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Tunable dual-band printed tab monopole antennas for wireless communications

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***Abstract*— The advance of communication systems requires new antenna designs to comply with the ever-increasing demands of the wireless market. The antenna designs are being conditioned by miniaturization and migration to new frequencies (IEEE 802.11a/g), while keeping compatibility with other systems poses yet additional constrains. This contribution presents a novel monopole multi-band printed antenna design for WiFi systems, featuring the use of a spur-line filter to obtain dual-frequency operation. Design constrains are discussed, along with simulated and measured results.**

I. INTRODUCTION *(HEADING 1)*

Printed antennas have acquired a great importance thanks to their compatibility to high precision and low cost production techniques. Due to their inherently narrow bandwidth, however, their design and fabrication, either isolated or integrated in an array, requires high accuracy.

II. THE DUAL-BAND ANTENNA SCHEME

Several printed dual-band antenna have been previously developed at Universidad Politécnica de Cartagena and other research units. The techniques employed included a spur-line filter in the perimeter [1-4], in order to achieve a dual frequency operation without incrementing the overall size of the patch. The same technique has now been applied to the design of dual band printed monopole antenna.

The tab monopole [5] consists of a sub-wavelength tapered radiating element fed by a suitable transmission line and situated above a planar ground plane. The tab monopole has been designed to obtain a resonance at 5.5 GHz, which is necessary for operation under the IEEE 802.11a/g standards. A spur-line filter embedded in its perimeter allows the operation at a new 2.4 GHz resonance, which is also necessary for IEEE 802.11 a/g.

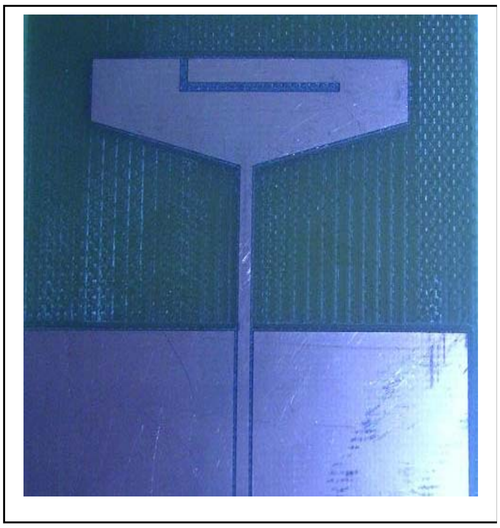

Figure 1. The dual band structure.

Up to now the spur-line filter has been used as an additional narrowband technique for broadening conventional patches bandwidths [6-7]. This is now applied to an inherently broadband antenna, producing relatively large bandwidths. In particular, the modified tab monopole, depicted in figure 1, has been designed for wireless communications needing more than 10% bandwidth in the 5 GHz band.

Numerous metalized vias connecting the front and back are used in the prototype tab monopole in order to suppress spurious parallel plate modes that are known to occur in the grounded coplanar waveguide line.

III. SIMULATED AND MEASURED RESULTS

To investigate the radiation and VSWR performance of the new antenna, the IE3D commercial EM-simulator is employed. The antennas have been made using the FR4 low cost substrate with a thickness of 1.524 mm and a dielectric constant of 4.27. Measurements are carried out using a HP8720B network analyzer.

Simulated and measured input return loss for the original tab monopole antenna at the natural resonance band is depicted in figure 2. A 14.7% simulated bandwidth (795 MHz at f_2=5.425 GHz) and 10.8% measured bandwidth (600 MHz at f_2= 5.55 GHz) were attained with the S_{11}<-10 dB criterion for the original tab monopole design.

The spur–line filter consists of two coupled $\lambda_g/4$ microstrip lines, with an open circuit at the end of one of them and the other two extremes connected to each other. The resonance of spur-line filter is easy tunable, and this characteristic is translated into the novel antenna design, as it is illustrated in figure 3 for spur lengths between $-\lambda_g/20$ and$+\lambda_g/10$.

