

# Low Frequency Reader and Antenna Design Using RFID

Waqas Malik

Department of Electrical Engineering, Bahria University 13 National Stadium Rd, Karachi  
\*Corresponding Author: [waqas.malik@bimcs.edu.pk](mailto:waqas.malik@bimcs.edu.pk)

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**Abstract** In the present era the technology is growing rapidly therefore it is necessary to adopt those methods in designing a system that are simpler and effective. The main concern is to design RFID system to secure entry points in an office environment. In this paper the work mainly specifies the design of RFID reader and antenna. The noncontact device of RFID system is more convenient approach instead of conventional bar code. Every RFID card (passive) is allocated with a different binary number for identification. The modulation technique used here is Frequency shift keying. The detectable operating frequency of RFID reader is 123.2khz for bit '1' and 134.2khz for bit '0'. To achieve the required frequency TMS 3705 IC has been used and it's interfacing with an antenna of 0.18mm enamelled copper wire with 102 turns. The other part of the interface in the IC is binary bits verification with microcontroller. The microcontroller is further controlling the relay operation and also serially maintaining the record of employee's arrival through Microsoft visual studio. Presently the application in which its significance is observed and implemented is calculating payroll, storage unit of defence artillery.

**Keywords** RFID Technology, Micro Controllers, Embedded Security System

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## 1. Introduction

The growth in the telecom industry is changing and playing very important role in efficiency and speed of electronic circuits. The process of radio communication is the electromagnetic waves which are transmitting wirelessly. The pattern of Electromagnetic waves radiating is generated through continuous oscillations of electromagnetic fields passing through a medium such as air travelling from one point to other. The information is obtained from tag to reader by process of modulation in which mostly amplitude modulation or frequency shifting is used. The electromagnetic field which is continuously oscillating results in induce alternating current in the electrical conductor (antenna). The information received on the antenna is converted into useful information obtained from tag.

Radio Frequency Identification (RFID) is a unique method of identifying automatically, data storing and

remotely information is obtained by a transponder (RFID tag). The RFID is a contactless or wireless identification. The RFID system composed of two main parts: RFID Reader and RFID Tag.

RFID reader can be incorporated as in both active and passive networks depending upon the application specific task desired. Main component of RFID reader are antenna, smart filters, modulating unit, demodulating unit, coupling device and a processing unit.

RFID tag is also defined in active and passive integrated device which transmit data to RFID reader when it starts communication and data logging. Main component of RFID reader are antenna, modulating unit, demodulating unit, memory unit.

RFID tag tracking via radio waves can be applied in variety of application because of its different variety in term of sizes and shapes. The automatic reading capability of RFID tag from a distance away and no compulsion of setting and adjusting its position make it as unique and user friendly electronic device that makes human lives easier and smarter.

This project is designed such as to cover a small working area for verifying (attendance) of concern persons and securing environment. Access control system based on RFID technology provides real time monitoring system which is also keeping up to date record of data in database management system.

The micro controllers is a central unit which reduces components and capable of controlling multiple tasks. The microcontroller is itself a suitable replacement of different ICs performing individually. Main components of controller are RAM, I/O ports.

Antenna designing plays an important role in transmitting and receiving data. The main issues was in design of coil loop antenna. However to achieve precision and accuracy efforts has been made.

## 2. Explanation

The project has been divided into different blocks or modules depend upon their tasks they performed. Figure 1 is the block diagram of the project. The areas which are highlighted by dashed lines are the fundamental parts of the system. Others additional blocks provide the application and utilization of the system. These additional parts are considered to be the optional that only enhance the

functional structure of the system. In Figure 1, we use 2D-lines and 3D-lines which are only use to distinguish between Parallel and Serial connections between the blocks. We now explain each block in details.

