

# Transparent Antenna for Body-Centric Communications

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**ABSTRACT:** This project aims to design, Antenna for an applications in wearable products using CST 2014(Computer Simulation Technology) Software. There are two antennas designed and compared with the parameter required for the wearable products. Type 'A' using Micro-strip antenna designed with substrate Copper (pure) and Teflon (PTFE) for coaxial probe. Type 'B' using Monopole antenna designed with substrate Rogers RO3230 and SEE-Silver for Patch. These antennas are designed in the frequency range between 2.5GHz and 5.2GHz. Under Time domain solvers in planar workflow type 'A' and 'B' are designed. At low frequency the comparison is made with the two antenna design and aims in analysing the Return loss, Directivity, Gain and Efficiency. Transparent antennas are used for body wearing electronic devices such as watches due to its body wearing idea of these type devices. These devices should be made less radiating towards the body because of tissue affection on the body. Here a body wearable microwave antenna is made to analyse the radiation. Type 'A' is efficient than type 'B' in patient monitoring at remote distances whereas type 'B' is efficient than type 'A' in rectangular shaped watches depending on the low frequency radiations.

**KEYWORDS:** CST, Micro-strip antenna, Return loss, Directivity, Realized Gain

## I.INTRODUCTION

The development of wearable computer systems has been growing rapidly. These are becoming smaller and more lightweight, no one wants to wear a bulky and heavy computer all day. We will soon see a wide range of unobtrusive wearable and ubiquitous computing equipment integrated to into our everyday clothes. In a possible wearable computer, the monitor/display would be on a pair of glasses, the keyboard worn on the wrist, and the motherboard worn on the waist. It is undesirable to use bulky cables to connect these devices, so communication will be wireless, using an antenna. The human body is an uninviting and often hostile environment for a wireless signal. Compact yet efficient antennas need to be fully characterized and integrated with the RF transceiver[1]. Some of these are conformability and immunity to frequency and polarization detuning. It is important to understand material properties of fabrics and potential use of microwave materials.

Micro-strip and Monopole antennas are widely employed in communication system and seekers. Micro-strip and Monopole antennas posse's attractive features such as low profile, flexible, light weight, small volume and low production cost. In addition, the benefit of a compact low cost feed network is attained by integrating the RF frontend with the radiating elements on the same substrate. A review of transparent wearable antennas designed and developed for various applications at different frequency bands. Microwave antenna is designed in such a way for remote monitoring Patient. Monopole antenna is designed for the rectangular shaped watches[2]. Transparent antenna is basically two types conductive and non conductive antennas. In this paper conductive antennas are used for transmitting the radio wave signals. Computer Simulation Software (CST) is finite element analysis commercial software which engages the frequency range and brings out the desired outputs for the designed work. These advances enhance the performance, usability and versatility of CST STUDIO SUITE without compromise and guide through complex electromagnetic systems with ease.

## II. ANTENNA DESIGN

Micro-strip antenna with frequency 2.55GHz to 3GHz is fixed first to design in CST which is type 'A' according to our design. Monopole antenna with frequency 3.5GHz to 5.2GHz which is type 'B'. The application area is Microwave, Radio Frequency and Optical then workflow is on Antennas[3]. Next step is selected with planar (Patch, Slot, etc.) A solver which is used for wideband or multiband is time domain. Various units can be given for the requirements needed. Finally the frequency minimum 2.5GHz to maximum 5.2GHz is mentioned [4]and selects the monitors of E-field, H-field, Far-field, Power flow and Power loss then defining the frequency to monitor the graphs.

### TYPE A ANTENNA DIMENSIONS

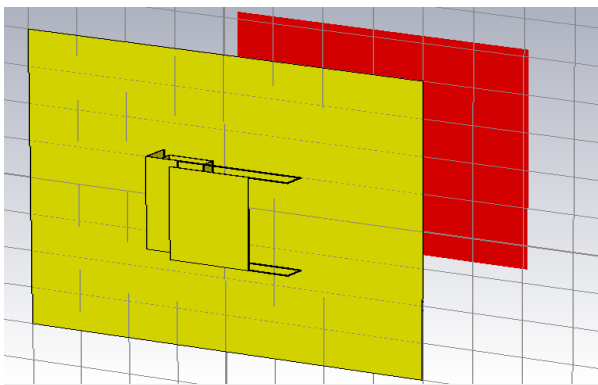


Fig 1. Perspective view micro-strip antenna of type 'A'

