ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 10, Issue, 11, pp. 42292-42297, November, 2020
https://doi.org/10.37118/ijdr.20429.11.2020

RESEARCH ARTICLE OPEN ACCESS

THE USE OF RADIO FREQUENCY IN THE INDUSTRY

James Araujo de Souza, Bruno Lopes Trindade, Rilmar Pereira Gomes, Bruno Pereira Gonçalves and *David Barbosa de Alencar

Academic Department of the FAMETRO University Center, AM -Brazil

ARTICLE INFO

Article History:
Received 27th August, 2020
Received in revised form
29th September, 2020
Accepted 07th October, 2020
Published online 30th November, 2020

Key Words:
RFID, Industry, HP.

Corresponding author:
David Barbosa de Alencar

ABSTRACT

This article covers RFID technology, which stands for Radio Frenquency Identification or Radio Frequency Identification. Technology that uses radio frequency communication to transmit and receive data from a mobile device to a reader, that device can be, for example, a tag, a card or even a key ring, which are known as a tag. It can be pointed out that there are several advantages, among them, its diversity of supports, security, easy integration, technological development capacity and achievable market value proves to be one of the most interesting solutions for automatically storing data. It was largely intact in the industry, as it proved to be efficient in process optimization and aid in the analysis of data related to production. The equipment necessary to install this technology in a company, the antennas, readers, tags and computers were also analyzed, and the cost compared to the profit the company will have when using this technology.

Citation: ***James Araujo de Souza,Bruno Lopes Trindade, Rilmar Pereira Gomes, Bruno Pereira Gonçalves, David Barbosa de Alencar.*** "The use of radio frequency in the industry*", International Journal of Development Research*, 10, (11), 42292-42297.

INTRODUCTION

As the name suggests it is a technology in which radio frequency communication is used to transmit data from a mobile device to a reader, in which that device can be a key ring or a tag (in which they are called a tag). The tags have an antenna and a chip surrounded by a material, such as glass or plastic, in which they respond to remote indicators from a reader that is normally plugged into a computer. An RFID system is built mainly by two components, tags (tag or transponders) and a reader. This system disseminates data by means of a non-routed medium of any object, using radio waves. The history of RFID really began in 1973, when Mario W. Cardullo applied for the first American patent for an active RFID system with rewritable memory. In the same period, Charles Walton, a California entrepreneur, acquired the patent for a passive system, in which it was developed to open doors without the need for keys (SANTINI, 2016). Until that time, the tags used were low frequency (LF), 125 kHz, until the companies that marketed these systems switched to high frequency (HF), 13.56 MHz, in which it was irregular. Nowadays, these systems are implemented in several applications, such as access controls and payment systems.

The rise of UHF (Ultra High Frequency) RFID was in 1999, when the Uniform Code Council, EAN International, Procter & Gamble and Gillete founded the Auto-ID Center at MIT, Massachusetts Institute of Technology, the birthplace of several other technological advances. The Auto-ID Center's research was to change the essence of RFID from a small mobile database to a serial number, which would bring down costs and transform RFID into a network technology, connecting objects to the Internet via tags (SANTINI, 2016)..

Theoretical Reference: When examining an RFID system it is noted that for its primary composition the fundamental devices for it to work, its particularities, types and main information. The mentioned devices are: Transponder or tag, antennas and readers.

TAGS: The tag, transponder (from the English transmitter and responder) or tag, has the purpose of transmitting and responding commands coming from radio frequency. Its primary infrastructure is: a chip that gathers information and a resistor acting as an antenna, covered by some material such as plastic or silicone.

The primary function of a tag is to incorporate data about an object. An example of a tag is Figure 1, where you can see its layers.

Fig. 1. RFID tag Source: hanser.com

Tags can be divided into three groups: passive, active and double:

PASSIVE TAGS: Nowadays passive tags are better known for having beneficial factors in terms of format and can be manufactured at a more affordable cost, in part, because they do not require battery power. The tags acquire energy through the electromagnetism expelled by the reader. There are several situations in which passive tags are used, such as industrial automation, electronic product surveillance and access control.

