V-SLOT ARRAY LOCATED ON THE NARROWWALL OF RECTANGULAR WAVEGUIDE ANTENNA WITH METALLIC FLANGES.

Joythi G [(1)], Usha Kiran K[(2)], R M Vani[(3)] and P V Hunagund[(4)]

[(1)] ***Department of Applied Electronics, Gulbarga University, Gulbarga 585 106, Karnataka***
[(2)] "as same as (1)"
[(3)] ***Department of USIC, Gulbarga University, Gulbarga 585 106, Karnataka***
[(4)] ***"as same as (1) but E-mail: prabhakar_hunagund@yahoomail.co.in"***

ABSTRACT

In this study, analysis of V-slot array located on the narrow wall of rectangular waveguide antenna (V-SNWWGA) with metallic flanges is presented. In this communication we have designed 3-pairs of symmetric, co-phase V-slots grooved on the narrow wall of the rectangular waveguide. For further improvements in the radiation characteristic of this antenna the metallic flanges are specially designed, machined which can be easily fixed to the V-SNWWGA with the help of hinges. The characteristics like VSWR, radiation pattern, beamwidth, and gain are measured experimentally for the parameters like flange angle and for different flange materials.

Key words: Narrowwall, Waveguide antenna, Slot array, Beam shift.

INTRODUCTION:

In the development of an electronically steered phased array antenna, the inclined slots located on the narrow side of the waveguide are widely used. Many researchers have reported on narrow wall waveguide slot antennas [1-2]. Auiliadora Herandez-iopez and Mercedes Quintillan [3] have investigated the coupling and radiation characteristics of a "V-shaped" slot on the narrow wall of a waveguide in which, the frequency behavior of the network has been presented. Switching of the main lobe was observed in accordance with frequency. It was also mentioned that the inclined slots on the narrow wall have wider bandwidth than that in broad wall. It is also learnt from the past literature that flange technique has been proved to be the promising one to improve the radiation characteristics of the slotted waveguide antenna [4-5]. Hence, an effort has been made to further enhance the radiation characteristics of the V-SNWWGA using flange technique. The schematic diagram of V-SNWWGA with metallic flanges is as shown in Fig. 1. The experimental study was carried out for different flange materials and their angles. Comparison has been done for with and without flange and also for different materials of flanges at the optimized angle.

ANTENNA DESIGN:

The design procedure of antenna is made separately in two parts such as designing of V-SNWWGA and design of flanges. The V-SNWWGA was designed using the procedure exactly that of A. F. Stevenson [6]. The V-slot array on the narrow wall of the rectangular waveguide is designed for 10GHz for TE_{10} mode. The arm of 'V' is taken as $l_1 = \lambda o/2$ and distance between two 'V' slots is kept $\lambda g/2$. The angle between two arms of V-slot $\theta s = 15°$. The artwork of V-SNWWGA is drawn using AutoCAD computer software. These V-Slots were etched on the narrow wall of the rectangular waveguide using Electro Discharge Machine (EDM) for higher precision. Metallic flanges are precisely designed and machined which can be easily attached to V-SNWWGA using hinges. The enamel paint is coated to the hinges so that there will not be any reflections from the hinges. This in turn will help the system to vary the included angle of the flange. The flange has been optimized to a height (L) of 5λ and width (W) of 1.5λ. The coating of silver and gold was made on copper flanges by electrolysis process and its effect was also studied for different flange angle α.

