DESIGN OF DOUBLE DUMBELL SHAPED PATCH WITH DGS FOR MULTIBAND APPLICATIONS

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ABSTRACT

This paper presents the design and analysis of a double dumbbell shaped patch with DGS for multiband applications and the proposed antenna has been developed with the dimension of 50x50mm. In order to improve the performance of the proposed antenna, square shaped slot in corners and top view of yagi-uda antenna shaped slot are etched on ground and this slot provides high gain and high efficiency than the other structures. The parameters of the antenna are simulated using ADS 2011.05 and it is suitable for the applications such as WiMAX & WLAN applications.

1. INTRODUCTION

Modern wireless communication system requires low profile, light weight, high gain, and simple structure antennas to assure reliability, mobility, and high efficiency characteristics. Micro strip antenna satisfies such requirements [1]. The key features of a micro strip antenna are relative ease of construction, high weight, low cost and either conformability to the mounting surface, an extremely thin protrusion from the surface. This antenna provides all of the advantages of printed circuit technology. These advantages of the micro strip antenna make them popular in many wireless communication applications such a satellite communication, radar, and medical applications [2]. The limitation of micro strip antenna is narrow frequency band and disability to operate high power level of waveguide, coaxial line or even strip line. Therefore, the challenge in micro strip antenna design is to increase the bandwidth and gain [3].

Different a configuration of micro strip antenna can give high gain, wide elements depends on feeding network. Suitable feeding network accumulates all of the induced voltage to feed into one point. The popularimpedance matching throughout the corporate and series feeding configuration provides high efficiency microstrip antenna [4]. Power distribution among antenna can be modified by introducing phase change. The choosing of design parameters (dielectric material, height and frequency etc) is important because an antenna performance depends on these parameters. Radiation performance can be improved by using proper design structures. The use of high permittivity substrate can miniaturize microstrip antenna size [5]. Thick substrate with lower range of dielectrics offer better efficiency, and wide bandwidth but it requires larger element size. The discontinuities in a micro strip patch reduce the length of resonating micro strip antenna and radiation efficiencyas well [6].

Often microstrip antennas are also referred to as patch antennas. The radiating elements and the feed lines are usually photo etched on the dielectric substrate [7]. The radiating patch may be square, rectangular, thin strip (dipole) circular, elliptical, triangular, or any other configuration. Square, rectangular, dipole (strip), and circular are the most common because of ease of analysis and fabrication, and their attractive radiation characteristics, especially low cross- polarization radiation. There are different types of losses in antenna one of which is surface wave loss due to the permittivity of the material and the thickness of the substrates [8], [9].

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DESIGN AND STRUCTURE

Final design is the design of double dumbell shaped patch antenna structure. It consists of two dumbells connected by two line strips as shown in fig.1 and 2. The feeding technique used in this design is coaxial or probe feed. The length and width of the substrate is 50 x 50 mm. FR4 is a dielectric material which is chosen as a substrate.

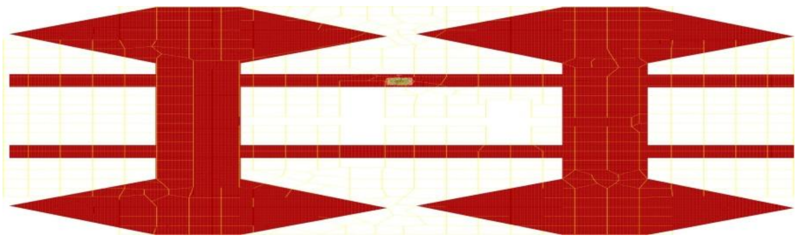

Fig.1 Top view of double dumbell shaped patch antenna

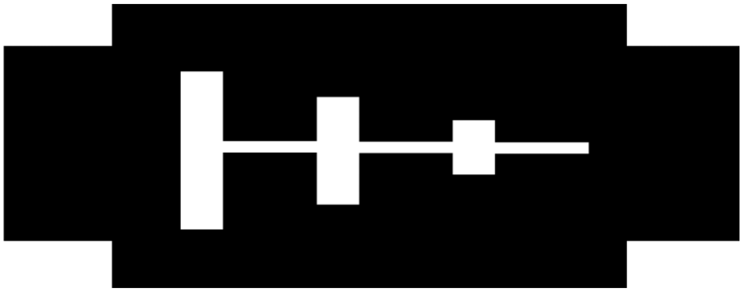

Fig.2 Bottom view of patch antenna

Table.1 Measurement for Final Design

Dimensions	Values in mm
Length of the ground (Lg)	50
Width of the ground (Wg)	50
Length of the patch (Lp)	50
Width of the patch (Wp)	50

