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# The Performance Enhancement Of Low Permittivity Microstrip Patch Antenna For Microwave Application

Vasant Naidu, R.Priyadharshini, K.Muthu Lakshmi, A.Senthil Kumar
*Department of Electronics and Communication Engineering Sethu Institute of technology Pulloor, Kariyapatti-626116 Tamil Nadu -India*

***Abstract:*** *This paper presents the design of Microstrip rectangular patch antenna with operating frequency at 3 GHz for Microwave application. Antenna arrays are used to achieve higher gain. Larger the number of antenna elements, better the gain of antenna array would be achieved. The array of patch array with Microstrip line feeding technique was designed. The antenna array designed on RT-Duroid substrate with dielectric substrate* $\varepsilon r$ *= 2.5. Initially we set our antenna as a single patch and after evaluating the outcomes of antenna features like radiation patterns, reflected loss, efficiency, directivity and antenna gain, we transformed in to a 4x1(Series) linear array and 2x2 (corporate feed) array has been designed and analyzed. Antenna arrays are used to enhance the directivity, gain, and efficiency and have better radiation patterns. The model of micro strip single and antenna array are designed and analyzed using the ADS 2009 Software. The good frequency increment has been increased the output radiated power with low return loss. The power and temperature both are directly proposal. Hence the higher heat energy will be used for microwave oven with higher directivity.*
***Keywords:*** *ADS, Rectangular Microstrip patch, Gain, Directivity, Microwave application.*

## I. Introduction

In recent years, there has been growing interest in the study of Nano Meta materials both theoretically and experimentally. The Meta materials have negative permittivity. These material's, high-impedance ground planes can improve the radiation efficiency. Electrically small antennas, high directivity and tunable operational frequency are produced with negative magnetic permeability. These materials permit smaller antenna elements that cover a wider frequency range. The rare-earth lanthanides are good electrical insulators with a high resistivity. The electromagnetic possible transition in Lanthanide doped Ferrite molecule from quantum state to another state, occurs in the parity state .Hence the Laporte rule is applicable for electric dipole transition in lanthanides doped ferrites. Since the wave function of a single electron of lanthanide is the product of space demand wave function and spin wave function. Therefore the activity occurs. Since the probability of transition from one state to another in a single step .Here, the Markov Chain said to be time Homogeneous. If the transition probability from one state to another are independent of time index n. The substrate material has been prepared by sol-gel route method. The advantage of this method as follows more quantity with cost effective. In this method, during the sintering process makes the material very hard at low temperature.

The Wireless Communication technology requires low profile and broadband antennas. To meet the expectation, the Microstrip patch antenna has been proposed. Microstrip patch antenna has more advantages such as low profile, lightweight, low cost and compatibility. At the same time it has some disadvantages. The narrow bandwidth and low gain are major drawbacks. Array concept is only main remedy for these drawbacks. These are series array and corporate array design. Array elements are connected in linear as called series array. Parallel design is called as corporate array design. RT Duroid is Glass Microfiber Reinforced PTFE composite. RT Duroid substrate has low loss tangent. They exhibit excellent chemical resistance, including solvent and reagents used in printing and plating, ease of fabrication – cutting, shearing, machining, environment friendly. The lanthanides are used as the substrate material for antenna design. Because of that have same direction of spinning rotation. That group only has special property compared than others.

The dielectric constant has more important part in antenna design. The maximum range of dielectric constant from 2.2 to 12. The lower constant increases the antenna dimensions. That increases the antenna performance as very well. The negative capacitance value makes the negative effective dielectric constant. Hence its property proves the substrate material is a Meta material. The lower tangent loss act as important parameter in performance enrichments. If the substrate height is less than 1 mm, that will produce the higher surface wave loss. The Return loss is decided by impedance matching. The matching is must as 50ohm. The losses are reduced to desired level. Since the gain and directivity has been improved. Hence total bandwidth percentage gets increased as unexpected level. In microwave technology, high directivity antennas are very big expectation. The higher directivity has been achieved from array concept.

