DESIGN OF A MULTI-STANDARD ANTENNA SYSTEM FOR PCMCIA

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ABSTRACT

Multipurpose PCMCIA devices require the use of integrated multiband antennas, usually with a dual-port configuration. In this paper, some investigations concerning the input return loss, isolation, radiation patterns and efficiency of a novel internal, multi-standard antenna system integrated into a PCMCIA card are presented.

INTRODUCTION

The increasing demand for access to mobile communications through portable equipment such as notebooks or PDAs with the use of PCMCIA cards requires the development of integrated, multiband antennas as shown in [1]. This helps provide the desired connectivity, through the access to cellular or private networks. Therefore, both mobile cellular standards, such as the GSM family, and third generation standards such as UMTS, as well as unlicensed network accesses, like WLAN, should be implemented into a single device.

Up to now, wire antennas such as monopoles or helix have been widely employed to implement such antenna systems. But as users demand more compact equipment, the trend leads to integrated solutions, like patch antennas, which should provide high efficiency and optimal performance, while keeping a reduced size. Again, as multiple standards have to be covered, multiresonant metallic patches are frequently used. These are both cost-effective and straightforward to produce and mount, whereas their inherent flexibility allows adapting them to the available antenna volume.

DESCRIPTION OF THE STRUCTURE

The structure of the antenna for PCMCIA is presented in Fig. 1. Fig. 2 displays the actual implementation of the structure, with two cables added for measurement purposes.

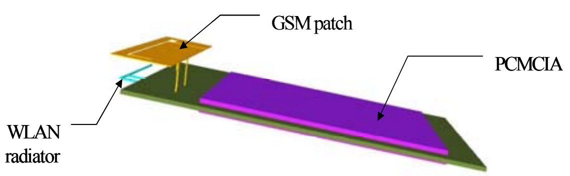

Fig. 1: Simulation model of the multiband antenna on a PCMCIA.

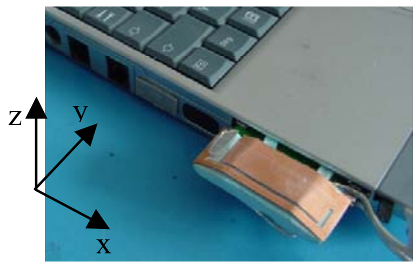

Fig. 2: PCMCIA antenna: implementation and measurement setup.

To implement a multi-standard PCMCIA antenna system that covers simultaneously the frequency bands of the GSM family GSM (namely, GSM 900, GSM 1800 and GSM 1900) and WLAN, two feeding ports are necessary, in order to comply with the current requirements of hardware manufacturers, who can thus use cost-effective- circuitry. This in turn arouses some problems concerning the isolation between the ports, which have to be addressed in order to obtain a good performance. Therefore, two separate radiating structures will have to be integrated within the available volume.

A PIFA [2] concept was chosen to cover the GSM bands. It consists of a probe-fed metal plate with a shorting pin, which allows obtaining two separate resonances: the first one for the GSM 900 band, the second one for both GSM 1800 and GSM 1900. Indeed, though multiple resonances are usually used to cover these two overlapping bands, a single mode with enough bandwidth can also be used. Also, an Inverted-F Antenna (IFA) was added, to ensure the access to WLAN. It consists of a shorted wire printed onto a non-metallised area of the PCB board. The GSM 900/1900/ 1800 antenna occupies a volume of 50mm x 18mm x 8mm, whereas a surface of 29mm x 6mm was reserved for the WLAN IFA. The overall size of the PCMCIA board is 54mm x 110mm.

MATCHING CHARACTERISTICS

The antenna performance was simulated using the FDTD-based em-solver EMPIRE [3]. Fig. 3 shows how two resonant modes are excited on the main patch, to cover the cellular frequency bands (GSM 900/1800/1900), whereas the IFA accounts for the WLAN operation. Then, a prototype of the antenna for the PCMCIA was built and mounted onto a test device. Its performance was also measured using a HP8719D network analyser. For the measurements, each of the two ports of the test antenna was connected to a semi-rigid cable. The PCMCIA card was inserted into the corresponding slot of a notebook. When measuring at one port, the second port was terminated with a 50Ω load. The measurements represented in Fig. 4 show a good agreement with those predicted by the simulation. The antenna displays good matching performances, and thus the frequency bands defined by the four standards can be covered with only three resonant modes. A matching better than –6 dB is achieved even in the band limits for GSM 1800, GSM 1900 and WLAN. As for GSM 900, the –6 dB matching level for the lower limit of the GSM 900 band should be easily achieved through a slight tuning of the resonant frequency.

