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Development of RFID EPC Gen2 Tag for Multi Access Control System

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ABSTRACT

A Radio Frequency Identification (RFID) use radio waves to identify an object, this technology become useful for the future because of the advantages. Access system using RFID card is commonly used in a building, parking area, housing complex, etc. This paper explore and develop the use of RFID EPC Class1 Gen2 tag for multipurpose access system for identification and access control, such as personal identity identification, door access control and gate entry permit or access control. With the same tag Identity (ID) user can access many areas. RFID EPC Class1 Gen2 tag working at UHF band 902-928 MHz, this type of tag more suitable for multi access control because of scaterring technique in reading for the tag, as for gate access need longer distance read range. All users ID and information stored at the one central database, every transaction at the controlled were recorded in a control system.

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1. INTRODUCTION

In recent years automatic identification, access control and entry permit procedure (auto identification) become popular for many areas, such as services industries, purchasing and distribution logistics, industry, manufacturing companies, and material flow system. Automatic identification procedure exists to provide information about people, animals, goods, and product in transit [1].

Radio Frequency Identification as a general mean is used radio frequency to transmit and receive identity of an object in form of a unique serial number identity by using wirelessly using radio waves. RFID evolution is as a major application in technology enabler such as for tracking goods and assets around the world [2]. A great deal of attention of RFID application is being paid to RFID by the IT industry, media and analysts.

RFID technology can be applied most in any applications they are can be categories as:

- Access System - RFID access system is a system to identify person to enter or access the area, with RFID tag replacing key or password to enter into building, room, area, etc.
- Automotive – Automotive industries have added security and convenience into an automobile by using RFID technology for identification, tracking and inventory systems.
- Animal Tracking – By tagging a tag to the animal to identification and to know the position. Livestock producers use RFID technology to meet export regulations and optimize livestock value.
- Asset Tracking –Since this technology do not need line of sight identification so become useful for asset identification and tracking, for example in hospitals and pharmacies RFID technology can apply for

patient monitoring and tracking, anti theft for new baby born, hospital equipment identification and tracking. In library limit theft and keep books in circulation more efficiently, and sports and entertainment entrepreneurs find that "smart tickets" are their ticket to a better bottom line and happier customers.

- Contactless Payments – In the payment or card transaction, RFID can be embedded into the card and just scan for transaction. It more time efficient compare for current using magnetic strip for transaction.
- Supply Chain – For the supermarket and store RFID is helpful for the inventories and counter. At the payment counter just pass thru the things or trolley than all the items will update this to reduce transaction time or queuing at the counter.

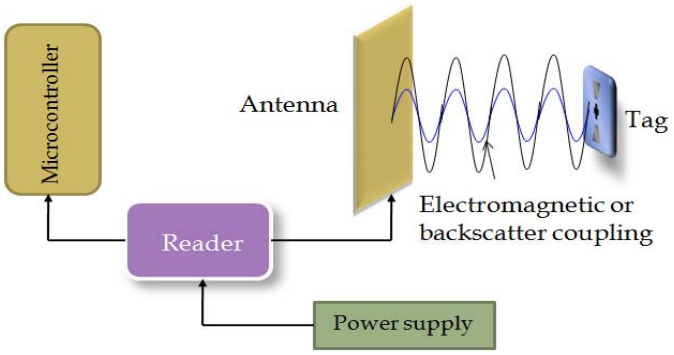

Figure 1. Basic concept UHF RFID system

A typical RFID system consists of an antenna and transceiver and transponder (RF tag) as shown in Figure 1. The transponder or RFID tag is an integrated circuit that contains information to be transmitted, an RFID tag is made up of a chip and antenna. The antenna allows the chip to transmit the information that is used for identification. The reader sends electromagnetic waves, which are received by the tag antenna. RFID technology differs from bar code systems in that it is not a line of sight technology.

2. EPC CLASS1 GEN2 TAG

The Electronic Product Code (EPC) is the next evolution of product identification, utilizing RFID technology to identify objects in a supply chain. Based on current numbering schemes (EAN, VIN etc.), EPC is divided into numbers that differentiate the product and manufacturer of a given item. The difference between EPC and previous numbering systems lies in the usage of an extra set of digits to uniquely identify one object [3]. An EPC number contains as shows in Figure 2.