## II. Electrical Property Studies

**Electrical property:**
**Capacitance:**

In the proposed antenna has been designed by using Nano Meta material. The capacitance and permittivity both are directly proposal. Capacitance value is measured by using N4L meter.

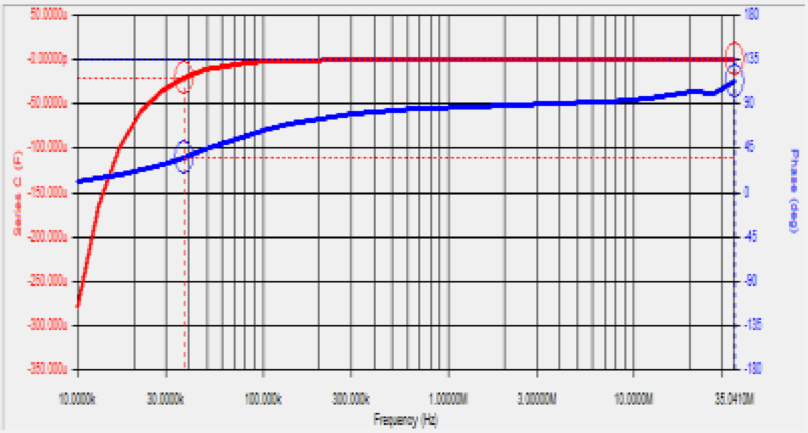


**Figure 1:** Capacitance output (N4L)

From this figure 2, the negative capacitance proves the substrate material is a meta material.
**Tangent loss:**

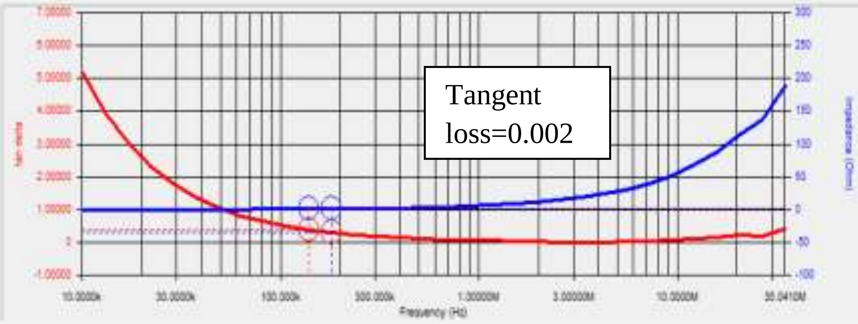



**Figure 2:** Tangent Loss (N4L)

From this figure 3, the tangent loss is 0.002. Hence, the tangent loss is very small.

## III. Antenna Design:

A very important concept of the relative dielectric constant in antenna design, how it affects the antenna performance. The dielectric constants which are decide the speed of radiation inside the material. If permittivity is lower, the antenna efficiency will be higher, because the dielectric constant decides the dimension of antenna as length and width.

In this proposed work has been done by Meta material on RT-Duroid Substrate. These plates have the dielectric constant as 2.5.

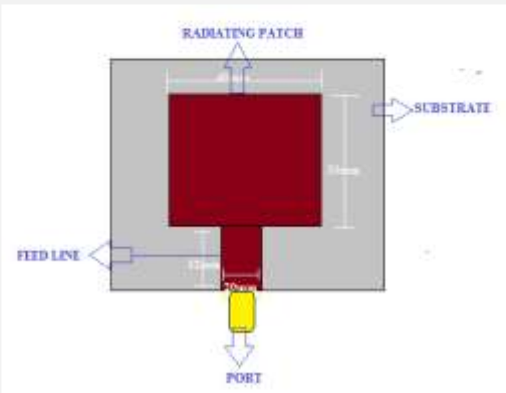



**Figure 3:** Microstrip Patch Antenna

**Table 1.1** Specifications of the proposed Microstrip patch antenna

| | |
|---|---|
| Operating Frequency | 3 GHZ |
| Substrate | RT-DUROID |
| Dielectric constant of substrate | 2.5 |
| Height of Substrate | 1.5mm |

**Simulation Output For Single Antenna**
The rectangular Microstrip patch antenna has been designed by ADS 2009 Software.

