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Squashed Amplifier Integration in Dual Slit-Cut Equilateral Triangular Microstrip Antenna

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Abstract – In this research work, authors have demonstrated an amplifier based microstrip antenna as a transmitter of dual slit-cut equilateral triangular microstrip patch structure for enhanced gain and bandwidth. The slit-cut equilateral triangular microstrip patch structure studied here is printed on economical RT Duroid substrate material having relative permittivity 2.32 and show an extra output gain with dual band. Design aspects of microstrip patch antenna with scientific results obtained from the laboratory are shown.

Keywords – Microstrip antenna, bandwidth, transistor, resonant frequency.

I. INTRODUCTION

An amplifier type slit-cut equilateral triangular microstrip patch structure incorporating a two-port amplifier circuit to a passive microstrip antenna to effort by way of a broadcast antenna. There is slit cut at the borders, as a substitute of slot cutting on the surface of the patch. The design may be realistic, applied, and useful to the antennas with equilateral triangular patch antennas. This slit cut add another resonant mode and appreciate the dual frequency band .While on having the feed in the patch the excitation and entrustment of more than one adjacent resonant modes occurs which is based on the concept used in slot-loading technique, similarly wideband performance may be achieved and realized when using and exhausting slit-cut in patch. "Additionally existence of the slits in the neighborhood of the feeding probe could drastic revolutionize the patch property in terms of increment in input impedance due to addition of capacitive load. The inductive part of probe's input impedance can counteract the capacitive load and could efficiently contribute with subsidize to resonance in the patch. If a thick substrate is chosen for wideband operation, the inductive part would. It is observed that this inductive part would inexorably be huge if a thick substantial substrate is chosen for wideband operation with great task. So, the addition of slits in the patch increase by two ways the width of the operation band, and it has been reported that greater bandwidth can be achieved. By controlling the slit's length, width and its position this will affect the frequency band curve. The slit cut in the patch divide the patch in the parts and each part correspond an equivalent circuit of resonance." [2] A proper arrangement of triangular radiating elements allows the antenna researchers to reduce the coupling between adjacent elements of array [1, 2]. Helszajn and James [3] studied the triangular microstrip antenna and reported theoretical and experimental investigation. The study of conventional equilateral triangular microstrip patch structure was done in [4-7]. Here in this paper, author presents a configuration of amplifier type active microstrip antenna, which have dual band in nature and enhanced antenna gain. Considering the behavior of microstrip antenna as a passive radiating element and parasitic element as a conductive element, typically a metal road which is not electrically associated to anything else. This "driven element" is joined to the radio receiver or transmitter through a feed line, and parasitic elements. Radiation pattern of radio waves emitted by the driven element are adjusted by parasitic elements by directing the beam in one direction, increasing the antenna's directivity gain.

"The active equilateral triangular microstrip patch structured antenna consists of passive microstrip antenna and an amplifier circuitry with a dc bias feedback resister. For achievement of better performance in terms of extra output gain, the collection range of a feasible extreme feedback resistance having maximum value is required in active circuitry for biasing the amplifier." [5]

There should be proper biasing of bipolar transistor amplifiers for its correct operation. Electric circuits made up with individual and distinct devices (discrete circuits), biasing networks consist of resistors, which are normally `engaged. The device which operates at a point is known as bias point, quiescent point, or Q-point, on the output characteristics that show and explain the DC collector–emitter voltage (V_{ce}) and the collector current (I_c) with no input signal functionally applied.

If we define, active antenna is an antenna whose radiation properties are intimately associated with active elements. Diode and its dc biasing would impact radiating behavior of equilateral triangular microstrip antenna, so in same way addition to a varactor diode to a passive structure would be considered to be a active antenna as shown in figure 1.

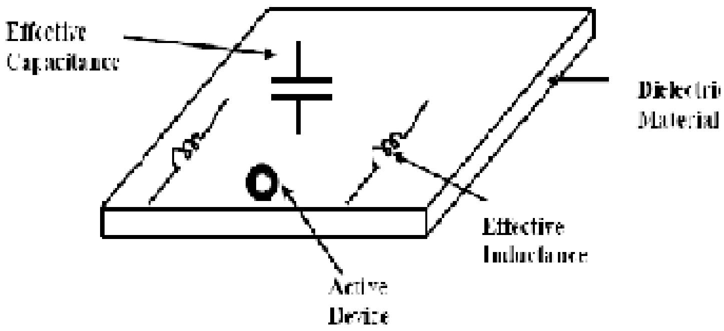

Fig. 1. Integrated active patch antenna structure

II. ANTENNA CONFIGURATION

The antenna is designed on substrate of thickness 0.159 cm with substrate material being used is RT Duroid having εr = 2.32. We can characterize the patch size using capacitive feed technique. There are many feeding methods available, but common method is capacitive feed. Here coaxial cables feed is closely attached to radiation patch while the ground plane has connection with the outer conductor [8-9]. The feed is placed in such a way to match with its input impedance. The chosen patch produces good normalized electric and magnetic field distribution beneath the patch. Writing Maxwell's equations for the region under the patch, we have,