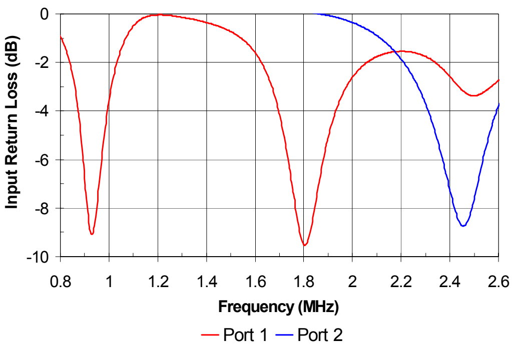

Fig. 3: Simulated input return loss. Port 1: GSM 900/1800/1900, Port 2: WLAN.

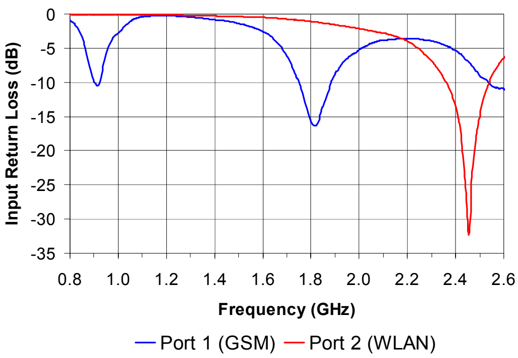

Fig. 4: Measured input return loss. Port 1: GSM 900/ 1800/1900, Port 2: WLAN

In Fig. 5, the simulated and measured isolation between both ports is represented. This isolation is reflected through the transmission coefficient S_{21}. Again, a good correspondence is achieved between simulation and measurements. As expected, the measured isolation values are better than –8 dB throughout the whole frequency band. Therefore no coupling problems are expected during the intended normal operation of the device, when used with a notebook.

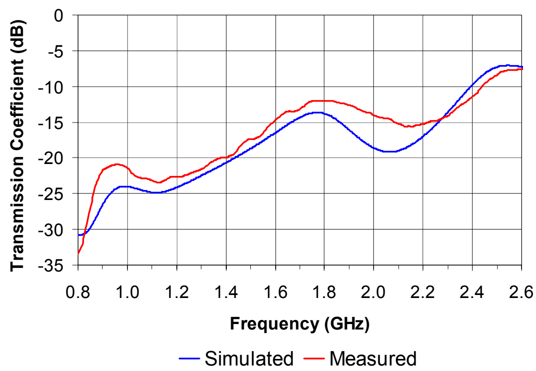

Fig. 5:Simulated and measured transmission coefficient.

RADIATION PATTERNS

The antenna gain obtained for the different frequency bands is shown in Table 1. For the measurements, a typical operation condition was assumed, in which the notebook was open, and the PCMCIA inserted in the corresponding slot. In this case, the total electric field was considered. The obtained results are in agreement to those normally obtained when considering integrated antennas.

Table 1: Measured antenna gain for the different standards.

Standard	Centre frequency (MHz)	Maximum gain (dBi)	Average gain (dBi)
GSM 900	920	1.9	-3.7
GSM 1800	1795	3.9	-1.2
GSM 1900	1920	2.2	-1.9
WLAN	2450	2.8	-2.5

In Fig. 6, the measured radiation patterns in the azimuth plane are presented. It can be noted that the patterns are distorted, due to the shadowing effect of the notebook. Nevertheless, the structure shows rather good azimuth coverage, and can thus be used for cellular and wireless applications.

