UNIVERSITI SAINS MALAYSIA

Laporan Akhir Projek Penyelidikan Jangka Pendek

Investigation on The Coupling Effect of The Dielectric Resonator Antenna Array

by

Assoc. Prof. Dr. Mohd Fadzil Ain

Assoc. Prof. Sabar Derita Hutagalung

Assoc. Prof. Srimala Sreekantan

Prof. Zainal Arifin Ahmad

2012

BORANG FRGS - P1(R)

Kod Projek :	FRGS/FASA_-TAHUN/(BIDANG)/(NAMA IPT)/(NO.RUJ. KPT)

F0496

PROGRESS REPORT
FUNDAMENTAL RESEARCH GRANT SCHEME (FRGS)

Laporan Prestasi Skim Geran Penyelidikan Asas (FRGS) IPT
Pindaan 1/2012

A

RESEARCH TITLE : Investigation On The Coupling Effect Of The Dielectric Resonator Antenna Array.
Tajuk Penyelidikan

PROJECT LEADER : **Asso.Prof.Dr mohd fadzil bin Ain**
Ketua Projek

PROJECT MEMBERS : **(including GRA)**
Ahli Projek
1. **Prof madya sabar derita hutagalung**
2. **Prof madya srimala a/p sreekantan**
3. **Profesor zainal arifin bin ahmad**

PROJECT ACHIEVEMENT *(Prestasi Projek)*

B

ACHIEVEMENT PERCENTAGE

Project progress according to milestones achieved up to this period	0 - 25%	26 - 50%	51 - 75%	76 - 100%
Percentage				100%

RESEARCH OUTPUT

	Indexed Journal	Non-Indexed Journal
Number of articles/ manuscripts/ books *(Please attach the First Page of Publication)*	Novel Modeling and Design of Circularly Polarized Dielectric Resonator Antenna Array	
	International	**National**
Conference Proceeding *(Please attach the First Page of Publication)*		
Intellectual Property *(Please specify)*		

HUMAN CAPITAL DEVELOPMENT

Human Capital	Number				Others (please specify)
	On-going		Graduated		
Citizen	Malaysian	Non Malaysian	Malaysian	Non Malaysian	
PhD Student	/	/			
Master Student					
Undergraduate Student					
Total					

EXPENDITURE *(Perbelanjaan)*

C

Budget Approved *(Peruntukan diluluskan)* : RM 40,000
Amount Spent *(Jumlah Perbelanjaan)* : RM 40,670.41

Balance *(Baki)* : RM -670.41
Percentage of Amount Spent *(Peratusan Belanja)* : % 101,67

SUMMARY OF RESEARCH FINDINGS *(Ringkasan Penemuan Projek Penyelidikan)*

D

The same feeding mechanism was used to archive other objectives, in parallel with gain improvement and the circular polarization, covered by DRA array as wideband as in paper accepted by Microwave and optical technology letters under Wiley, which entitled "Design and Modeling of a High Gain Wideband Circular Polarized Dielectric Resonator Antenna Array"

A simple technique from the literature to enhance the operation band was employed in our array designs. Figure 1 bellow show the notched DR technique to enhance the band.

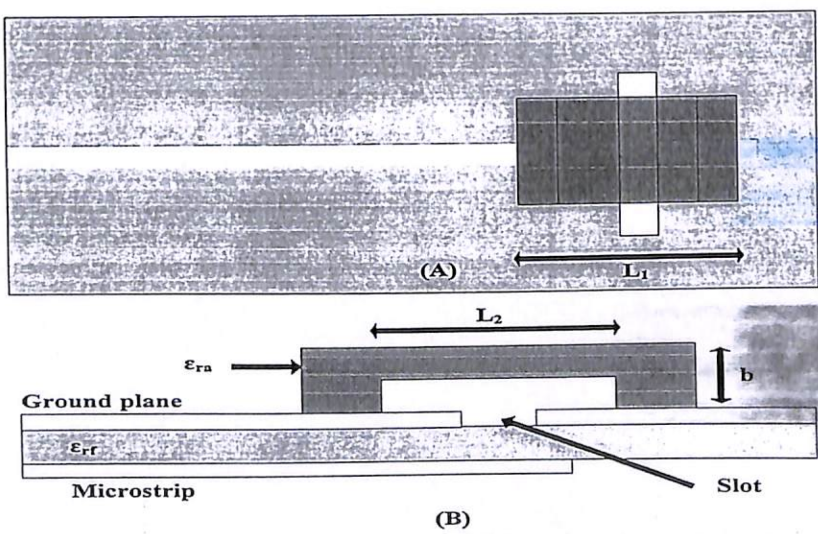

Fig1. Geometry of the notched rectangular DRA (a) top view and (b) side view.

Once this DR rotated 45 degrees with respect to the coupling slot a circular polarization will occur. Figure 2 shows the DRs placement to acquire wideband as well as circular polarization.

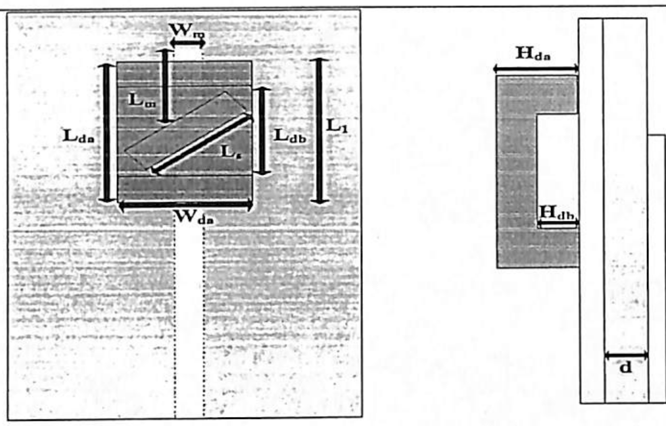

Fig2. Geometry of the notched rectangular DRA with 45° rotated slot coupled (a) top view and (b) side view

The array will be modeled on Agilent advanced design system (ADS) to determine the dimensions of the DR and after that in computer simulation technology (CST) to ensure the array specifications as in figures 3 and 4.

