CHARACTERIZATION OF AN RFID READER.

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ABSTRACT:

Radio frequency identification (RFID), which was developed during World War II, is a technology that provides wireless identification and tracking capability and is more robust than the bar code. From Electronic Article Surveillance (EAS) for article (mainly clothing) security to more sophisticated uses, RFID is seen by some as the inevitable replacement for bar codes.
With increasing use comes increasing concern on privacy and security. Clearly there is considerable work to be undertaken before RFID becomes as pervasive as bar codes although the tempo of change is increasing rapidly.

INTRODUCTION

The RFID system configuration comprises at least one reader (interrogator), a reader antenna, tag (transponder), a host computer, and "middleware" that include software and a database.

In general, the reader emits a signal at a certain frequency. When an RFID tag passes within the reading area of the reader antenna, the reader detects and asks to tag their information content.

This process is carried out by electrical / magnetic coupling or capture electromagnetic waves through the antenna. El lector (reader) is able to store and transfer information of the object, which may include the inventory number, current location, status, and as wide a variety of other possible information to a central computer system.

The tags are attached to a wide variety of articles for the purpose of identification and tracking. Which one of the tags has installed by the manufacturer with a unique identification code and memory space. An RFID reader is a device that can read / write data from / to RFID tags compatible. The act of writing data from the tag by a reader who is called to create a label.

The process of creating a unique label and association with a known object placed on the label. Similarly labels can be destroyed. The time during which a reader emits RF energy to read labels is called a cycle, which is internationally regulated. An RFID tag or

Transponder is a device that can store and transmit data to a reader (no contact) via radio waves.

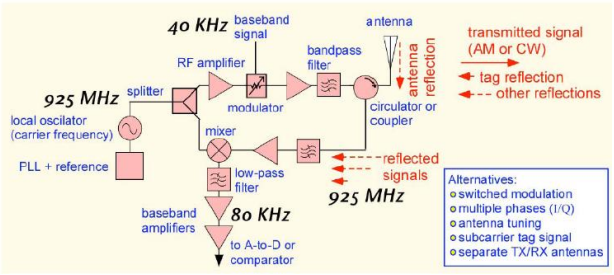

Figure 1: Block diagram of the RF section of a typical RFID reader

Most labels are a chip ", which consists of two main components: a small application-specific integrated circuit (ASIC) and an antenna. A reader (reader) communicates with an RFID tag through the reader antenna that transmits signals from a transmitter RF reader with its environment and receives the response of the labels.

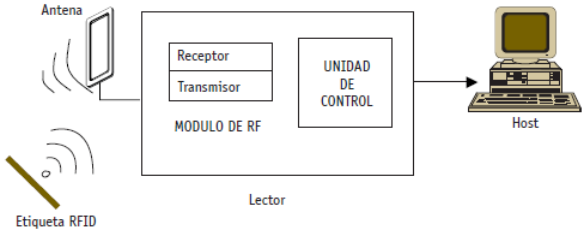

Figure 2: Scheme of an RFID

Because the available frequency for RFID applications ranging from uses a low frequency (LF) of 125-134.2 kHz, a high frequency (HF) 13.56 MHz ultrahigh frequency (UHF) 840-960 MHz microwave frequency (MWF) of 2.4 GHz, 5.8 GHz and 24 GHz, the reader antennas used for RFID applications features.

1. DEVELOPMENT WORK

The antennas of the reader (reader) play an important role in RFID applications. RFID systems readers, who use antennas to optimize the characteristics of these, the enhanced detection range, higher detection accuracy, more common configuration, easy deployment, and lower costs. [1]

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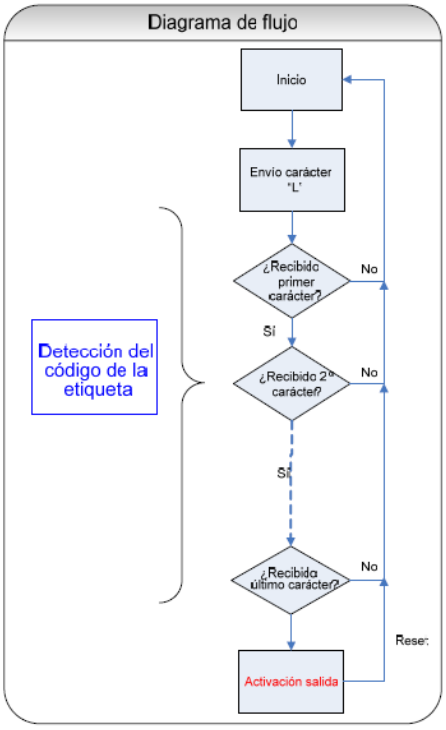

Figure3: Flowchart

In general, the loop antennas used in LF / HF RFID systems are required to generate desired magnetic field strength within a specific area of coupling. While in the UHF band and MWF, patch antennas are usually taken as the reader antenna, which is preferred to be circularly polarized, with broadband and high gain.