$$\nabla\times E = -j\omega\mu 0H$$
$$\nabla\times H = j\omega\varepsilon E + J$$
$$\nabla . E = q/\varepsilon$$
$$\nabla . H = 0$$

Where

ε=permittivity of the substrate
μ0=permeability of free space
J=current density due to the feed

Resonant frequency of a ETMA with a perfect magnetic walls is given by

$$f_{ri} = \frac{2c}{P_e\sqrt{\varepsilon_r}}\left(m^2+mn+n^2\right)^{\frac{1}{2}}$$

Here c is a speed of light, P_e is the effective perimeter of customized triangular patch antenna.

If we consider the composition of the amplifier-type active microstrip antenna which works as a broadcasting antenna as shown in figure 2.

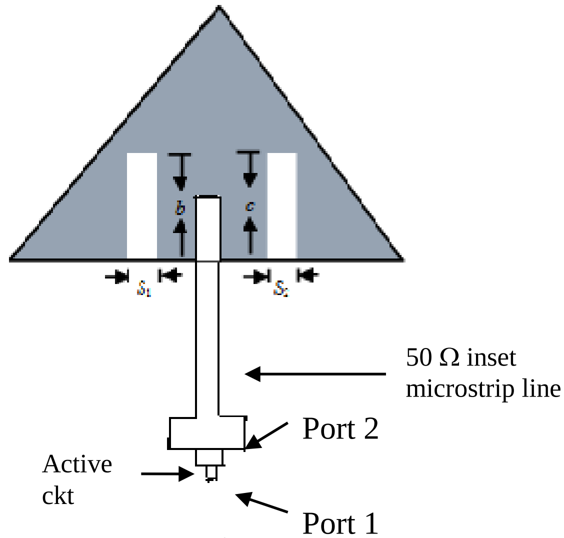

Fig. 2. Amplifier Type Active Microstrip Antenna

Here designer may exchange the port 1 with port 2 in the above configuration, then resulting and subsequent microstrip antenna will purpose as a receiving antenna. Here, 50 Ω inset microstrip line fed has been directly connected. Corresponding to unslotted triangular microstrip patch antenna, the passive microstrip patch antenna can have 03 times wide bandwidth [10]. The passive microstrip antenna can work as a transmitting or receiving antenna both [11, 12]. This characteristically acquiesce high input impedance, designer would similar to adjust the feed position in this situation. The current is small at the end of a half-wave patch and enhancing in magnitude towards the canter, if patch was fed closer to the canter the input impedance (Z=V/I) could be reduced. The basic technique of doing this is by using an inset feed. There is also decrement in magnitude of voltage by the same amount that the current increases. Hence, using Z=V/I, the input impedance ranges as: $Z_{in}(R) = \cos^2\left(\frac{\pi R}{L}\right) Z_{in}(0)$

The composition of active circuitry is shown in figure 3.

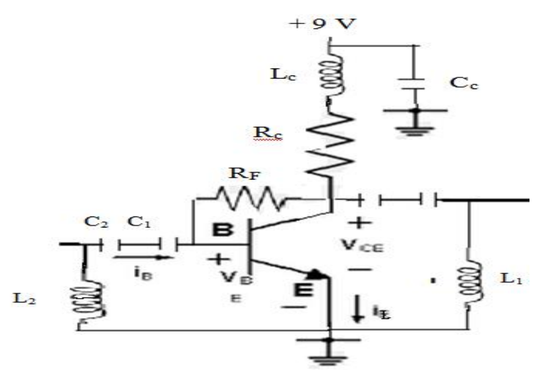

Fig. 3. Active Circuitry

The passive microstrip antenna has directly connection with active circuit. "The use of, 50 Ω inset microstrip line reduce the need for quarter-wave length transmission line for proper impedance matching. In this research, work a low noise bipolar transistor is utilized which is biased through collector resister Rc and feedback resister RF. Biasing of the amplifier into the active region, for a given extra output gain, the impedance bandwidth of the active microstrip antenna can be significantly enhanced which is shown in figure 4. Here capacitors C1 and C2 are the dc blocking capacitors used for prevention of RF signal from feeding back to the dc source of circuit, we have used Lc and Cc as a RF chokes"[5]. Maximum possible feedback resistance RF is selected in such a way in active circuitry for biasing the amplifier into an active region by which impedance bandwidth of resulting active antenna can be greatly increased as shown in figure 4. Computation of resonant frequency of dual slit-cut equilateral triangular microstrip patch antenna [13].