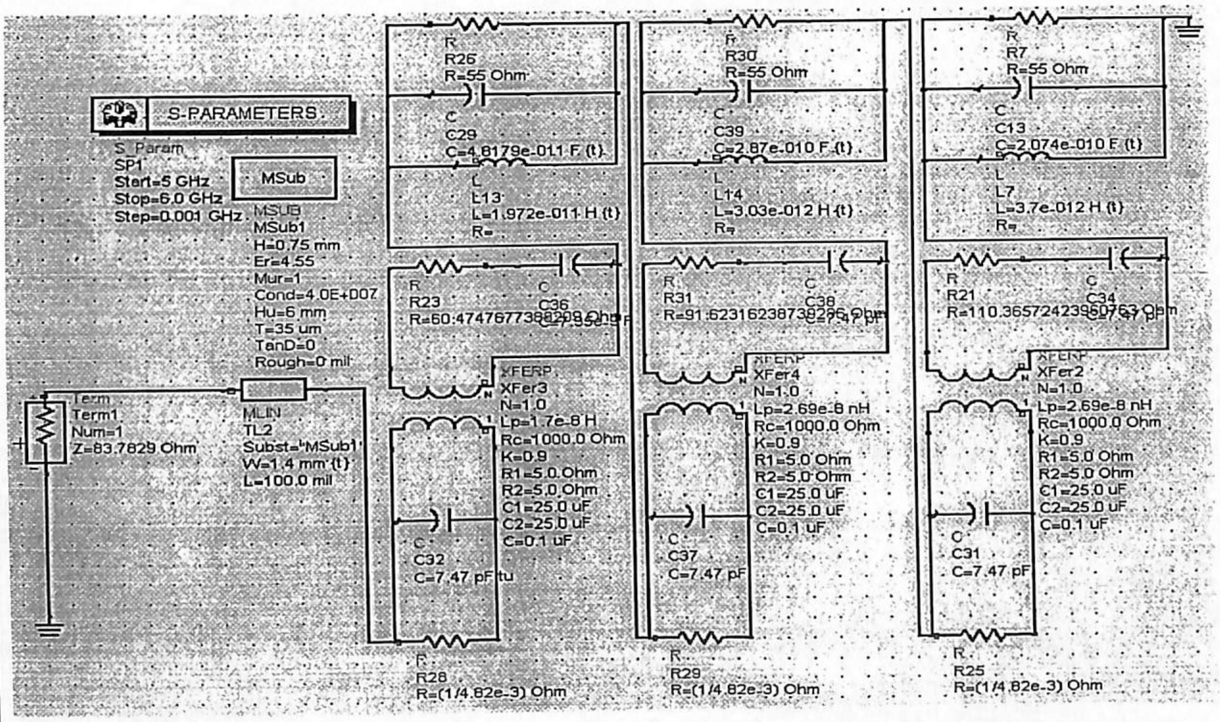

Fig 3 The dielectric resonator antenna array model in ADS

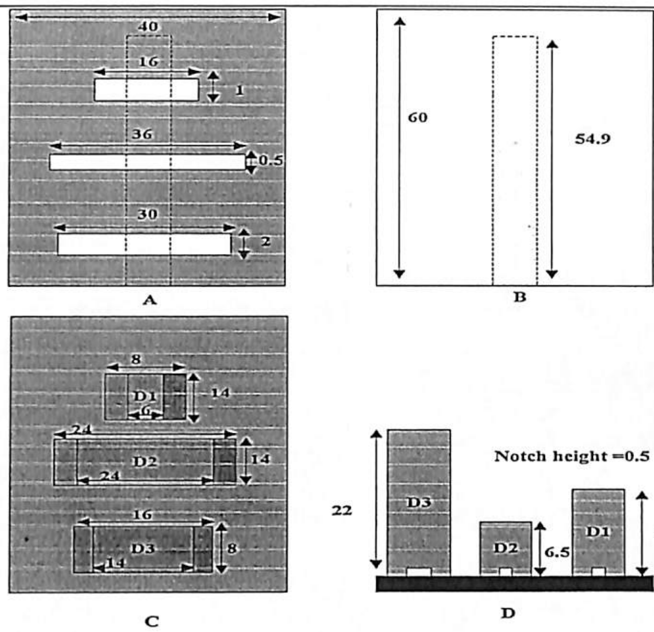

Fig 4 The designed structure in CST A) Slots dimensions. B) Microstrip dimensions (width=1.7mm), C and D) Dielectric elements dimensions [all dimensions in mm]

The simulation and measurement results for the input return loss are given in Figure 5. The simulated ADS return loss shows three resonant frequencies at 7 GHz, 7.2 GHz and 6.6 GHz. The simulated CST bandwidth was (6.3–7.28) GHz. The minimum return loss of -13.57dB was at 7.62 GHz with an impedance of 45.23-j5.33. The measured bandwidth was (6.25-7.3) GHz with minimum return loss of 23.62dB at 6.64 GHz while impedance was 48 +j5.77.

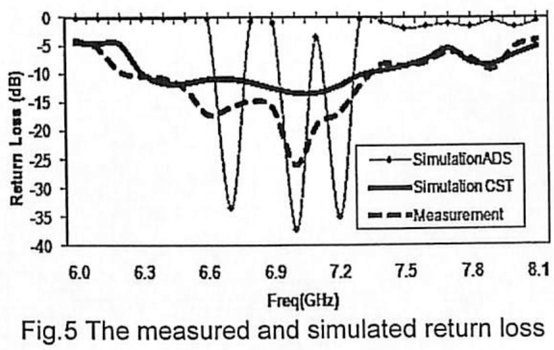

Fig.5 The measured and simulated return loss

Figure 6 shows the simulated and measured Eco-polarization and Ecross-polarization patterns in the xz -plan at 7.5 GHz. The cross-polarization is lower in measurement than co-polarization by 25 dB in the broadside direction, which is the characteristic of circular polarization radiation. Simulation results also show good agreement with the measured radiation patterns.

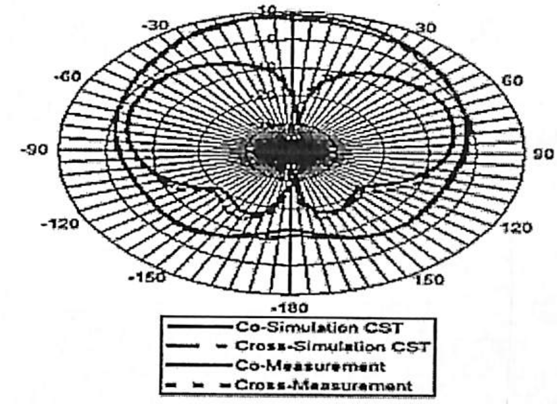

Fig.6 Radiation patterns of the DRA array at 6.9 GHz.