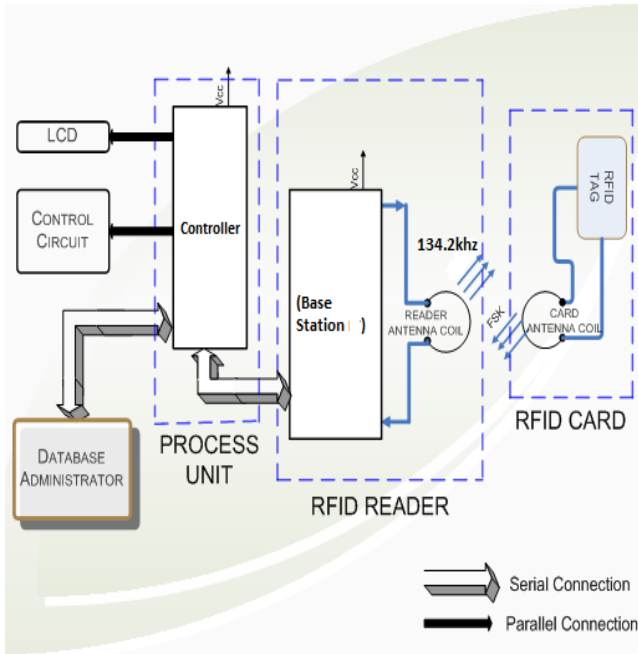


Figure 1. Block Diagram

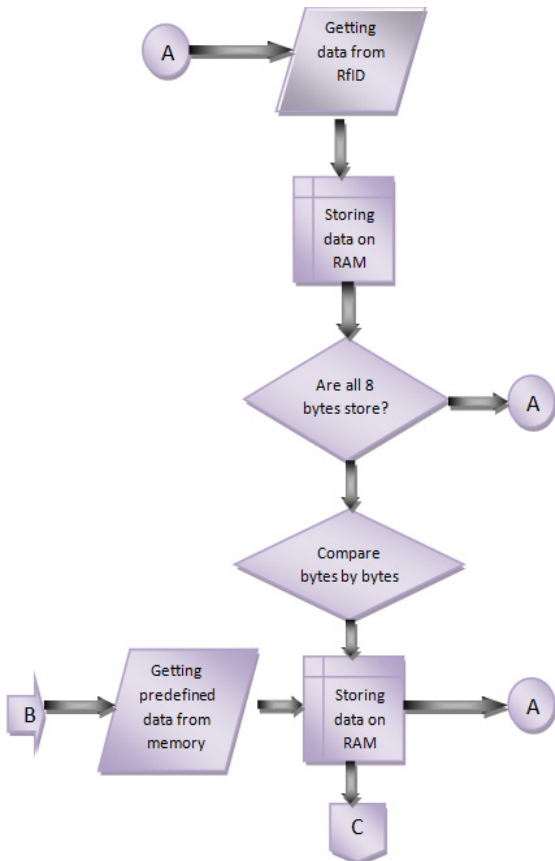


Figure 2. Flow Diagram

### 3. System Flow

In the flow diagram Figure 2 and Figure 3, I mention connector A as the beginning of the flow. The RFID reader generates a carrier signal of 134.2 KHz, once it senses that the card is in the antenna range. The card in response to 134.2 KHz transmits its code back to RFID Reader. The RFID Reader gets the card code and sends it to microcontroller for verification. A Microcontroller temporary hold the card code in it's RAM and verify this code to the codes stored in Memory. If the card is not verified then microcontroller clears pin 0.7 and sets pin 0.7 of Port0. Thus the flow of the program comes at A. If the card is verified then microcontroller sets pin3.4 and clears pin3.4 of Port3. Along with this signal microcontroller also sends signals to other circuits (which we will discuss in the later chapters). After verification, microcontroller transmits the verified code to the administrator's computer.

