INTEGRATED ANTENNA AND PACKAGING TECHNOLOGY FOR FUTURE MM-WAVE WIRELESS SYSTEMS

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ABSTRACT

In this report, coplanar waveguide (CPW)-fed quasi-Yagi antenna is presented. Two methods for transforming the CPW mode, which feeds the antenna, to coplanar stripline (CPS) mode, which excites the driver dipoles, are presented. Measured results for X-band prototypes using the two transitions are compared. Performance of microstrip quasi-Yagi arrays is also discussed, including an endfire and tilted beam array. Experimental results of an X-band eight element linear array are reported.

INTRODUCTION

Future broadband wireless and mobile communications systems will benefit greatly from the development of low-cost, high performance planar printed antennas. Characteristics of the quasi-Yagi antenna including wide bandwidth and low mutual coupling make this antenna a promising candidate for such systems. Because this antenna is amenable to high dielectric substrate construction, it is scalable to millimeter wave frequencies and can be fabricated on alumina or MMIC substrates. In this continuing MICRO project, applications of the quasi-Yagi antenna are investigated, including coplanar waveguide (CPW)-fed versions of the antenna, and beam-steering planar arrays.

CPW QUASI-YAGI ANTENNA

The lack of via holes in CPW structures makes it desirable for millimeter wave circuits since MMIC fabrication can be considerable simplified. Two CPW-fed quasi-Yagi antennas has been developed that can be integrated with CPW circuits, either with the MMIC flip-chip mounted on the substrate, or fabricated on the same substrate as the circuit itself.

In [1] a CPW-fed quasi-Yagi antenna is developed using an 180 deg. open stub to transform the CPW mode to coplanar stripline (CPS) mode, which excite the driver dipoles. The transition is shown in Fig. 1 (a). The open stub induces a relative 180 deg. phase shift on one side of the CPW so that the CPW mode is transformed to a balanced mode. Another CPW-fed quasi-Yagi antenna presented in [2] is depicted in Fig. 1 (b). It uses a circular patch transition to transform the CPW mode to CPS. The circular patch is a broadband open circuit element, and functions similarly to the 180 deg. open stub of the previous antenna.

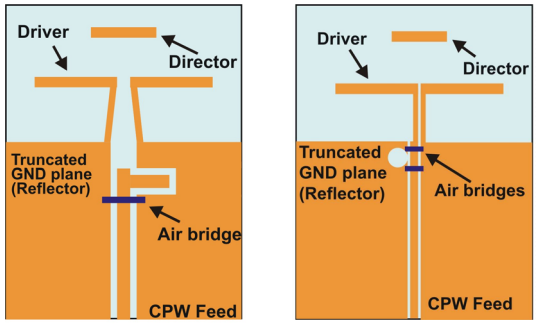
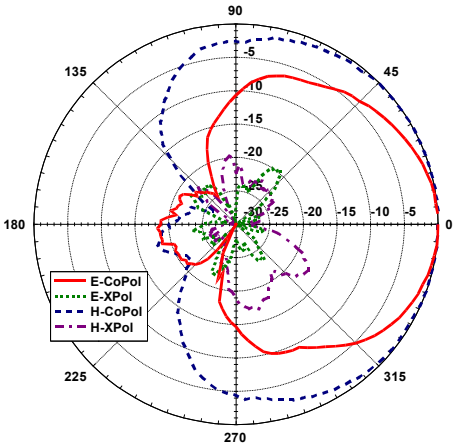
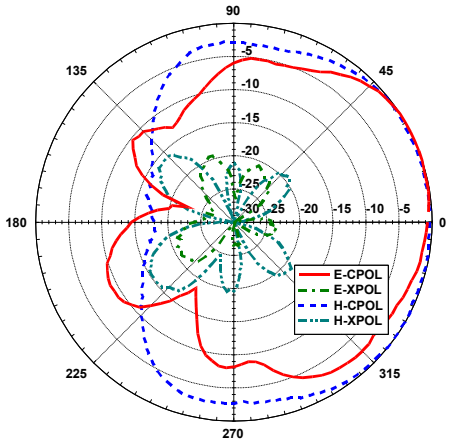


Fig. 1 CPW fed quasi-Yagi antenna with (a) 180 deg. open stub transition and (b) circular patch transition.

Both CPW-fed antennas are prototype at X-band on 25 mil Duroid substrate with dielectric constant of 10.2. The measured endfire radiation patterns are plotted in Fig. 2. Other properties are compared in Table 1.



(a)



(b)

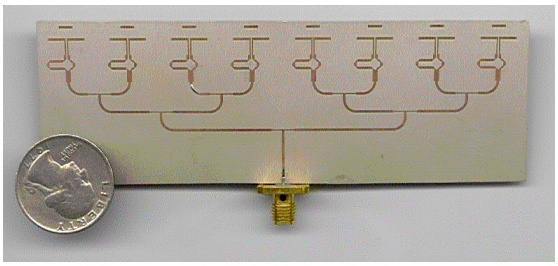
Fig. 2 Measured radiation patterns of CPW-fed quasi-Yagi antenna with (a) open stub transition at 10 GHz and (b) circular patch transition at 9 GHz.

