Multi-standard UHF and UWB antennas for RFID applications

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1. Introduction

Radio Frequency Identification (RFID) is widely developed this last past years. It's consist on identify devices automatically and in real time by radio waves. One of the frequency band allocates for RFID applications is in the UHF band (860-960MHz). Nevertheless UHF RFID systems have a relatively narrow band-pass. To enhance it there are actually some research which applied Ultra Wide Band (UWB) technologies for RFID applications [1]-[3]. UWB systems offers several advantages as high data rate, localization and tracking, low power consumption, low cost, immunity to multi-paths, small sizes etc... One application to have a tag which can works on UHF RFID and UWB band is to feed the UWB chip thanks to UHF antenna and to respond in UWB band. In this paper we submit two antennas' prototypes, one for readers and the second one for tags. Reader and tag's antennas are designed to work in all UHF RFID band (860-960MHz) and European UWB band (6-8.5 GHz). Specifications, simulations, measures and perspectives are presented.

2. Antennas characteristics

2.1 Tag antennas.

The substrate is FR4 0.8 mm ε_r =4.4 with credit card sizes. Tag is composed of two antennas (Fig.1), one for RFID system and another one for UWB system. The connection between chips should be assumed by bounding. UHF tag antenna has typical impedance for RFID applications in this frequencies, a reactance significant compared to the resistance, with a quality factor up to 10 [4][5]. UWB antenna has an impedance near 50 Ω between 6 and 8.5 GHz. The shape and the way to match the UWB antenna are clearly explained in [6]. The highest challenge is to minimize coupling effect, which perturb radiation pattern in the highest frequencies (Fig.3.b)), between UHF and UWB antennas. To reduce the coupling, L5 and L2 must be as important as possible and L4, contrary to L1.

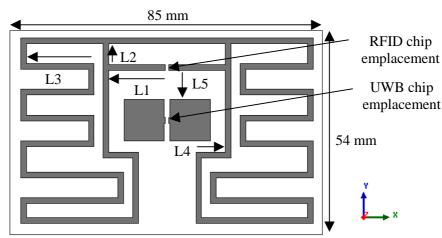
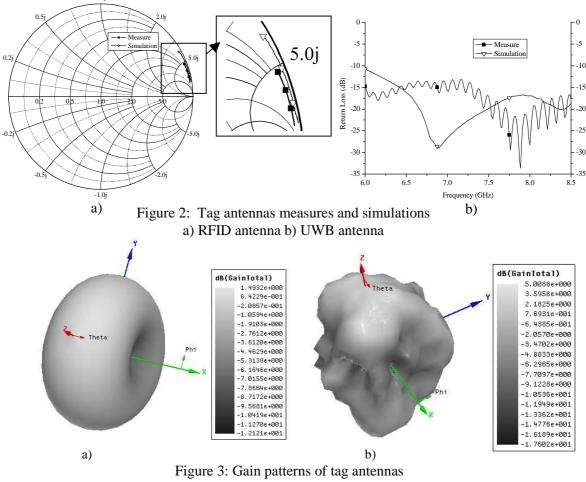


Figure 1: Tag antennas

Measures conditions are same as describe in [5], and simulations were made with Ansoft HFSS V.11. In UHF RFID band (860-960 MHz) measure are close to simulation (Fig.2.a)), the main difference is a resistance greater in measure, this is partly due to the measure environment. The impedance at 915 MHz in simulation is Z=15+j390 with 1.5 dBi gain. Varying L1, L2, L3 and L4 length can easily modify this impedance. UWB chip has an impedance around 50 Ω in European UWB's band (6-8.5 GHz) and the antenna have a return loss lower than 10dB (Fig.2.b)) with 5.5 dBi gain at 7.25 GHz.



a) at 915 MHz b) at 7.25 GHz

2.1 Reader antenna.

The substrate is FR4 1.6 mm ϵ_r =4.4 without sizes restraint. In opposition to previous antenna, the reader is composed of a single antenna, which is matched at 50 Ω on twice (UHF RFID and UWB) bands. The design in composed of a dipole and a bow-tie antenna (Fig.4.).

