

## Research on How to Design an Android-based RFID Reader

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### Abstract

*Android is a very popular system in Chinese mobile phone market, while radio frequency identification device (RFID) which is originally used in fields of retail and logistics etc., is going to be installed into Android to realize the visualization of commodity information (including the updating, discounting, and after-sale service) and the general use for publics. This study firstly discussed the overall design requirements of an Android platform-based RFID reader. Subsequently, basing on design positioning and principle, the design idea and parameters involved in the design realization were given a detailed description. Design was completed with the aid of related mobile phone applications developed by Android smart phone and multi-level technology testing and research. The new design is attempt to build a new technological life in future and further improve life quality.*

**Keywords:** RFID reader, android, commodity information

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### 1. Introduction

RFID is commonly called as electronic tag. It is a wireless system composed of an interrogator (or reader) and a lot of transponders (or tags).

Early in 2006, RFID technology was highly promoted by retailers including Wal-Mart. This attributes to that RFID technology solves retail industry's two major problems: goods supply shortage and loss (the products lost due to theft and supply chain disturbance) [1].

RFID technology shows many advantages in logistics field, such as fast warehousing speed, high efficiency and smooth process in sorting and ex-warehousing, short time required, and high accuracy. With the development of the e-commerce industry in China, these advantages have been fully played in logistics field. The fast and accurate information obtained enable e-commercial enterprises make rapid response to market in short time period. Meanwhile, market adaptability is also greatly enhanced. At present, RFID technology has been more mature and met the requirements of being extensively applying to business. Moreover, the cost problems that restrict RFID technology application are relieved with the increase in China's artificial cost. Thus RFID technology will be more and more widely used in e-commercial logistics [2].

With the gradual maturing of RFID technology application in commercial field, Android shows fairly high performances in the world's largest mobile phone market (China market). In the first 3 months before the end of May, 2013, the market share of Android smart phone has exceeded 70% in China [3]. More and more people begin to use mobile phone for delicious, fun, share, and communication etc.. The prosperity of the smart phone explores the vast terrain in mobile e-commerce application.

Even if the technology is so advanced, consumers can easily be involved in the following conditions: when a consumer buys one commodity from Wal-Mart, the RFID of the commodity shows no further use after buying. Meanwhile, the discount or new arrivals' recommendation information of shopping malls cannot be transmitted to consumers. In addition, when the commodities purchased by e-commerce are delivered to buyers, before-use installation instructions and after-sale service etc. are required. In case of DIY failure, the most common solving mean is calling for help or waiting for professionals' home services. However, the commodities with RFID provide users with one-to-one guidance services etc. to achieve "instant field solutions" although they are out of their original locations.

In technology age, the RFID technology which is originally widely applied in commercial fields (such as retail and transportation) [4] can be universally used by common people through smart phone. Thus it is necessary to design and develop a most popular and general-purposed RFID reader for the most common mobile phone users. By relying on the openness of Android, users can experience the technology life brought by REIF reader and the smoothness and efficiency of information.

## 2. The Overall Design of RFID Reader

RFID reader is a micro read/write device cooperatively used with Android smart phone or tablet computer. It can replace the traditional RFID handheld products in multiple environments to ensure mass users querying large amount of commodity updating information [5] wherever at different time, or acquire relevant technology and service.

### 2.1. Design Positioning

Along with the great popularity of mobile phones such as Samsung, HTC etc., Android user group rapidly expands in a large age span, stretching from youngsters (including students) to the middle-aged and elderly class who has certain economic strength to pursue fashion. Therefore, the popularity and fashion are the major theme; legerity, pocket-friendly size, and easy-to-carry are practical requirements; the short-distance RFID reading is a major principle for cost reduction and practical design.

The RFID normalization design that has been used in certain commercial fields needs to be standardized and unified. To match with different RFID types, the RFID readers designed for home users should realize frequency coverage and meet more industry standards as much as possible in current industry background.

