Design and Simulation of Slotted Super Wide Band Antenna with Coplanar Waveguide Feeding

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Abstract— In this paper a slotted super wide band antenna is presented. Since the bandwidth of super wide band antenna is very large but due to non availability of some frequency components it is desired that the proposed antenna should not operate on that frequency band. Hence to full fill above requirement a slot has been cut from super wide band antenna. A comparative analysis has been done for super wide band antenna and slotted super wide band antenna. CST Microwave Studio simulation software is used for simulation. 14.27 GHz frequency component has been taken for analysis purpose.

Key words: Slotted Super Wide Band Antenna, CST Microwave Studio, Return loss, Gain.

I. INTRODUCTION

Super-wideband radio technology is a potential approach that enables high-resolution sensing in free space and in matter including ground penetrating radar and through-wall sensing. Super-wideband radio technology has several advantages as compared to narrowband technology, and also comprised all UWB-RT's advanced features with larger channel capacity, higher precision and super resolution in communication, ranging and screening, respectively. The major challenge in the realization of SWB radio systems is the development of a suitable antenna that sustains SWB signaling. To obtain larger bandwidth several bandwidth enhancement techniques have been studied such as: using microstrip-line feed and notching the ground plane [2] , using symmetrical notch in the Coplanar waveguide feeding(CPW) [3], using log periodic arrays in which the different elements are deduced from an homothetic ratio [4], introducing a capacitive coupling between the radiating element and the ground plane [5], adding T-slots for both patch and feeding strip [6]. All these techniques discussed above are based on the modification of the surface current distribution to broaden the antenna's impedance bandwidth. Literature research shows that super wide band radiators could not support both "SWB" and "pattern-stability" over the obtained SWB-bandwidth.

In the designing of microwave and millimeter wave antennas and components, planar technology offered several advantages in comparison to wire and waveguide technologies such as low cost, planar, light weight, low profile and small volume, compatible with integrated or active circuits, easy integrate into passive or active phased arrays and communication systems.

The planar technology facilitates the designers more flexibility in designing a myriad of different UWB and SWB antennas, the architectures of these antennas may different but their topology mainly resembles the traditional wire version of monopole or dipole antennas. The nomenclatural of planar antennas are confusingly taken over from the wire-version with similar topology.

II. ANTENNA TOPOLOGY AND ARCHITECTURE

This paper presents a slotted super wide band antenna architecture. Structure is designed to support the functional section design approach (FSD) in which the antenna structure is divided into functional sections. The FSD was used to increase the bandwidth optimization process. The presented topology and architecture has been taken from available literature [1]. The super wide band antenna and functional section design together have enabled the designer to obtain antennas with SWB performances by optimization of just a most significant parameter. The proposed slotted super wide band antenna architecture provides SWB bandwidth lager than 10:1 and also exhibited a much stable radiation patterns in its SWB bandwidth. The advantage of this topology is its simplicity, and the essence of the antenna's architecture is the logicalness of dividing the antenna into functional sections that enables the multi-variable optimization (MVO) process into a sequence of single-variable optimization (SVO) process.

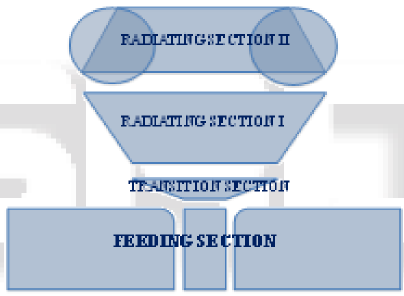

Fig. 1: Functional Section Design

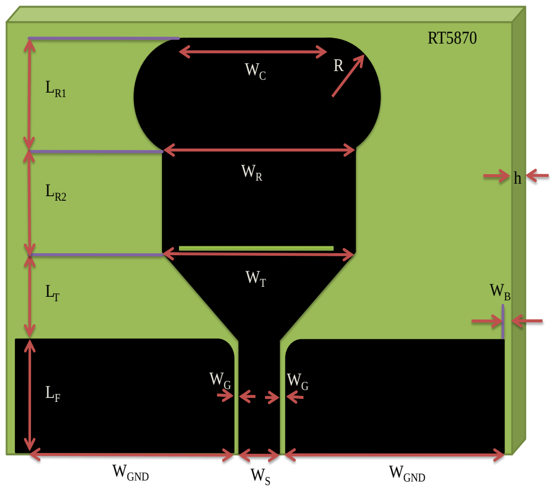

Fig. 2: Antenna Architecture

III. DESIGN AND SIMULATION OF SLOTTED SUPERWIDE BAND ANTENNA

In this paper a super wide band antenna has been presented which does not allows passing a particular frequency band in its operating frequency range. For this we have cut a slot in the reference antenna. The designed antenna has been shown in figure 3.

The frequency at which Rejection is required = 14.27 GHz (Design parameter and can be changed according to requirement)

Hence wavelength at 14.2 GHz = 21.0231 mm

Therefore guided Wavelength at 14.2 GHz = $21.0231/\sqrt{\epsilon_r}$ = 14.1738 mm

Slot length is given by following equation:

$$\text{Length of slot} = \frac{\text{Guided Wavelength}}{2}$$

So slot length = 14.1738/2 = 7.0869 mm

Designed slot length = 8.1 mm

Slot position = 6.1 mm (from input Port)

Slot position has been selected in such a way that it will not disturb the higher frequency of operation and Slot length has been chosen according to effective wavelength at frequency of rejection.