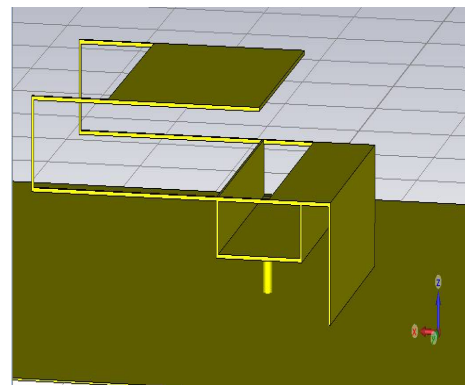


Fig 2. Interior view of type 'A'

Micro-strip antenna designed with the patches and the probe which is connected in cylindrical path. The material used in antenna is Copper (pure). Its electrical conductivity is  $5.96e+007$ [s/m]. Probe is designed with Teflon (PTFE) (lossy) material. Permittivity is 2.1 and permeability is 1.

Table 1: Dimension for designing type 'A' Inner dimensions Table 2: Parameter list

Componens	Xmin	Xmax	Ymin	Ymax	Zmin	Zmax
Solid 1	-a/2	-a/2+.2	-f/2	f/2	.1	.1+e
Solid 2	-a/2	-k	-f/2	f/2	.1+e-.2	.1+e
Solid 3	-.5	-9.5	-f/2	f/2	.1+g	.1+g+.2
Solid 4	-9.5+.2	-9.5	-f/2	f/2	.1+g	.1+g+c
Solid 5	-.5	-.5-.2	-f/2	f/2	.1+g	.1+g+c
Solid 6	-k	n	f/2	-f/2+.2	.1+e-.2	.1+e
Solid 7	-k	n	f/2-.2	f/2	.1+e-.2	.1+e
Solid 8	n-.2	n	-f/2	-f/2+.2	.1+e-.2	.1+e-.2+d
Solid 9	n-.2	n	f/2-.2	f/2	.1+e-.2	.1+e-.2+d
Solid 10	n	n-o	-f/2	-f/2+.2	.1+e+d-.2	.1+e+d
Solid 11	n	n-o	f/2-.2	f/2	.1+e+d-.2	.1+e+d
Solid 12	n-o	n-o-m	-f/2	f/2	.1+e+d-.2	.1+e+d
Ground	-1/2	1/2	-w/2	w/2	0	.1

Na /	Value
a	25
c	3
d	4.5
e	6
f	25
g	3
k	6
l	80
m	16
n	19
o	8
w	80

## TYPE B ANTENNA DIMENSIONS

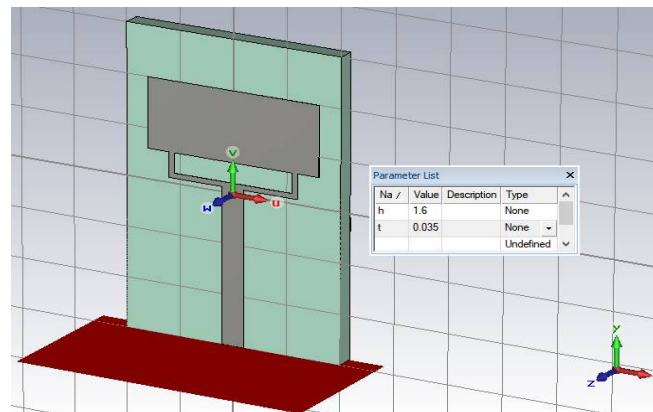


Fig 3. Monopole antenna design

Monopole antenna designed with the patches and port. The material used for substrate is Rogers RO3203 (loss free) with permittivity 3.02 and permeability 1. The solids are designed with SEE – Silver, its electrical conductivity is  $6.3012 \times 10^7$  [S/m] and permeability is 1.