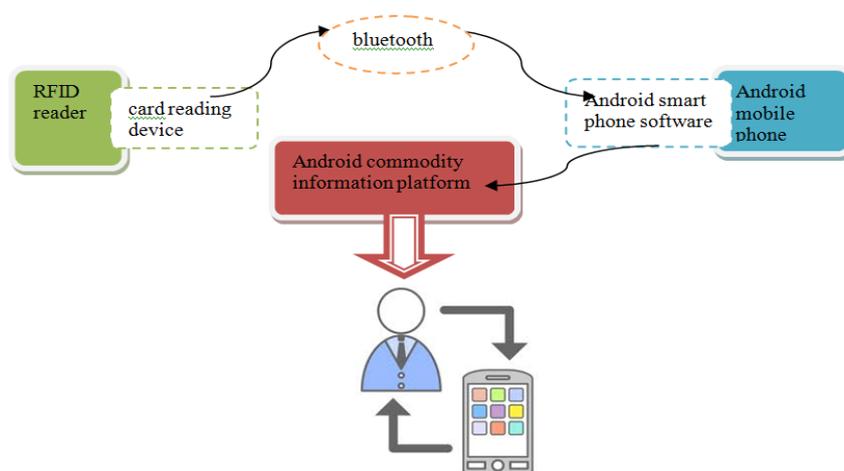


Figure 1. Working Principle of RFID Reader

### 2.2. Working Principle

RFID reader consists of two parts including card reading device and Android smart phone software. The card reading device communicates with Android mobile phone via bluetooth and sends RFID to mobile phone terminal. Through the commodity information query platform in mobile phone, the commodity information carried by RFID etc. can be inquired. The functions of RFID reader are briefly shown in Figure 1:

(1) Card reading device: bluetooth communication, lithium battery power supply, reading RFID, micoUSB charge.

(2) Android commodity information platform: bluetooth communication, electronic product code (EPC) RFID display, card reading, RFID information querying by connecting to remote database via Internet.

### 2.3. Communication Protocol

Communication protocols are required in the transformation of the RFID information read by card reading device into relevant information in Android mobile phone. Here, bluetooth protocol is set as an example. Communication interface meets relevant standards.

## 3. Design Details and Realization

### 3.1. The Information Sealed in RFID

Commodity manufacturers or companies seal the related information in RFID in advance. Mobile phone users login from the information query platform of smart phone (an interface) and inquire related information to obtain commodities.

### 3.2. Related Design Parameters of RFID Reader

As a general-purposed RFID reader, the outside environment, such as temperature and humidity etc. should meet the basic requirements. Besides, the inside environment, including voltage, working frequency, identification protocols, and standards etc., is also required to satisfy relevant requirements. Moreover, the working mode and on-off operation etc. should be smooth and easy to learn, understand, and handle. The main technical parameters of the design are shown in Table 1.

Table 1. The Related Design Parameters of Reader

NO.	Characteristic requirements	Characteristic Description	Graduation
1	Working voltage	DC 3.7V	A
2	RFID working frequency	902~928MHz	A
3	RFID protocol	ISO18000-6C及EPC CLASS 1 GEN 2	A
4	The maximum output power	27dBm	A
5	Data communication mode	bluetooth	A
6	Shape and size	Approximately 80mm(L)×60mm(W)×7mm(H)	A
7	Battery capacity	≥300mAh	A
8	Standby time	≥30h	A
9	Reading time	≥1h	A
10	RFID antenna type	Internal antenna	A
11	Commodity credit tag identification distance	0cm~20cm	A
12	Tag identification time	<500ms	A
13	Working temperature	-20℃~70℃	A
14	Working humidity	10%~90%	A
15	Storage temperature	-30℃~80℃	A
16	Storage relative humidity	≤90%	A
17	Unit cost	<350RMB	A
18	Pilot light	Indicators of power supply, battery capacity, bluetooth connectivity, and status identification etc.	A
19	Power button	Long press the power button for starting up; long press the power button for shutdown	A
20	Time of power	<500ms	A
21	Android smart phone software	Providing a function call interface that can be used for the second development in forms of apk development package based on Android system; completing the initialization of read/write device and ID read etc. via interface call.	A
22	working mode	Opening the power switch of reader and the client software in Android mobile phone; connecting phone and reader via bluetooth; reading the pre-read RFID using the reader controlled by software.	A