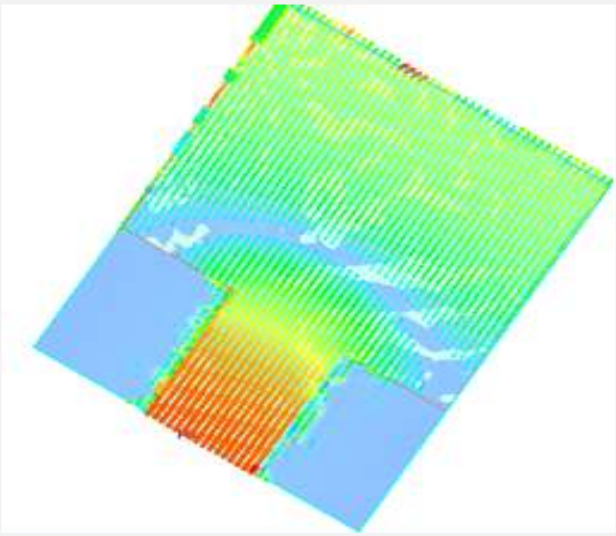
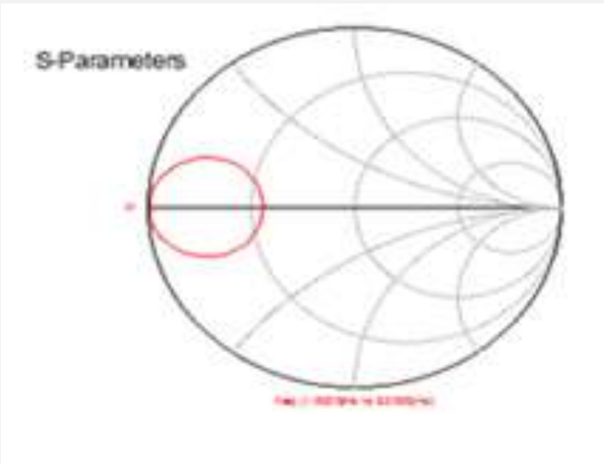