### Ground:

$U = -10$  to  $10$ ,  $V = 1$  to  $15$ ,  $W = 0$  to  $t$

### Solid 1:

$U = -6$  to  $6$ ,  $V = 0.5$  to  $3$ ,  $W = 0$  to  $t$

### Solid 2:

$U = -8$  to  $8$ ,  $V = 3$  to  $10$ ,  $W = 0$  to  $t$

### Solid 3:

$U = -5.5$  to  $5.5$ ,  $V = 1$  to  $3$ ,  $W = 0$  to  $t$

### Substrate:

$x = -10$  to  $10$ ,  $Y = -15$  to  $15$ ,  $Z = 0$  to  $h$

### pattern:

$U = -1$  to  $1$ ,  $V = -15$  to  $15$ ,  $W = 0$  to  $t$

Finally the picks are placed in the patch and by using solvers the port 1 is created. Simulation is done on the antenna 'A' and 'B' then the both antennas are analysed with their parameters. 1D, 2D, 3D results are analysed in results and discussion.

## III. RESULTS AND CONCLUSION

Four important parameter to analyse the body-centric communication [5]. These all are analysed by the Return loss, Efficiency, Gain and directivity. Apart from this E-field, H-field, VSWR, Y-matrix and Z-matrix are analysed [6]. Far field is much more necessary than the near field because the radiation in remote area need to travel a long distance.

### EFFICIENCY

Antenna efficiency is defined as the ratio of the aperture effective area,  $A_e$  to its actual physical area,  $A$ . it describes the percentage of the physical aperture area which actually captures radio frequency (RF) energy [7]. Type 'A' radiated efficiency (3GHz, -2.6dB) and total efficiency (3GHz, -3.35dB). Type 'B' produce radiated efficiency (3.45GHz, -1.15dB) to (5.2GHz, -1.26dB) and total efficiency (3.45GHz, -1.17dB) to (5.2GHz, -1.45dB). Type 'A' is efficient than type 'B' in patient monitoring at remote distances whereas type B is efficient than type A in rectangular shaped watches depending on the low frequency radiations [8].

### RETURN LOSS

The most commonly quoted parameter in regards to antenna is S11. S11 represents how much power is reflected from the antenna, [9] and hence known as the reflection coefficient or return loss.

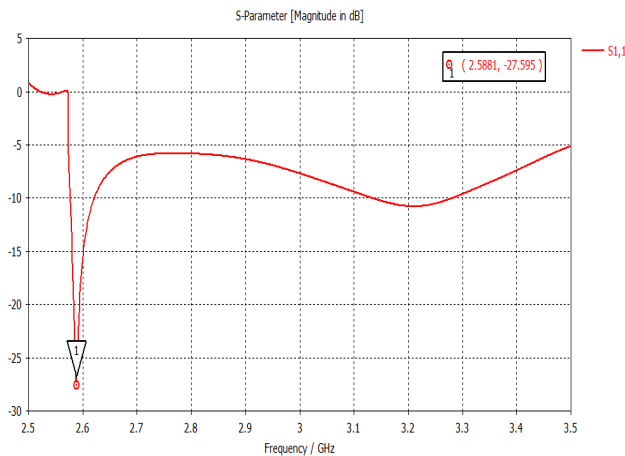


Fig 4. Type A return loss

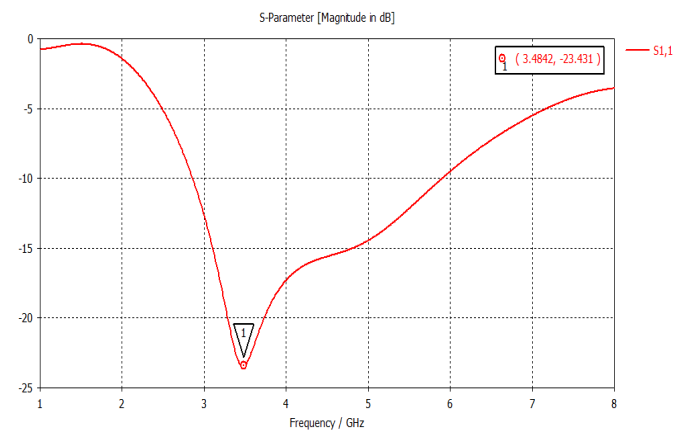


Fig 5. Type B return loss

### GAIN AND DIRECTIVITY

Gain is a key performance number which combines the antenna's directivity and electrical efficiency. Gain is understood to refer to the peak value of the gain, [10] the gain in the direction of the antenna's main lobe. A plot of the gain as a function of direction is called the radiation pattern. Micro-strip antennas produce (3GHz, 0.92dB). Monopole antennas produce from (3.4GHz, 2.02dB) to (5.2GHz, 2.38dB).

