TESTING OF UHF RFID READER FOR ITS APPLICATION IN WAREHOUSING MANAGEMENT

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Abstract: This paper deals with UHF RFID reader testing of optimal tag positions for maximal and minimal read range. Consequently, this knowledge about optimal tag position is used in verification of UHF RFID technology suitability in the environment of plastic raw materials warehouse. Finally, results of the testing along with graphical scheme are described and graphically shown.

Keywords: RFID, UHF, warehouse management

Introduction

It is well known that RFID technologies are progressively penetrating into various parts of human's life and industrial applications. In this paper some results of testing of RFID components and configuration which was specified for its use in warehouse management will be presented. One from important activity in warehousing management is operative evidence of production. There are several possibilities how to gather data about actual state of goods in the warehouse. In present time many companies use barcode technology for this purpose. Despite many unquestionable advantages of this technology against the manual data entry and data collection, by its use human factor is not eliminated at all. Just this disadvantage is possible to eliminate by RFID technology which ensures higher automation of operations in warehouse management. This paper is structures as following. Firstly our attention is focused on testing of optimal tag position towards RFID antenna. Subsequently this optimal tag position will be used for verification of automatic method for evidence of goods in warehouse based on RFID technology. Finally, obtained results will be discussed.

1. Testing of optimal tag position

In generally we can use two basic types of RFID tags:

- active RFID tags (contain battery, therefore they can be read from longer distances),
- passive RFID tags (tags are supplied by energy transmitted by RFID reader).

RFID tags can be divided also according to operating frequency to [1.]:

- **LF** → less than 135 kHz → mostly passive, biggest antenna of all RFID tags, no or poor anticollision algorithm,
- **HF** → 13,56 MHz → mostly passive, cheaper than LF RFID tags, used in Smart Cards,

- **UHF** → 860 - 930 MHz → in large volumes cheaper than LF and HF RFID tags, longer read distance than LF and HF, good readability of multiple tags, can be passive or active,
- **Microwave** → 2,45 GHz → similar properties as UHF RFID tags, but with higher read speed, can be passive or active, typically used in electronic toll systems or location tracking,

There are many specifications of RFID tags, nowadays mostly of used are working on LF 125 kHz and HF 13,56 MHz, but recently also UHF tags 860 – 930 MHz (according to location) are going to take large part of the market. In our research UHF RFID technology for testing will be used. Specifically we selected for this purpose Alien ALR-8800 that operates on 866MHz frequency. Testing of UHF reader was carried out in our laboratory conditions.

In order to determine radiation diagram of Alien reader, measurements have been carried out in free room with one standard antenna and Alien ALL-9540-02 passive tag (called also world tag because it can operate from 860 MHz to 960 MHz).

Reader was connected by serial output and consequent USB reduction to the USB port of the computer. Alien RFID Gateway software has been used to identify the interrogation zone of the tag that was attached to the wooden stick. Passive tag and antenna were placed in the same altitude and reader's output signal strength was set to maximum. Overall, three different positions of the tag towards the RFID antenna have been tested:

1. horizontally towards floor and parallel to RFID antenna,
2. vertically towards floor and parallel to the RFID antenna,
3. vertically towards floor and perpendicular to the RFID antenna.

Other positions of the tag were unreasonable because the tag can not receive enough energy to send back information requested by reader if placed only by its edge towards the RFID reader antenna. Therefore horizontally placed tag to the RFID antenna is unreadable and does not require further testing of this position.

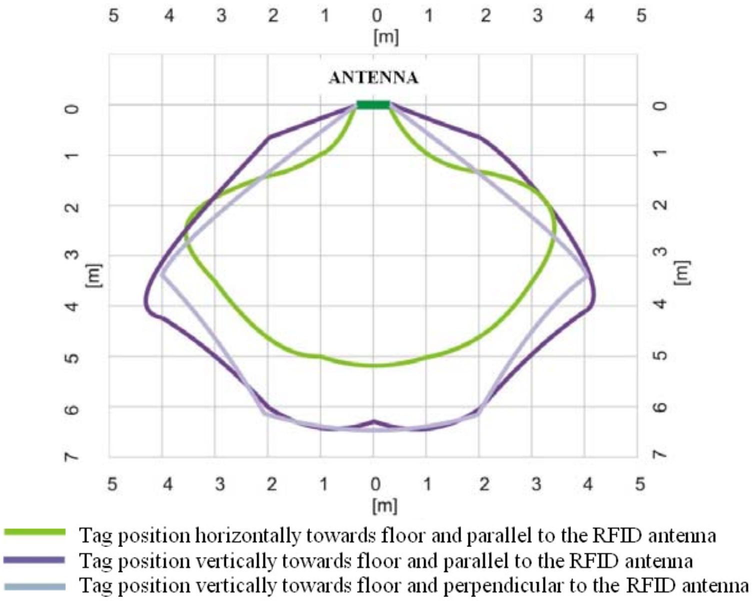

Fig. 1. Summary measurement results of ALR-8800 read range

In each position, the tag was moved through the empty room from the close front of the antenna. The room was empty in order to minimize influence of the surrounding materials to the tag/reader communication, because in these communication frequencies the waves are not only absorbed, but also reflected. In the event that the tag was not recognized anymore by the reader, the border position of the tag read range was recorded. Summary measurement results are shown in the Fig.1. The grid represents 1 meter lengths and each color represents different tag position as mentioned above. Green rectangle presents Alien RFID reader antenna.