- A Header, identifying the length, type, structure, version and generation of EPC.
- The Manager Number, which identifies the company or company entity.
- Object Class, similar to a stock keeping unit or SKU.
- Serial Number, which is the specific instance of the Object Class being tagged.

The Electronic Product Code promises to become the standard for global RFID usage.

EPC global is now leading the development of industry-driven standards for the Electronic Product Code (EPC) Network to support the use of Radio Frequency Identification (RFID) in today's fast-moving, information rich trading networks. EPC global is a member-driven organization comprised of leading firms and industries focused on creating global standards for the EPC global Network. The EPC global Network is a set of technologies that enable immediate, automatic identification and sharing of information on items in the supply chain. In that way, the EPC global Network will make organizations more effective by enabling true visibility of information about items in the supply chain [3].

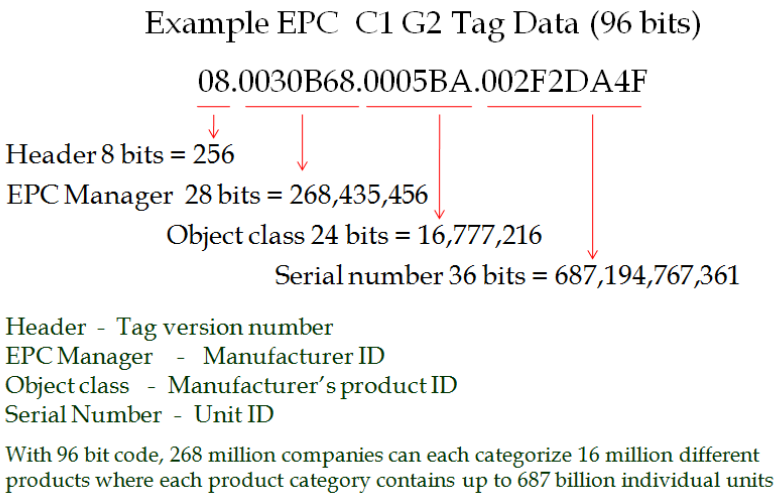

Figure 2. Example of EPC Class1 Gen2 tag ID

3. MULTI ACCESS CONTROL SYSTEM

3.1. System Configuration

The system has three major blocks diagram namely input, output and processing unit. In this multi access control system input unit is RFID reader and antenna, information from the tag captured by reader will process by processing unit and send data to the output or database. Because of multi RFID readers are used for this system, a centralized database is required to provide same user information.

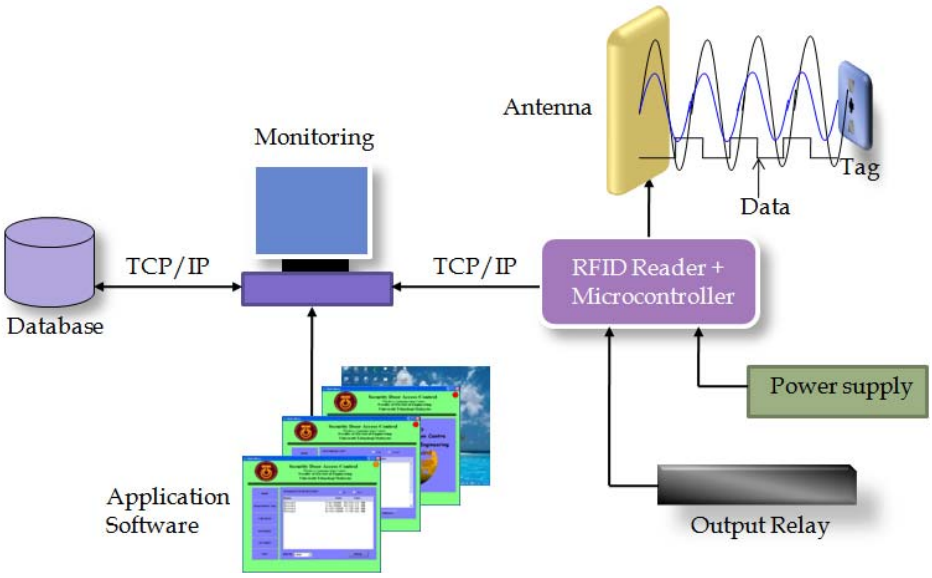

Figure 3. Architecture RFID access control system

As shown in Figure 3, RFID access control system architecture diagram, represent for one system of they are identity identification, door access and gate entry permit system