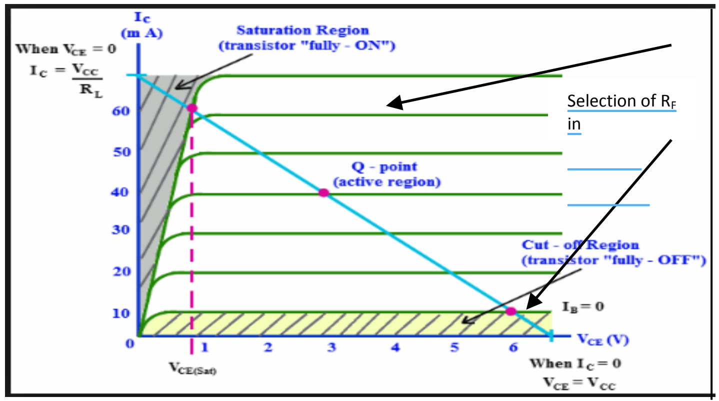

Fig. 4. Selection of RF in active region

III. CONCLUSION

The microstrip patch antenna which is put into operation using the substrate material RT Duroid of thickness 0.159 cm having εr = 2.32, showing the return loss for four dissimilar values of RF : 23 kΩ, 32 kΩ and 50kΩ. It is understandable from results that there is increment of impedance bandwidth with an increasing value of RF.

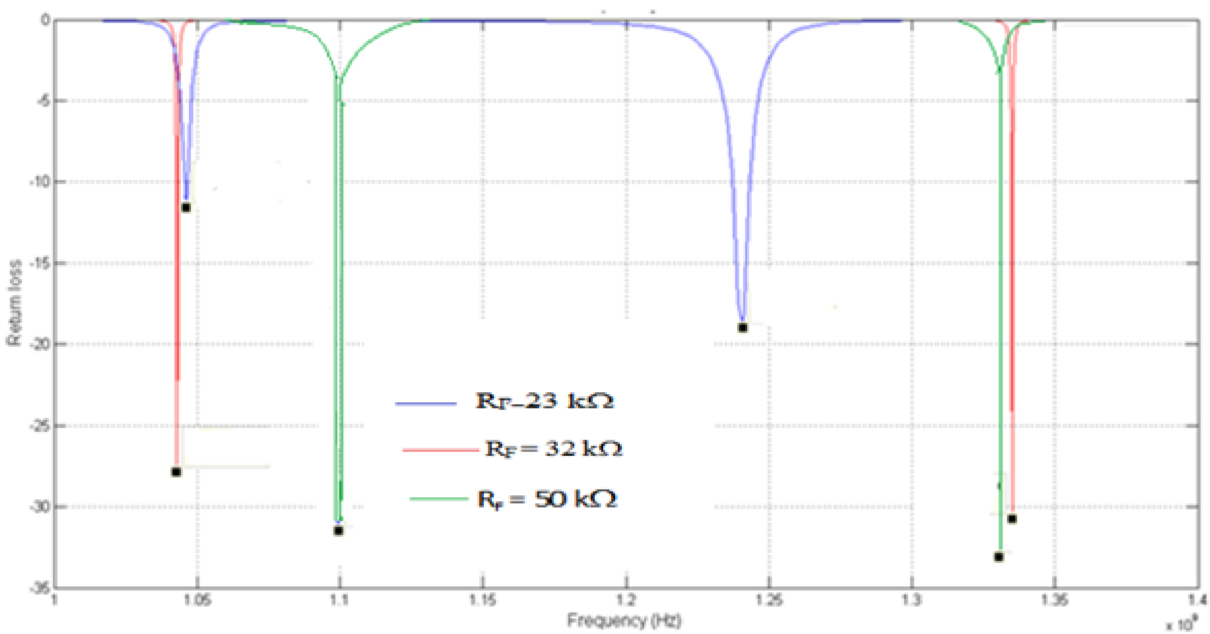

Fig. 5. Outcome and Conclusion

The results obtained shows good radiation characteristics compared to the inactive slotted triangular microstrip patch antenna.

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