ANALYSIS CHARACTERISTIC AND PERFORMANCE OF PASSIVE RADIO FREQUENCY IDENTIFICATION (RFID) FOR 13.56MHZ SYSTEMS.

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ABSTRACT

Now a day world technology of RFID will used in a global security of identifications. This technical paper is consist the analysis of development of RFID for low range frequency coverage for passive RFID 13.56MHz. Scopes of work include the algorithm for RFID flow in which frequency band will be continually implemented considering pre-determined constraints. Hence optimization technique will also be incorporated in this work analysis.

1.0 INTRODUCTION

It is the goal of this technical paper to describe the characteristic and performance of 13.56MHz RFID system and to give a high level summary about its technological capabilities and the regulatory framework.

2.0 OPERATING PRINCIPLE

Today the vast majority of 13.56MHz systems operate on passive that is meaning without the need of an integrated battery. This has positive implication on cost, life-time and environmental situation. The basic operating principle of passive 13.56 MHz RFID system is energy and data transmission using inductive coupling.

This exactly the same principle as used in transformer. An antenna of the reader generates a magnetic field, which induces a voltage in the coil of the tag and supplies the tag with energy. Data transmission from the reader to the tag is done by changing one parameter of the transmitting field (amplitude, frequency or phase).

The return transmission of the tag is done by changing the load of the field (amplitude/phase).in this analysis are founded this context 13.56 MHz and <135 kHz use the same principle.

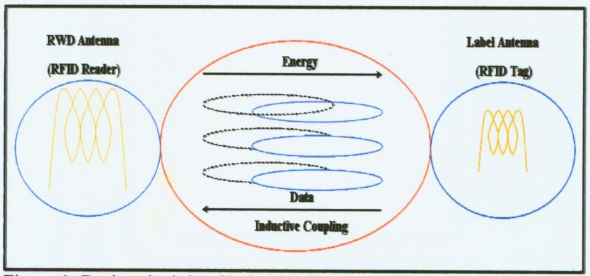


Figure 1: Basic principle of inductive Passive RFID System.

Differing from UHF system and μW system, the operating zone of passive (battery less) inductive RFID system (13.56MHz and also < 13.56MHz) is near field of the reader transmission antenna.

3.0 TYPICAL TAG

Today 13.56MHz tag is available in many shapes and with different functionality; of course this has been influence by applications and their requirements. The facts that a few turns of the tag antenna are sufficient to achieve well tuned tags is one of the recognized benefit to allow low cost tag production based on different antenna.

On this analysis to study development of passive RFID tag antenna there are using ISO CARD: World wide application for 13.56MHz (ISO 14443 ,ISO 15693) classes with currently smart card .

Functionality:
Memory Size : Typically frim 64 bit
Memory types : Factory programmed "Read only'
Security :basically all requirement level can be realized.
Special functions : Different features implemented

3.1 Calculation of B-Field in a Tag antenna

$$Vo = 2\pi fNSQBo\cos\alpha = 4$$

$$Bo = \frac{4(\sqrt{2})}{2\pi fNSQ\cos\alpha}$$

$$= 0.0449(\mu wbm^{-2})$$

Where the following parameters are used in the above calculation:

Tag coil size (ISO card)= 86.6 mm^2 x 54 mm^2
= 0.0046224 m^2

Frequency = 13.56 MHZ

Number of Turn = 4

Q of tag antenna = 40 coil

AC coil voltage to turn on the tag = 4Vpp

Cos α = 1

3.2 Antenna Design

One of the limiting factors in low frequency passive RFID is reading distance. Typical reading distance on this analysis is only a few centimeter (cm) because the power and frequency is not always practical a common solution to increasing reading distance is modified being used. In ideal conditions the bellow formula are used to calculate the number of turn for antenna:

$$N = \sqrt{\frac{L(6a + 9h + 10b)}{(0.31)a^2}}$$

And for a cruder approach is to match the resonant frequency.