From the measurement results we can determine that maximal read range in this particular room and conditions is 6,5m. Measurements have also shown how to place the tag if we want to achieve maximal or minimal read range. According to Fig.1 it is obvious that maximal read range can by achieved by placing tag vertically towards floor and parallel to the RFID antenna and minimal read range can be achieved by positioning tag horizontally towards floor and parallel to the RFID antenna. This is essential, because not all applications of RFID technology require just the maximal read range. Some applications like RFID terminals for items identification demand to have accurate read ranges, but not higher than requested.

2. Verification of UHF RFID technology to collect items data from warehouse

Verification was applied in company producing plastic components with which we have longer mutual research activities. Based on their demand we are presently involved in modernization of their warehouse management, especially with focus to automate items data gathering to the enterprise resource planning (ERP) system.

Initial state of the warehouse management can be described as following. After receiving of raw material, which is in form of granulates, it is stored and manually registered into ERP. Each type of granulate has its unique code, which is subsequently used for raw material (item) identification. Releasing of items into buffer stock is organized by FIFO. Overall, warehouse contains around 60 to 70 kinds of material items. Buffer stock is planned to be sufficient for 24 hours. The requirement to know actual warehouse state is related to optimization of warehouse stock in order to decrease financial sources lock-up.

As output items from production are equipped by barcode, company managers a priory preferred solution based on this technology. Due to the fact of mentioned disadvantages of barcodes, we decided to verify for automation purpose UHF RFID technology. To test suitability of this technology it was necessary to:

- Determine where RFID antenna(s) will be situated. Since fork lift is practically continuously moved in the warehouse it was reason to try place antenna directly to the fork lift (see Fig.2). Moreover it was necessary to locate antenna into check-in and check-out gates. Due to the needs to cover the size of check-in and check-out gates it would be necessary to install four antennas (see Fig. 3.).

Fig. 2. Fork lift with antennas

Fig. 3. Interrogation zone of antennas

- Simulate situation in which tags can be located on any place in the warehouse. It was practically impossible. Accordingly the solution was to place tags in the critical places in the warehouse.
- Carry out testing by use of our laboratory RFID technology system (see Fig. 4.). During the testing fork lift was performing ordinal manipulation activities and simultaneously served as carrier of RFID reader, antenna and wireless access point (see Fig. 5.).

Fig. 4. RFID technology system configuration

Fig. 5. RFID system configuration with the access point

By repetitive measurements in various altitudes it was recognized that the best results were achieved when antenna was 0,7m above the floor. Overall results of measurements are shown in Fig. 6.

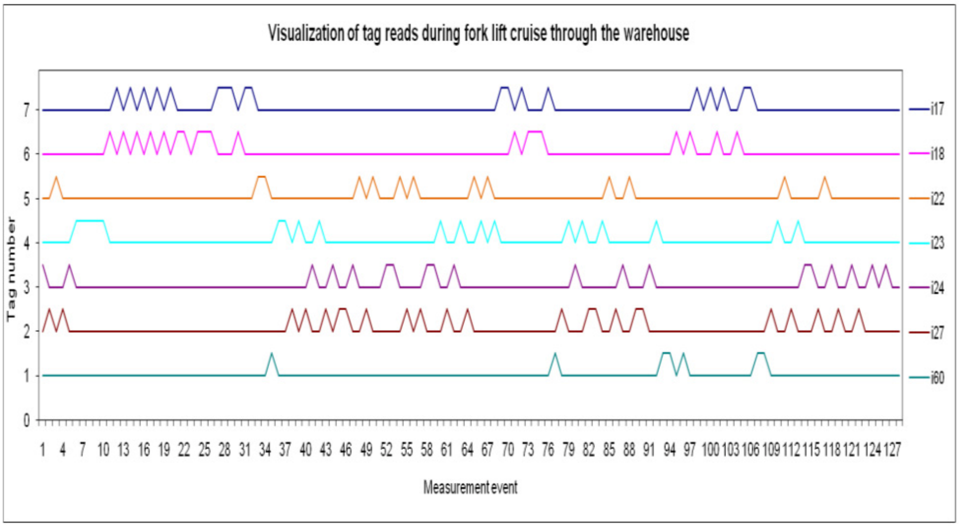

Fig. 6. Graph of measurement results

Testing of RFID system was based on the following principle. By moving of antenna, which was situated on the fork lift were one by one recorded events about tag read and tag signal loss. During experiment we recorded 127 events. Simulation of real conditions took 238 seconds. This time was in our opinion sufficient, because during this period fork lift one time repeated common trajectory that simulated real work conditions in the warehouse. Frequency of tag reading was set to 1 second. Tag was positioned vertically towards floor and parallel to the RFID antenna in order to achieve maximal read range. Construction of results shown in Fig.6 is based on the following rules (R):

- R1: In one event can be just one tag read.
- R2: Two or more neighbor events can occur in the same time.

3. Conclusions

Results of testing recorder during fork lift cruise through the warehouse show that all tags were read repeatedly but in different appearance. To conclude obtained measurement results it is possible to formulate the following findings:

1. Repetitive read occurrence of each tag during given time period at least adequately if not supernumerary suits requirements for operative evidence of stock items in real time regime.
2. Different appearances of tag reads during the same time period were caused by non-equal distances and surrounding environment.

Based on the above findings, it can be stated that testing of UHF RFID read technology approved this technology as applicable for given conditions.

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