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ANALYSIS OF NOVEL CURVE MICROSTRIPLINE ARRAY ANTENNA DESIGN IN X BAND FREQUENCY FOR SATELLITE COMMUNICATION

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ABSTRACT

The design of a novel curve microstripline 2x2 array antenna is presented in this research. In this design, antenna work in X Band frequency. The total size of antenna is 40mm x 40mm. The result indicates that the antenna characteristics parametric showed by Voltage Standing Wave Ratio (VSWR≤2) of the proposed antenna is 1.06 (in simulated); 1.29 (in measured) and 1.20 (in numeric analyzed), bandwidth is 260.0 MHz (in simulated) and 310.0 MHz (in measured) and reflection coefficient is 0.03 (in simulated) and 0.17 (in measured) and return loss is -29.43dB (in simulated) and -27.12dB (in measured) respectively. The antenna has achieved a stable radiation performance with a maximum gain of 6.67dB (in simulated) and 5.53dB (in mesured). Novel curve microstripline 2x2 array antenna with 50 Ohm impedance and easy integration are making this model suitable for X-Band frequency (8GHz-12GHz) satellite communication applications. Details of the proposed antenna design and results are presented and discussed.

KEYWORDS 2x2 Array; Microstripline Antenna; Satellite Communication

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INTRODUCTION

To design and analyze the shape and size of the antenna required special knowledge regarding the electromagnetic field theory. Electromagnetic fields generated depend on the distance of the source access and terrain. The further course of electromagnetic fields produced less meaning in the spreading process electromagnetic waves from the transmitter to the receiver experiencing attenuation (weakening) signals. Therefore, the required antenna design with specific dimensions that have a high gain value and high directivity with return loss is very small. [1,2,10,11]. Various studies have been conducted on microstrip antenna type [1,2,8,10,11,12,13,14,16], among which is to perform a wide variety of designs and shapes microstrip antenna, by giving the slot [18] and patch microstrip antenna and adding to the number of the array [17]. Use of the slot will be able to increase the bandwidth [15], the smaller the width of the slots will be even greater bandwidth while increasing the number of arrays will increase the directivity and the gain of the antenna [3,4]. The array of Antenna [17,19] is used to direct radiated power toward a desired angular sector. The number, geometrical arrangement, and relative amplitudes and phases of the array element depend on the angular pattern that must be achieved. One type of antenna that will be designed to have the characteristics in question are novel curved microstripline array antennas design. This antenna is an antenna type Microstrip with the characteristics of a thin cross-section, the mass that is lightweight, easy to make, can be easily integrated with Microwave Integrated Circuits (MICs) and can be made to multifrequency [5,6,7,9]. In this paper Novel curved microstripline array antenna design is propose to develope in X-Band frequency for many satellite communications transmisions. The proposed Novel curved microstripline array antenna is afford to operate in X-Band frequency in range 8 GHz – 12 GHz. The target of Novel curved microstripline array antenna is in 10.0 GHz center frequency, reflection coefficient or return loss (S_{11} parameter) less than –10dB, Voltage Standing Wave Ratio (VSWR) less than 2, input impedance close to 50Ω, and gain more than 4dB in linear polarization, respectively. Can be seen in Table 1.

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Table 1. Target of the antenna parameter.

Parameters	Specification
Center Frequency	10.0 GHz
Input Impedance	Close to50Ω
S_{11} (Return Loss)	< -10dB
VSWR	< 2
Gain	> 4dB
Polarization	Linear (Vertical)

RESEARCH METHOD

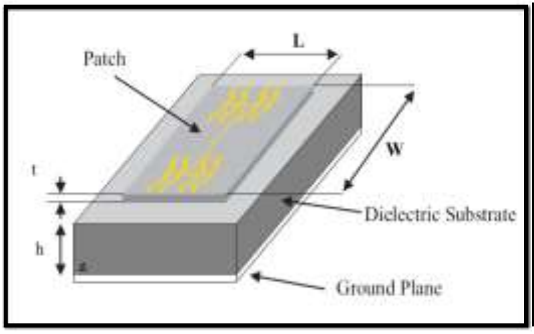
Antenna geometry and design

The parameters of the Novel Curved Microstripline Array Antenna Design consist of the following table. (Table.2):

Table 2. Dimension Parameter of the Novel Curved Microstripline Array Antenna Design.