EFFICIENCY

To further characterise the antenna performance, its efficiency was also measured, using an improved Wheeler-Cap measurement setup [4]-[5]. In this case, only the PCMCIA card, and not the whole notebook, was considered. The efficiency levels attained for the different frequency bands are shown in Fig. 7.

A distinction was made between radiation efficiency and total efficiency: bandwidth restrictions are not caused by the antenna itself but by mismatching, as radiation efficiency is higher, and more constant over the frequency than the total efficiency. Thus, the use of a passive matching network would permit to increase the total efficiency and bandwidth. In any case, the total efficiency of the antenna remains over 60% over the different bands defined by the considered standards. Therefore, the use of this configuration could be envisaged.

CONCLUSIONS

An integrated, multistandard antenna system for PCMCIA devices has been presented. With a combination of a dual-band PIFA and an IFA, four different standards can be covered with a small antenna system. Though two different ports have been used, good performance has been achieved regarding input return loss, isolation, radiation properties and efficiency levels. Further investigations will focus on the integration of a second WLAN radiator, to implement a spatial diversity scheme.

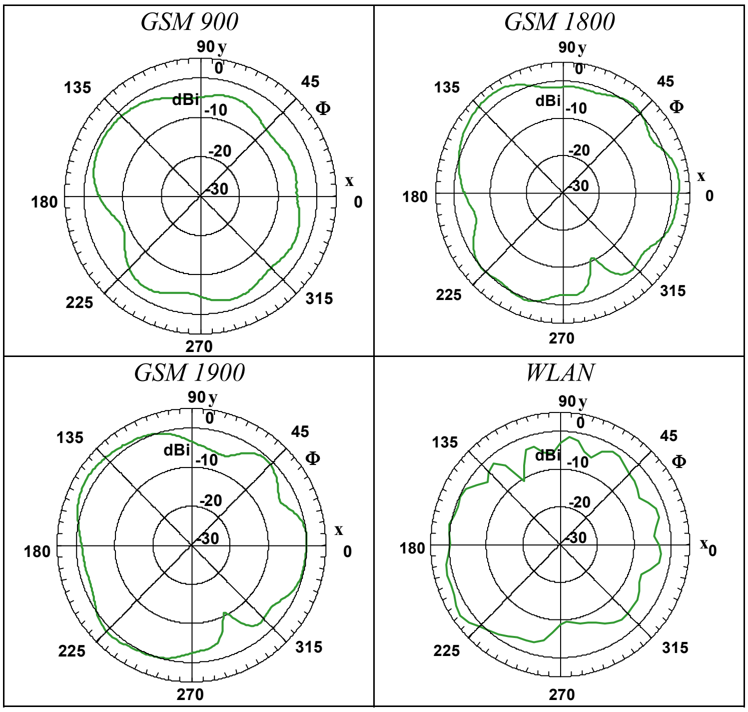

Fig. 6: Radiation patterns for GSM 900, GSM 1800/ GSM 1900 and WLAN.

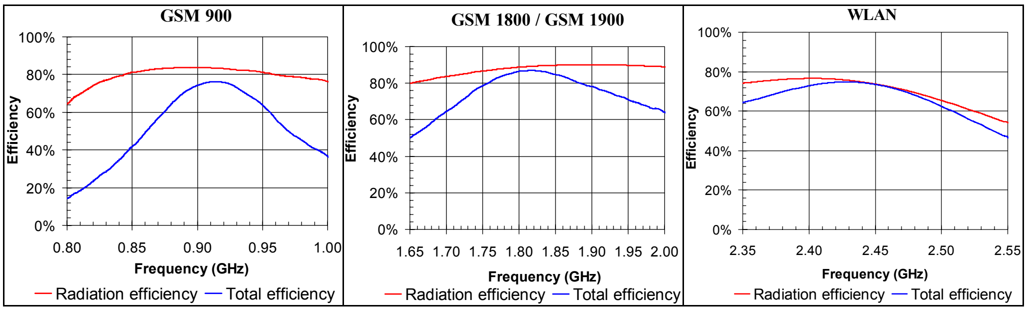

Fig. 7: Measured antenna efficiency for GSM 900 (left), GSM 1800/ GSM 1900 (centre) and WLAN (right).

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