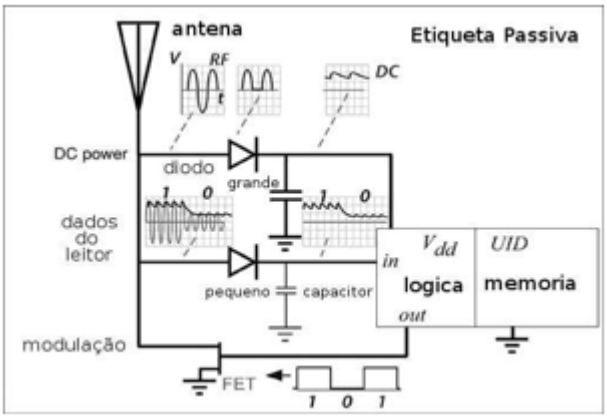

Fig. 2. Block Diagram of the Passive Label Source - DOBKIN, 2017

The electromagnetic waves coming from the reader device are irradiated through dipole antennas to the antenna located on the label, which is a dipole antenna. As the signal is obtained is an alternating current and the internal circuits require a direct current, a full wave rectifier circuit (circuit with the diodes in figure 2) is used to obtain a continuous voltage that will charge the capacitors that will serve as batteries to power the label. In which the same receiving channel is also used to irradiate the data gathered on the tag to the reader device by means of a modulation process.

ACTIVE TAGS: Active tags are also known as two-way. They contain in its structure an internal battery in which it feeds the internal circuits and a transmitting circuit, which in some cases has a relatively high operating radius when compared to other label technologies, in addition to capturing data in motion.

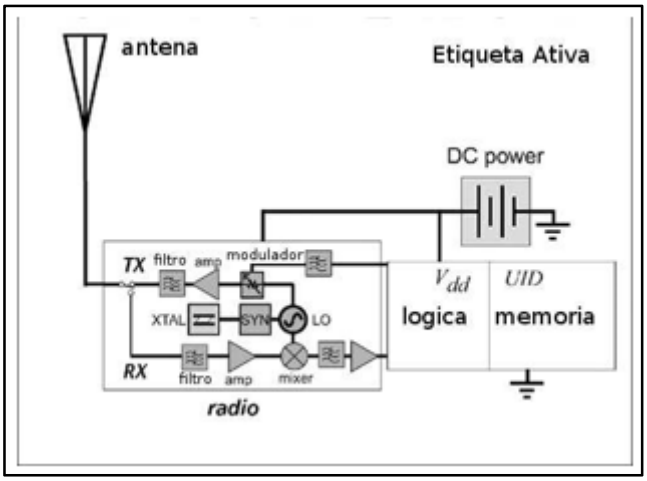

Fig. 3. Block Diagram of the Active Source Tag - DOBKIN, 2017

With these characteristics the device has a higher cost, focusing on the use of products with high monetary value, such as trucks and automobiles. These tags work in a frequency range that ranges from 850 MHz to 5.8 GHz. Therefore, the active tags are radio systems that contain a battery, receiver, transmitter and control circuit in their structure (DOBKIN, 2017). In the label represented in figure 3, the signal that will transmit the information, or carrier wave, is caused by an oscillator circuit (LO) in which the frequency is defined through the internal crystal (XTAL), certifying the communication through a specific band of frequency. The data provided by the logical unit modulate this generated carrier. The consequent signal is amplified (amp) and filtered before being routed to the antenna for transmission (TX). In the reception process, the signal received by the antenna is filtered, amplified and "demodulated" in such a way that the received data is recovered. This type of tag makes it possible to operate on different communication channels (different frequency bands).

SEMI-PASSIVE TAGS: Semi-passive tags, contrary to passive tags, contain auxiliary batteries in their structure that are used to power internal circuits. These tags are not capable of radiating their own signal, and their communication is still made by the reader. Compared to passive tags, they are more expensive, but deliver a greater operating distance (GOMES, 2015). The functionality of this type of identifier is between passive and active, because even though it has a battery, it only feeds the internal circuits and cannot create a new radio frequency signal for the reader (GOMES, 2015). The batteries that are equipped with these tags are only focused on expanding the processing capacity in more hostile radio frequency environments.

This type of technology is widely used for access control due to its low cost and easy adaptation to cards made of plastic and glass materials. The main difference between passive semi-passive tags is the use of an internal battery that powers the logic reception circuits (NARCISO, 2018). This type of label is often used in situations where it is desired to have an operating radius greater than that provided by the passive label, also improving reading in special conditions. The block diagram of the internal circuit of a semi-passive label. It can be seen that figure 4 is very similar to figure 2, which shows the internal diagram of a passive label. However, the difference is the presence of the battery to supply the logic circuits.

