Toward Augmented UHF RFID Passive Tags

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The requirement of new functions for smart tags in the Internet of Things (IoT) deployment has raised the need of additional sources of energy. Among the possible energy sources, the natural or ecologic sources such as solar, motion, human body are of first interest. Another relevant approach is the use of wasted electromagnetic energy that can constitute a suitable powering source for low power consumption devices. Indeed, as it had demonstrated in practice the minimum required power to turn on UHF passive tags is the order of 10µW and several natural or green physical effects can provide much more power. In this context, the technology that best suits the requirements of enhanced functions and additional energy is the passive RFID technology, also due to its Wireless Power Transmission (WPT) operation. Therefore, in a society leaded by the information and networking, a link is defined between our real world and a virtual scenery for all the everyday objects. The linker device used in this paper is an RFID tag, that besides the identification function, it offers to enhance its powering and operation performances in applications such as sensing, authentication or location.

In this paper, we discuss some of the ways to augment the functionalities and capabilities of passive RFID tags. The main idea behind this evolution is to maintain the traditional huge advantages of RFID tags : battery-less and wireless. So, two novel approaches for the design of augmented RFID passive tags are presented. It is worth noting that the augmented must be on compliance with existing standards and regulations, in particular the EPC C1 GEN2. The first design approach is focused on the redundancy of information while the second deals with the powering techniques of passive RFID tags. The passive RFID technology, besides its WPT and battery-less operations, is chosen in this study because of its most recently evidenced feature: the exploitation of its non-linear behavior (G. Andia-Vera, S.D. Nawale, S.D., Y. Duroc, and S. Tedjini, "Optimum integration of passive UHF RFID tag-rectenna in a single feed dual band antenna," *General Assembly and Scientific Symposium, 2014 XXXIth URSI,* 2014, pp.1-4).

From concept point of view, this paper unfolds the design considerations and operation techniques in the use of non-linear signals, i.e. harmonic signals produced by passive RFID chips. Indeed due to the harvesting stage at the input of any RFID chip nonlinear effects exist and they produce harmonics of the fundamental frequency. So, depending on the frequency response of the tag antenna some of the harmonics can be favored and exploited to augment the tag functionality or performance. The harmonic signals, considered as carriers of power and information are used in two applications cases:

(1) the design of a harmonic RFID tag which offers redundancy of information,
(2) the design of a harmonic harvester tag that empowers the RFID chip with additional energy, commonly wasted.

Based on these studies, experimental results and applications perspectives including sensing, location authentication or non-invasive monitoring are discussed.