For four full turn inductor, there are 16 straight segments. *s* is the spacing between conductor, and *d* (= s + w) is the distance f track centers between two adjacent conductors. *l1* s the length of conductor 1, *l2* is the length of conductor 2, and so on. The lengths of conductor segments are:

$$l_3 = l_1,\ l_4 = l_2 - \delta,\ l_5 = l_1 - \delta,\ l_6 = l_4 - \delta,\ l_7 = l_5 - \delta,\ l_8 = l_6 - \delta,\ l_9 = l_7 - \delta,\ l_{10} = l_8 - \delta,\ l_{11} = l_9 - \delta,\ l_{12} = l_{10} - \delta,\ l_{13} = l_{11} - \delta,\ l_{14} = l_{12} - \delta,\ l_{15} = l_{13} - \delta,\ l_{16} = l_{14} - \delta$$

$$\begin{aligned} M_+ = {} & 2(M_{1,5} + M_{1,9} + M_{1,13}) \\ & +2(M_{5,9} + M_{5,13} + M_{9,13}) \\ & +2(M_{3,7} + M_{3,11} + M_{3,15}) \\ & +2(M_{7,11} + M_{7,15} + M_{11,15}) \\ & +2(M_{2,6} + M_{2,10} + M_{2,14}) \\ & +2(M_{6,10} + M_{6,14} + M_{10,14}) \\ & +2(M_{4,8} + M_{4,12} + M_{4,16}) \\ & +2(M_{8,12} + M_{8,16} + M_{12,16}) \end{aligned}$$

Equation 1: Total positive mutual inductance

$$\begin{aligned} M_- = {} & 2(M_{1,3} + M_{1,7} + M_{1,11} + M_{1,15}) \\ & +2(M_{5,3} + M_{5,7} + M_{5,11} + M_{5,15}) \\ & +2(M_{9,3} + M_{9,7} + M_{9,11} + M_{9,15}) \\ & +2(M_{13,15} + M_{13,11} + M_{13,7} + M_{13,3}) \\ & +2(M_{2,4} + M_{2,8} + M_{2,12} + M_{2,16}) \\ & +2(M_{6,4} + M_{6,8} + M_{6,12} + M_{6,16}) \\ & +2(M_{10,4} + M_{10,8} + M_{10,12} + M_{10,16}) \\ & +2(M_{14,4} + M_{14,8} + M_{14,12} + M_{14,16}) \end{aligned}$$

Equation 2: Total negative mutual inductance

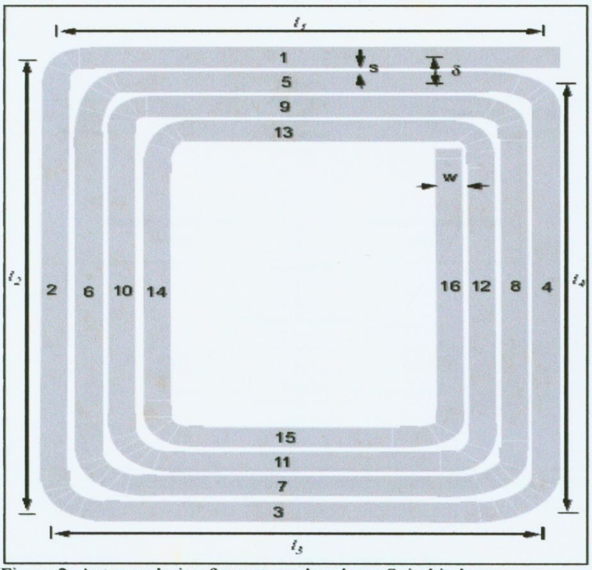


Figure 2: Antenna design for rectangular planar Spiral inductor.

The most effective antenna structure for such an antenna with small dimensions is a loop antenna on a PCB. Therefore the design of the antenna is based on a previously implemented loop.

4.0 METHODOLOGY

4.1 Laboratory Test

This laboratory test can measure signal strength and manual radiation pattern. Manual procedure to catch radiation pattern on 13.56MHz RFID systems are used on this analysis. It enables to provide quick result of radiation pattern for this system.