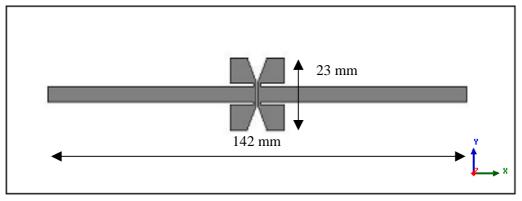
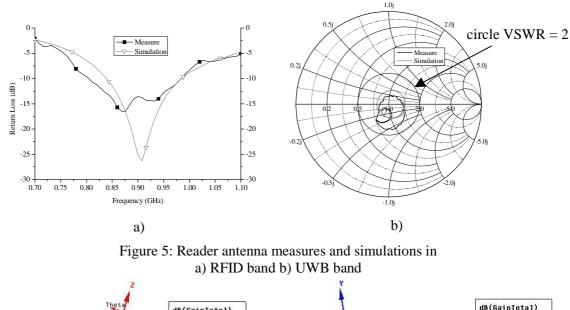
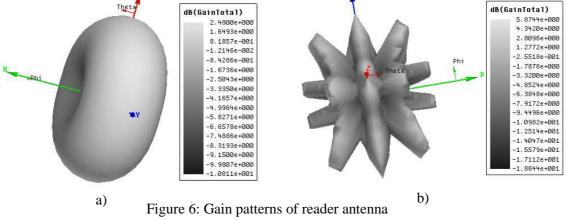


Figure 4: Reader antenna

Simulation and measure are close between 860 and 960 MHz and the return loss are under 10 dB (Fig.5.a)). Between 6 and 8.5 GHz the appearance of measure and simulation are sensitively the same (Fig.5.b)) with a phase shift partly due to the measure environment. Simulation and measure return loss on UWB band are largely under circle VSWR<2 (near -10 dB) (Fig.5.b)).





a) at 915 MHz b) at 7.25 GHz

In lower frequencies, most of the current is propagated trough the main dipole, this is the reason why the radiation pattern at 915 MHz look like the radiation pattern of a classical dipole (Fig.6.a)). In higher frequencies, the current distribution is homogeneous so around 7.25 GHz the antenna radiates in many directions (Fig.6.b)). The main dipole is the most fluent parameter in UHF RFID band. To enlarge or shift the UWB match band without perturb too much matching in UHF band it is advised to only vary the sizes and the angle of the bow-tie antenna [6].

3. Perspectives.

Perspectives related to reader antenna is to increase the UWB bandwidth to the entire FCC UWB band (3.1-10.6 GHz) and keep the UHF RFID band. First simulations consist on enlarge the bow-tie antenna and to match the main dipole consequently (Fig.7). VSWR is lower than 2 on twice bands in simulation (Fig.8), next step is to measure this antenna. Concerning tag antennas it's actually difficult to have an UHF antenna and a 3.1-10.6 GHz UWB antenna in the same tag. There isn't enough spaces, so coupling between the antennas would be too important. There are many solutions, enhance the tag sizes, change the UHF antenna's shape or make a tag with a single UWB antenna with batteries.

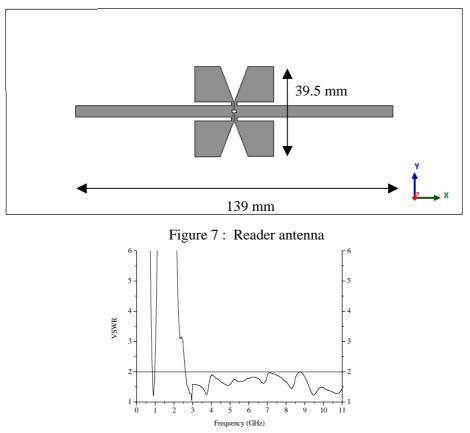


Figure 8: Reader antenna simulations between 0.5 and 11 GHz

4. Conclusion.

In this paper we have presented different antenna's topologies for UHF and UWB RFID applications. Concerning tag antennas, a multi-chip solution was chosen and the main difficulties consist to minimize coupling effects between UHF and UWB antenna. UHF antenna has typical impedance and it's possible to reconfigure it easily to every kind of UHF RFID chip impedances. UWB antenna has a classical shape and the return loss is under 10 dB. Reader antenna cover twice band with an impedances of 50Ω . It's matched in simulation and measure to all UHF RFID and European UWB bands with a return loss lower than 10 dB. Perspectives are to make a reader and tag antenna matched on all UHF RFID and FCC UWB band.

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