Figure 7 shows the simulated and measured gain of the antenna at a frequency range of 6 GHz to 8 GHz. The maximum simulated gain obtained at 6.25 GHz from CST was 11.75 dBi. The maximum measured gain obtained at 6.7 GHz was 11.54 dBi which is high compared to standard antenna using gain transfer methods. It indicates that this antenna has high efficiency with minimum loss.

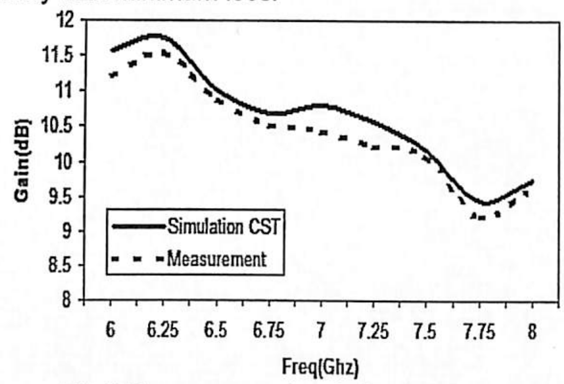

Fig.7 The measured and simulated gain

PROBLEMS / CONSTRAINTS IF ANY *(Masalah/ Kekangan sekiranya ada)*

E

Date : 16/4/12
Tarikh

Project Leader's Signature:
Tandatangan Ketua Projek

COMMENTS, IF ANY/ ENDORSEMENT BY RESEARCH MANAGEMENT CENTER (RMC)
(Komen, sekiranya ada/ Pengesahan oleh Pusat Pengurusan Penyelidikan)

F	Ini adalah laporan Akhir. Output projek sekadar memuaskan.
	Name: *Nama:* Date: 24/7/13 *Tarikh:* Signature: *Tandatangan:* [signature]

REFERENCES

1. P. Nepa, G. Manara, A.A. Serra, and G. Nenna, Multiband PIFA for WLAN applications, IEEE Antenna Wireless Propag Lett 4 (2005), 349–350.
2. S.K. Oh, H.S. Yoon, and S.O. Park, A PIFA-type varactor-tunable slim antenna with a PIL patch feed for multiband applications, IEEE Antennas Wireless Propag Lett 6 (2007), 103–105.
3. T.H. Chang and J.F. Kiang, Dualband split dielectric resonator antenna, IEEE Trans Antennas Propag 55 (2007), 3155–3162.
4. H.M. Chen, Y.K. Wang, Y.F. Lin, S.C. Lin, and S.C. Pan, A compact dual-band dielectric resonator antenna using a parasitic slot, IEEE Antenna Wireless Propag Lett 8 (2009), 173–176.
5. K.G. Thomas and M. Screenivasan, Compact CPW-fed dual-band antenna, Electron Lett 46 (2010), 13–14.
6. Y.F. Lin, H.D. Chen, and H.M. Chen, A dual-band printed L-shaped monopole for WLAN applications, Microwave Opt Technol Lett 34 (2002), 166–169.
7. C.M. Wu, Dual-band CPW-fed cross-slot monopole antenna for WLAN operation, Microwaves Antennas Propag IET 1 (2007), 542–546.
8. S. Chen, Y. Jiao, W. Wang, and F. Zhang, Modified T-shaped planar monopole antennas for multiband operation, IEEE Trans Microwave Theory Tech 54 (2006), 3267–3270.
9. W.C. Liu, C.M. Wu, and N.C. Chu, A compact CPW-fed slotted patch antenna for dual-band operation, IEEE Antenna Wireless Propag Lett 9 (2010), 110–113.
10. Y.C. Lin and K.J. Hung, Design of dual-band slot antenna with double T-match stubs, Electron Lett 42 (2006), 438–439.
11. L. Liu, Y.F. Weng, S.W. Cheung, T.I. Yuk, and L.J. Foged, Modeling of cable for measurements of small monopole antennas, In: Loughborough Antennas & Propagation Conference, 14–15 November, Loughborough (LAPC 2011), UK, 2011.
12. Y. Lee and J. Sun, A new printed antenna for multiband wireless applications, IEEE Antennas Wireless Propag Lett 8 (2009), 402–405.

DESIGN AND MODELING OF A HIGH GAIN WIDEBAND CIRCULAR POLARIZED DIELECTRIC RESONATOR ANTENNA ARRAY

M. F. Ain,[1] Y. M. Qasaymeh,[1] Z. A. Ahmad,[2] M. A. Zakariya,[1] M. A. Othman,[1] and M. Z. Abdullah[1]
[1] School of Electrical Engineering, Universiti Sains Malaysia, Nibong Tebal 14300, Malaysia; Corresponding author: mfadzil@eng.usm.my
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Received 19 August 2011

ABSTRACT: *In this letter, a circular polarized dielectric resonator antenna (DRA) using notched resonators excited through narrow slots is presented. To improve the gain, the slot positions were determined based on the characteristic of standing wave ratio over a short ended microstrip feeder. To enhance the bandwidth and circular polarization, three notched rectangular dielectric elements were rotated 45° with respect to the sides of the exciting slots. The DRAs are modeled as a parallel RLC component, as that will be used to determine the dielectric resonator dimensions. Antenna characteristics of the array antenna including return loss, radiation patterns, and antenna gain are presented. The size of the whole antenna structure is 40 × 45 mm² which gives its potential use in wireless communication systems.* © 2012 Wiley Periodicals, Inc. Microwave Opt Technol Lett 54:1396–1399, 2012; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.26860

Key words: *dielectric resonator antenna; array; gain; wideband; circular polarization; notched*

1. INTRODUCTION

Dielectric resonator antennas (DRAs) are proven to have several attractive features such as a wide impedance bandwidth, high radiation efficiency, compact size, and simple feeding mechanisms [1]. The study of series dielectric waveguide-fed DRA array for millimeter wave applications was done by Birand and Gelsthorpe [2] in the early 1980s. Other schemes were also well reported in the literature such as microstrip lines, coplanar waveguide, slotted waveguide, and dielectric image line. Among these excitation schemes, aperture couple from a microstrip feed line is the most frequently used. Feeding mechanisms are generally used to excite the DRA with a microstrip line coupled to a narrow slot, or a narrow slot excited by a coplanar waveguide. These feeding mechanisms are fabricated on one side of the ground plane and the radiating element (DRA) is on the other side, which results in the radiation being essentially from the DRA only, with little disturbance from the feeding structure. However, circular polarized (CP) antennas are more preferable than linear polarized (LP) in some applications, such as in radar systems and satellite communications. The CP array DRA can be constructed using LP or CP DRA elements [3, 4]. The CP arrays that are formed from CP DRA elements can give better performance in terms of 3-dB bandwidth axial ratio and gain.