3.2. Identity Identification

The use of RFID technology for identity identification is very useful for company or university to verify that tag ID is wearer by correct person. By using handheld terminal as shows in figure 4 with application software can do spot check at any time and any where with convenience read range to the tag, information verification of data from handheld terminal can do by wireless system that can connect to backend database.

Figure 4. Identity identification using HHT

3.3. Door Access

Nowadays most of doors are attached with access system to get easy access into room or building and record person in and out [4]. Currently most of door access system using short distance reading range reader. The tag used magnetic coupling RFID system, so not be applicable to apply these tag for long range RFID reader, in this development use of RFID Class1 Gen2 tag for door access and can be apply for long range reader as required for gate access system.

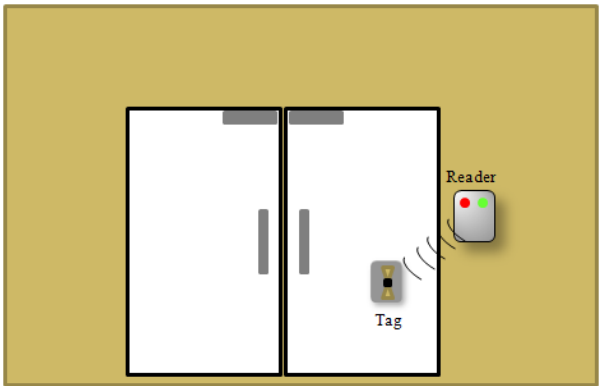

Figure 5. Door access system

Figure 5 shows how door access installed at main door and when tag tap to the reader the door automatic open and record the person based on tag ID.

3.3. Gate Access System

Radio frequency identification technology can be applied almost in any area, one of application is checkpoint or gate access system, before vehicle enters to the area and user can use RFID tag as identification to access [5]. With the advantages this technology that can read tag up to a few meters for passive type and make this system suitable for gate access system where user do not need to take ticket as access token.

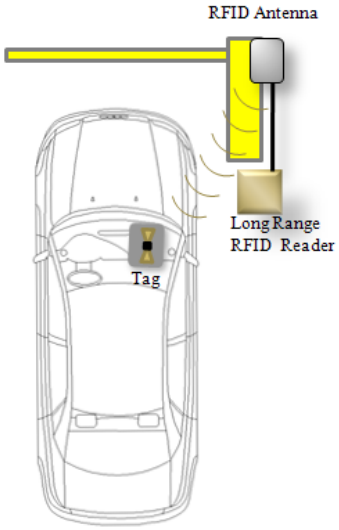

Figure 6. Example gate entry system

RFID antennas are installed at entrance and exit lanes of areas and system communicate using radio frequency to RFID tags that mounted in each vehicle. Reader will capture information in RFID tag when they are in reading range of reader, then system will send the information to computer system for verification to database system. If the tag is valid information, gate barrier will release for a vehicle, when the information not valid or not registered in database system alert an alarm message. All the valid information will record to database documentation and transaction log report. Figure 6 shown how RFID long range reader and antenna installed at gate, reader will read tag in the vehicle then verify. The tag can be put at dashboard or hanging at mirror of vehicle. RFID for gate access control system also applicable for development in automatic parking system, vehicle monitoring system, asset tracking system and with similar configuration

4. TESTING AND ANALYSIS

Some testing with various scenarios have been done, measurement data was collected and analysis. Equipment setup in this experiment and method of data collection as shows in below. Some data analysis and discussion also explained.