Spectrum analyzer and oscilloscope is used to measure the frequency signal and voltage peak to peak (Vpp). There are tested on variation distance, it is to define the characteristic and performance of RFID for 13.56 MHz systems.

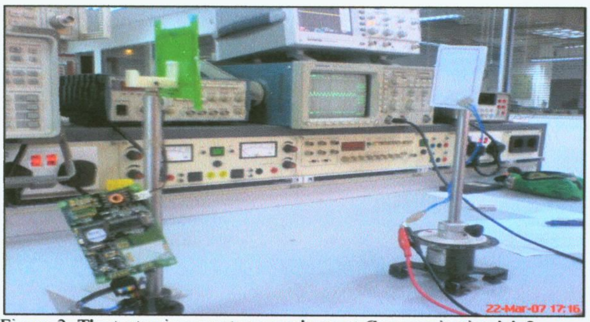


Figure 3: The test using spectrum analyzer at Communication lab 2.

4.2 Interface Software using Visual Basic.

This testing procedure is to ensure the tag and reader can communicate on the system. These procedures are done using the Production Mifare version 1.5.0 created by Iris Technologies (M) Sdn Bhd as reference before write the simple software program.

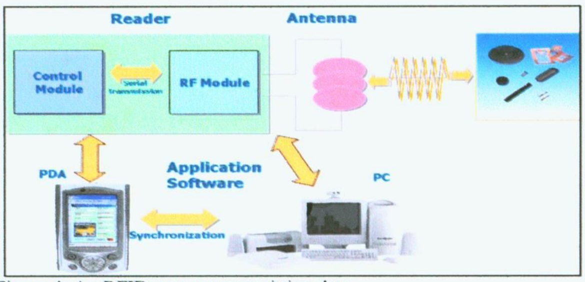


Figure 4: An RFID system transmitting data

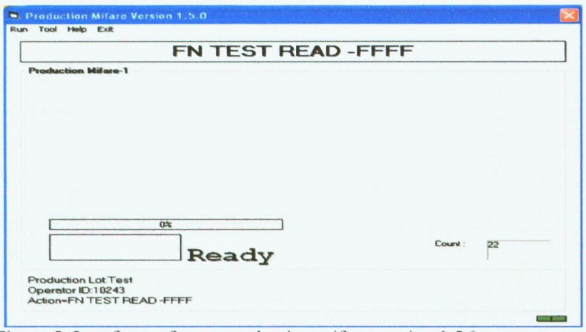


Figure 5: Interface software production mifare version 1.5.0.

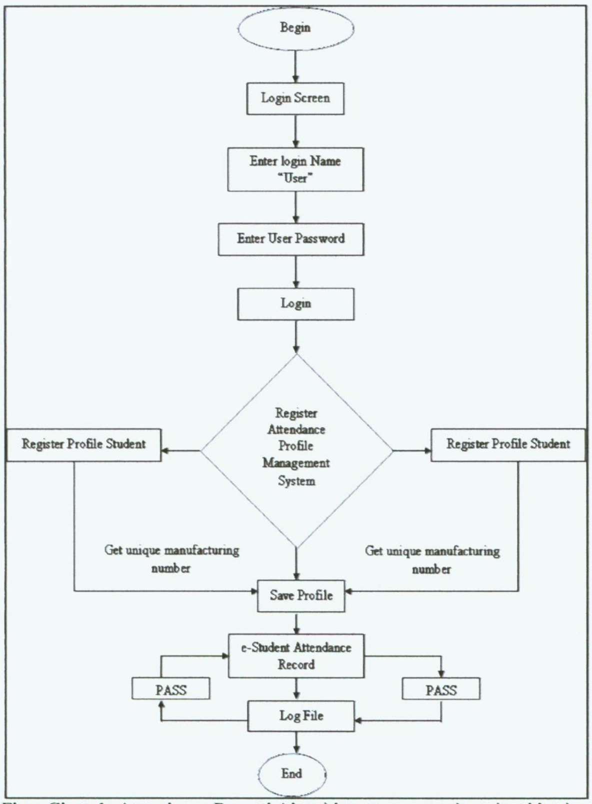
4.3 Loss and Impedance Test.