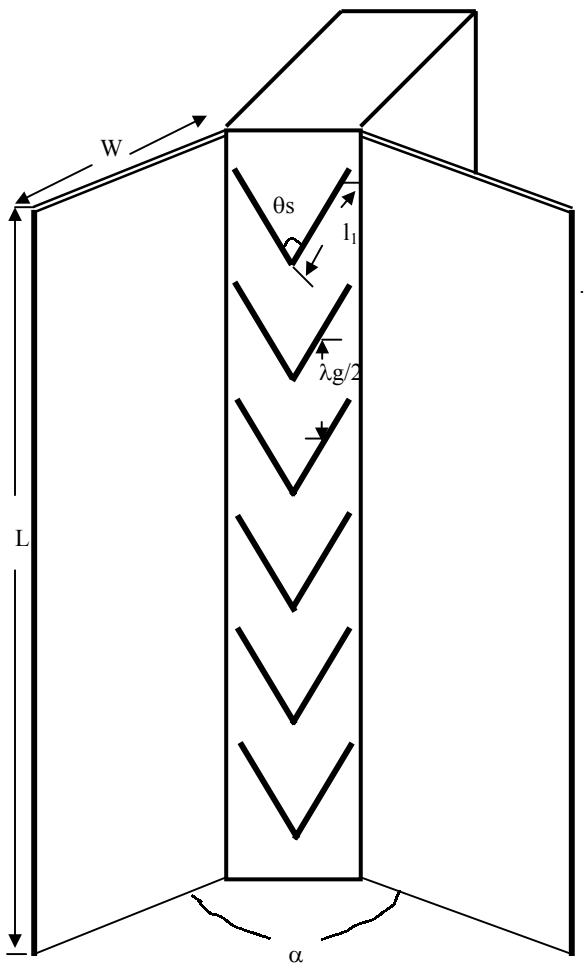

Fig. 1 V-SNWWGA attached with metallic flanges.

EXPERIMENTAL MEASUREMENTS AND RESULTS:

The V-SNWWGA antenna systems with different flanges have been measured for the characteristics like VSWR, radiation pattern, beamwidth and gain. The measured experimental results are tabulated in Table 1. The On-axis power '*Po*' (OAP) is power radiated along the axis of the system. This is measured for the far field region i.e., at distance $R \geq 2D^2/\lambda$ from the transmitter. The OAP of V-SNWWGA is measured for different flange materials and their flange angles. From the experimental measurement it is found that the OAP without flange is 0.21nW with the flanges the OAP has been increased to 2.1nW. This shows the superiority of the flange technique when attached to V-SNWWGA Fig. 2 shows the variation of OAP for different flanges at different angles. From the figure it is found that the OAP of silver flange for the included flange angle for 20° is more when compared to other flanges. Figs 3-4 shows the radiation patterns without and with flanges like copper silver and gold flanges for the optimized flange angle 20°respectively. From these figures it is amply clear that the beam is sharpened using flange technique. From the Table 1, it is observed that beamwidth without flange is 26° and with flange it decreases to 11°. Further it is also observed experimentally that when V-SNWWGA is attached to with silver flange the beam splits into two halves for the operating frequency 10GHz. The beam of V-SNWWGA also splits into two halves when it is not attached to any flange as shown in Fig.3. This beam splitting characteristics is not found for V-SNWWGA when it is

attached to copper and gold flanges as shown respectively in Fig. 4 and Fig. 6. Where as the main lobe shift towards the right side of the common axis by 40°R and 20°R for copper and gold flanges respectively. From the Table 1 it is observed that gain of the V-SNWWGA without flange is –17.2 dB and with the flange gain increases to –12dB. It is amply clear from the table that the presence of flange technique with different materials enhances the gain of V-SNWWGA.

Table 1 Experimental results of V-SNWWGA

Flanges	**Flange angle α = 20°**			
	VSWR	**Gain (dB)**	**HPBW (Deg.)**	**Shift in main lobe (Deg.)**
Copper	1.06	-12	11	40R
Silver	1.07	-12.5	19*	-
Gold	1.09	-14.5	25	20R
Without Flange	1.20	-17.2	26*	-

*Beamsplits; Where R: Shift in the main lobe towards the right side from the common-axis.

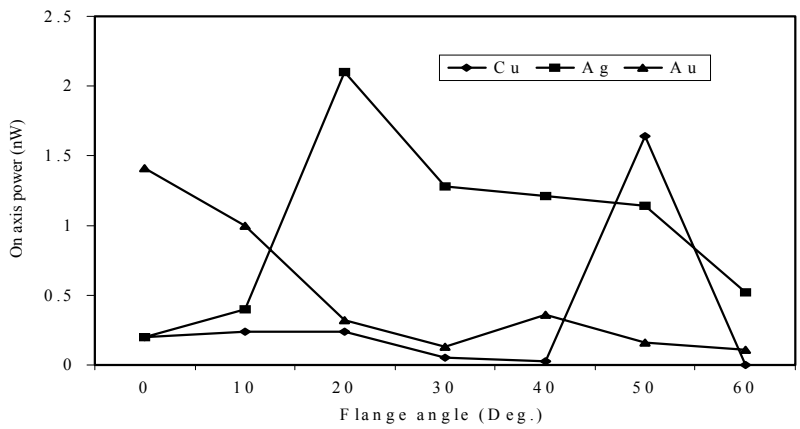

Fig. 2 Variation of on-axis power with flange angle (Cu,Ag,Au).