Difference between theoretical value and optimized value of slot length can be attributed to sharp corner truncation at higher frequency, copper thickness and slot width.

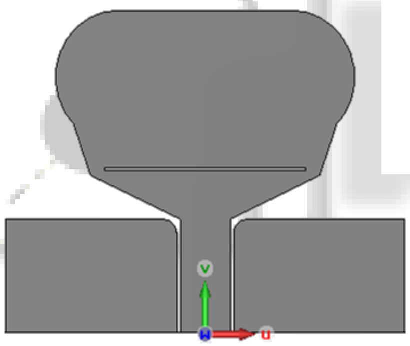

Fig. 3: Designed Antenna

Rejection of a particular frequency component is caused due to the change in the path current flowing in the radiating element. The current distribution in slotted super wide band antenna at 14.27 GHz frequency is shown in following figure 4.

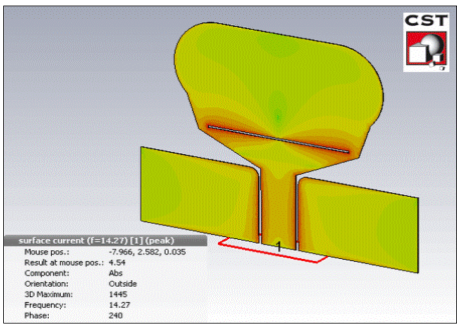

Fig. 4: Current Distribution

A. *Reflection coefficient:*

Due to the insertion of slot in radiating section, the reflection coefficient of antenna is badly affected at the desired frequency. It means that the input power given to input port of the antenna is almost reflected back to the same port and very less amount of power is transmitted at that particular frequency. In other words we can say that at that particular frequency antenna is not working efficiently. The comparison of return loss antenna with and without is given in figure 5.

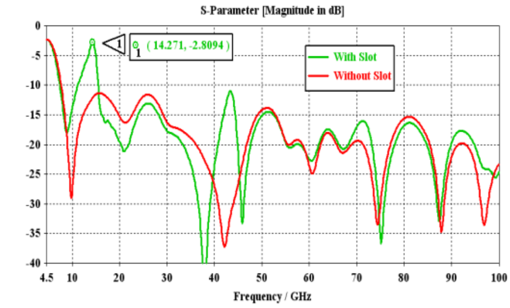

Fig. 5: Comparison of S- parameters

B. *Gain:*

Gain of the slotted antenna has to be increased at that particular frequency where reflection coefficient also increases. But the effect of increasing gain at that particular frequency has no importance because reflection coefficient is not good at that frequency. Comparison of gain of super wide band antenna with and without slot is shown in figure 6.

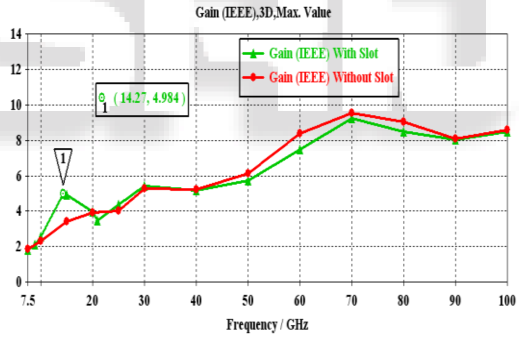

Fig. 6: Comparison of Gain

IV. CONCLUSION

The restriction on non availability of a particular frequency component has been resolved by slotted super wide band antenna which has been designed and simulated in this paper. A comparison between reference super wide band antenna and proposed slotted super wide band antenna has been made. 14.27 GHz frequency component has been taken for slotted super wide band antenna to be rejected in its operating frequency range. Good pattern stability has also been achieved with slotted super wide band antenna.

REFERENCES

[1] D.Tan, A.Szilagyi, I.E.Langer, P.Aubry, L.P.Ligthart "A super wideband antenna" EuCAP 2011

[2] Tourette, S. et al.; "Compact UWB printed antennas for low frequency applications matched to different

transmission lines", MVO technology letters, Vol. 49, No.6, pp.1282-1287.

[3] Zhang, X., et al.; "Design of CPW-Fed monopole UWB antenna with a novel notched ground", MVO technology letters, Vol. 51, No.1, pp. 88-91.

[4] Rahim, M.K.et al.;"The design of nine element quasi microstrip log periodic antenna",Proc.of the RFM2004,Oct.2004, Malaysia, p.132–135.

[5] Rmili, H. et al.;"Design and analysis of wideband double-sided printed spiral dipole antenna with capacitive coupling", MVO technology letters, Vol. 50, No.5, pp. 312-1317.

[6] Rahayu, H., et al.;"Slotted ultra wideband antenna for bandwidth enhan-cement", AP-Conference, 17-18, Mar. 2008, Loughborough, UK.