Parameters	Dimension	Description
Wg	100	Width
T	0.035	Thick
Lg	50	Length
H	1.6 (+18mm)	High
l_1	30mm	Length of feeding stripline
$l_2 = l_3$	15mm	Length of curve stripline
$w_1 = w_2$	1mm	Width of stripline
w_3	2mm	Width of curve stripline
θ	30^o	Gradient in curve line

The Curved Microstripline Array Antenna Dimension can be seen in Figure 1:



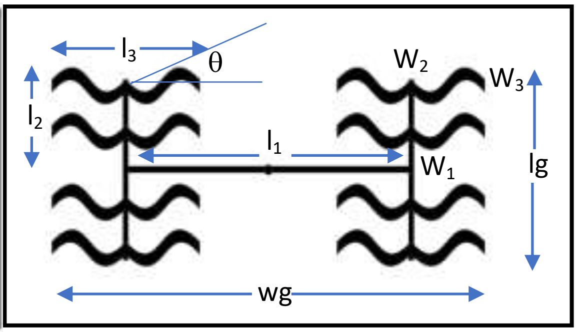
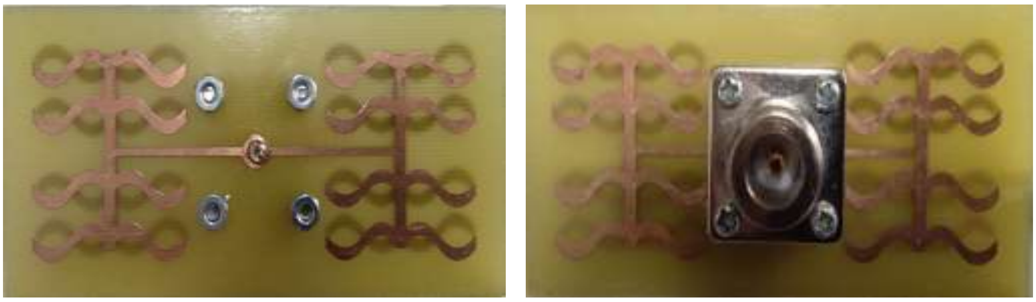


Figure 1. Curved Microstripline Array Antenna Dimension

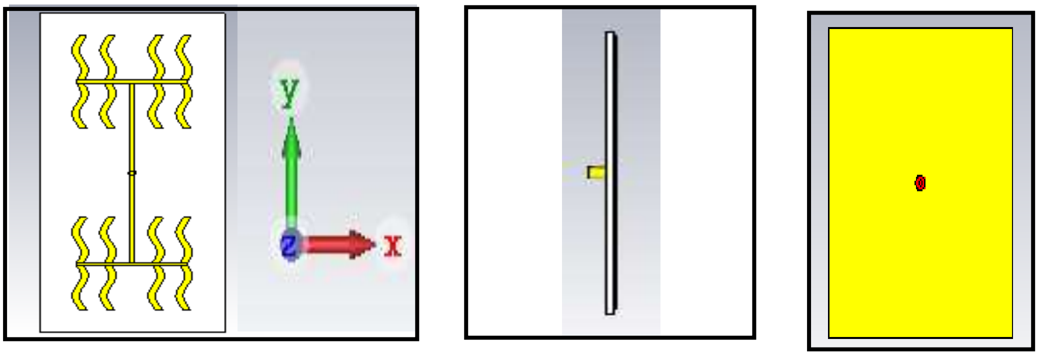
The result of fabrication using FR_4 substrate can be seen in the following figure (Figure 2):



(a) (b)

Figure 2. The fabricated prototype Curved Microstripline Array Antenna.
(a) Top View (b) Back View

The simulations was created by using CST software. The result of simulation is presented in figure 3.



(a) (b) (c)

Figure 3. Simulation result Curved Microstripline Array Antenna.
a) Top View (b) Side View (c) Bottom View

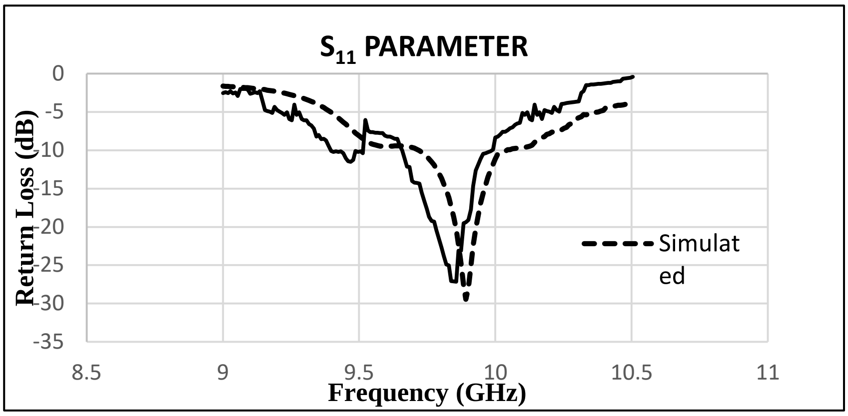
The following figure (Figure.4) is Measuring Antenna at Laboratory.