Table 1 Comparison of CPW-fed quasi-Yagi antennas.		
transition type	Open Stub (10GHz)	Circular Patch (9GHz)
gain	5 dBi	3.8 dBi
bandwidth for 10 db return loss	30%	40%
front-back ratio	> 15 dB	>9.5dB
cross-polarization	< -17 dB	<-19dB

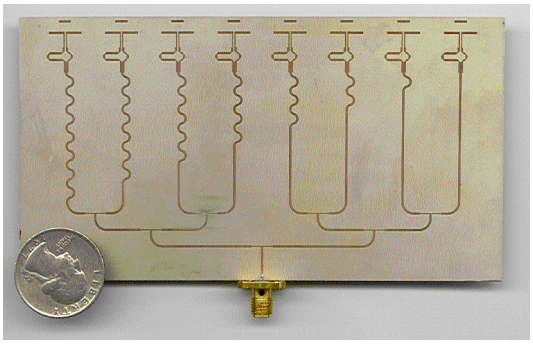
QUASI-YAGI ANTENNA ARRAY

The broadband and low mutual coupling properties of the quasi-Yagi antenna also makes it advantageous for antenna array applications. Furthermore, its compact size ($<\lambda_0/2$) allows greater design freedom in array spacing.

Two X-band eight-element microstrip-fed quasi-Yagi E-plane linear arrays are presented in [3]. They are also fabricated 25 mil Duroid with dielectric constant of 10.2. Both arrays have bandwidth greater than 50%. The array elements pictured in Fig. 3 (a) have equal amplitude and phase distribution, resulting in the endfire fan beam pattern measured in Fig. 4. The side lobe levels are less than –11 dB, with front-to-back ratio of 23 dB and cross-polarization less than –13 dB. Fig. 3 (b) shows an array with a tilted beam resulting from the phase delay lines feeding each element. The measured tilted beam is plotted in Fig. 5 at 8, 10, and 11.7 GHz. The 3-dB beamwidth ranges from 10-17° in this frequency range. With equal amplitude distribution, sidelobe levels less than –11 dB are measured.



(a)



(b)

Fig. 3 Eight-element microstrip-fed quasi-Yagi antenna array with (a) endfire main beam and (b) 12° tilted beam.

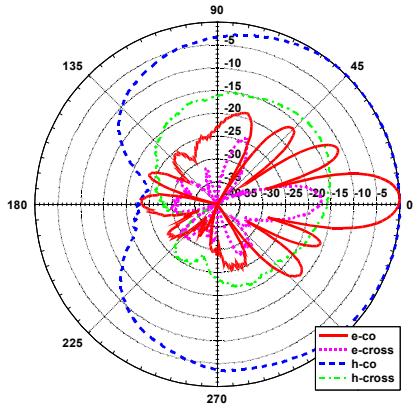


Fig. 4 Measured radiation pattern of eight element endfire array at 9 GHz.

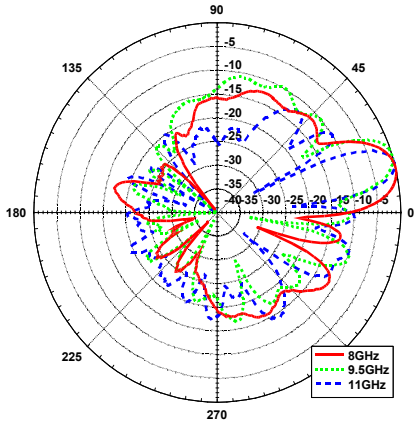


Fig. 5 Measured E-plane pattern of tilted fan beam array.

CONCLUSIONS

Various implementation and applications of the quasi-Yagi antenna has been presented. It can be realized with either microstrip or CPW feeding. Additionally due to its planar nature, the antenna simply scales to millimeter wave frequencies, and integrates suitably with MMIC components. Furthermore, two quasi-Yagi antenna arrays were presented. These arrays feature broad bandwidth and excellent radiation qualities, applicable for radar, power combining, and electronically steered phased arrays.

REFERENCES

[1] J. Sor, Y. Qian, and T. Itoh, "Coplanar waveguide fed quasi-Yagi antenna," *Electronics Lett.*, vol.36, pp.1-2, Jan. 2000.

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[3] J. Sor, W. R. Deal, Y. Qian, and T. Itoh, "A broadband quasi-Yagi antenna array," *Proc. of 29th European Microwave Conf.*, vol. 3, pp. 255-258, Oct. 1999.

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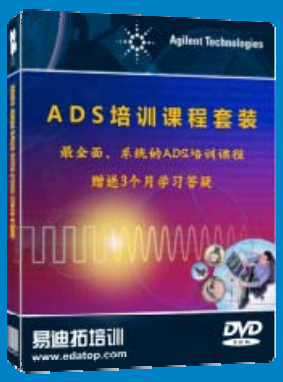

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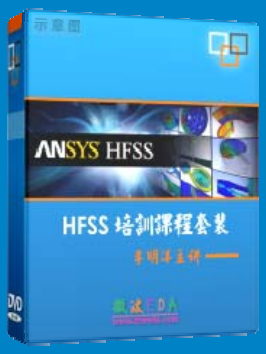

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