Moreover, common factors such as reliability, size, weight and cost should also be considered in all RFID antenna designs. The RFID system consists of the following additions:

1.1 The Microcontroller

By definition, a microcontroller is an integrated circuit that contains all the structure (architecture) of a computer, ie CPU, RAM, ROM, and several peripherals integrated circuits and analog / digital converters, timers, counters, etc. For our application, the use of a microcontroller is ideal, yet will not limit the possibilities for future developments, as for example, any microcontroller midrange / low allows the handling of a larger external memory.

In addition, the services offered by it allow several of the pins may be associated with different programming integrated peripheral circuits, which need to be used. As for the selection of the microcontroller. The main points to consider are:

1. Ability to interface serial communication with the RFID reader.

2. Have at least one control output.

3. Ability to reprogram easily and quickly, for future modifications and expansions.

A low-cost microcontroller, which amply meets the requirements set out above, is the 16F628A model of Microchip. The ability of hardware serial communication (UART integrated) simplifies programming and downloading at the same microcontroller software management routines, which should be implemented in the opposite case. Figure shows a schematic functional microcontroller used [7]:

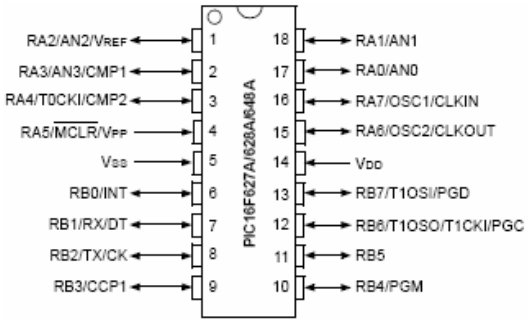

Figure 4: Microcontroller 16F628A

1.2 The Label

The label contains data that is transmitted to the reader when he's "questioning", that is, when a reader encounters found in its range. The most common tags consist of an integrated circuit (IC) consisting of memory and a control chip. A label can perform basic tasks (read / write from / to memory), and even manipulate the data that is stored in its memory.

Basically, the memory capacity of a label can be read-only (read-only, RO) of a script and multiple reads (write once, read many, WORM) or read-write (read-write, RW) [1].

Writing skills in the memory increase total cost of the label, while also provide the ability to perform more complex functions. At the same time, read-only tags will eliminate the risk of accidental or malicious overwrite or modify data.

The equipment used supports the so-called passive tags. Such labels have a number of factors that enable low-cost production. Not require a standalone battery and get the energy advantage of the magnetic field generated by the

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reader antenna. The energy is captured by an antenna itself, usually integrated in the same area as the control chip to form a single unit. This process of reception of energy is called inductive coupling.

Several antenna configurations typical in this type of cloud. Although the integrated circuit can be quite small (the size of a grain of rice or smaller), the size and shape of the antenna generally determines the limits of the dimensions of the packaging label.Compatible with the reader used:

Figure 5: Transmission format of the label

The reader sends the code in a particular host, using the format called industrial (Industrial Tiris Format). In this case, the code has a length of 64 bits. Of those 64 bits the reader turns the 12 most significant decimal sending a 4 digit decimal number (from 0000 to 4095), known as application code, the remaining 52 bits are also converted to decimal in a number of 16 digits (0000000000000000 to 4503599627370495), called tracking. Figure 9 shows the component parts of this format:

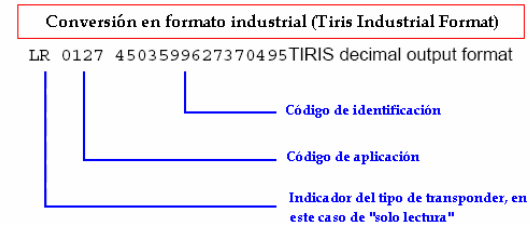

Figure 6: Industrial Format Conversion

For example, if the reader detects a tag can be reprogrammed, it will send the character "W", and if it is set in line mode will send the string "LW", followed by the identification code [8] such as LW 0000 0000000013444555 <CR> <LF> (where CR and LF are non-printable ASCII characters).