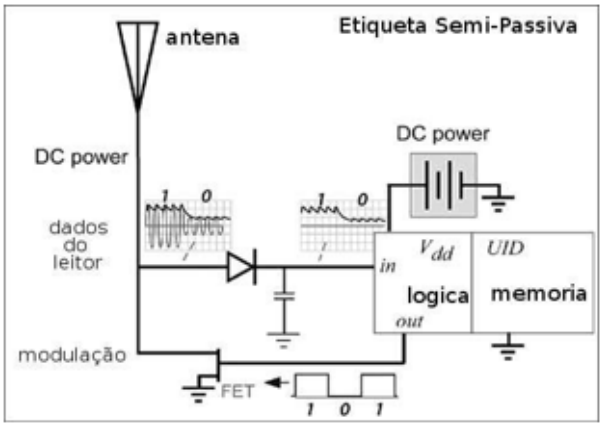

Fig. 4. Block Diagram of the Semi-Passive Label Source - DOBKIN, 2017

ANTENNAS: Antennas have a fundamental role in the telecommunications area and consequently in RFID technology, since they are based on transceivers. They are essential for wireless communication, being a means to both transmit and receive radio waves. Therefore, they are responsible for the transformation between irradiated energy and energy directed in a transmission medium. The radiation from electromagnetic waves occurs in all conductors subject to a potential difference and / or electric current that varies over time. The antenna is a component in which it was designed to work in a specific frequency range based on the characteristics of the project (FINKENZELLER, 2015). There are several types of antenna and many variations, this is due to the fact that each application generally modifies some characteristics to better adapt to a specific system.

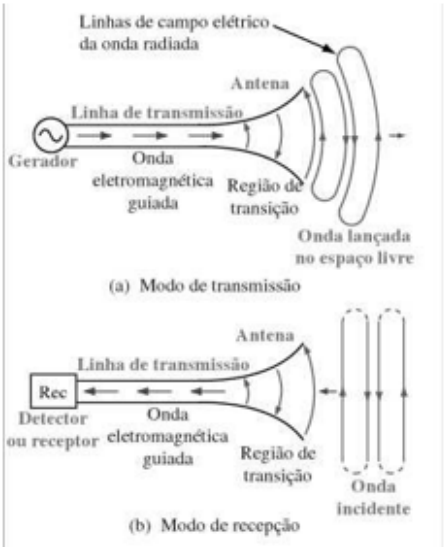

Fig. 5. Antenna "seen" as a transducer between the guided electromagnetic wave and the wave in free space, both for transmission and reception Source - ULABY, 2015

READER OR TRANSCEIVER: Readers are components that are in communication with the tags through an antenna that emits radio frequency signals. In short, they are transceivers - transmitters and receivers in a single device. These signals stimulate the label that behaves like a transponder - a device in which it accepts a signal with a certain frequency and retransmits, and that retransmitted signal may have a frequency different from that received - accepting the communication with the reader device, which will radiate the product data for middleware (CORNELIUS, 2015).

Those who are only able to read are classified with passive tags, and have the function of only capturing the data of the energized tags. On the other hand, those who perform "read / write" are used with active tags, and can both capture and transmit data. The RFID reader works with standardized frequencies ranging from 125 KHz to 2.4 GHz.

CONTROLLER: This physical device as the name suggests is responsible for controlling the reader. There are several types of readers that can vary from a small reader to a microcomputer with a server system and several functionalities.

