ISSN: 0975-766X
CODEN: IJPTFI
Available Online through ***Research Article***
www.ijptonline.com

EFFECT OF MICROSTRIPLINE FEED AND DRA HEIGHT ON RADIATION CHARACTERISTICS OF RECTANGULAR STUFF RESONATOR ANTENNA

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Received on: 15.10.2016 *Accepted on: 22.11.2016*

Abstract

This paper presents the impact of Microstripline Feed and DRA height on radiation characteristics of aperture-coupled rectangular material resonator antenna resounding at 18GHz. Analysis is formed from the simulated results and feed and DRA height square measure varied from the customary values.

Keywords: Rectangular DRA, Aperture coupling.

1. Introduction

For many years, the dielectric resonator (DR) has primarily been used in microwave circuits, such as oscillators and filters, where the DR is normally made of high-permittivity material, with dielectric constant $\varepsilon r > 20$. Because of these traditional applications, the DR was usually treated as an energy storage device rather than as a radiator. Although open DRs were found to radiate many years ago , the idea of using the DR as an antenna in cylindrical mode[1] was published in 1983. It was observed that the frequency range of interest for many systems had gradually progressed upward to the millimetre and near-millimetre range (100-300 GHz). At these frequencies, the conductor loss of metallic antennas becomes severe and the efficiency of the antennas is reduced significantly. Conversely, the only loss for a DRA is that due to the imperfect dielectric material, which can be very small in practice.

II. Rectangular Dielectric Resonator Antenna

As compared to the microstrip antenna, the DRA[2] has a much wider impedance bandwidth (~ 10 % for dielectric constant $\varepsilon r \sim 10$). This is because the Microstrip antenna radiates only through two narrow radiation slots, whereas the DRA radiates through the whole DRA surface except the grounded part.[3] Avoidance of surface waves is another attractive advantage of the DRA over the Microstrip antenna. Nevertheless, many characteristics of the DRA and microstrip antenna are common because both of them behave like resonant cavities. For example, since the dielectric wavelength is smaller than the free-space wavelength by a factor of $1/\varepsilon r$, both of them can be made smaller in size by increasing ε_r.

Moreover, virtually all excitation methods applicable to the microstrip antenna can be used for the DRA.

The dielectric resonator antenna (DRA) can easily be coupled by nearly all kinds of transmission lines[7]. In coaxial-probe feed, a hole is drilled inside the DRA to accommodate the probe penetration[8]. But drilling a hole in a super-hard DR is difficult and it is impractical to have a probe that perfectly fits the size of the hole, and usually an air gap exists between the probe and the hole, causing the measured results to deviate from the predicted value. In the direct microstripline [9] and co-planar waveguide feed methods [10], the DRA is on the same side as the feed network. This may produce unwanted spurious radiation and coupling. Another common method of exciting a DRA is through an aperture in the ground plane upon which the DRA is placed.

By keeping the slot dimensions electrically small, the amount of radiation spilling beneath the ground plane can be minimized. The aperture can itself be fed by a transmission line. Aperture coupling offers the advantage of having the feed network located below the ground plane, isolating the radiating aperture from any unwanted coupling or spurious radiation from the feed.

III. Antenna Configuration

1 shows the geometric configuration of a slot-coupled DRA fed by a microstrip line. FR4 substrate with thickness T = 1.6mm is used. The ground-plane with an etched slot is located on the top surface of the substrate, and a microstrip line with width Wm= 1.6mm is placed on its bottom plane. A length of microstrip line (Lm =2.5557mm) is added from the slot center to the end of microstrip line to serve as a matching circuit. The designed[3] DRA dimensions are Lr = 1.9622mm, Wr = 1.9612mm, and Tr = 1.4205mm, with dielectric constant 30. Meanwhile, the substrate length and width are L = 5.0344mm and W = 2.0184mm, respectively. Finally, the dimensions of the coupling slot are Ls = 1.9744mm, Ws = 0.7199mm, and the offset distance between the edge of the DRA and the center of the coupling slot is Od = 0.61495.

IV. Simulation Results

2 and 3 illustrate the E field and H field variations along x-z and y-z planes respectively. 4(a) illustrates the magnitude of the reflection coefficient of the offset slot coupled DRA. The simulated center frequency is 18.121GHz, and the corresponding reflection coefficient value (S11 in dB) is -35.996dB. Additionally, the simulated bandwidth for the reflection coefficient below -1OdB is 579MHz. 4(b) plots the measured S-parameter in smith chart for the

frequency range of 17 to 19 GHz. s 5 and 6 show the radiation directivity and gain patterns at 18.121GHz in the y-z plane and x-z plane respectively. In y-z plane the angular width obtained from the simulation is 112.7^0 , directivity and gain are 4.4dBi and 4.3dB respectively, with side lobe level below -6.3dB. In x-z plane the angular width obtained from the simulation is 138.9^0, directivity and gain are 4.5dBi and 4.5dB respectively, with side lobe level below -5.5dB.

V. Analysis Results

A. Variation in Feed width:

7 illustrate the simulated results of S11 variation for various feed-widths normalized to half of the guided wavelength; feed-width is varied from the customary value. Maximum matching is achieved when the feed widths are 0.15 and 0.173 times half of the guided wavelength. 8 describes the observed variation in resonant frequency for various feed-widths normalized to half of guided wavelength.