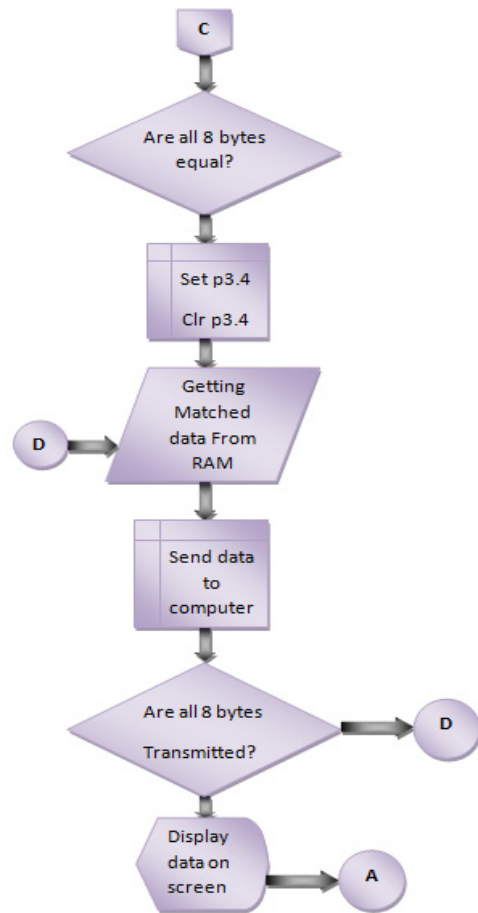


Figure 3. Flow Diagram

### 4. RFID Reader Design

TMS 3705 RFID reader chip is used in this Reader module. The antenna connected at pin 5 and 7 of transponder base station IC detects the RF signal. The modulation technique which has been used is FSK (Frequency Shift keying). The

binary coded data is in the form of ‘0’ or ‘1’ and it has been adjusted at two selected high frequency for high ‘1’ (123 KHz) and for low ‘0’ (134.2 KHz). The graphical representation of communication over view of selected frequencies is shown in figure 4. The signals received from reader will completely charge the passive tag and will transmit data for verification. TMS 3705 IC at the reader communicates to the receiving port of controller and will perform bit by bit comparison of binary data with the actual data bits that are programmed in controller. The circuit diagram of low frequency RF module with TMS3705A reader is shown in figure 5. Description of components used in Figure 5 are shown in table 2. Pin assignment of TMS3705 IC is shown in table 1.

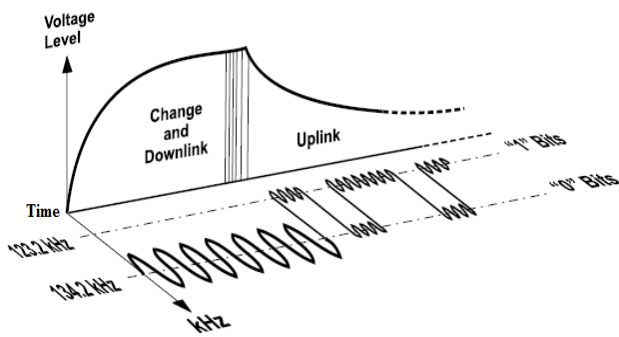


Figure 4. Communication over View

Table 1. Pin assignment of TMS 3705 IC

Pin No.	Pin Function
1	not used
2	not used
3	TXCTL-
4	RXOUT
5	GND
6	GND
7	not used
8	+5 V
9	+5 V
10	reserved for +12 V

### 5. Frequencies in RFID

The unlicensed frequency band is used in RFID which mostly provide us with cost benefits RFID deployments tend to use unlicensed frequencies for their obvious cost benefits. The frequency bands used worldwide in domain of RFID are:

- Low frequency (LF) 123/134.6 KHz.
- High frequency (HF) 13.56 MHz.
- Ultra high frequency (UHF) (including 869 and 915 MHz).
- Microwave (at 2450 MHz, a band familiar to ISPs).

