HYBRID-RESONATOR ANTENNAS
FOR BROADBAND WIRELESS APPLICATIONS

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ABSTRACT

The concept of a hybrid-resonator antenna, consisting of a microstrip-patch resonator coupled to a dielectric resonator, is presented. Considering the importance of "real estate" in wireless applications, the dielectric resonator is positioned symmetrically above the patch resonator to minimize the footprint. A truncated substrate is used for the patch resonator. Measurements on a prototype antenna show an input return loss better than 10dB in the frequency range from 5.24 GHz to 6.66 GHz (24%). The experimental return loss compares well with theoretical results when an estimated 0.1mm air gap between the patch and the DR is included in the analysis.

INTRODUCTION

Antennas with increased bandwidth can be designed by tightly coupling several narrowband antennas that resonate at different frequencies. A common example of multiple-resonator antennas is the stacked-patch microstrip antenna that consists of several slot-coupled microstrip patch resonators [1]. Recently we have taken this approach further by developing a hybrid-resonator antenna consisting of a dielectric resonator and a microstrip patch resonator. The concept and experimental results of this antenna will be described in this paper.

Although several investigators have claimed many advantages of dielectric-resonator (DR) antennas such as high efficiency, large bandwidth, low weight, low material cost, loose tolerances, ease of coupling, etc. [2], it has proved up impossible up to now to extend the bandwidth of a DR antenna by tightly coupling two dielectric resonators. This is because in a conventional DR antenna there is no metal wall to isolate the electromagnetic fields of one resonator from the other. It is possible to improve the bandwidth by introducing several additional dielectric resonators as parasitic elements [3], but such array configurations take more space and may not be suitable for space-critical applications such as wireless networks of notebook computers.

CONFIGURATION

We propose extending the bandwidth of a DR antenna by coupling the DR to a microstrip patch resonator. In our hybrid-resonator antenna, the DR is symmetrically placed over the microstrip patch to minimize the area taken up by the hybrid antenna. The coupling between the electromagnetic fields in the two resonators is achieved by introducing a slot (or aperture) in the patch. The microstrip patch itself may be coupled to the antenna feed (usually a microstrip transmission line) using a second slot on the ground plane or by other conventional coupling schemes.

To demonstrate the hybrid approach, we have designed and fabricated an antenna suitable for 5GHz wireless computer network systems. The design process was outlined previously [4]. The key parameters of the prototype antenna are given below.

Dielectric resonator	: 12.7×12.7×9.5 mm TMM material (ε_r = 9.2)
Microstrip patch	: 15×15 mm
Patch substrate	: 20×20×1.575 mm Duroid (ε_r = 2.2)
Ground plane	: 50×50 mm
Upper slot	: 2×8 mm
Lower slot	: 2×9 mm
Feed substrate	: 0.635mm Duroid (ε_r = 10.2)
Feed microstrip width	: 0.56 mm
Matching stub length	: 1.8 mm (from the slot center)

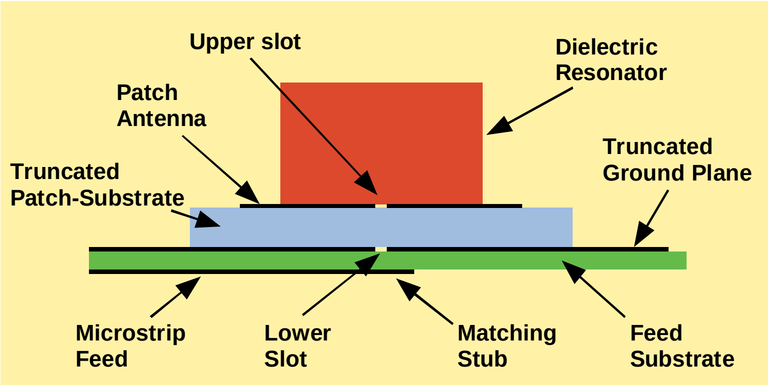

Fig. 1. The hybrid antenna configuration

RESULTS

The first prototype antenna achieved a return loss better than 10dB in the frequency range from 5.24 GHz to 6.66 GHz (24%) as shown in Fig.2. The experimental input return loss compares well with theoretical results obtained using HP-HFSS software when an estimated 0.1mm air gap between the patch and the DR is included in the analysis. Most importantly, this investigation demonstrates that the electromagnetic fields in a dielectric resonator can be efficiently coupled to the fields in a patch resonator without perturbing the radiation characteristics of each resonator.

References

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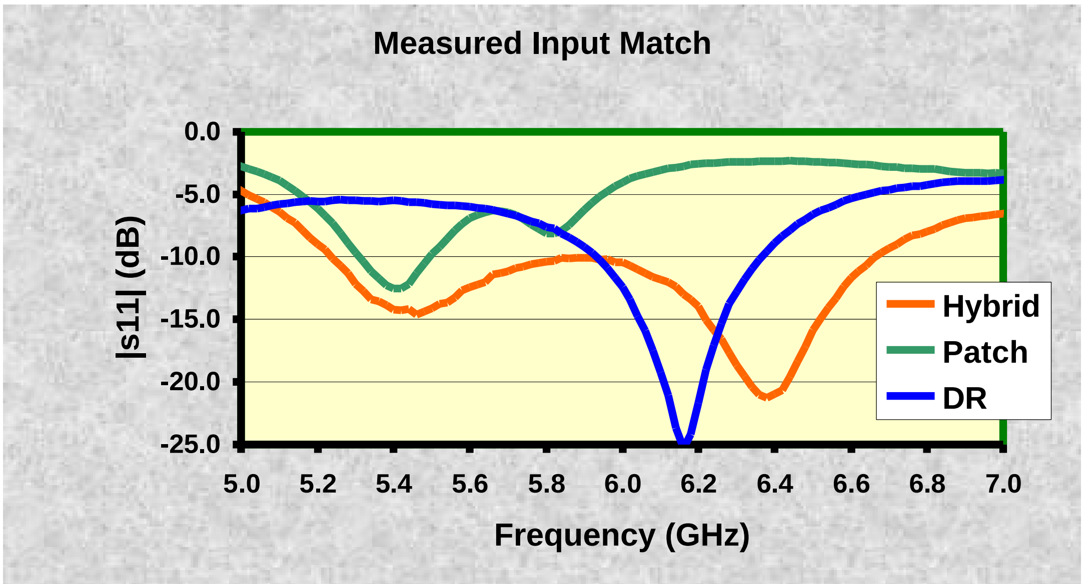

Fig. 2. The measured input return loss of the hybrid antenna is shown in red. Other curves show the return loss of the individual dielectric-resonator antenna and the patch antenna.