Varying the ratio of the length and width, two degenerate modes with 90° phase difference can be excited in the DRA and will produce a circular polarization [5]. If a rectangular DRA is excited by a narrow rectangular slot of 45°, it produces the circular polarization too. Some other circular polarization DRAs techniques have also been reported including ones which use quadrature feed, single feed, tailor-made DRA, parasitic patch placed on top of a rectangular DRA, or a crossed-shape DRA. Recently, the elliptical CP DRAs were introduced. Other techniques use a geometrically modified rectangular DRA. A sequential rotation subarray of circularly polarized or linearly polarized antenna elements is able to enhance the CP AR bandwidth.

A lot of researchers have focused on the wideband and some techniques have been proposed to enhance the DRA's bandwidth. For example, Kishk et al.[6] were the first researchers to propose stacked DRAs with different materials to obtain dual-resonance operation. From the technique, an enhancement bandwidth of up to 25% has been achieved. Other wideband DRAs have also used the stacking method. The embedded DRAs, structure can be achieved by producing T-shaped and L-shaped structures, introducing an air gap between the DRA and ground plane, carving a notch in the DRA, and merging two or more DRA modes. By adopting these methods, an impedance of 30–65% can be achieved.

The purpose of this article is three folds. The first is to acquire wideband impedance, the second is to enhance the gain, and the third is to achieve a circular polarization. The gain can be effectively improved through the use of the standing wave ratio over the microstrip short ended characteristic. The high bandwidth can be achieved from the use of notched dielectric elements due to the low Q value of mixing the dielectric resonator (DR) and air. The circular polarization is obtained from the rotation of the DRA elements to make a perfect 45° with respect to the slot sides. A slot couple feeding technique was chosen since a ground plane isolates the feeding structure from the radiator, the radiation characteristics are mainly those of the DR general method.

2. ANTENNA GEOMETRY

The DRA was excited by a 50-Ω microstrip feeder with a width of 1.4 mm on RO4003C substrate with ε_s of 4.6 and thickness of 0.75 mm. The ZrSnTiSiO material with a dielectric constant ε_r = 10 was used as a resonator. Microstrip fed aperture coupled patch

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BORANG FRGS - P1(R)

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Laporan Prestasi Skim Geran Penyelidikan Asas (FRGS) IPT
Pindaan 1/2011

A

RESEARCH TITLE : Investigation On The Coupling Effect Of The Dielectric Resonator Antenna Array.
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Ketua Projek

PROJECT MEMBERS : 1. **Prof madya sabar derita hutagalung**
(including GRA) 2. **Prof madya srimala a/p sreekantan**
3. **Profesor zainal arifin bin ahmad**
Ahli Projek

PROJECT ACHIEVEMENT *(Prestasi Projek)*

B

ACHIEVEMENT PERCENTAGE

Project progress according to milestones achieved up to this period	0 - 25%	26 - 50%	51 - 75%	76 - 100%
Percentage			75%	

RESEARCH OUTPUT

	Indexed Journal	Non-Indexed Journal
Number of articles/ manuscripts/ books *(Please attach the First Page of Publication)*	Design and Modeling of a High Gain Wideband Circular Polarized Dielectric Resonator Antenna Array	

	International	National
Conference Proceeding *(Please attach the First Page of Publication)*	An Equivalent Circuit of Microstrip Slot Coupled Rectangular Dielectric Resonator Antenna	
Intellectual Property *(Please specify)*		

HUMAN CAPITAL DEVELOPMENT

Human Capital	Number				Others (please specify)
	On-going		Graduated		
Citizen	Malaysian	Non Malaysian	Malaysian	Non Malaysian	
PhD Student	/	/			

	Master Student					
	Undergraduate Student					
	Total					

EXPENDITURE *(Perbelanjaan)*

C

Budget Approved *(Peruntukan diluluskan)* : **RM 40,000**
Amount Spent *(Jumlah Perbelanjaan)* : **RM 40,670.41**

Balance *(Baki)* : **RM -670.41**
Percentage of Amount Spent *(Peratusan Belanja)* : % 101.67

SUMMARY OF RESEARCH FINDINGS *(Ringkasan Penemuan Projek Penyelidikan)*

D

The same feeding mechanisim was used to achive other objectives covred by DRA array as circular polarization as in paper accepted by **Progess in electromagnetic research C,** which entitled "Novel Modeling and Design of Circularly Polarized Dielectric Resonator Antenna Array"

One of the major objectives studied by DRA arrays is circular polarization (CP). Besides the gain enhancement using the same feeding method, another goal was achieved, which is CP. A simple technique from the literature was used to acquire the CP by rotating the DR 45 with respect to the slot sides as shown in figure1.