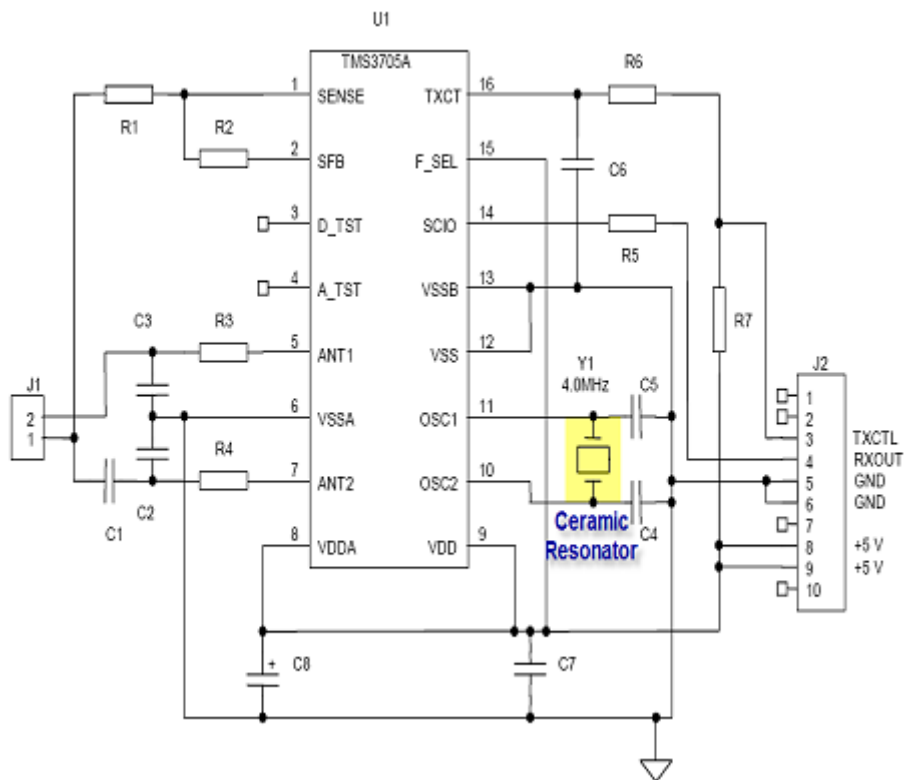


Figure 5. Circuit Diagram for Low Frequency RF Module with TMS3705A Chip

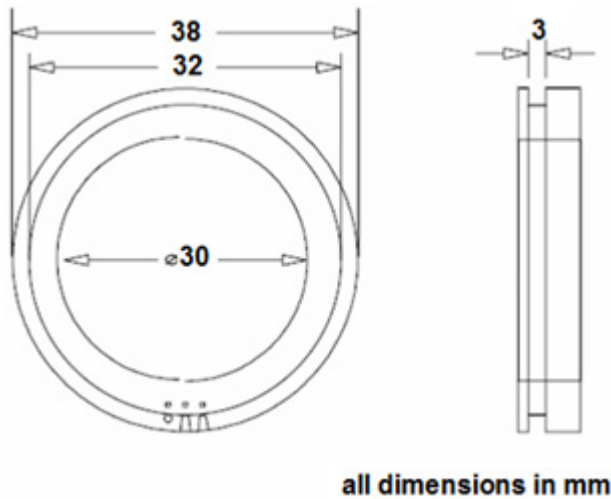
**Table 2.** Component list for Low Frequency RF Module with TMS3705A Chip

Pos.	Ref.	Description	Shape	Value
1	U1	TIRIS ASIC	SO16	TMS3705AD
2	Y1	Ceramic Resonator	3pin	4.0 MHz
3	C1	Ceramic Capacitor	1210	3.3nF, 50V, 2% matching with Antenna coil
4	C2	Ceramic Capacitor	0603	220 pF, 50V
5	C3	Ceramic Capacitor	0603	220 pF, 50V
6	C4	Ceramic Capacitor	0603	(10 pF) see description
7	C5	Ceramic Capacitor	0603	(10 pF) see description
8	C6	Ceramic Capacitor	0603	1 nF, 50V
9	C7	Ceramic Capacitor	1206	0.1 uF, 50V
10	C8	Tantalum Capacitor	D	22 uF, 16V
11	R1	Resistor	0603	47 kOhm
12	R2	Resistor	0603	150 kOhm
13	R3	Resistor	1206	4.7 Ohm
14	R4	Resistor	1206	4.7 Ohm
15	R5	Resistor	0603	220 Ohm
16	R6	Resistor	0603	1 kOhm
17	R7	Resistor	0603	10 kOhm
18	J1	Connector	R= 2.54 mm	2 pin female
19	J2	Connector	R= 2.54 mm	10 pin male