4.1. Equipment Setup

Figure 7 shows equipment setup for measurement tag reading distance, started with minimum transmits power of reader to maximum power.

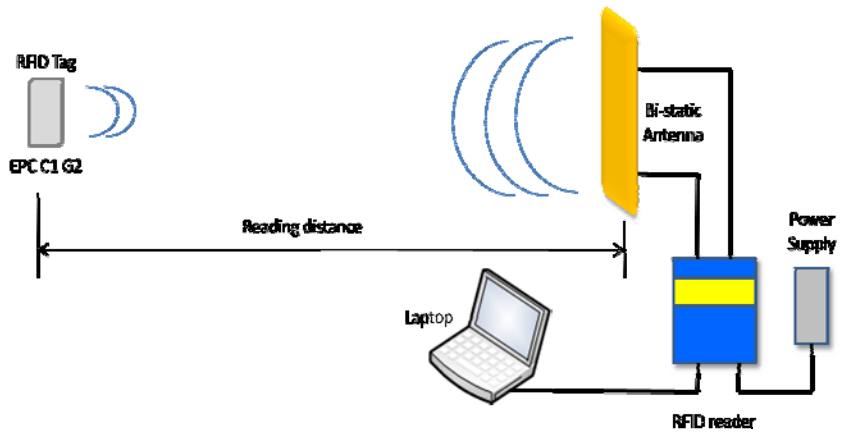

Figure 7. Equipment setup for measurement

4.2. Measurement Results and Analysis

Theoretically reading distance of RFID system can be measured by using Frii's free space formula [6], to calculate maximum reading distance as equation (1).

$$R_{max} = \frac{\lambda}{4\pi} \left(\frac{P_t G_t G_r \delta}{P_{th}} \right) - 1 \quad (1)$$

where :

λ = wave length
Pt = transmit power
Gt = reader antenna gain
Gr = tag antenna gain
Pth = tah threshold power
δ = power transmission coefficient

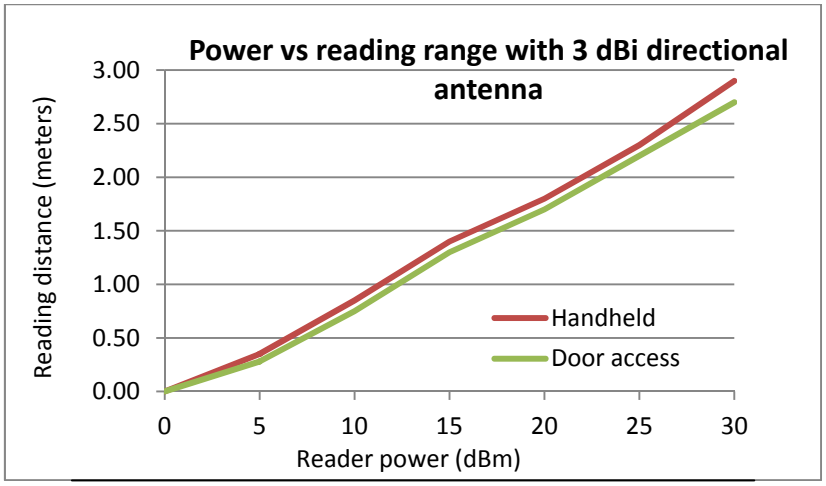

Figure 8. Result handheld and door access reading range versus reader power

Refer on equipment setup as Figure 7, some testing and measurement was conducted to get reading performance and distance of RFID tag. Measurement used card type of tag, with packing PVC material [7]. Each RFID system also tested to get comparison for every system such as handheld reader, door access and field reader. By adjusting transmits power of reader started with minimum to maximum power than measure reading distance every increasing power. Figure 8 shown graph of measurement distance of RFID tag to reader in meter versus transmits power of reader in dBm. First red line is handheld reader for identity identification that used low antenna gain and second is green line measurement of door access reading also with low gain antenna. Both above reader designed with low gain antenna because for they are application does not require long reading distance.