1.2 The Antenna

The antenna is the device responsible for transmitting and receiving data and provides the energy needed for the labels to send its identification code. As mentioned above, the reader works by inductive coupling generates a magnetic field. There are several possible antenna geometries (circular, square, stick or focused, rectangular, in turn).

The relative orientation of the tag antenna and reader affects the amount of transmitted power, having a peak position and a null position, for which the label is not getting power (this occurs when the surface of the tag antenna, supposing for simplicity a loop, it is not traversed by any magnetic field line). show magnetic field lines generated by a square antenna and the orientation of maximum induction of energy in a label, depending on their relative orientation with respect to the magnetic field lines generated by the antenna:

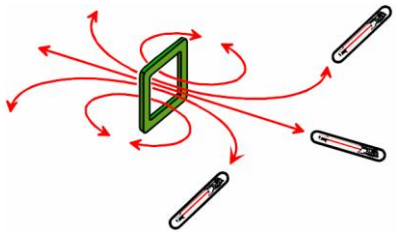

Figure 7: Magnetic field lines

Los factores a tener en cuenta en el diseño de antenas de acoplamiento inductivo son los siguientes:

1. High quality factor Q (around 100) A high quality factor results in a higher power transmission. The quality factor is calculated according to equation:

$$Q = \frac{2\pi \cdot f \cdot L}{R} \quad \ldots (1)$$

Where:
f = 134200 Hz (134.2 KHz)
L = inductance of the antenna
R = resistance to 134.2 KHz

Although the resistance should be measured at the working frequency, the continuous value can give a rough measure of Q [8]. A low Q factor worsens the performance of the antenna, resulting in a lower reading distance:

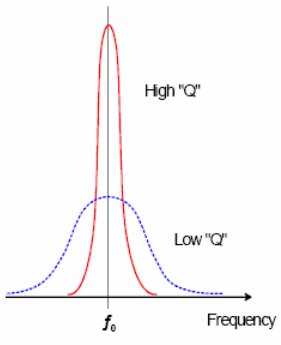

Figure 8: Q Factor

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2. Lower cable resistance. In relation to all the above, a high resistance decreases the quality factor Q.

Thus, for the antenna performance is not poor, the total resistance of the cable should be about 0.3 Ω.
To achieve this we used a type of cable called litz wire [2], which maintains low resistance to the working frequency.

3. Tune in resonance equipment. The reader antenna is part of a series resonant circuit, in a generic way we can define this type of circuits to those formed by inductors and capacitors, in which their impedances to certain frequencies are canceled, with the maximum current in and dependent only of the resistive component. When driving the maximum current possible, so the magnetic field generated and the higher power transmission from the antenna to a [11]; this point, known as a resonance should occur at the working frequency, 132.4 KH z (resonance frequency). With the equation we can calculate the resonant frequency:

$$f_{res} = \frac{1}{2\pi\sqrt{LC}} \quad \text{... (2)}$$

The reader used works at the point of resonance when the inductance of the antenna has a value of 27 uH [8]. This detailed parameter is dependent on the dimensions and geometry of the antenna. Considering a rectangular antenna (Figure 13), its inductance can be estimated by the following equation [11]:

$$L = \frac{0.0276 \cdot \left|(CN)^2\right.}{1.908C + 9b + 10h} \quad \text{... (3)}$$

Where:

L: inductance resulting (in henrys)
N: number of turns
x: width of the antenna
and: length of the antenna
C = x + y + 2h
b: width of the cross section
h: height of the cross section

Since this estimate is based on the number of turns of wire required for the construction of the antenna. To check the accuracy of the calculation, we used an inductance meter, once built the antenna.

2.3.1. Transponders

The microchip includes:
• An analog circuitry that handles the transfer of data and to provide food.
• A digital circuitry including:

• The control logic.

• The logic of security.

• The internal logic or microprocessor.

•. Records of data (buffers) temporarily support both incoming data following demodulation and outgoing before modulation. It also acts as an interface with the antenna.

• The label information is transmitted amplitude modulated (ASK Amplitude Shift Keying), frequency (FSK, Frequency Shift Keying) or phase (PSK, Phase Shift Keying). That is, for amending the transmission amplitude, frequency or phase of the signal of the reader.

The antenna which is supplied to be able to transmit the data stored in the microchip can be of two types:

a) An inductive element (coil).
b) A dipole.

2.3.2. Types of Tags

Active tags also collect energy from the reader, are fed from a battery.

Typically incorporate a battery that has a high power-weight and are capable of operating in a range of temperatures ranging from -50 º C to 70 ° C.