## 6. Antenna Design

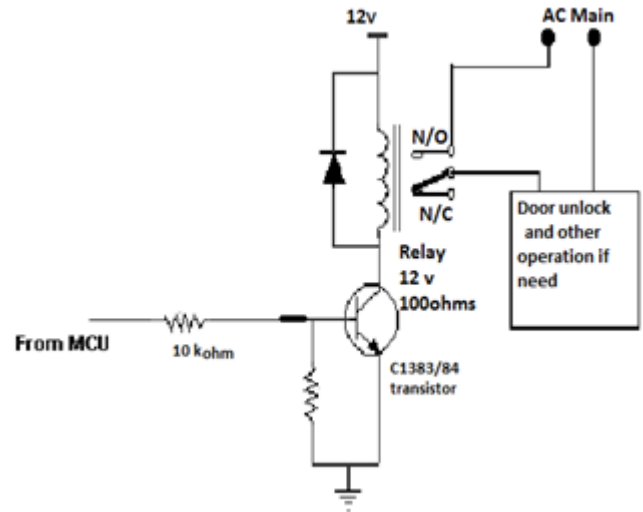
The inductance of the antenna coil is designed in order to provide optimum effective range when used together with the reader. An antenna couples RF energy to the air medium. The transmitter in the card sends an RF signal to the antenna, which is located in the reader. The Antenna coil receives the RF signals and the set specific frequency is detected.

The recommended coil as shown in figure 6 is made up of enamelled copper wire of diameter 0.18 mm and approximately 102 turns.

**Figure 6.** Circular -Shaped Loop Antenna

## 7. Relay Operation Control

The relay operation has been controlled through microcontroller and the relay operation control circuit diagram is shown in figure 7.

**Figure 7.** Relay operation Control Circuit

## 8. Mathematical Calculation

- a) The RFID operational frequency is about 132.2 KHz. Using Eq-1:

$$v = f\lambda \quad (1)$$

From Eq-1  $\lambda$  wavelength of the signal is calculated in Eq-2 below:

$$\lambda = (3 \times 10^8) / (132200) = 2269.288\text{m}. \quad (2)$$

- b) Inductance for the circular coil is determined by the following Eq 3:

$$L = 0.31 (a N)^2 / (6a+9h+10b) \tag{3}$$

Where,

*L* is in micro Henries

*a* is average radius of the coil in cm

*h* is the height of the coil (in cm).

*b* is winding thickness (in cm).

*N* is the number of turns

Therefore Inductance of the antenna is:

$$L = 7256.79/11.43 = 634.887\mu\text{H}$$

- c) Resonant frequency is calculated through Eq-4 :

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \tag{4}$$

Where,

*f* is the resonant frequency (in Hertz)

*L* is inductance (in Henries)

*C* is capacitance (in Farads).

Therefore resonant frequency of the antenna is:

$$f_0 = 1/9.09 \times 10^{-6} = 122.2 \text{ KHz}$$

**Note:** Here I took the closest value of series capacitor ( in path of antenna) available to set resonant frequency close to operating frequency i.e. 3.32nF in calculating actual it was 2.285nF which was not available if this value of capacitor was available then more precise resonant frequency can be achieved.

- d) Bandwidth (BW) :

If the full recovery of signal is required from the tag, the reader circuit need a bandwidth that is at least twice the data rate i.e. for 132.2 KHz data rate FSK (÷10) is 13.22 KHz calculating bandwidth in Eq-5

$$\text{Bandwidth} = 13.22 \times 2 = 26.44 \text{ KHz} \tag{5}$$

- e) Quality Factor (Q) :

Using Eq-6 to find quality factor Q of the signal is:

$$Q = f_0 / \text{BW} = 134.2 / 26.44 = 5.07 \tag{6}$$

## 9. Results

This project has been carried out successfully except some issues faced during hardware design. The main point which have been achieved includes, design and hardware implementation of RFID Reader operating at 123.2KHz and 134.2KHz carrier frequency, Construction of a circular loop antenna, Interfacing microcontroller with the reader and database server simultaneously, Interfacing of a parallel EEPROM(Electronically Erasable Programmable Read Only Memory) with the microcontroller to store the tags information for access control, Design and hardware implementation of control circuitry, LCD display interfacing with microcontroller and database management system on visual studios. System is performing well, but for the next stage it is propose to interface RFID system with FPGA which will result in reducing number of components and total cost of the device.

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