For this design as shown in table.1 we obtained the return loss of -23.681, -20.672, -30.127, -13.666, and 13.209 is obtained at 2.285, 2.95, 4.009, 4.272, 5.678 GHz respectively. The gainobtained for this design is 5.966.

3. SIMULATED COMPARISON

This section deals with the comparison of performance of all the design involved in reaching final design of high gain patch antenna. ADS (Advanced Design System) are the software used for designing this patch antenna. We obtained the antenna parameters such as gain, directivity, and return loss using the simulation process from ADS software. Value for these parameters is identified using the respective graphs obtained.

Return loss (S11)

The fig.3 shows the comparison of S11 curves for the four designs. The return loss must be below -10 dB for an antenna, then only the antenna start radiating in desired direction.

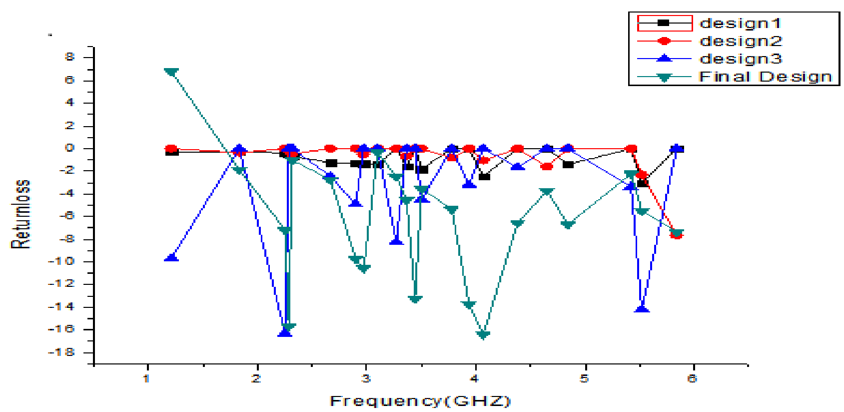

Fig.3 Comparison of Return loss for 4 Designs

Design 1 has the return loss of -11.498 at frequency 6.25 GHz and the gain is -2.63 dB. It does not give appropriate results. Design 2 has the return loss of -22.137,-11.209, and 10.936 at the frequency of 7.92, 8.00 and -10.936 GHz. The gain obtained for this design -3.744. But the results obtained are at high frequency which is not applicable. Design 3 has the return loss of -14.849, -15.304, -14.194, and 29.468 at the frequency of 1.75, 2.175, 5.417, and 7.495 GHz were the gain is 3.51. Due to low gain we will go for next design. Our final design has obtained the return loss of -23.681, 20.672,-30.127,-13.666, -13.209 at the frequency of 5.966, 2.285, 2.951, 4.009, 4.272, 5.678GHz respectively. We have obtained the high gain of 5.966.From the above discussion it is clearly seen that the final design gives the better performance with respect to return loss and gain.

Gain

Gain is designed as the "ability of an antenna to measure radiated power in given direction". The following fig.4 shows the Gain values obtained at different frequencies for the final design.

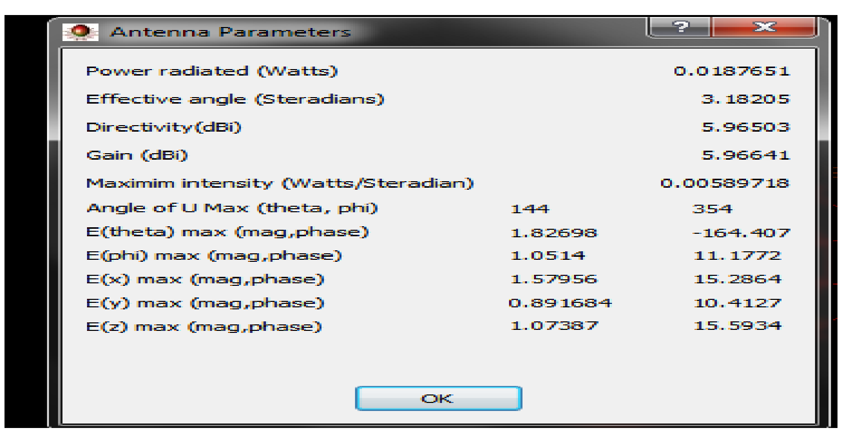

Fig.4 Gain for final design

Radiation Pattern

The following fig.5 shows the 3D radiation pattern for the final designat different frequencies.