This procedure is used to trigger the loss and impedance on RFID 13.56MHz systems. Equipment HP 8753C 300Khz-3GHz network analyzer and HP 85046A 300Khz -3.0 GHz S-Parameter Test Set is used on this laboratory test. This testing are done at Panasonic Electronic Devices (M) :R&D department.

Figure 6: HP 8753C 300Khz-3GHz network analyzer and HP 85046A 300Khz – 3.0GHz S-Parameter Test Set .

4.4 Develop Software Program using Visual Basic 6.0.

This basically is to learn how the application of passive RFID transferring the data and to show the application on the passive RFID can be programmed using the interface software.



Flow Chart 1: Attendance Record Algorithm program using visual basic 6.0 software.

5.0 RESULT AND DISCUSSION

5.1 Laboratory Test Result

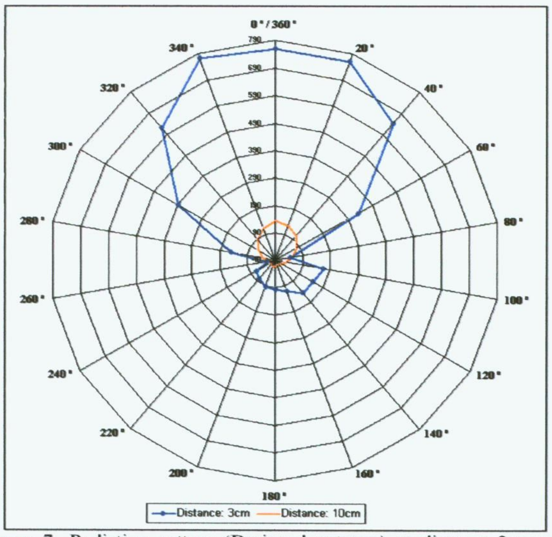


Figure 7: Radiation pattern (Designed antenna) at distance 3cm and 10cm.

Patterned antenna coverage to received RFID signal is wide compared to designed antenna. Designed antenna can be improved by correct material are used and also calculation on designing pattern.

Design Antenna		
Rotation Degree (°)	Distance:3cm	Distance: 10cm
	Vpk-pk (mV)	Vpk-pk (mV)
0 ° / 360 °	760	134
20 °	758	123
40 °	640	103
60 °	329	75
80 °	43	47
100 °	164	26
120 °	144	15
140 °	142	10
160 °	108	10
180 °	96	14
200 °	92	18
220 °	81	10
240 °	66	13
260 °	20	12
280 °	152	37
300 °	389	60
320 °	620	88
340 °	772	114

Table 1: Designed antenna radiation data collected using the manual procedure.

Patterned Antenna		
Rotation Degree (°)	Distance: 3cm	Distance: 10cm
	Vpk-pk (mV)	Vpk-pk (mV)
0 ° / 360 °	928	130
20 °	808	112
40 °	488	81
60 °	116	36
80 °	176	20
100 °	252	30
120 °	256	44
140 °	244	50
160 °	240	54
180 °	242	54
200 °	250	54
220 °	264	54
240 °	278	49
260 °	268	35
280 °	176	10
300 °	111	36
320 °	544	80
340 °	856	116

Table 2: Patterned antenna radiation data collected using the manual procedure.

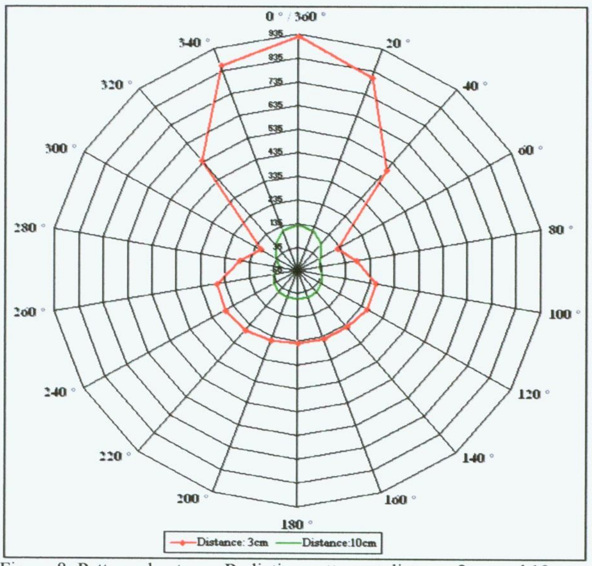


Figure 8: Patterned antenna Radiation pattern at distance 3cm and 10cm.