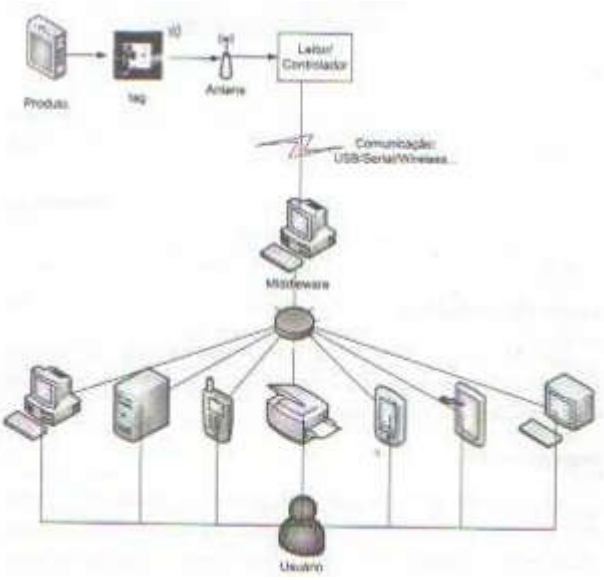

Fig. 6. Main components of an RFID system Source: SANTINI, 2016

MATERIALS AND METHODS

After an analysis of the main devices of an RFID system, it is essential to clarify its operation so that there is a distinction between the applications of the technology. Describing how the interaction between the two ends of the system takes place: the tag and the reader. Briefly, a reader modulates a certain radio frequency, radiates to a tag that captures through a coupling element and transmits them to your microchip. If the tag did not have its own battery, the power is supplied through the reader by means of radio waves, therefore, it will only be operating when it is within the reader's range. Thus, communication takes place through radio frequency, in both directions. There are three designations according to Santini (2016, p. 31) adopted to classify RFID systems which are: Low-end Systems, Mid-Range Systems and High-end Systems. Which will be described below. Low-end Systems are the simplest systems characterized by the system. They analyze whether there is a tag in the antenna's range, also known as the interrogation area. Also, in this type of designation are the tags with microchip and read-only memory, in which they normally have a single immutable serial number. When in a interrogation area, the tag begins to radiate its signal throughout. The moment this occurs we call it broadcast. Thanks to this feature, it is not allowed to have more than one tag in the same interrogation area, as there will be conflict and they will not communicate with the reader. That is why only one tag is placed under the interrogation area at a time when using Low-end Systems. Despite having

weaknesses, it remains an excellent system due to its simplicity. The tags can be compact and do not require batteries and memory, with low energy consumption, their market value can be reduced.

They can work at all frequencies and their range can be wide, thanks to the low consumption of the microchip. They usually operate where the amount of data required is low. Mid-Range Systems is known for a variety of systems with memory that accepts writing, ranging from a few bytes to 100 Kbytes, with EEPROM (Electrically-Erasable Programmable Read-Only Memory) or SRAM (Static Random Access Memory) memories. As for the system design, the tags are successful in processing some type of information, such as a treatment that avoids conflicts, and may have more than one tag in the interrogation area. Another feature is the ability to retain encryption processes, such as a validation between the reader and the tag, which can work at any available frequency. High-end Systems, on the other hand, has the greatest complexity in the chain's RFID system, characterized by a microprocessor and a Smart Card operating system. Thanks to the use of this microprocessor, it is possible to implement more efficient validation and encryption algorithms. The chain hierarchy belongs to the dual interface Smart Card, in which there is a cryptographic coprocessor. A benefit of using this coprocessor is the enormous time saved, which makes Contactless Smart Cards usable in applications that require a high level of data transmission security, such as an electronic bag or public transport ticket systems. This type of system operates only at the frequency of 13.56 MHz. Regarding communication, the tag is linked to the reader through a radio frequency, which makes its classification essential. In Full Duplex (FDX), the tag and the reader can communicate at the same time, where data is transferred from the tag to the reader and the same occurs from that to that. Half Duplex (HDX), each has a turn to communicate, the data transferred by the tag is similar to communication by walk-talk (SANTINI, 2016).

RESULTS AND DISCUSSION

This system provides and transmits electromagnetic waves, so they are legally classified as radio systems because it has the same or is affected by some already existing one. The figure below shows the division between the frequency types, where we have their frequency value (f), the wavelength (λ) and their classification. VLF is Very Low Frequency, LF is Low Frequency, MF is Medium Frequency, HF is High Frequency, VHF is Very High Frequency, UHF is Ultra High Frequency, SHF is Super High Frequency (EHF) and EHF is Extremely High Frequency (Extremely High Frequency).

Table 1. Frequencies of Operation

	VLF	VL	MF	HF	VHF	UHF	SHF	EHF	
f	0,01	0,1	1	10	100	1000	10000	100000	MHZ
□	30000	3000	300	30	3	0,3	0,03	0,003	m

Source - SANTINI, 2016, p.38.