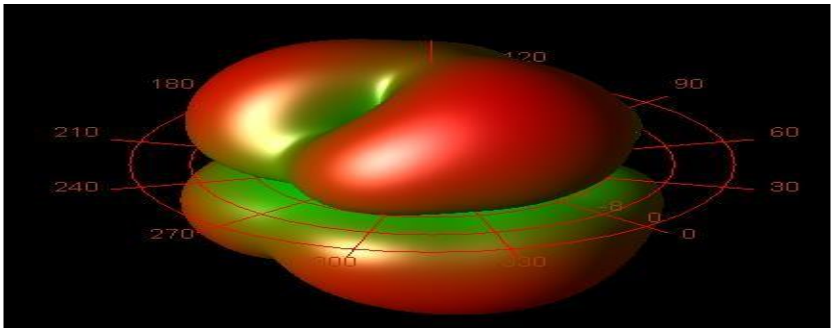

Fig.5 Radiation pattern for final design

Return loss for Final Design

The following fig.6 shows the Return loss obtained for the final design.

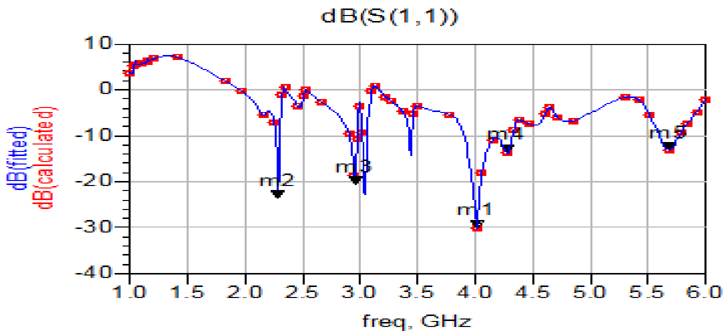

Fig.6 Return loss for final design

Polarization

Polarization is the direction of wave transmitted (radiated) by the antenna. It is a property of an electromagnetic wave describing the time varying direction and relative magnitude of the electric field vector. Polarization is classified as linear, circular, or elliptical. The following fig.7 and 8 shows the polarization of our fabricated antenna.