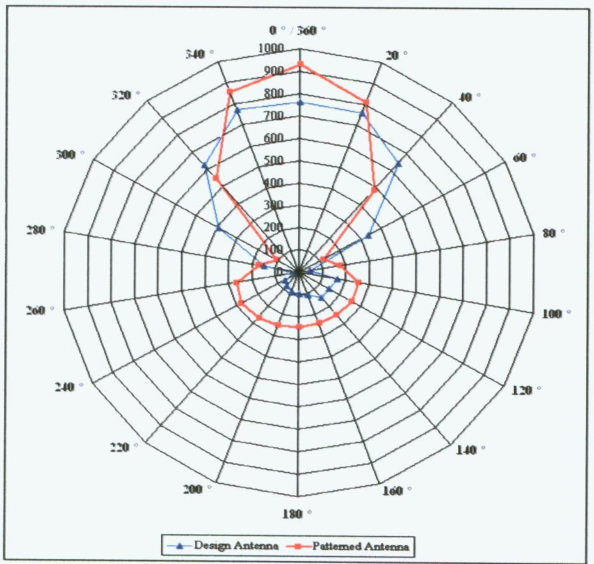


Figure 9: Radiation pattern between design and patterned antenna.

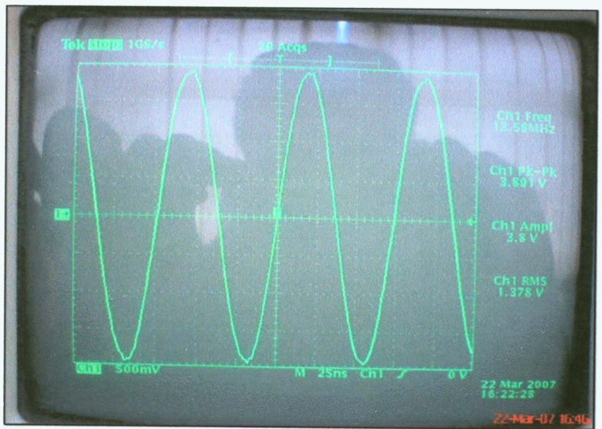


Figure 10: output high strength RFID 13.56MHz transmission.

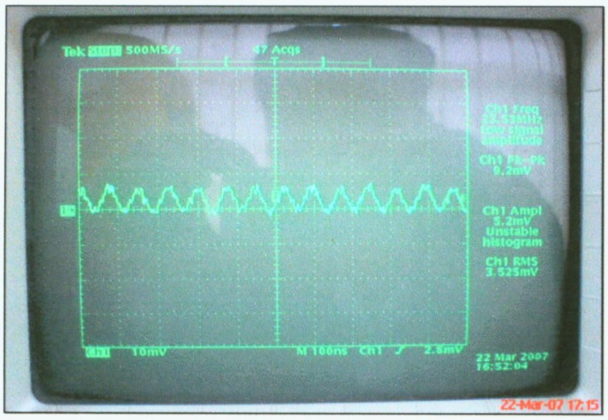


Figure 11: output low strength RFID 13.56MHz .

To defined the good transmitted range between reader antenna and tag antenna that are shown different amplitude of Voltage peak to peak and also shown the unstable histogram sinusoidal wave form.