(a) (b)

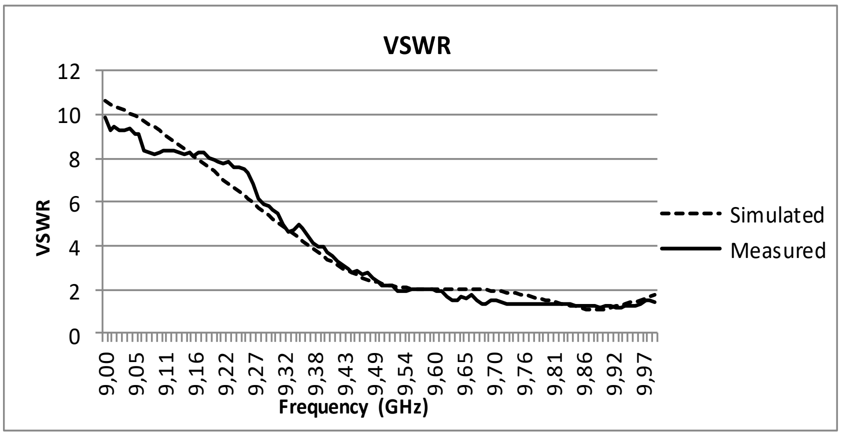
Figure 4. Measuring Process at Laboratory.

RESULT AND DISCUSSION

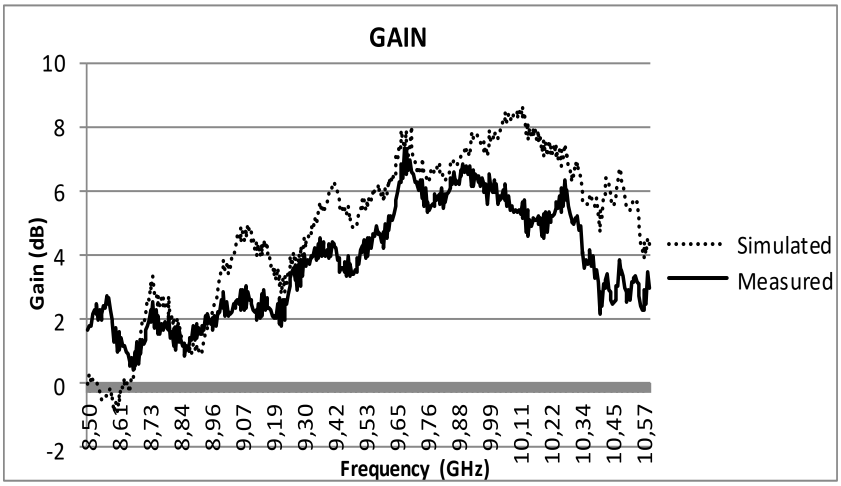
In simulation Curved Microstripline Array Antenna work in 9.89 GHz frequency with bandwidth range aproximately 260.0 MHz (9.72 GHz – 9.98 GHz). The simulation result shown the antenna works well within the design frequency range. This indicate that the novel curved microstripline array antenna giving the good effect in bandwidth and antenna performance that can be apllied in communication especially in X-Band frequency range. The simulation shown in S_{11} parameter is reflection coefficient 0.03, Voltage Standing Wave Ratio (VSWR) 1.06, return loss -29.43 dB and 6.67 dB in Gain. In measurement Curved Microstripline Array Antenna work in 9.84 GHz frequency with bandwidth range aproximately 310.0 MHz (9.66 GHz – 9.97 GHz), reflection coefficient 0.17, Voltage Standing Wave Ratio (VSWR) 1.29, return loss -27.12 dB and 5.53 dB in Gain. The results of measuring and simulation can be described in the following figure (Fig. 5):



a) S_{11} Parameter.



b). VSWR.



c). Gain

Figure 5. The result of Novel Circular Microstrip Patch Antenna.

The polarization and radiation pattern in curved microstripline array antenna is linear polarization and omnidirectional radiation pattern. The performance in terms of polarization in Curved Microstripline Array Antenna presented in Figure 6.