**Figure 4:** Animated Output



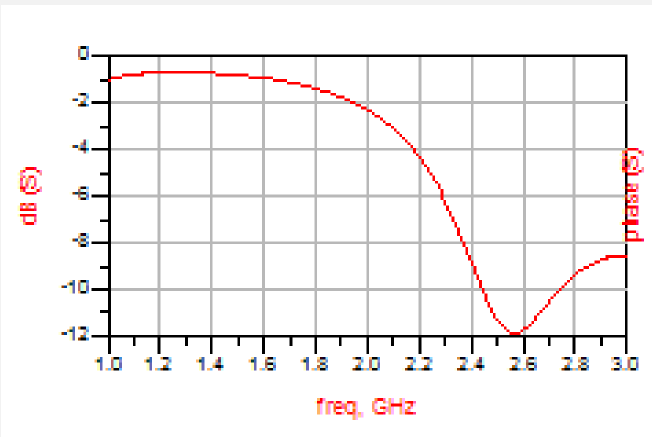




**Figure 5:** Return Loss

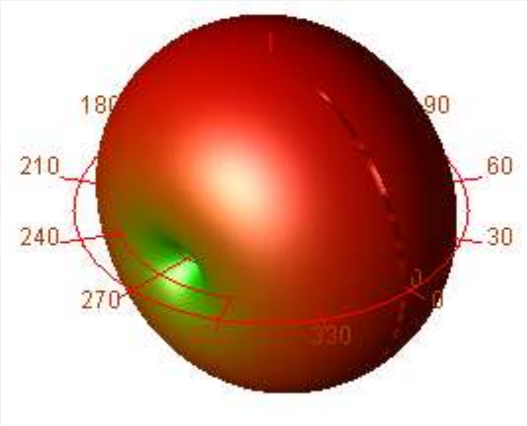



**Figure 6:** For Field Pattern

| | | |
|---|---|---|
| Power radiated (Watts) | | 0.00805866 |
| Effective angle (Steradians) | | 8.24018 |
| Directivity(dB) | | 1.83273 |
| Gain (dB) | | -19.1046 |
| Maximim intensity (Watts/Steradian) | | 0.000977971 |
| Angle of U Max (theta, phi) | 174 | 351 |
| E(theta) max (mag,phase) | 0.135631 | -19.2119 |
| E(phi) max (mag,phase) | 0.847624 | -18.5393 |
| E(x) max (mag,phase) | 0.00168259 | 93.1128 |
| E(y) max (mag,phase) | 0.858288 | -18.5558 |
| E(z) max (mag,phase) | 0.0141773 | 160.788 |

**Figure 7:** Antenna Parameter

## IV. Antenna Array

Micro strip antenna consists of very small conducting patch which can take any possible shape like square, triangular, circular, and rectangular. In this paper Rectangular Micro strip Patch antenna is used because rectangular patch antenna have few benefits, including the flexibility, and ease of manufacture. To achieve high directivity, low profile nature is obvious as well as small size of antenna is required. Radiating patch placed on a ground plane. Dielectric substrate material separates the two, the patch element and the ground plane. The radiating patch and the feed lines are designed on the substrate material using etching technique. Micro strip antennas have limitations of low bandwidth and low gain. These drawbacks are overcome by Array concept.

**Series Array:**

- Antenna elements are arranged in series manner
- In the proposed design, 4×1 linear array has been designed using ADS Software.

**Smulation output for series array antenna:**

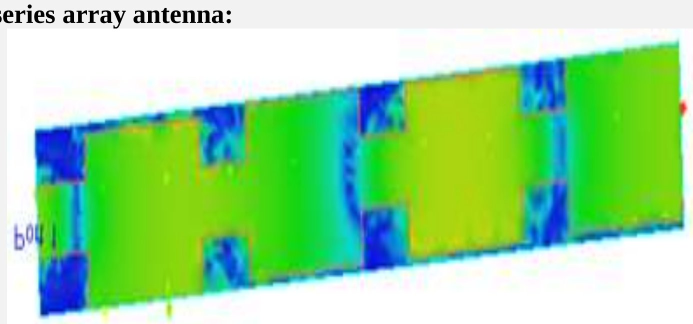


**Figure 8:** Animated Output

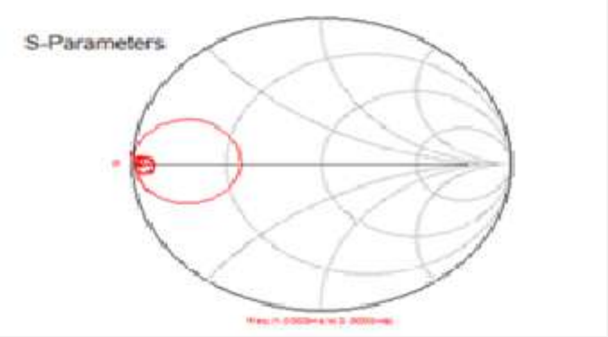
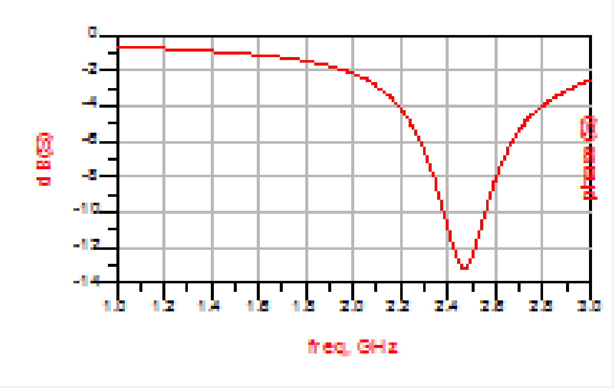