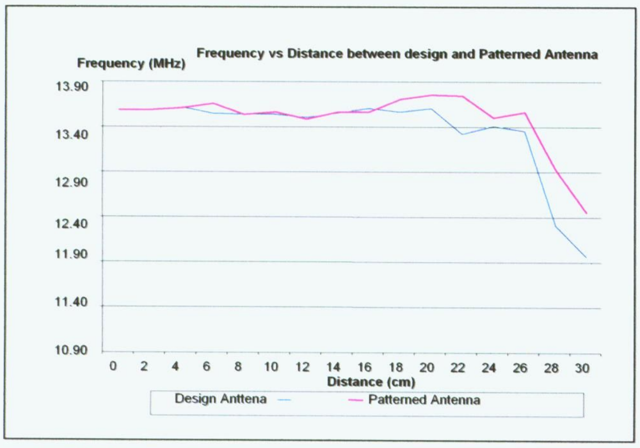


Figure 12: Variation of distance away from the reader antenna tested in Communication Lab (frequency).

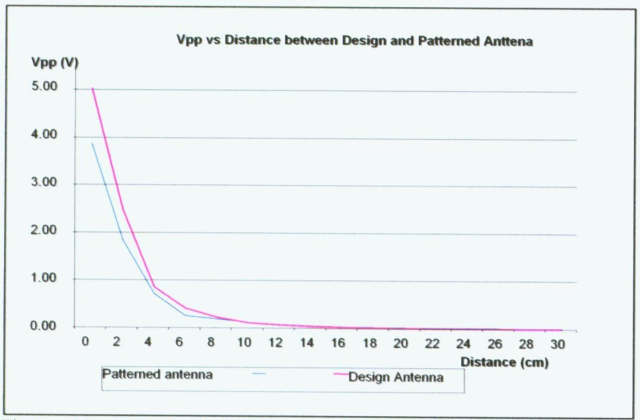


Figure 13: Typical behaviour of Variation distance tested in Communication Lab versus Voltage peak to peak.

5.2 Interface software using Visual Basic Result.

From testing, with has performed using the interface software production Mifare version 1.5.0, has shown successful pass. This result also is given the consequence for designed antenna can be generated and transferring data accordingly to run passive RFID for 13.56MHz system.

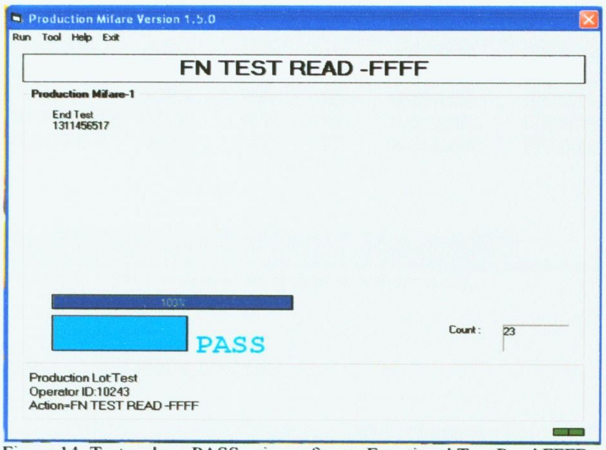


Figure 14: Tester show PASS using software Functional Test Read FFFF.

5.3 Loss and Inductive Test Result

From the testing has perform using the equipment HP 8753C 300Khz-3GHz network analyzer and HP 85046A 300Khz -3.0 GHz S-Parameter Test Set, for losses we can see form the plotting graph there is -0.9794 db loss on the antenna design (Figure 15).

346.3 pF inductance measurements has finding in the test result (Figure16).

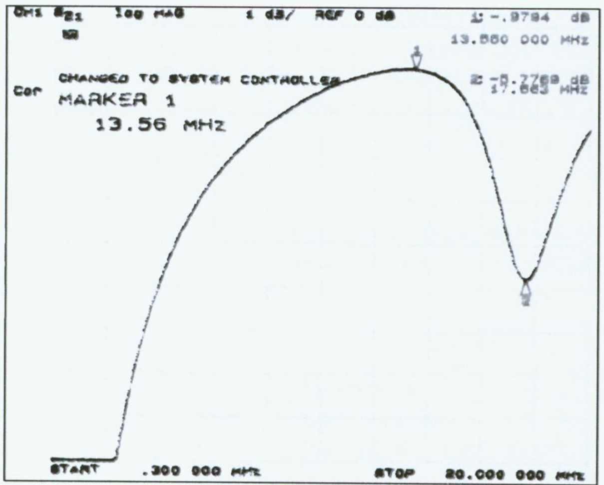


Figure 15 : Designed antenna losses graph.