Measurement results for both above system give similar response because they use same antenna gain. The response with maximum reading 3 meters is enough for they application, since for door access only require a few centimeters. RFID field reader as system measurement, used high gain antenna with 8 dBi to get maximum reading distance, since this application require long reading range of tag [8]. Measurement was conducted in two field environment, where first measurement with line of sight to see basic reading performance and second measurement place the tag inside vehicle as actual application.

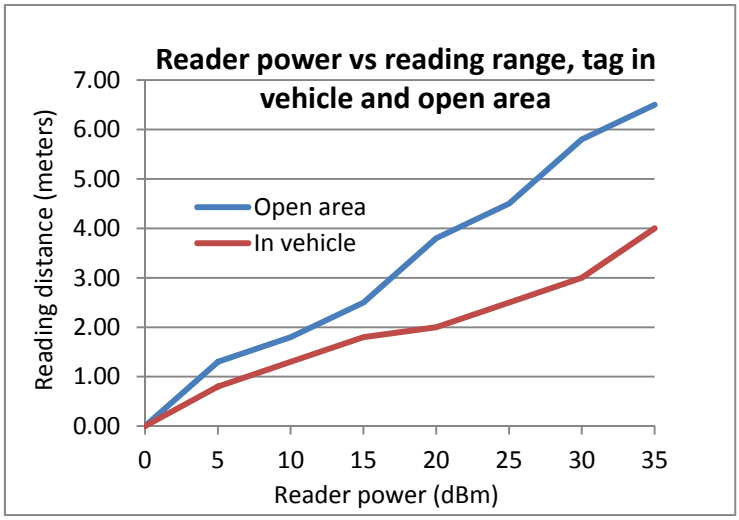

Figure 9. Result field reader reading range versus reader power

Figure 9 shown graph for field RFID reader performance, first results with blue line is open area or line of sight measurement and second is red line measurement that tag placing in vehicle. By adjusting transmits power of reader, reading distance measured every increasing power. Similar for above system reading distance measured in meters and transmits power of reader in dBm. Both measurements give different response, open area give good response with maximum reading up to 6 meters for 30 dBm power, where in vehicle tag give maximum reading only 3 meters for 30 dBm power. However, this response still acceptable for this applications, normally distance of gate barrier to the vehicle lane less than 3 meters. Testing alsoconducted some scenarios with a few models of vehicle, reading performance depends on vehicle models and environment, environment of vehicle mean some of vehicle use sun glass that effected to reading distance. Since RFID technology defer to metal and water environment.

5. CONCLUSION

Development of EPC Class1 Gen2 tag application for multi access control system was done. By using the same tag, user can access many place and also as identity. The tag stored ID and every user registered in a central database, application software used for registration, check identity and check the record of transaction. Some data was collected with optimum reading range versus reader transmits power, antenna gain much affected to reading distance and performance. High gain antenna gives optimum reading distance and good reading performance.

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Evizal received his M.Eng. degree from Universiti Teknologi Malaysia, Malaysia in 2008. He is currently a PhD. student at the Wireless Communication Centre, Faculty of Electrical Engineering, Universiti Teknologi Malaysia. He have been worked in several companies that provide system solution in telecommunication and radio frequency identification, currently is continuing his research activity related to the wireless communication, radio frequency identification and wireless sensor network. His research interest is in the field of antenna design, smart system, RFID and sensor network.

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Sharul Kamal Abdul Rahim obtained his first degree in Electrical Engineering in 1996 from University of Tennessee, U.S.A., M.Sc. in Engineering (Communication Engineering) from Universiti Teknologi Malaysia (UTM) in 2001 and PhD in Wireless Communication System from University of Birmingham, U.K. in 2007. Currently, Dr. Sharul is an Associate Professor at Faculty of Electrical Engineering, UTM and an academic staff member of Wireless Communication Centre (WCC). His research interest is smart antenna on communication system. He is also a member of IEEE Malaysia section (MIEEE), member Board of Engineer Malaysia (MBEM), member of Institute of Engineer Malaysia (MIEM) and Eta Kappa Nu Chapter (International Electrical Engineering Honour Society, University of Tennessee). He has published a number of technical papers including journals and international conferences on rain attenuation and smart antennas