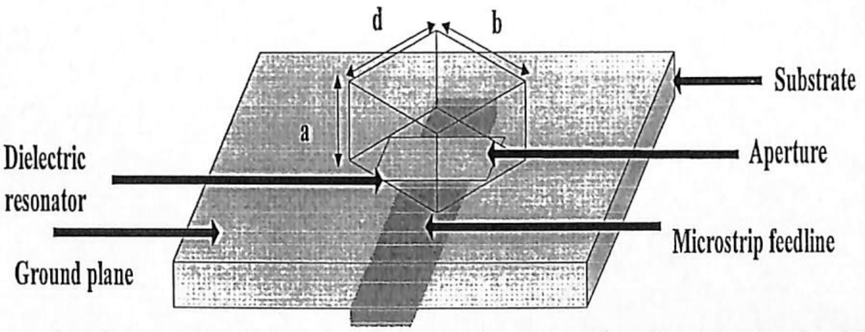

Fig. 1. Rectangular slot coupled with dielectric element making 45° with slot sides for CP radiation

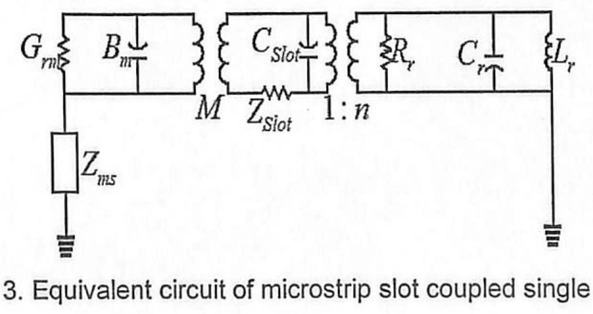

Fig. 3. Equivalent circuit of microstrip slot coupled single DR.

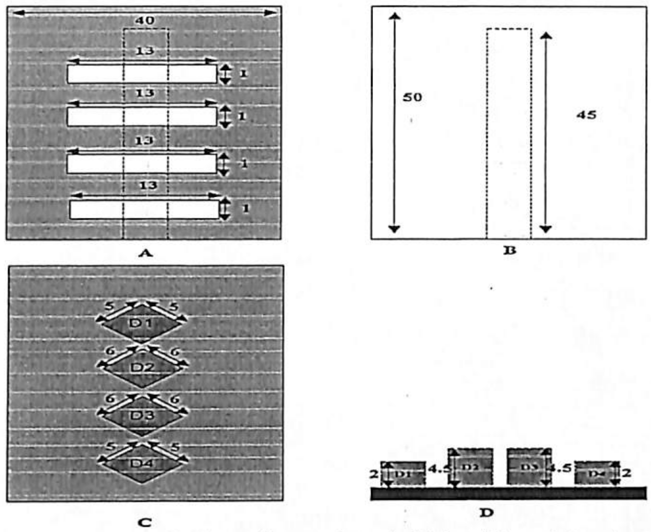

Fig4. The designed structure in CST A) Slots dimensions (width of the slots=1mm)(dielectric omitted. B) Microstrip dimensions (width=1.7mm), C) dielectrics lengths and widths (slots omitted) and D) Dielectric elements heights.

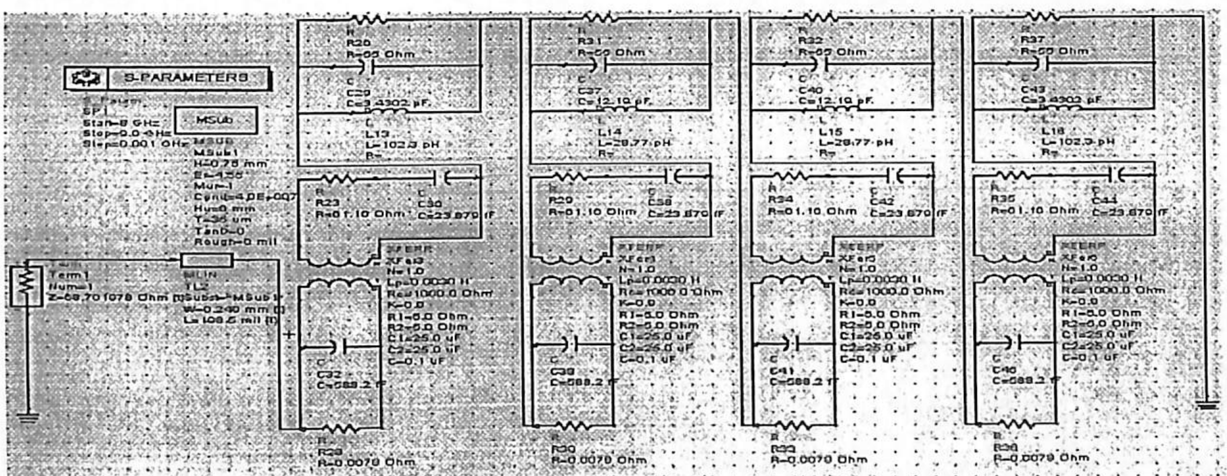

Fig5. The dielectric resonator antenna array model in ADS

Figure 6 shows the simulated and measured co-polarization and cross-polarization patterns in the *xz* -plane at 8.45 GHz. The cross-polarization is lower than co-polarization by 20 dB in the broadside direction in measurement, which is the characteristic of right hand circular polarization (RHCP) radiation. Simulation results also show good agreement with those measured radiation patterns values achieved.

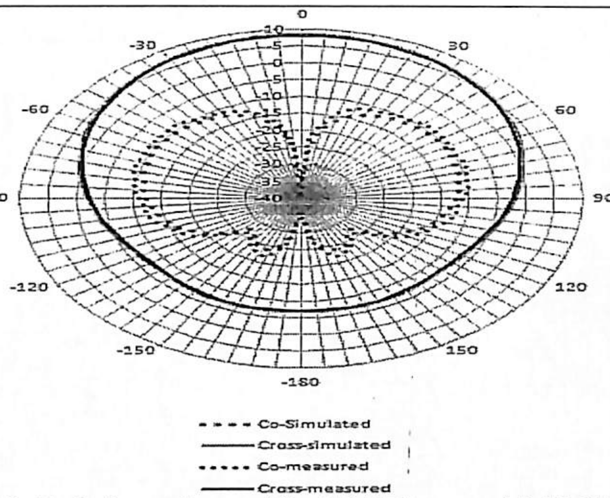

Fig.6. Radiation patterns of the CP DRA array at 8.45 GHz.

Figure 8 shows the simulated and measured gain of the antenna at a frequency range of 8.43 GHz to 8.45 GHz. The maximum simulated gain obtained from CST was 8.63 dBi at 8.45 GHz. The maximum measured gain was 8.51 dBi at 8.45 GHz, compared to the standard helix antennas using gain absolute methods by using the network analyzer to measure the S_{21} of the designed DRA array and compare it to the S_{21} measured for the standard known gain antenna. The array shows a gain improvement since the antenna gain of a single DRA is limited to about5 dBi. It indicates that this antenna has high efficiency with minimum loss. This is because there is no conductor loss in the DR., However, conductor loss exists in the microstrip line but is very small.