**Figure 9:** Return Loss



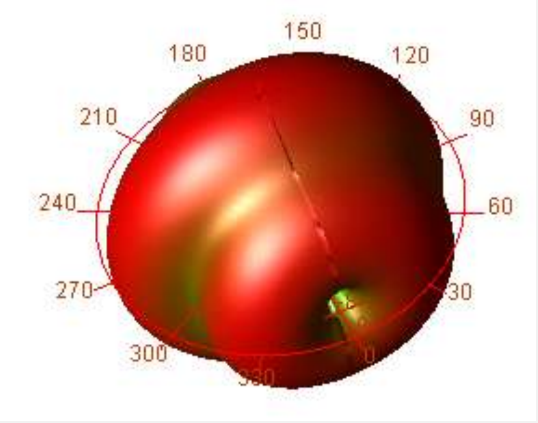




**Figure 10:** For Field Pattern

| | | |
|---|---|---|
| Power radiated (Watts) | | 0.733023 |
| Effective angle (Steradians) | | 3.49427 |
| Directivity(dB) | | 5.55854 |
| Gain (dB) | | 4.20971 |
| Maximim intensity (Watts/Steradian) | | 0.209779 |
| Angle of U Max (theta, phi) | 6 | 135 |
| E(theta) max (mag,phase) | 8.27452 | 153.229 |
| E(phi) max (mag,phase) | 9.46532 | -34.0774 |
| E(x) max (mag,phase) | 1.1817 | 107.152 |
| E(y) max (mag,phase) | 12.4866 | 149.32 |
| E(z) max (mag,phase) | 0.864923 | -26.7714 |

OK

**Figure 11:** Antenna Parameter

**Corporate Array:**

- Antenna elements are arranged in parallel manner.
- In the proposed design, 2×2 linear array has been designed using ADS Software.

**Smulation output for corporate array antenna:**

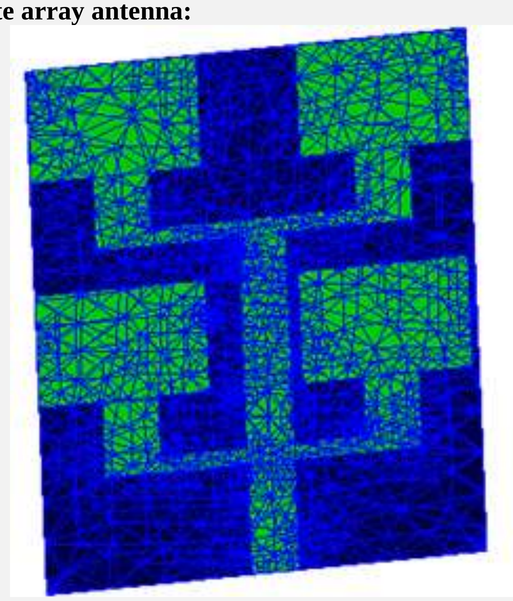
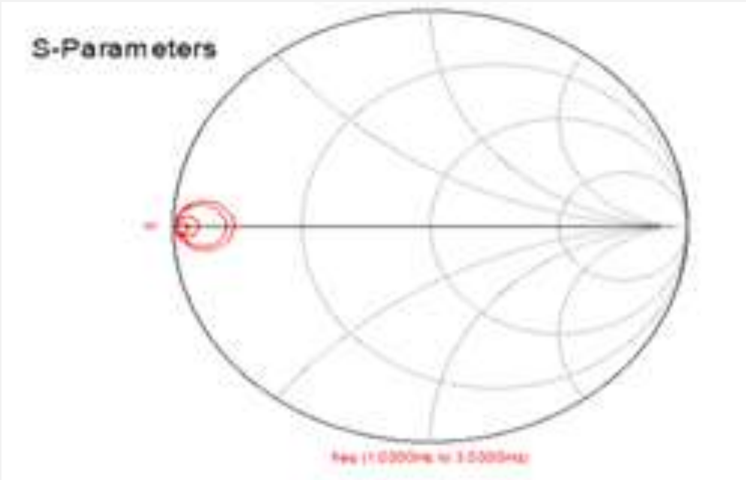