It is observed that the resonant frequency is getting reduced as the feed-width increases. 9 illustrates the variation in the percentage bandwidth for various feed widths normalized to half of guided wavelength. Bandwidth increases till the feed width is 0.148 times half of the guided wavelength measured from the slot's center and later the bandwidth remains almost constant. This shows the cancellation of reactance of the slot and the reactance of the feed after the above the value mentioned above.

B. Variation in Feed Length

The variation in S11 values for various feed-lengths normalized to half of the guided wavelength are illustrated in 10. By keeping the design value as reference, feed-length is varied on either ends. Minimum reflection coefficients are achieved when the feed length is 0.209 and 0.546 times half of the guided wavelength.describes the observed variation in resonant frequency for various feed-lengths normalized to half of guided wavelength. It is observed that the resonant frequency increases as the feed-length increases that occurs due to the change in reactance of feed which affects the reactance cancellation between the feed and the slot. the variation in the percentage bandwidth for various feed lengths normalized to half of guided wavelength. Bandwidth increases till the feed length reaches 0.284 times guided wavelength and later the bandwidth gets reduced on further increase in feed-length.

C. Variation in DRA Height

13 illustrates the simulated results of S11 variation for various DRA Heights normalized to half of the guided wavelength of dielectric constant 30; Maximum matching of below -20dB is achieved when the DRA height is

between 0.802 and 1.197 times half of the guided wavelength. 14 describes the observed variation in resonant frequency for various normalized DRA heights. It is observed that the resonant frequency gradually gets reduced as the DRA height is increased. 15 illustrates the variation in the percentage bandwidth for various DRA heights. Bandwidth increases till the height is reaches 1.065 times the guided wavelength, later the bandwidth remains constant on further increase in DRA height.

VI. Conclusion

The effects of feed-width, feed-length and DRA height on radiation characteristics of aperture-coupled rectangular dielectric resonator antenna resonating at 18GHz are presented in this paper. The dielectric resonator antenna is first designed for providing optimum radiation characteristics performance and then feed-length, feed-width and DRA height are varied. The analysis shows that the resonant frequency decreases as feed-width and the DRA-height are increased, and it increases with increase in feed-length. This is due to the variation in the reactance of the stub extension from the point below slotcenter, which introduces mismatch of impedance's reactive part between the slot and stub extension, resulting in the shift of resonant frequency. The bandwidth also increases as the feed-width and DRA-height are increased. But when the feed-length is increased, bandwidth reaches an optimum value and then decreases. The analysis also shows that proper impedance matching is attained when feed-widths are 0.148 and 0.173 times the guided wavelength. When feed-lengths are 0.209 and 0.546 time the guided wavelength, good matching is attained. On increasing DRA-height from 0.447 times half of its guided wavelength, impedance matching for center frequency increases and attains good value at 0.999 times half of its guided wavelength, after which the impedance mismatch increases.

References

1. S. A. Long , M. W. McAllister and L. C. Shen, "The resonant cylindrical dielectric cavity antenna", IEEE Trans. Antennas Propagat., vol. 31, pp. 406-412, May 1983.
2. Mongia, R.K., and A. Ittipiboon, "Theoretical and Experimental Investigations on Rectangular Dielectric Resonator Antennas," IEEE Transactions on Antennas & Propagation, Vol. 45, No. 9, pp. 1,348-1,356, Sept. 1997.
3. K. M. Luk and K. W. Leung, " Dielectric Resonator Antennas ", ISBN 0-86380-263-X, pp. 57-63, pp. 72-24, 2002.
4. Qinjiang Rao, Tayeb A. Denidni and Ronald H. Johnston, "Dielectric Reflector Backed Aperture-Coupled

Antennas for Reduced Radiation, *IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY*, VOL. 48, No. 2, pp. 287-291 , MAY 2006.

5. Ittipiboon, A., et al., "Aperture Fed Rectangular and Triangular Dielectric Resonators for Use as Magnetic Dipole Antennas," IEE Electronics Letters, Vol. 29, No. 23, pp. 2,001- 2,002, Nov. 1993.
6. Aldo Petosa, “Dielectric Resonator Antenna Handbook”, ISBN: 9781596939226, pp. 51-52, pp. 55-66, Feb 2007.
7. Simons, R.N., and R.Q. Lee, "Effect of Parasitic Dielectric Resonators on CPWAperture- Coupled Dielectric Resonator Antennas," *IEE Proceedings Part-H*, Vol. 140, pp. 336-338, Oct. 1993.
8. Long, S.A., M.W. McAllister, and L.C. Shen, "The Resonant Cylindrical Dielectric Cavity Antenna," *IEEE Transactions on Antennas & Propagation*, Vol. 31, No. 3, March 1983, pp. 406-412.
9. Luk, K.M., et al., "Technique for Improving Coupling Between Microstrip Line and Dielectric Resonator Antenna," *IEE Electronics Letters*, Vol. 35, No. 5, March 1999, pp. 357-358.
10. Wu, J.Y., C.Y. Huang, and K.L. Wong, "Low-Profile, Very-High-Permittivity Dielectric Resonator Antenna Excited by a Coplanar Waveguide," *Microwave and Optical Technology Letters*, Vol. 22, No. 2, July 1999, pp. 96-97.