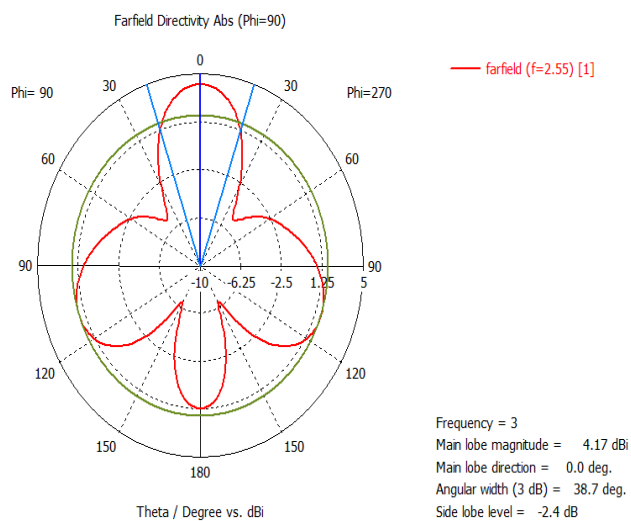


Fig 6. Linear graph of type 'A'

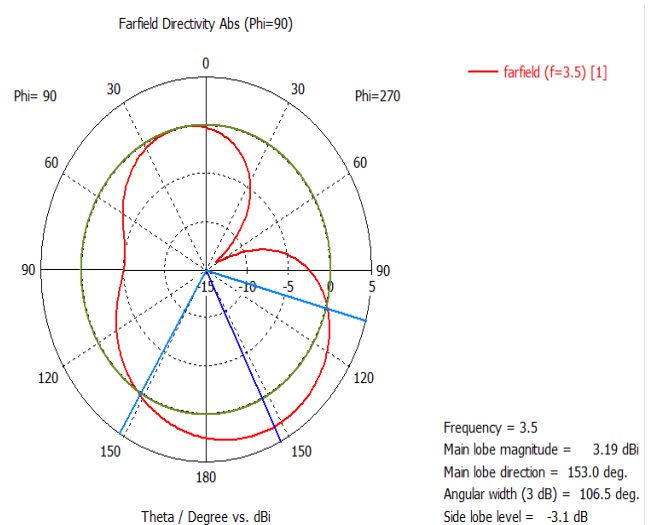
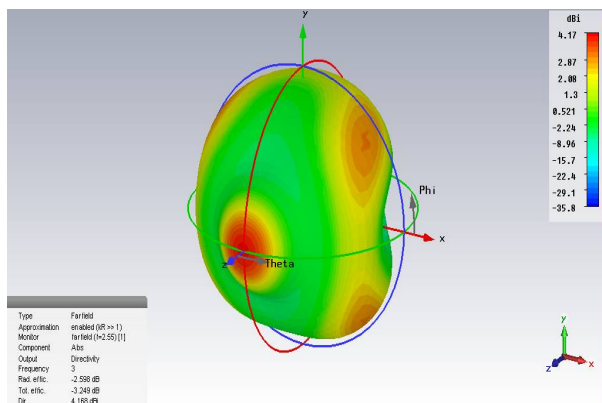


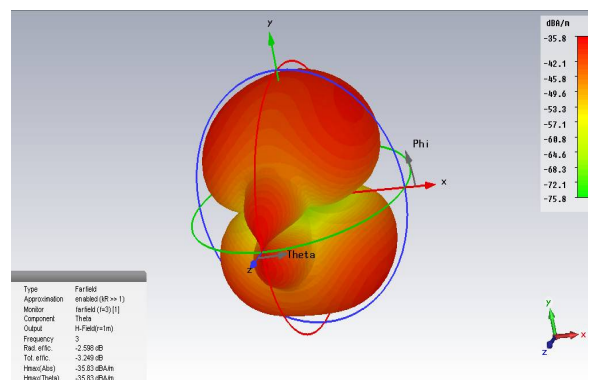
Fig 7. Linear graph of type 'B'

Directivity is a fundamental antenna parameter. It is a measure of how 'directional' an antenna's radiation pattern is. An antenna that radiates equally [11] in all direction would have effectively zero directivity, and directivity of this type antenna would be 1(or 0dB).  $G = KD$  where G is Gain, D is directivity and K is antenna efficiency. Type 'A' gives the directivity of (3GHz,4.18dB) and Type 'B' from