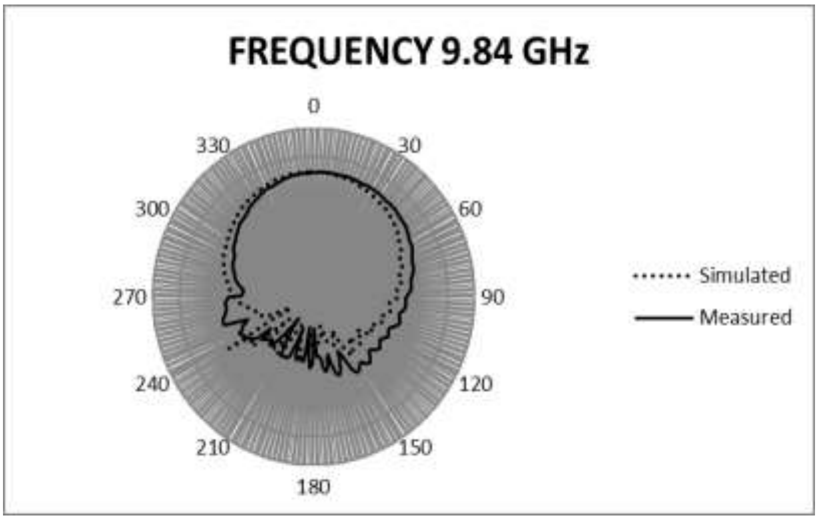


Figure 6. The Polarization of the Curved Microstripline Array Antenna

A maximum gain in simulation is 6.67dB and in measurement is 5.53dB. That results to indicate that the Curved Microstripline Array Antenna gain is still acceptable for the X-Band antenna frequency.

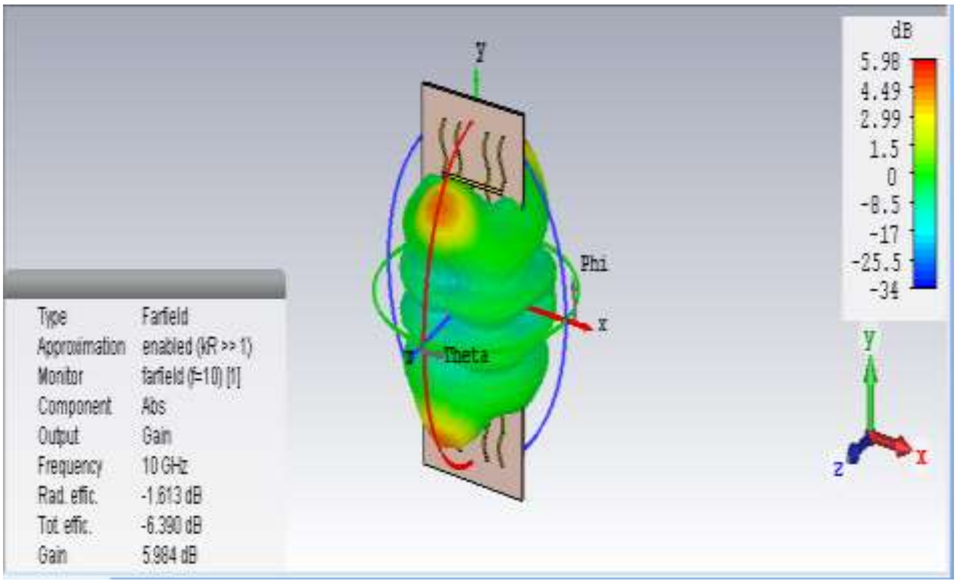


Figure 7. 3D Far Field Polarization Pattern of the Curve Microstripline 2x2 Array Antenna.

In general, the proposed antenna is designed to operate at X-Band and it can be observed from return loss and gain in antenna design that this antenna is suitable for being used in satellite communication. It can be easily observed from the radiation pattern that the designed antenna produces linear vertical polarization radiation pattern. There are some significant advantages if a patch antenna has a stable and symmetrical in radiation pattern. One of the major advantages is that during construction of an antenna, the radiation pattern would be more stable across the operating bandwidth.

CONCLUSION

The following table (Table.3) is summarizing the comparison between numeric analyzed, simulated and measured.

Table. 3. The result of comparison between numeric analyzed, simulated and measured.

Parameters	fc (GHz)	RL (dB)	VSWR	Γ
Numeric Analyzed	10.00	-20.92	1.20	0.09
Simulated	9.89	-29.43	1.06	0.03
Measured	9.84	-27.12	1.29	0.17

These results indicate that the novel curved microstripline array antenna designed has the characteristics of antenna parameters that can be applied in X-Band frequency communications. In the next research, from this design will be develope to antenna design in Curved Microstripline Array Antenna with the circular polarization.

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