Each frequency range has its pros and cons due to the size of the wave and due frequency, which implies attributes such as the signal range, its quality and use. RFID systems can operate with frequency bands known as ISM (Industrial-Scientific-Medical or Industrial-Scientific-Medical). In Brazil, according to EPC Global Inc., regulations work in the 902 to 907.5 MHz (UHF) spectrum and from 915 to 928 MHz for products.

The official frequency for nearby identification devices (smart cards, ticketing, among others) is 13.56MHz (SANTINI, 2016).

Applications

The RFID system can be adhered to in several areas, for example, in Hospitals, Vehicles, Human Implants, Security, Industries, among others. Hospitals use active RFIDs in order to track pieces of equipment when requested by the doctor. The screening has two roles: first, the medical team, primarily nurses, reduce the time looking for equipment, consequently dedicating proportionately more time for direct attention to patients, and secondly, hospitals can make more efficient use of equipment that have, decreasing the expenses related to the lease and purchase of additional equipment. The RFID implemented for tolls and parking in shopping malls can propose greater speed in your payments. Through the application of an adhesive label glued to the windshield, the user has access to points that have the antenna installed and this makes the reading and opens the gate automatically. The same RFID chip implants used in animals can also be used in humans. In 1998, British cybernetic professor Kevin Warwick performed an implant on his arm. The company Applied Digital Solutions proposed that its chips be used as a solution to identify fraud, security in accessing certain locations, computers, drug databases, anti-kidnapping initiatives, among others. Combined with sensors to monitor body functions, the Digital Angel device could monitor patients (CLAMPITT, 2017).

The use of this technology in the security area can be applied to immobilization systems. In the 90s there was a growth in relation to car theft, which made the security market for cars, alarms and immobilization systems, a growing market. For years we have seen alarm controls on the market with a range of 5 to 20, and they are small radio frequency transmitters that operate at a frequency of 433.92 MHz. In this type of car security system, it is only this control that can trigger the unlocking of the car, allowing it to be opened without a noise being emitted, the alarm, the doors unlock. Allowing the car to be started is the work of the immobilization system. Looking at the industry's field, RFID systems can be applied in several areas. An example is in the Semiconductor Industry, where an increasing number of semiconductor manufacturers, such as Motorola, SGS (Société Générale de Surveillance), Thomson and Wacker, started using RFID in their aseptic rooms, with the aim of implementing superior levels of control, increase quality, increase the efficiency of operators and the use of equipment.

Implementing RFID in the Industry: There are several applications for RFID systems in the industrial sector. It can be implemented in the identification of tools that, in the industries that occupy the highest level of the hierarchy, facilitate the process of maintenance, replacement and administration of them. Another application in the industry that would mean greater speed and quality of service and would provide security would be in the identification of containers, packaging and bottles, mainly in chemical products and gases, in which any error without packaging can cause serious damage. Currently, there is a range of product management systems that is based on bar codes, but in industries, it is not the most reliable system in existence.

With the use of the transponder, information such as the owner of the container, its content, volume, filling, analysis or maximum pressure can be stored, there are applications in which it is possible to implement a security mechanism that protects the reliability and editing of the information (SANTINI, 2016). The tags are inductive coupling, work in a frequency range of 135 KHz and accept conditions such as dust, impacts, radiation, acids and very high or very low temperatures (from -40ºC to + 120ºC). With the use of RFID for industrial automation, it qualifies some characteristics that provide the efficiency of processes. Its use automates the assembly process through the use of this technology to verify components and assembly instructions.

Semiconductor Industry: There is also a need to keep the environments hygienic, which makes RFID the natural solution to adopt, as it completely eliminates the need for human manipulation to capture data (SANTINI, 2016). Losses due to production stops are especially high in the semiconductor industry. The weekly production of a factory can reach values of the order of 200 million chips, making any stoppage a significant source of losses. In one of these sanitized rooms, there can be as many as 800 locations where semiconductors are transported. A common type of error in human manipulation is that of semiconductors being placed on trays that do not belong to the corresponding lot. By identifying these boards with an RFID tag, there will be an increase in the accuracy of the process (BUSINESS CONTROL, 2018).

In a standard execution for this industry, both transport trays and employees have an RFID tag. At each production step, the shipping tray and employee tags are scanned, and certified by a production workflow system, ensuring that the process is being followed correctly. The system certifies the process for each batch, equipment, container and operator. If the established standard process is not followed, a warning signal is issued, and the equipment is stopped, and it is not possible to put it into operation until there is a normality signal (BUSINESS CONTROL, 2018). Before joining the use of RFID, this process was carried out manually, by operators who collected the data through barcode scanners and by entering the identification numbers and access codes on keyboards. The system also started to inspect the equipment for the detection of bottlenecks and other deficiencies (BUSINESS CONTROL, 2018).