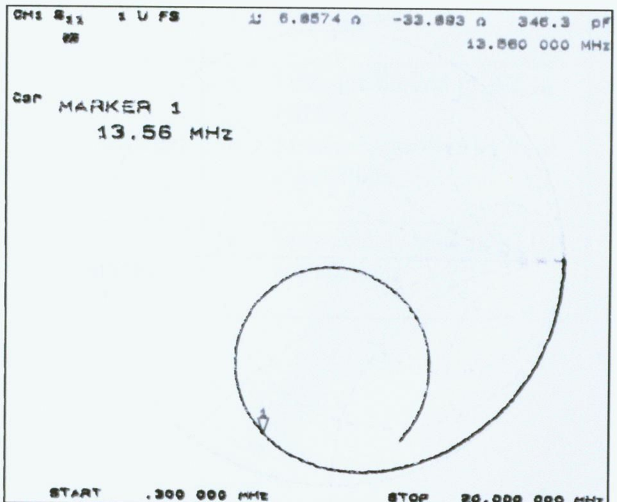


Figure 16 : Designed antenna inductance result.

5.4 Develop Software program using Visual Basic 6.0 result.

Writing software using the visual basic 6.0 software are successful to develop. E-Student attendance record as title software project to develop, it is used to show the RFID 13.56MHz system operational.

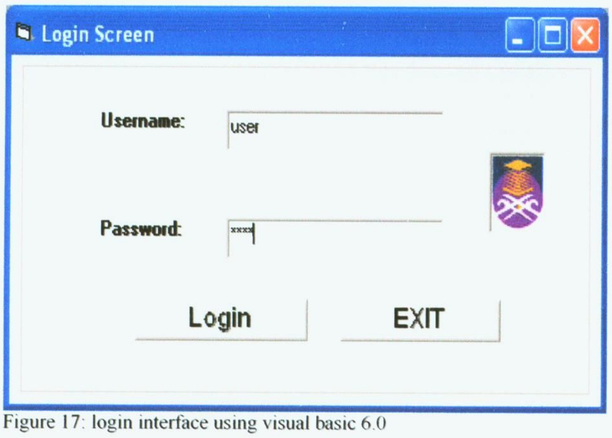


Figure 17: login interface using visual basic 6.0

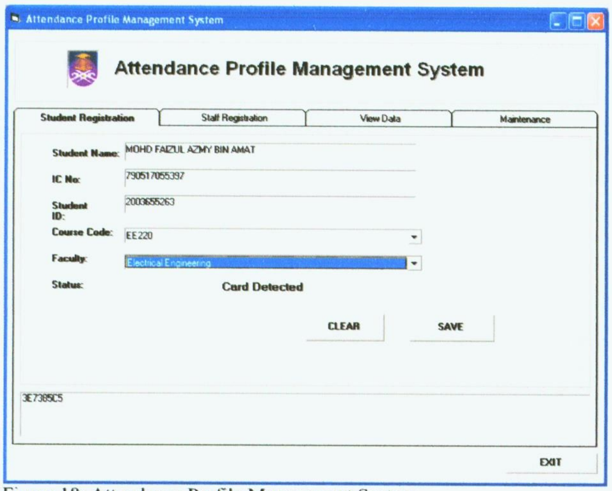


Figure 18: Attendance Profile Management System.