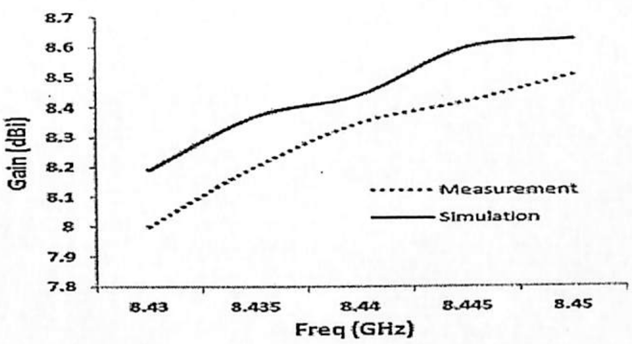

Fig7. The measured and simulated gain

PROBLEMS / CONSTRAINTS IF ANY *(Masalah/ Kekangan sekiranya ada)*

E	

Date / *Tarikh* : 16/4/12

Project Leader's Signature: / *Tandatangan Ketua Projek*

COMMENTS, IF ANY/ ENDORSEMENT BY RESEARCH MANAGEMENT CENTER (RMC) *(Komen, sekiranya ada/ Pengesahan oleh Pusat Pengurusan Penyelidikan)*	
F	.... **Name:** *Nama:* **Signature:** *Tandatangan:* **Date:** *Tarikh:*

Progress In Electromagnetics Research C, Vol. 28, 165–179, 2012

NOVEL MODELING AND DESIGN OF CIRCULARLY POLARIZED DIELECTRIC RESONATOR ANTENNA ARRAY

M. F. Ain[1, *], Y. M. Qasaymeh[1], Z. A. Ahmad[2], M. A. Zakariya[1], M. A. Othman[1], S. S. Olokede[1], and M. Z. Abdullah[1]

[1]School of Electrical and Electronic Engineering, Universiti Sains Malaysia, Malaysia

[2]School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia, Malaysia

Abstract—This paper presents a design of circularly polarized dielectric resonator antenna (DRA) array. The dielectric resonators (DRs) were excited by rectangular aperture coupling slots feed with a linear microstrip. The slot positions were determined based on the characteristic of standing wave ratio over a short ended microstrip to deliver the maximum amount of coupling power to the DRs, in order to improve the array gain Each DR element was rotated 45° with respect to the sides of the exciting slot to generate circular polarization pattern. The DRA array was modeled and simulated as a parallel RLC input impedance component using Agilent (ADS) software, since that will ensure the resonant frequency of the antenna as primary design step before simulating in (CST) software and doing the measurements. The results of the return loss, gain radiation and pattern axial ratio are shown. The gain of the proposed array in X band was about 8.5 dBi, while the 3 dB axial ratio bandwidth started from 8.14 to 8.24 GHz. The impedance bandwidths started from 8.14 GHz to 8.26 GHz. The proposed DRA exhibited an enhancement of the gain in comparison to a single pellet DRA. The size of the whole antenna structure is about 40 mm × 50 mm and can potentially be used in wireless systems.

1. INTRODUCTION

Since first introduced by Long et al. [1] in 1983, the dielectric resonator antenna (DRA) has received increasing attention in the last two

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* Corresponding author: Mohd Fadzil Ain (mfadzil@eng.usm.my).

An Equivalent Circuit of Microstrip Slot Coupled Rectangular Dielectric Resonator Antenna

M. F. Ain[1], Y. M. Qasaymeh[1], Z. A. Ahmad[2], M. A. Zakariya[1], and Ubaid Ullah[1]

[1]School of Electrical and Electronic Engineering
University Sains Malaysia, Pulau Pinang, Malaysia
[2]School of Materials and Mineral Resources Engineering
University Sains Malaysia, Pulau Pinang, Malaysia

Abstract— In this paper, an approximate model of the rectangular dielectric resonator antenna fed by microstrip slot coupled is presented. The equivalent model will be based on the input impedance of the antenna sub-elements. Since the antenna sub-elements impedances are functions of relative dimensions, the resonant frequency can be predicted using this model. The validity of the modeling is supported by comparing the values of the return losses measured of antenna geometry using computer simulation technology (CST) against those obtained by proposed model using Agilent advanced design system (ADS).

1. INTRODUCTION

Since the dielectric resonator antenna (DRA) was introduced by Long et al. in 1983 [1], over the past few years, considerable attention has been directed towards the development of analysis techniques capable of dealing with these antennas. These antennas show the benefits of light weight, small size, low cost, ease of excitation and the deficiency of conduction losses in the resonator [2]. Moreover, various antenna features such as input impedance, bandwidth, and radiation patterns can be easily regulated by varying the antenna specifications and feed mechanism.

Normally, the dimensions of the individual DRs are determined using the equations in [3, 4]. In this paper, a simple approximate model based on the input impedance of the antenna is presented. The equivalent circuit of the structure is given and calculations for the determining its elements impedance are outlined. The approach is particularly useful for fast evaluation of the rectangular DRA fed by microstrip slot coupled resonant frequency.

2. MODELING

In most designs, the dimensions of the rectangular DRA determined by using the Equation (1) stated in [4] by an iterative manner:

$$\varepsilon_r k_o^2 = k_x^2 + k_y^2 + k_z^2 \tag{1}$$

where: $k_o = \frac{2\pi}{\lambda_o} = \frac{2\pi f_o}{c}$, is the free-space wave number, $k_x = \frac{m\pi}{a}$, propagation number in X direction, $k_y = \frac{n\pi}{b}$, propagation number in Y direction.