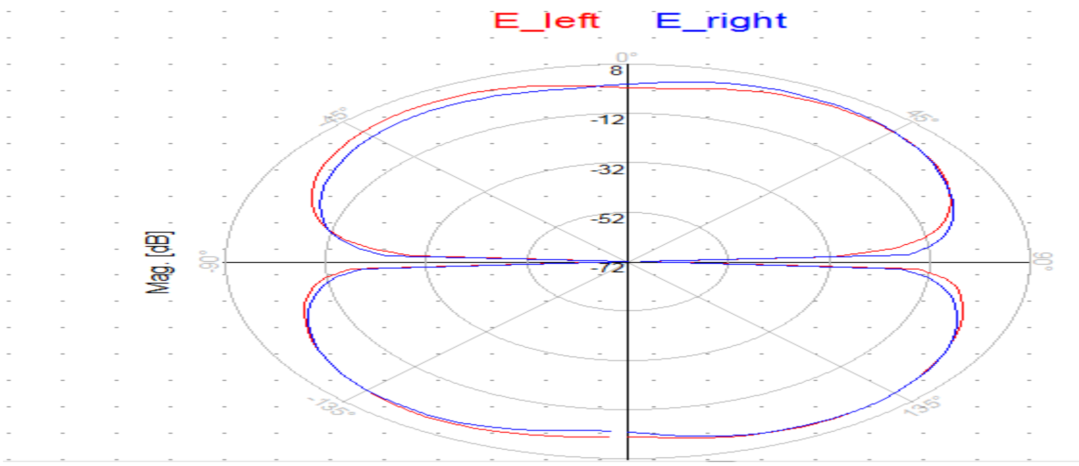

Fig.7 Circular Polarization for final design

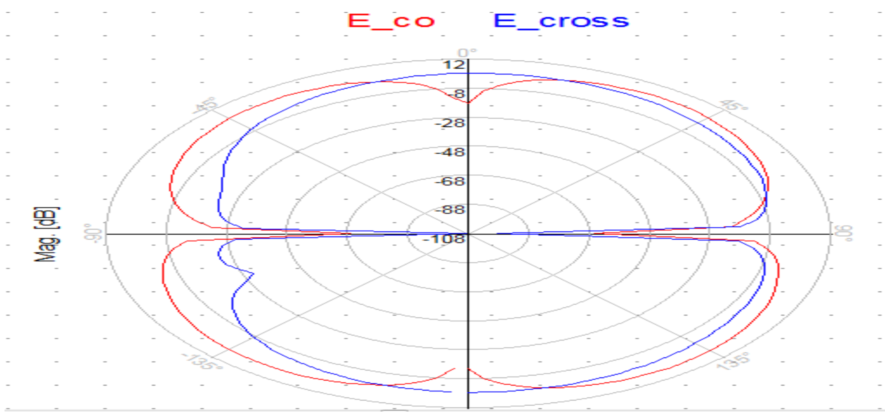

Fig.8 Linear Polarization for final design

4. HARDWARE IMPLEMENTATION

BASIC CONCEPT

The antenna is printed on FR4 substrate with thickness of 1.6mm and the dielectric constant of 4.4.This antenna is simulated with ADS 2011.05 software. After simulation the fabrication is done. The hardware aspects what we have done is described in below section. The fabricated antenna is connected with SMA connector antenna structure. The testing of antenna is done by network analyzer.

NETWORK ANALYZER

The network analyzer is an electronic instrument which provides the variable basic S-PARAMETER at high frequencies. This instrument measures the network parameters of electrical Network. Network Analyzer is often used to characterize two-port networks such as amplifies and filters, but they can be used on networks with an arbitrary number of ports.

FABRICATION AND TESTING

The Micro strip patch antenna is analyzed using network analyzer equipment as shown in fig.9. Our antenna is connected is connected to the network analyzer is shown below and its readings are taken. We can also compare the measured and tested resulted of the fabricated antenna.

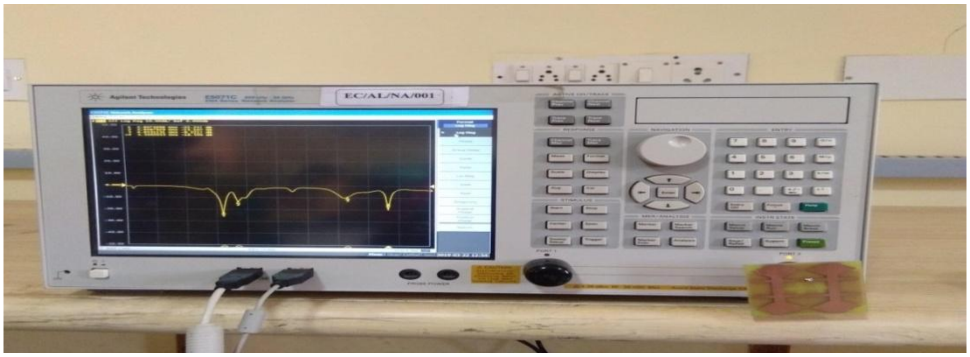

Fig.9 Network Analyzer with double dumbell shaped patch antenna

The antenna is having patch dimension of (50 x 50) mm.

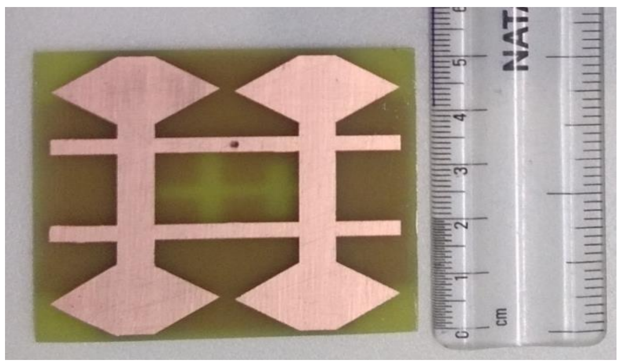

Fig.10 Front view of Fabricated Antenna

The stimulated antenna is fabricated and tested in the laboratory. The figure 10 & 11 shows the front view and back view of the fabricated antenna which is tested using network analyzer.