Cost Benefit: It is observed that the benefits for the implementation of RFID can be classified based on time (short and long term) or tangibility (direct and indirect). In some cases, such as item-level labeling in an application in an end-to-end supply chain, a network effect may also be present. The value for using RFID can be minimized when only a few participants use it. However, there is a significant increase in value when most of the supply chain participants have RFID and the data is shared among the participants (OLIVEIRA, 2019).

Elements of Cost: When studying the cost of using RFID, we speak between three main areas: hardware, software and services. Hardware costs include the cost of tags, readers, antennas, the central computer and network equipment (cables, routers, among others). Software costs include the cost of creating or updating middleware and other applications. Service costs include the cost of installation, tuning, integration of the various components, training, support and maintenance and reengineering of the business process (workflow) (SANTINI, 2016).

Project Benefits: The incorporation of RFID technology was very beneficial for the HP company and brought with it results, for example, the levels of efficiency and optimization of production time. These benefits can be quantified by measuring progress in time saved (in operations) by the success in product tracking, which will result in minimizing working hours, preserving and taking advantage of the company's resources (MALTA, 2016). An evaluation of the production time in the manufacturing and customization lines was carried out with the before and after of the implanted technology, the result was the reduction of the production cycle time. With the possibility of tracking its products, the company ensured a better view on the efficiency of its supply chain, ensuring greater efficiency in delivering its products to customers. These data were observed from the reports generated based on the data obtained by RFID. HP estimates that it will be able to reduce the stock of the printers by about 20% and with the products labeled from the beginning to the end of the assembly process, the company has data that alert when a stage is taking longer than it should be, obtaining results on the spot on the time and quantity of products that have an impact during the process. With this, the company will be able to solve its problems, checking the equipment on the production line and the quality of the parts that are being used, analyzing the assembly process and certain factors in order to solve any accused problem (ALMEIDA, 2016). Because the ink cartridges have an expiration date, the “install by date” does not let the goods expire in stock, stating their deadline. The company points out that product shipment times were reduced by 12% and inventory times by 17% (MALTA, 2016).

Disadvantages of RFID Technology: Despite the numerous benefits of technology, there are still some shortcomings. We have as a negative aspect the high values of the components, mainly for a national company that imports these items, since going in the opposite direction to what many think immediately, the technology is not limited only to the microchip placed in the product, but there are other components of extreme importance for the functioning of technology examples of antennas, readers, communication systems, etc., which raise the value of technology as a whole. Although the issue of standardization is well resolved, it is still something that is constantly progressing. Consumer privacy issues are a subject that is being addressed a lot by customers lately, about the monitoring of labels placed on products. Another issue isthe collision of frequencies in the same environment, which requires studies, tests and a good configuration of antennas and technology as a whole (GTA, 2015).

Conclusion

The objective of this work was to carry out a systemic analysis of the RFID, analyzing the technical aspects and its general functioning, as well as the characterization of the entire system. This objective was successfully achieved, given that all its components, its different types and their respective functions in the system were detailed throughout. The cost of implementing RFID in an industry was also raised, checking whether it was feasible or not, and the equipment needed to make the system efficient enough for the customer's objective.

The use of antennas, tags, readers and computers that will process the information is extremely necessary, therefore, it is necessary to observe the total cost of this equipment in order to carry out a study in the industry and see if there will be a significant improvement in production, and consequently increased profits. The observed case study was very important to confirm the application of RFID. Many challenges faced in the implementation of the RFID project have enabled several studies, such as the analysis in the optimization of production and advances in the RFID area, and have prompted several other companies to study and adopt the new technology, and the price of RFID technology is still a limiting factor for many companies.