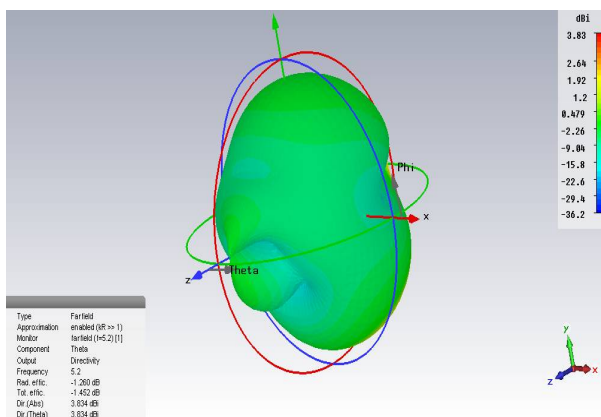


(3.5GHz,3.18dB) to (5.2GHz, 3.83dB).

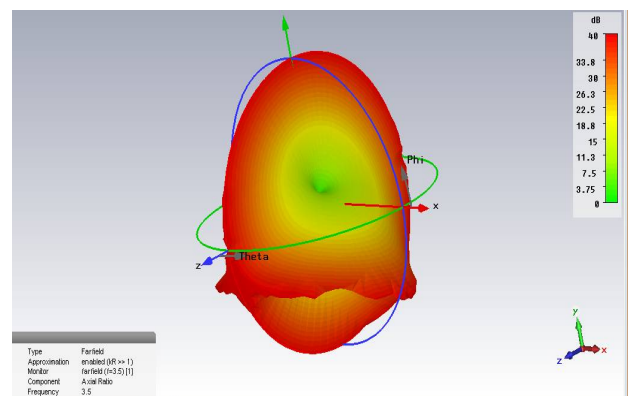
(a)



(b)



(c)



(d)

Fig 8. Far-Field results (a) abs result at 2.55GHz for Micro-strip antenna (b) Theta result at 3GHz for Micro-strip antenna(c) Theta result at 3.5GHz for monopole antenna (d) Axial Ratio result at 5.2 GHz for monopole antenna.

### VSWR:

VSWR stands for Voltage Standing Wave Ratio [12], and is also referred to Standing Wave Ratio (SWR). VSWR is a function of coefficient which describes the power reflected from the antenna.

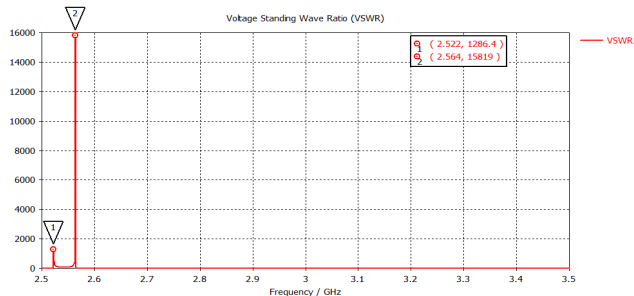


Fig 9. Micro-strip VSWR

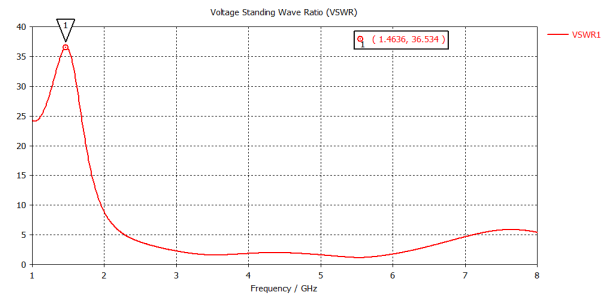


Fig 10. Monopole VSWR

## IV. CONCLUSION

Antenna which plays a major role in transmitting and receiving the signals. Two successful antenna is designed at low frequency and have very less radiation effects on the body.[13] By considering various parameters especially return loss, gain and directivity type 'A' antenna is suitable for the remote monitoring system for the patient where as type 'B' is not suitable for high accuracy signals to send the biological sensors.[14] But type 'B' antenna can be used for the rectangular watch applications which perfectly suite for that shape.[15] Hence Micro-strip and Monopole antenna are designed for body-centric communication at low frequency.

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