic of far field phase is linear in UWB frequency band and pulse communication will be possible.

3. TIME DOMAIN CHARACTERISTICS

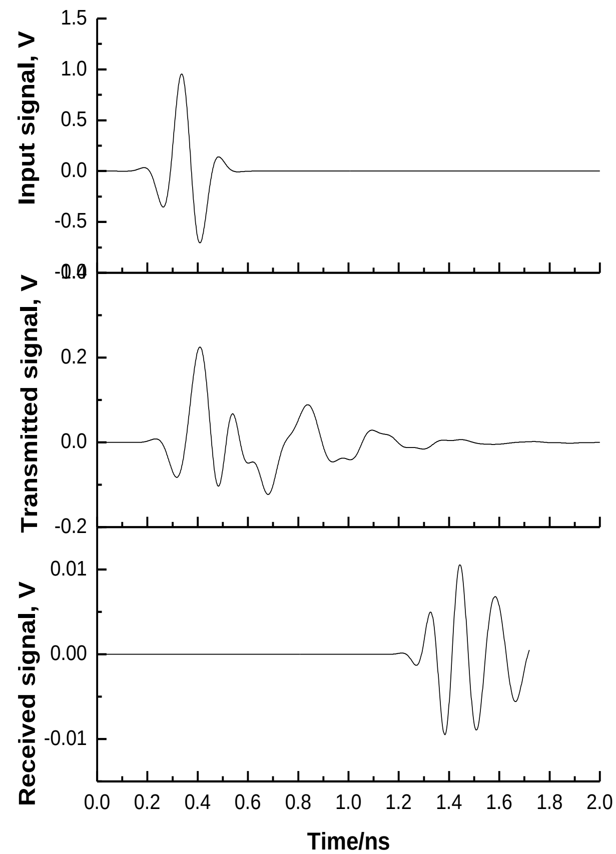


Fig. 8 Input, Transmitted and Received signals.

In addition to the distortion characteristics in frequency domain, it is necessary to consider the transmitted and received signals in the time domain. Fig. 8 shows the input and transmitted signals of first antenna and received signal at the second antenna when they are placed face to face at 30 cm apart. The received signals at the second antenna when they are placed face to face and side by side are shown in

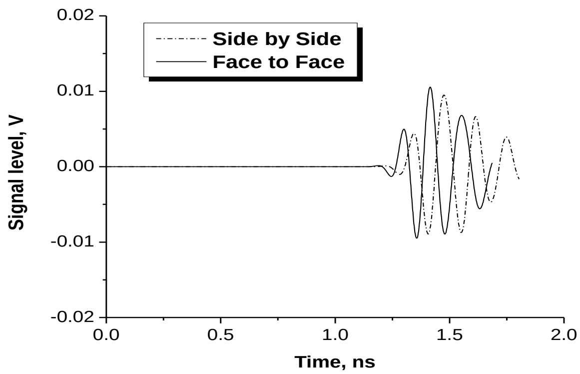


Fig. 9 Received signals when antennas Face to Face and Side by Side

Fig. 9. A very slight difference between the received signals is observed. The amplitude of received signal when they are placed side by side is slightly less and there is small time delay in the received signal compared to antennas when they are placed face to face.

For evaluating the waveform distortion, a well known parameter named correlation factor [7] was calculated between the input signal at the transmitting antenna terminal and far-field electric field intensity signal. The correlation factor is given by

$$\rho = \max_{\tau}\left\{\frac{\int S_1(t)S_2(t-\tau)dt}{\sqrt{\int {S_1}^2(t)dt}\sqrt{\int {S_2}^2(t)dt}}\right\}$$

Where $s_1(t)$ and $s_2(t)$ are transmitted and received signals respectively. If the correlation factor is unity then the received signal is same as transmitted signal but amplitude is less because of path loss but if the correlation factor is less than unity then the received signal is deviated from the transmitted signal.

Table 1. Correlation factor

TX/RX setup	ρ
Antennas placed face to face	0.87
Antennas placed side by side	0.82

The transmitted and received signals are obtained from the port signals in the CST Microwave studio and correlation factor is calculated from the equation. From the obtained correlation factor shown in Table 1 we can say, the antenna is suitable for UWB systems.

4. CONCLUSION

H-Shaped dielectric resonator antenna has been designed with low dielectric constant and the parametric study has been done. With the slot in the ground plane the antenna covers total Ultra wide band. The constant path loss and Group delay, correlation factor calculated shows that the antenna is well suited for UWB applications. Fabrication of the proposed antenna will be carried out in future.

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