In search of increased efficiency in the organization, control and even distribution of products and goods, RFID, if well applied, optimizes time and manpower, provides more agility, reliability and speed by updating the database, tracking goods and reducing the need for human intervention in the management of the system. It is worth mentioning that RFID is a technology that is still in full development and several standards have not yet been developed. Costs are falling, as large retailers, manufacturers and technology companies are increasingly opting for the system in their production lines, warehouses, shelves, security, among others. The use of the RFID system can be diversified in the company, considering that it can be applied in several sectors, for example, in security for employee access control, in the processes of improving production efficiency and checking the time used in each line and thus make a study to minimize time and increase productivity, and in logistics to control inventory faster and more effectively. Therefore, in view of the exponential growth in the needs for using RFID in an increasingly globalized economy, developments related to this technology would be extremely important.

REFERENCES

ALMEIDA, Lucas Cavalcante de. Aplicações da Tecnologia de Identificação por Rádio Frequência – RFID. Ceará, 2016. Trabalho de Conclusão de Curso – Universidade Federal do Ceará.

BERNARDO, Claudio Gonçalves. A Tecnologia RFID E Os Benefícios Da Etiqueta Inteligente Para Os Negócios. Revista Eletrônica Unibero de Produção Científica, São Paulo, Sp, n. , p.1-9, set. 2004. Disponível em:<http://aulas-gelsimar.googlecode.com/svn/trunk/TOLER%C3%82NCIA_FALHAS/A_Tecnologia_RFID.pdf>. Acesso em: 15 set. 2015.

BHUPTANI, Manish.; MORADPOUR, Shahram. RFID: implementando o sistema de identificação por radiofrequência. São Paulo: IMAM, 2015. 250 p.

BROWN, Dennis E.. RFID Implementation. New York: Mcgraw-hill Professional, 2017. 466 p.

BUSINESS CONTROL. Tecnologia RFID: Aplicações para a Indústria e Distribuição. Disponível em: < http://www.business-control.pt/documentos/RFID_Pt.pdf> Acesso em: 8 de Out de 2018.

CLAMPITT, Harold G. The RFID Certification Textbook. [s. L.]: American Rfid Solutions, 2017.

DOBKIN, Daniel Mark; WANDINGER, Titus. A Radio-Oriented Introduction To RFID—Protocols, Tags And Applications. High Frequency Electronics,[s.L.],n.,p.32-46, ago.2017.Disponívelem: <http://applications.www.mobiusconsulting.com/papers/HFE0805_RFIDTutorial.pdf>. Acesso em: 25 set. 2017.

GTA. RFID. Disponível em: <http://www.gta.ufrj.br/grad/07_1/rfid/RFID_arquivos/utilidades.htm> Acesso em: 8 de Out de 2015.

JUNIOR, Joel Andrelo. RFID – Identificação Por Radiofreqüência. 2017. 52 f. Monografia (Bacharelado) - Faculdade De Tecnologia De Praia Grande, Praia Grande.

MALTA, Camila Rodrigues. RFID: Aplicações e novas tecnologias. São Paulo, 2016. Trabalho de Conclusão de Curso – Faculdade de Tecnologia da Zona Leste.

OLIVEIRA, Alessandro de Souza.; PEREIRA, Milene Franco. Estudo da tecnologia de identificação por radiofreqüência – RFID. Brasília, 2019. Projeto de Graduação – Universidade de Brasília, UnB.

OLIVEIRA, Paulo Cristiano de; DIONÍSIO, Renato de Castro; BAPTISTA, José Abel de Andrade; RAMIREZ, Paulo. Proposta de Implantação da Tecnologia de Rádio Frequência (RFID) em um Operador Logístico. Disponível em: <http://www.anpad.org.br/diversos/trabalhos/ EnADI/enadi_2011/2011_ENADI45.pdf> Acesso em: 12 de Out de 2019.

Santana, Sandra R. M.. Identificação por radiofreqüência. WIRELESS BRASIL. Disponível em: <http://www.wirelessbrasil.org/wirelessbr/colaboradores/sandra_santana/rfid_01.html>. Acesso em: 15 de set. de 2015.

Santini, Arthur Gambin. RFID: Conceitos, Aplicabilidade E Impactos. Rio de Janeiro: Ciência Moderna, 2016. 81 p.

Santos, Marcos Guimarães. Abordagem Sobre a Aplicabilidade da Tecnologia RFID na Cadeia de Suprimentos e na Administração de Estoques. São Paulo, 2019. Trabalho de Conclusão de Curso – Faculdade de Tecnologia da Zona Leste.

Ulaby, Fawwaz T.. Eletromagnetismo para engenheiros. Porto Alegre: Bookman, 2015. 382 p.

****