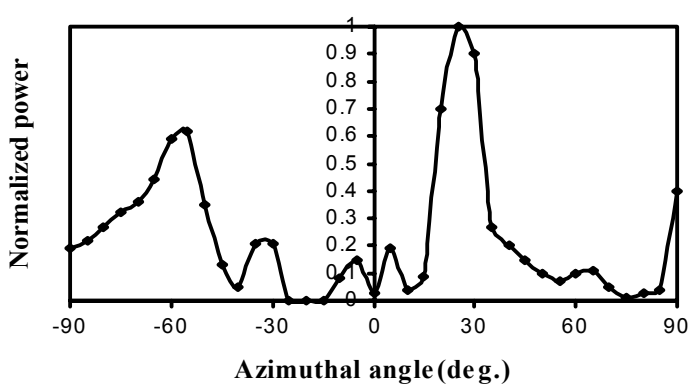

Fig. 3 Radiation pattern of V-SNWWGA without flange.

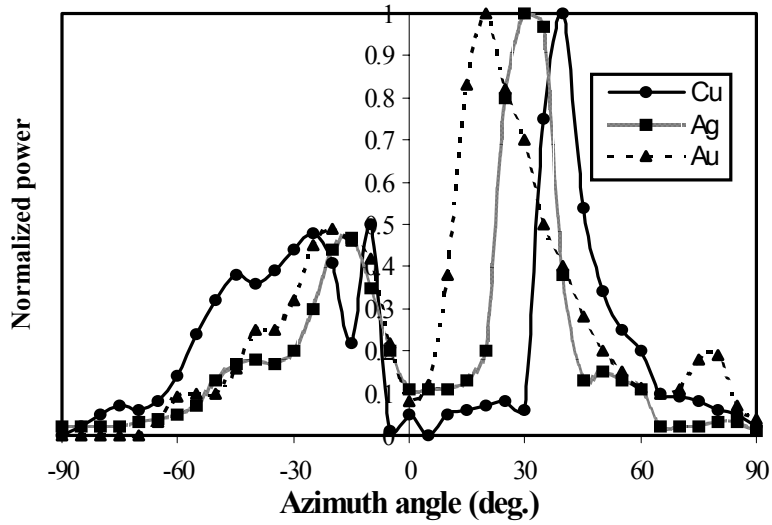

Fig. 4 Radiation pattern of V-SNWWGA at flange angle 20º

CONCLUSIONS:

The V-slot arrays located on a narrow wall of a rectangular waveguide antenna with metallic flanges is measured and analyzed. From the exhaustive experimental study, it can be concluded that H-Plane radiation patterns of V-SNWWGA can be sharpened by flange technique. This flange technique is effective in improving the impedance of the system when compared to without flange.

REFERENCES:

[1] T. Sphicopoulos, "C-Slot: a practical solutions for phased arrays of radiated slots located on the narrow side of rectangular waveguides", *IEE Proc.,* vol. 129, Pt. H, No. 2, pp. 49-55, 1992.

[2] V. V. S. Prakash, S. Christopher and N. Bala Krishnan, " Method of moments analysis of the narrow-wall slot array in a rectangular waveguide", *IEE Proc-Microw. Antennas Propag*., Vol. 147, No. 3, pp. 242-246, 2000.

[3] M. Auxiliadora Hernandez-Lopez and Mercedes Quintillan, "Coupling and radiation through "V-Shaped" narrow slots using the FDTD method", *IEEE Proc-Microw.Antennas and Propag*, Vol. 49, No.10, pp. 1363-1369, 2001.

[4] Hunagund P. V., K. A. Jose, P. Mohanan and K. G. Nair, "An experimental investigation of the effect of flange angle on radiation patterns of V-slot waveguide antenna"*, Indian Journal of Radio and Space Physics*, Vol. 21, 70-72, 1992.

[5] B. S. Makal, Hunagund P. V., S. F. Farida, R. M. Vani and S. N. Mulgi, "Effect of dielectric flanges on V-Slot array antenna", *Progress in Electromagnetics Research Symp.,* p. 938, 2000.

[6] A. F. Stevenson, "Theory of slots in rectangular wave-guide" *Journal of Applied Physics*, Vol. 19, pp. 24-34, 1948.