Although the use of batteries involves a finite lifetime for the device, placing a stack properly attached to the low power circuitry can ensure a lifetime of more than 10 years, also depending on conditions work where you are, ie, temperatures, cycles of read / write and use.

There are two types of active tags:

• Those that are normally turned off (sleep mode) and activated (aroused) when a reader asks. This will save battery.

• Those who regularly send signals, but a reader not questioned. Operate at lower frequencies and lower transfer rates, to save power.

Passive tags operate without an internal battery, getting the power they need to operate the field generated by the interrogator. We summarize the comparison of the main characteristics in Table:

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Propagation / inductive coupling	EM wave propagation
* Work in the near field: low coverage. * Consider the orientation of the antenna. * Usually works at low frequencies. * Usually use passive tags. * It is very sensitive to interference Electromagnetic.	* Work in the far field: better coverage. * The antenna orientation is irrelevant. * Usually works at high frequencies. * Usually use active tags. * Need regulation.

Table I: Main characteristics of the propagation modes

1. RESULTS

Overall this project is to cover the topic of the implementation of recognition through RF systems in a given specific application. To this end, we collect information on the various applications and work previously developed by researchers. Just as it has been necessary to standardize the information contained in bar codes to all companies having a common understanding of its meaning, it is essential that RFID technology is also on the definition of a standard that allows its use widespread and global. We considered the distance at which they were sensitive antenna for transmitting information in a manner consistent with the requirements of our particular application.

1. CONCLUSIONS

This paper studied the application of RFID reader using Series 2000 Low Frequency RFID. The design of a communication program for the 16F628A microcontroller, and a printed circuit board to configure the RFID reader in a specific mode of operation and activate a signal upon detection of a code specified in the program. In addition, the use of programming capabilities, allow reprogramming the microcontroller without removing the plate, with the advantage that this entails.

On the other hand, the study of the requirements of the antennas for low frequency devices has established a design methodology that enables construct and attaches antennas with some flexibility.

One of the main characteristics of this type of antenna is its inductance. Using Matlab has developed a program that provides an estimate of the number of turns of wire in terms of geometry and dimensions of the antenna.

	Active Tags	Passive Tags
Incorporated battery	si	No
Cost	Mayor	Minor
Lifetime	Limited	Almost unlimited
Coverage	Mayor	Minor
Data Capacity	Mayor	Minor

Ultimately, the circuit board, along with the RFID reader, allowing the use of this equipment in applications of self-identification of products, access control and industrial safety, without having to use a PC, with the advantages in cost and space that this entails.

1. REFERENCES

- [1] Zhi Ning Chen & Kwai Man Luk (2009) Antennas for base station in wireless communications. McGraw-Hill.
- [2]Consultas técnicas realizadas con el departamento técnico de Texas Instruments. Carlos Motolese, Iva Sergieva, Susana Russo. *European Product Information*.
- [3]Enrique Palacios, Fernando Remiro, Lucas J. López. "*Microcontrolador PIC16F84. Desarrollo de proyectos"*, Editorial Rama, febrero 2004. ISBN: 8478976000.
- [4] Himanshu Bhatt, Bill Glover, "*RFID Essentials"*, O´Reilly, Enero 2006, ISBN 0-596-00944-1.
- [7] Microchip Technology. "*Microchip. PIC16F627A/628A/648A. Data Sheet, Flash-Based, 8-bit CMOS Microcontrollers with nano Watt Technology"*. 2006. Nº de referencia: DS40044E.
- [8] Texas Instruments. "*LF Technical Training, Installation & Set-up*". 2002
- Yan Zhang, Laurence T Yang, Jiming Cheng (2010) RFID and sensor networks. New York: CRC Press.
- Everard, J (2001) Fundamental of RF circuit desing with low noise oscillators. New York: Wiley.
- Carr, J J (¿?)Secrets of RF Circuit Design. New York: Mc Graw-Hill.
- Rowan Gilmore, Les Besser (2003) Practical RF Circuit Design for Modern Wireless Systems. Norwood: Artech House.
- Alan Davis, W; Krishna Agarwal (2001) Radio frequency circuit design. New York: Wiley.
- Kraus, J D (1997) Antennas. New York:Tata Mc Graw-Hill.
- Cardama Aznar, A; Jofre Roca, L; Ruis Casals, JM; Romeu Robert, J; Blanch Boris, Sebastian; Ferrando Bataller, M (2002) Antenas. Barcelona: Edicions UPC.
- Balanis, CA (2005) Antenna Theory Analysis and Design. New Jersey: Wiley.

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