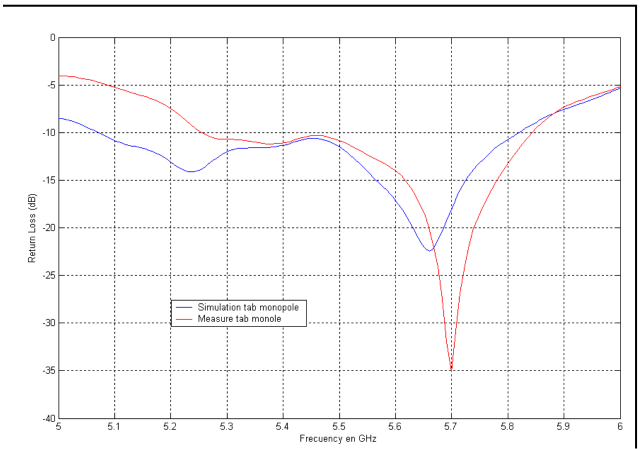

Figure 2. Simulated and measured input return loss in the 5 GHz band.

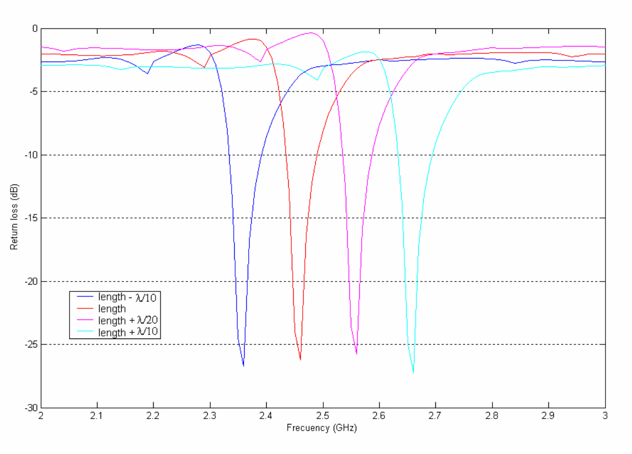

Figure 3. Simulated tunable input return loss in the 2.4 GHz band.

The currents distributions and radiation patterns are show in figures 4 to 6. The radiation patterns for the modified tab monopole are very similar to those of the original tab monopole [5].

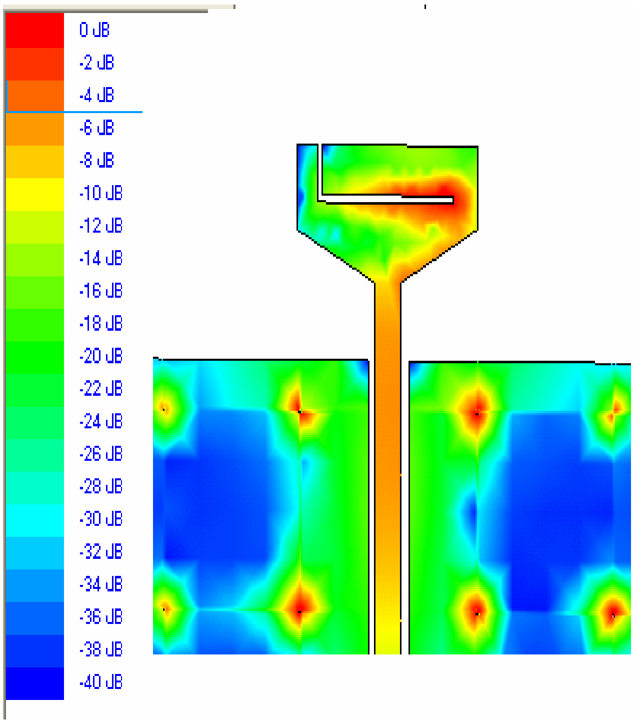

Figure 4. Simulated current distribution at 2.4 GHz.