The aim of analyzing the input impedance of the proposed antenna is to ensure the dimensions of the DR at a certain frequency. The first step used in the experiment was to model the DR with a RLC network. The formulas used to represent a resonator as parallel resonant circuit can be found in [5], when the resonator is coupled to the excitation source.

$$R_r = \frac{2n^2 z_0 s_{11}}{1 - s_{11}}, \tag{2a}$$

$$C_r = \frac{Q_0}{\omega_0 R_r}, \tag{2b}$$

$$L_r = \frac{1}{C_r \omega_0}. \tag{2c}$$

It was mentioned in [5] that the value of R_r can be chosen since the value of R_r plays an important role in determining the values of C_r and L_r. Thus, finding a suitable value of R_r in order to obtain reasonable C_r and L_r values is a complicated process. Agilent advanced design system (ADS) program was used to build the model and extract the optimum values of RLC at a specific resonant

F0476

BORANG FRGS - P2(R)

Kod Projek :	FRGS/FASA1-2006/(BIDANG)/(NAMA IPTA)/(NO.RUJ. KPT)

PROGRESS REPORT
FUNDAMENTAL RESEARCH GRANT SCHEME (FRGS)
Laporan Prestasi Geran Penyelidikan Fundamental IPTA (FRGS)
Pindaan 1/2010

A

RESEARCH TITLE : Investigation On The Coupling Effect Of The Dielectric Resonator Antenna Array.
Tajuk Penyelidikan

PROJECT LEADER : **Asso.Prof.Dr mohd fadzil bin Ain**
Ketua Projek

PROJECT MEMBERS (including GRA) :
1. **Prof madya sabar derita hutagalung**
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3. **Profesor zainal arifin bin ahmad**

Ahli Projek

PROJECT ACHIEVEMENT *(Prestasi Projek)*

B

ACHIEVEMENT PERCENTAGE

Project progress according to milestones achieved up to this period	***0 - 25%***	***26 - 50%***	***51 - 75%***	***76 - 100%***
Percentage		60%		

RESEARCH OUTPUT

Number of articles/ manuscripts/ books *(Please attach the First Page of Publication)*	***Indexed Journal***	***Non-Indexed Journal***
	A NOVEL 5.8 GHz HIGH GAIN ARRAY DIELECTRIC RESONATOR ANTENNA	
Conference Proceeding *(Please attach the First Page of Publication)*	***International***	***National***
Intellectual Property *(Please specify)*	High gain dielectric resonator antenna for 5.8Ghz wireless applications	

HUMAN CAPITAL DEVELOPMENT

Human Capital	***Number***				***Others*** *(Please specify):*
	On-going		***Graduated***		
Citizen	Malaysian	Non Malaysian	Malaysian	Non Malaysian	
PhD Student	/	/			
MSc Student					
Undergraduate Student					
Total					

EXPENDITURE *(Perbelanjaan)*

C

Budget Approved *(Peruntukan diluluskan)* : RM 40,000
Amount Spent *(Jumlah Perbelanjaan)* : RM 34,327

Balance *(Baki)* : RM 5,672
Percentage of Amount Spent *(Peratusan Belanja)* : % 85.82

SUMMARY OF RESEARCH FINDINGS *(Ringkasan Penemuan Projek Penyelidikan)*

D

A new feeding method of DRA array was achieved to improve DRA gain and reduce the size of the array compared with those reported in literature . According to this new feeding method, the paper entitled A NOVEL 5.8 GHz HIGH GAIN ARRAY DIELECTRIC RESONATOR ANTENNA " has been published a silver medal won in ITEX 2010, and a patent was also been accepted.

This new feeding mechanism can be seen in figure 1. When the microstrip is short ended the voltage antinodes is going to repeat itself every half wave length, the dielectric resonators (DRs) will be placed over the antinodes in order to get the maximum power coupling to the DRs in the hope that the array gain will be increased.

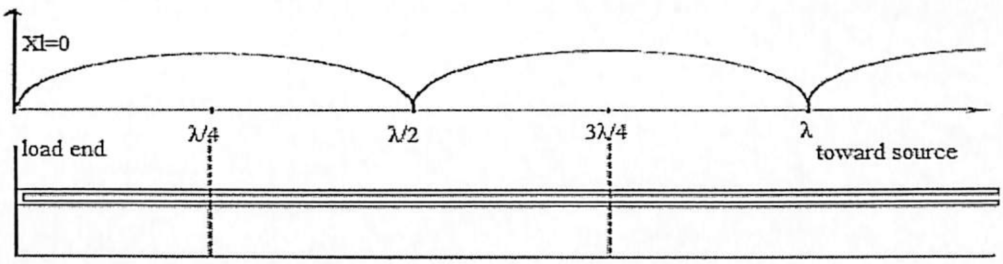


Fig1. The Standing wave ratio on a microstrip feeder.

Since the antinodes is going to repeat itself every half wave length along the transmission line, the array elements will be positioned every half wave length in order to get the maximum power radiation of the antenna array. Figure 2 shows the spacing between the array elements depending on the calculation of the wave length. S1 is the distance to separate the elements which are equaled to half wave length, while S2 equals to quarter wave length, which represents the last element of the array. X was the distance from the source to the first element was less than the half wave length.

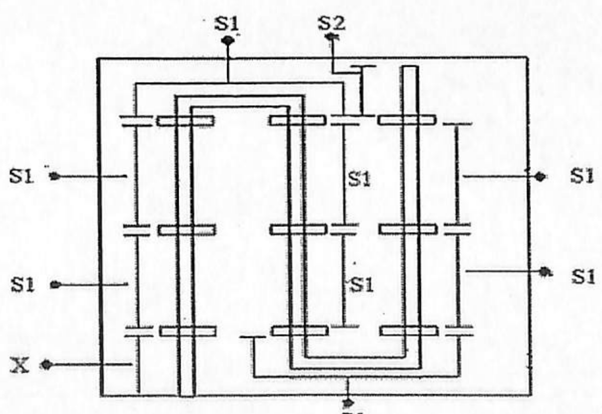
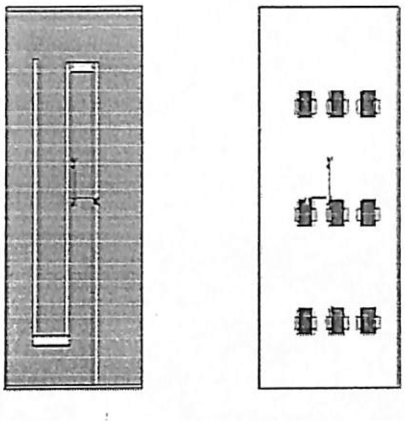


Fig2. The proposed DRA array.

This design was aiming for 5.8 GHz, so all the calculation will be based on this frequency. In figure 3 shows the proposed DRA array modeled in CST software.