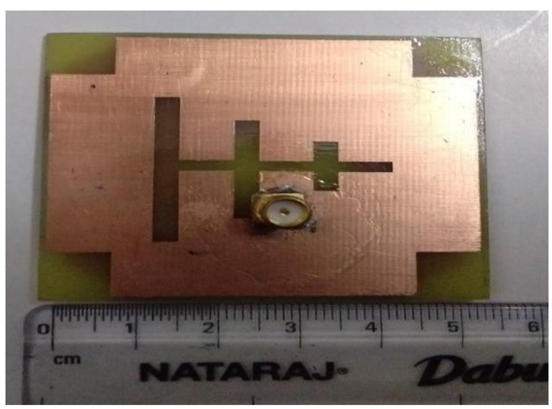

Fig.11Back View of Fabricated Antenna

RETURNLOSS Vs FREQUENCY

The following figure 12 shows the Return loss v_s Frequency plot of thefabricated antenna.

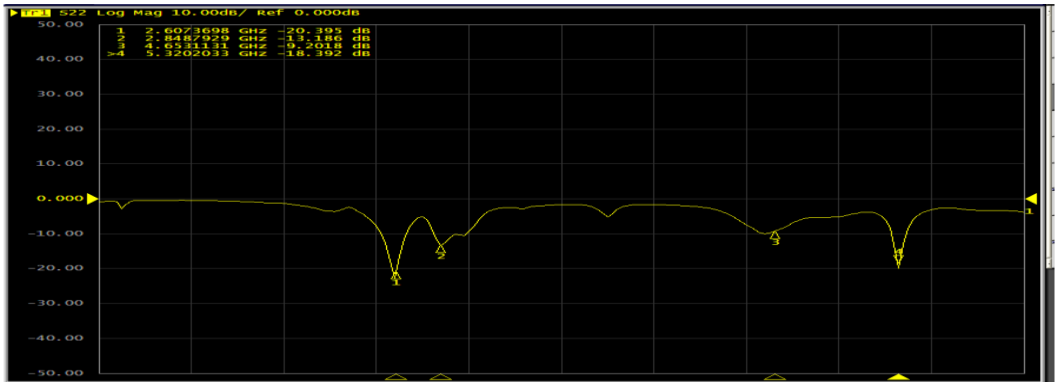

Fig.12 Return loss Vs Frequency plot from network analyzer

The antenna produces the return loss of -18.479dB,-11.692dB,-10.742dB,-18.301dB at 2.594GHz,2.867GHz, 4.602GHz, 5.320GHz.