**Figure 12:** Animated Output



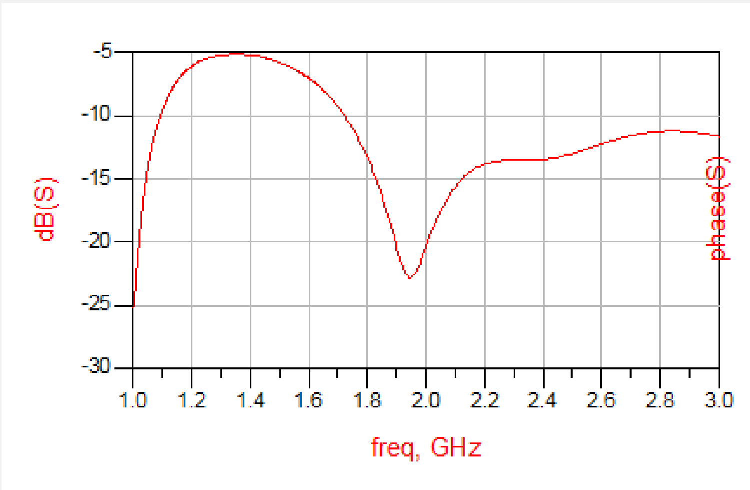




**Figure 13:** Return Loss

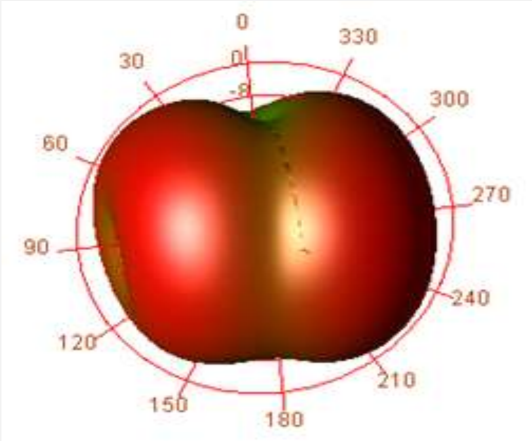
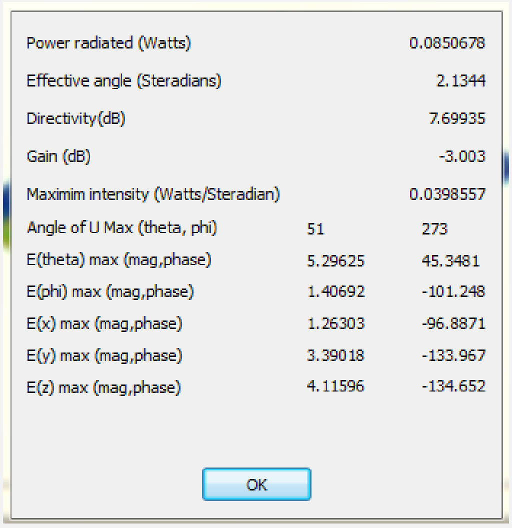



**Figure 14:** For Field Pattern



| | | |
|---|---|---|
| Power radiated (Watts) | | 0.0850678 |
| Effective angle (Steradians) | | 2.1344 |
| Directivity(dB) | | 7.69935 |
| Gain (dB) | | -3.003 |
| Maximim intensity (Watts/Steradian) | | 0.0398557 |
| Angle of U Max (theta, phi) | 51 | 273 |
| E(theta) max (mag,phase) | 5.29625 | 45.3481 |
| E(phi) max (mag,phase) | 1.40692 | -101.248 |
| E(x) max (mag,phase) | 1.26303 | -96.8871 |
| E(y) max (mag,phase) | 3.39018 | -133.967 |
| E(z) max (mag,phase) | 4.11596 | -134.652 |