A B

Fig3. The designed structure in CST A) font view and B) back view

The simulation and measurement results for the input return loss are given in Figure5. The minimum simulated input return loss frequency could be fine-tuned to 5.79 GHz equals to -21.4 dB with a bandwidth of 80 MHz and impedance of 52.23-j4.55 Ω. The minimum measured input return loss is 5.85 GHz of -19.8 dB and a bandwidth of 60 MHz and impedance of 51.23+ j 3 Ω.

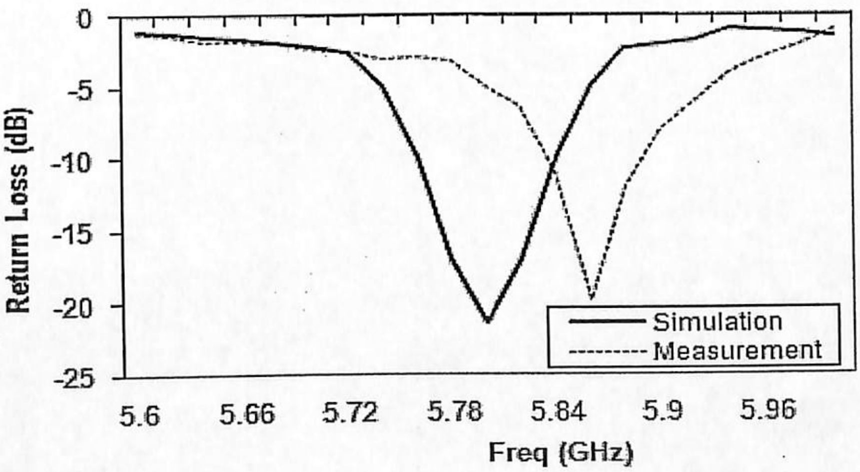


Fig5. measured and simulated return loss.

Figure 6 shows the simulated and measured gain of the antenna at frequency range of 5.4 GHz to 6 GHz. The simulated gain obtained from CST was 11.4 dBi. The measured gain was 10.7 dBi compared to a standard monopole antenna. It indicates that this antenna has high efficiency with minimum loss. This is because there is no conductor loss in the dielectric resonator. However, conductor loss exists in the microstrip line, but it is very small.

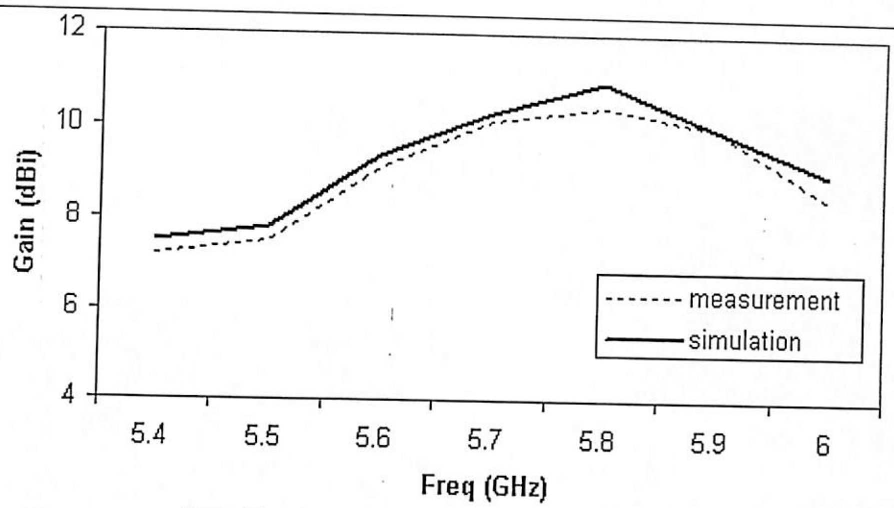


Fig6. The measured and simulated gain in dBi.

PROBLEMS / CONSTRAINTS IF ANY *(Masalah/ Kekangan sekiranya ada)*

E	None

Date : 16/4/12
Tarikh

Project Leader's Signature:
Tandatangan Ketua Projek

COMMENTS, IF ANY/ ENDORSEMENT BY RESEARCH MANAGEMENT CENTER (RMC)
(Komen, sekiranya ada/ Pengesahan oleh Pusat Pengurusan Penyelidikan)

F

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Name:
Nama:

Signature:
Tandatangan:

Date:
Tarikh:

Progress In Electromagnetics Research C, Vol. 15, 201–210, 2010

A NOVEL 5.8 GHz ARRAY DIELECTRIC RESONATOR ANTENNA

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Abstract—In this paper, a novel nine elements array dielectric resonator antenna (DRA) is presented. The DRA was excited by a microstrip feeder with a rectangular aperture coupled slots. The slot positions were determined based on the characteristic of standing wave ratio over a short ended microstrip. The measured gain of the array DRA operating at 5.84 GHz was about 10 dBi having impedance bandwidth of 60 MHz. The proposed DRA exhibits an enhancement of the gain in comparison with a single pellet DRA. The size of the whole antenna structure is about 60 mm × 40 mm and potentially can be used in wireless systems.

1. INTRODUCTION

Since the dielectric resonator antenna (DRA) was introduced by Long et al. in 1983 [1], DRAs have been extensively studied. These antennas overture the benefits of light weight, small size, low cost, ease of excitation and deficiency of conduction losses in the resonator [2]. Moreover, various antenna features such as input impedance, bandwidth, and radiation patterns can be easily regulated by varying the antenna specifications and feed mechanisms. Recently, extensive research has been done to achieve wide DRA bandwidth using embedded DRAs, stacked DRAs, or other specific formations of the DRAs [3]. All these aspects make wideband DRAs favorable as antenna elements for array implementations.

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A NOVEL HIGH GAIN DIELECTRIC RESONATOR ANTENNA FOR 5.8 GHZ APPLICATIONS

at the

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THE APPLICANT(S) REQUEST(S) THE GRANT OF A PATENT IN RESPECT OF THE FOLLOWING PARTICULARS:

I. Title of invention:

High Gain Dielectric Resonator Antenna Array For 5.8 Ghz Applications

II. APPLICANT(S): [the data concerning each applicant must appear in this box or, if the space is insufficient, in the space below]

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