VSWR Vs FREQUENCY

The following figure 13 shows the VSWR V_S Frequency plot

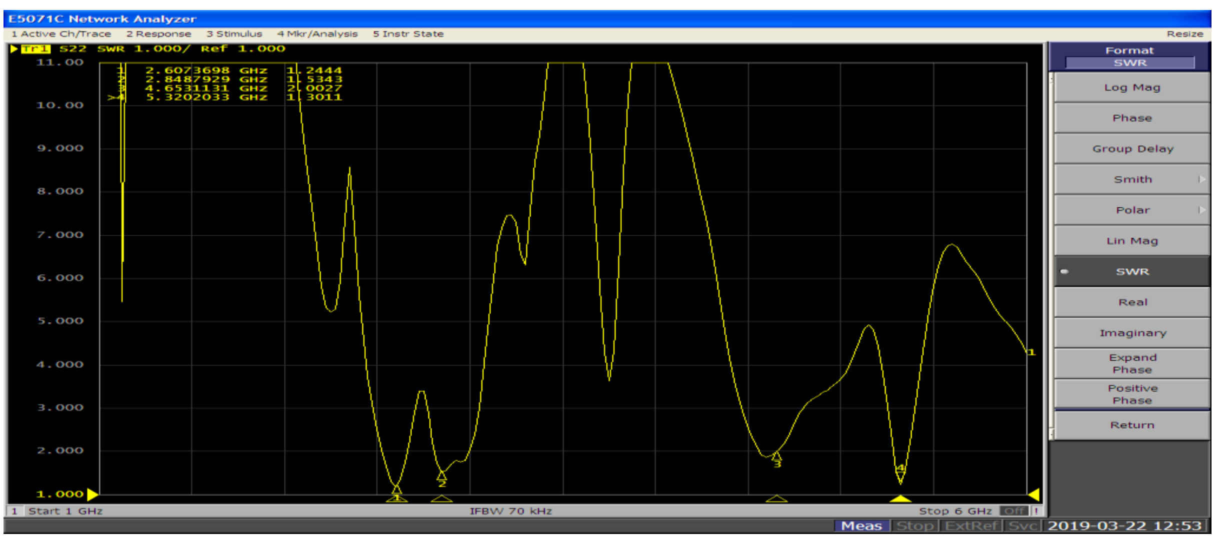

Fig.13 VSWR Vs Frequency plot from network analyzer

5. COMPARISION RESULTS

The following tablerepresents the comparison betweentested and simulated result.

Table-2 Simulation comparison of all the designs

Parameter	Design1	Design2		Design3		Final Design		
Frequency(in GHz)	6.25	7.92	8.00	7.49	2.12	2.28	2.95	5.67
Return loss(in dB)	-11.49	-22.13	-11.20	-29.46	-15.30	-23.68	-20.67	-13.20
Gain(dB)	-2.63	-2.26	-3.74	2.09	2.8	4.09	4.37	4.94

Table-3 Comparison of simulated and tested results of the antenna

S.No	SIMULATED RESULTS			MEASURED RESULTS		
	FREQUENCY (GHz)	RETURN LOSS(dB)	GAIN (dB)	FREQUENCY (GHz)	RETURN LOSS(dB)	VSWR
1.	2.285	-23.681	4.09	2.594	-18.479	1.244
2.	2.951	-20.672	4.37	2.867	-11.692	1.534
3.	4.272	-13.666	4.52	4.602	-10.742	2.00
4.	5.678	-13.209	4.94	5.320	-18.301	1.301

GRAPHICAL COMPARISON

Return loss

The following figure 14 shows the graphical comparison of simulatedand measured results for the return loss of fabricated antenna.

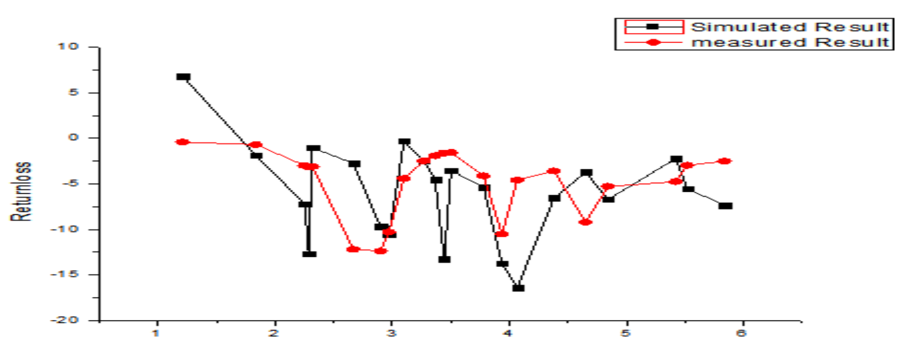

Fig.14 Comparison of simulated and measured results for return loss

6. CONCLUSION

In this paper, double dumbbell shape patch antenna with DGS for multiband application has been designed and simulated using ADS software. The proposed antenna exhibits the promising characteristics of return loss, VSWR, gain, directivity which is suitable for the applications such as WiMax, WLAN, MIMO &satellite application. It has been observed the return loss and frequency -18.479dB,-11.692 dB, -10.742 dB, -18.301db at 2.594 GHz, 2.867 GHz, 4.602 GHz, 5.320 GHz. It has been analyzed that the position of feed point has a serious effect on the performance of the designed antenna since it may change the valuesof return loss and the VSWR. The designated antenna fulfils the desired parameter values with a very compact size, which are the fabulous achievements of antenna design when compare to conventional patch antenna. Finally, we obtain the gain of 5.966dB.It was concluded that hardware results are obtain and are matched with predicted software results.

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