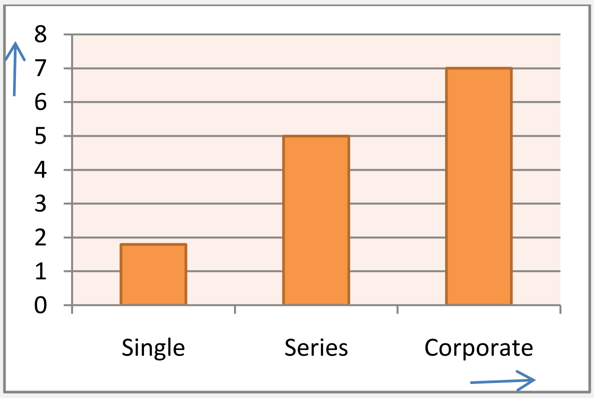
OK

**Figure 15:** Antenna Parameter

**Output Comparison**

| | | |
|---|---|---|
| 1 | Single Antenna | **RL= -12db**<br>**Directivity=1.8db**<br>**Gain=-19db** |
| 2 | Series array | **RL=-13db**<br>**Directivity=5db**<br>**Gain=4db** |
| 3 | Corporate array | **RL=-22db**<br>**Directivity=7db**<br>**Gain=-3db** |

**Figure 16:** Antenna Parameter Comparison in tabular form



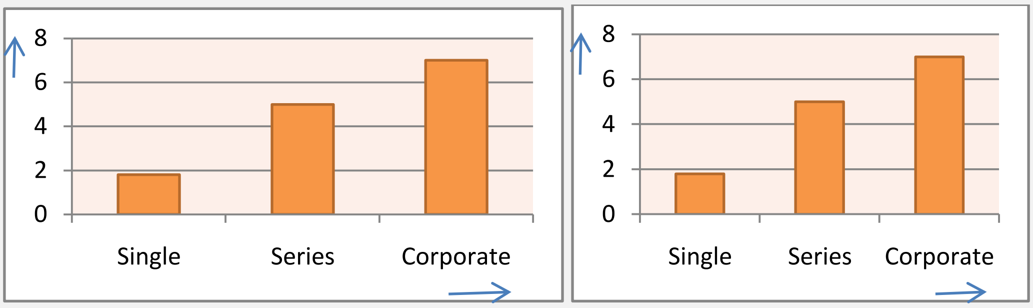
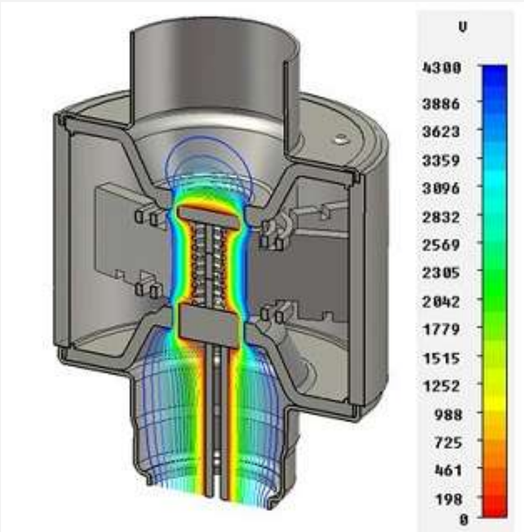



**Figure 17:** Antenna Parameter Comparison in graphical form (a. Resonance frequency b. Gain in GHz c. Directivity in GHz)

**Microwave Oven:**

The proposed antenna designs have the higher directivity. Hence the array antenna used to produce the high radiation, which will be used for higher heat transfer. The foods are cook very quickly with sort time period. The microwave oven works at 300MHz to 300GHz.




Microwave Oven- antenna Radiation

## V. Conclusion

In this paper, the design of Single antenna, series array and corporate array has been designed at 3 GHz. From these Output comparison array design has been provided the higher efficiency. Hence its proved through Nano meta material substrate. In microwave Oven works from 300MHz to 300GHz range. The proposed design of array antenna surely increases the overall performance at 2.4GHz range. At the same time the higher directivity and low return loss has been obtained in miniaturization of Microstrip patch antenna.

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