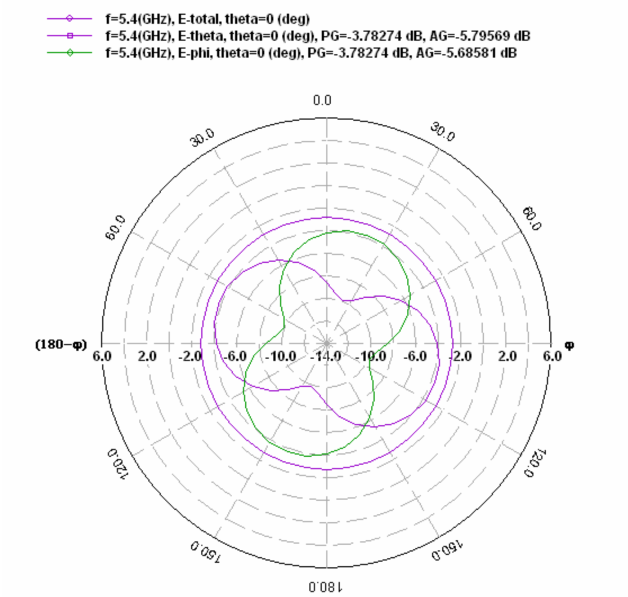

Figure 5. Simulated radiation patterns at 5.4 GHz (acimut).

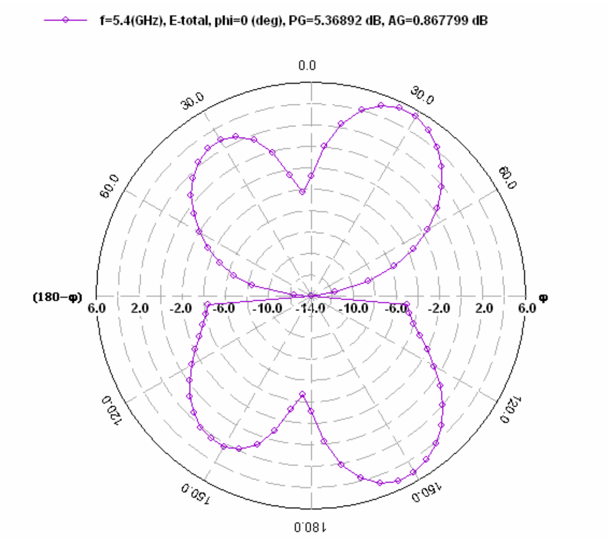

Figure 6. Simulated radiation patterns at 5.4 GHz (elevation).

A consistent 1.85 % difference between simulated and measured input return loss was encountered for the modified design, which is attributable to variation in dielectric constant of low-cost substrates and manufacturing limitations [8].

With these prediction errors accounted for, the measured input return loss measured for the final design is depicted in figure 7, wherein the operating bands fall within the required bandwidths for commercial WiFi systems. Final measured bandwidths of 4.9% (120 MHz at f_1=2.45 GHz and 13.6% (740 MHz at f_2=5.43 GHz) were attained for the modified tunable tab monopole.

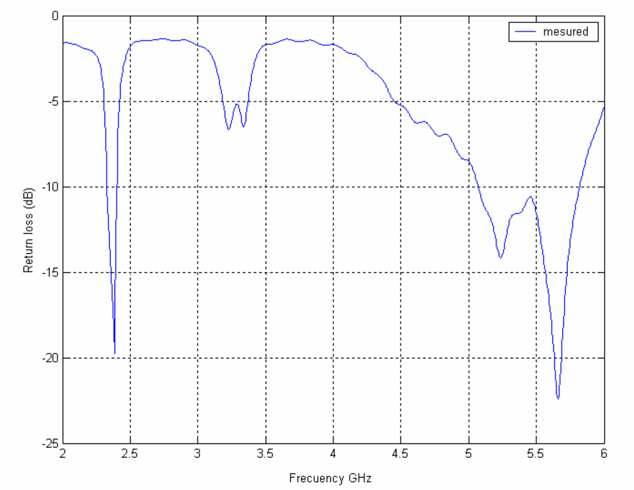

Figure 7. Final measured results for modified tab monopole.

IV. CONCLUSIONES

The novel tunable dual-band antenna has shown excellent performance and bandwidth. This antenna can be used for commercial wireless communications systems like 802.11 a/g or Hiperlan2.

ACKNOWLEDGMENT

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