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Radio Frequency Identification Systems. Survey

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Abstract—The paper considers classification, design concepts and circuit engineering of radiofrequency identification devices. A survey on circuit designs for the readers and passive tags of the system is presented. The survey results indicate the perspectivity of implementation of particular communications protocols and of ultrawideband systems in order to provide multiple access under the collision conditions.

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1. INTRODUCTION

A promising concept for the development of wireless data transmission systems is the development of the sensor networks for monitoring and control over the physical objects of various nature. This concept is called an Internet of Things (IoT), and besides the implementation of this approach requires the construction of interconnected networks based on the radio frequency identification (RFID) [1].

In general terms a RFID system represents a set of transceiver device called a reader, and the so-called tag. Depending on the applied technology and on the solved problems the tag is an elementary reflector, or a simplified transceiver device, whose objective is the transmission in the form of a response to the input action from the reader of information about the unique tag number, which is expressed in the form of a corresponding digital code.

Depending on the classification criteria and tag type of the RFID systems are divided into the following classes: active, semi-passive, passive; programmable, non-programmable; low frequency (50–134.2 kHz), high frequency (13.56 MHz), ultrahigh frequency (UHF) (860–960 MHz) and microwave (2.45 GHz). Note that the selection of a particular value of carrier frequency range is largely determined by the regional standards [2]. For example, it falls within the 866–869 MHz band in Europe, 902–928 MHz in the United States of America, 950–956 MHz in Japan, etc.

A key factor in the implementation of RFID systems is the substantial reduction in cost while maintaining the principal requirements for the tags, namely ultra low power consumption and the possibility to operate without the power supply; programmability; integration capacity on the chip of microwave part of the tag circuit and the nonvolatile memory (typically of flash type) in the case of programmable tags application. Estimations show that in mass production the cost of tag integrated circuit approaches to 5 cent per unit [3], which makes it possible to utilize sensor RFID networks in almost all areas of life: industrial process control systems, “smart city” integrated security systems, logistics, medicine, etc.

The purpose of this paper is the survey and comparative analysis of circuit engineering of main circuit solutions for the devices of RFID systems. The paper is organized as follows: after the introduction in the second section the circuits of the readers are considered, including both generalized structures and specific circuit designs of the main blocks. The third section presents the basic structures of the passive tags of mainly semiconductor type, and it also briefly describes the features of tag construction based on surface-acoustic-wave resonators. The fourth section is dedicated to the solution of the collision problem, including the utilization of ultrawideband systems. Taking into account that low frequency RFID systems are characterized by the low data rate, large dimensions due to the antenna sizes, short reading distance the paper considers mainly microwave RFID systems as the most promising ones.