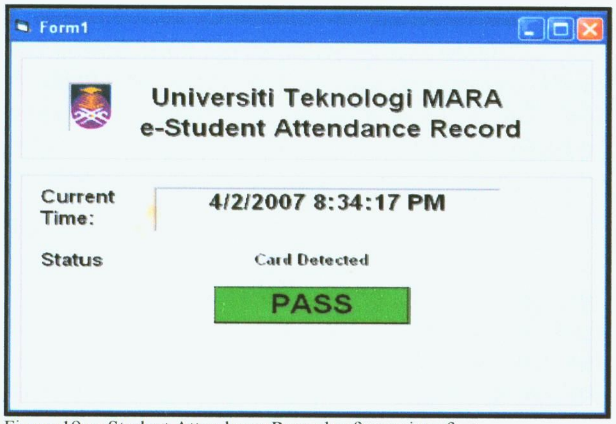


Figure 19: e-Student Attendance Record software interface.

The Graphical User Interface (GUI) program successful to write for modeling the system and to perform the laborious calculations required to solve meaningful problems and analysis. Without any doubt the tag IC has big influence on the performance of the final RFID system. Many different ways software program can be write depending on the application requirement.

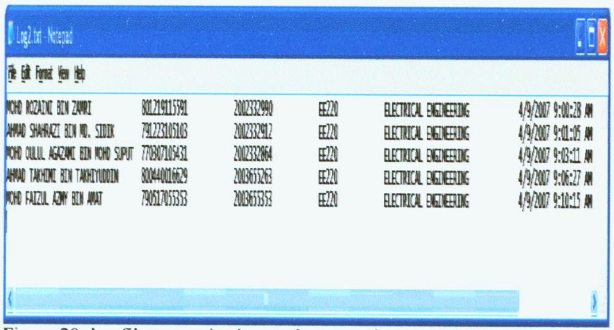


Figure 20: log file to monitoring student attendance result.

6.0 CONCLUSION

An analysis on development and characteristics of Passive RFID (13.56MHz) is presented. The study will involve the development of passive RFID algorithm and frequency range.

Upon completion of this project, a general passive RFID will be able to understand. The resulting antenna has generally met our expectations at the beginning with a practical and solid structure and easy implementation.

The sufficient return loss value shows that the design has been successful. The capacitive effect of the antenna in total shows that the matching is not very well adjusted, also the antenna radiation will only be effective in very short distances because the total antenna length is very short compared to the wavelength. However with finer tuning and enhancing the matching circuit, the antenna effectiveness can be improved dramatically.

Finally the characteristic and performance of passive antenna will be presented on the analysis development of the RFID 13.56MHz systems.

Passive RFID System	
Advantages	• Longer life time • Wider range of form factors • Tags are more mechanically flexible • Lowest cost
Disadvantages	• Distance limited to 4-5 m (UHF) • Strictly controlled by local regulations
Remarks	• Most widely used in RFID applications

RFID – HF Characteristics (13.56MHz)

- Less effective frequency in the presence of metal and water
- Not susceptible to electrical noise
- Higher data transfer rate (20m sec for read command)
- Simultaneous reads, 50 tags per second (Anti-collision)
- Tags can easily be embedded in any non-metallic product (labels, plastic, etc)
- Read Range variable: proximity to 1.5 meters
- Optimal reading depends on tag and antenna orientation
- Ultra-thin inlays and smart labels (0.13")
- Larger memory (2048 bits; 256 ASCII characters)
- Frequency is usable worldwide (no restrictions)
- Global Standard: ISO 15693, 14443, 10536
- Standards being finalized: EPC and ISO 18000-3
- Low cost, flexible inlays.

Common Applications:

- Access Control
- Wireless Commerce (Shell, Visa, MC, Amex)
- Ticketing
- Marketing and Loyalty programs

7.0 RECOMMENDATION

Besides the above aspect another design improvement might be to change the one-sided design to a two sided PCB design to avoid the wire connection between the inner loop and ground connection for a more robust structure on the RFID passive signal 13.56MHz system. Maximum reading distance can improve by frequency, power and signal interface.

Laboratory Test should done at closed environments to ensure best result can be presented accurately.
It should be noted that at high frequencies where propagation effect cannot be ignored, a full field solution using high frequency simulator becomes necessary.

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