### 3.3. Appearance Design and Product Denomination

Android mobile phone owns huge users in wide age spans and profession types. These users are typically characterized by fashion and popularity. Certainly, the two characteristics should be reflected in RFID reader design.

### 3.3.1. Simple Shape

As a pocket-size product, RFID reader should be handheld and portable. In handheld state, hand feeling is an important factor deciding whether this reader will be repeatedly used later. The RFID reader is mainly in straight line shape with slight arcs. Such design is a classic style. It provides users with good hand feeling and reduces the aesthetic fatigue possibility in short time.

### 3.3.2. Color

Silver, black, and white are 3 major “sign” colors commonly applied by many mobile phone manufacturers in style design. Referring to many years of mobile phone manufacturers’ commercial experiences, RFID reader successfully imitates the three “sign” colors. Moreover, the color allows to be upgraded for fresh demands. Relying on downstream shell packaging manufacturers, candy color type and limited type etc. can be launched to cater to the fresh taste of the young and creative groups.

### 3.3.3. Name

This pocket-size RFID reader is denominated according to related industrial requirements and general denomination way, as shown in Figure 2.

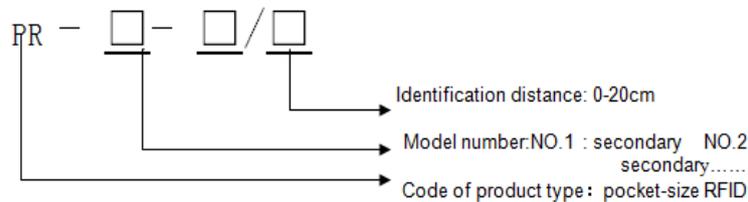


Figure 2. Introduction of How to Name RFID Reader

### 3.4. Android Mobile Phone Client

In the information docking between mobile phone and client, information visualization of RFID reader needs to be achieved through an Android commodity information platform.

Android commodity information platform can display the RFID information in card reading device on Android phone via bluetooth communication technology. Meanwhile, RFID information has access to remote database and queries the commodity information, discount updating information, or after-sale instruction etc. carried by RFID via mobile phone network, as shown in Figure 3.



Figure 3. The Example of Android Commodity Information Platform

#### 4. Test and Improvement

To determine whether or not the RFID reader is practical, stable, and capable of realizing short-distance identification, the technology of products need to be tested in the last procedure. All assembled products should be tested on the basis of technical indexes. Only the devices meeting test standard can be used. Device consistency [6] is detected together with circuit board (PCB); Unit device is welded on circuit board for technology detection. The technology test mainly includes the RFID unit test, power test, communication test, function test, and appearance test.

##### 4.1. RFID Unit Test

The RFID unit circuit test mainly focuses on testing the power supply, power consumption, RFID unit temperature, antenna identification tag distance. The EPC regions of unified RFIDs are continuously read. PC software is employed to control and display RFID information. The test is repeated for 20 times constantly.

##### 4.2. Power Supply Detection

The reader is powered by a lithium battery; control system adopts voltage stabilizing circuit; RFID unit is controlled by metal oxide semiconductor (MOS) tube switch circuit; communication power supply is managed by a switch. The following terms are tested, including the voltage stability and current output capacity of lithium batteries, the voltage ripple of control system, the circuit current load and ripple of RFID circuit, and the voltage and current of communication circuit.

System power detection aims at detecting the power supply system stability of the whole circuit, including the load capacity, stability, and anti-interference of circuit.

Lithium battery employs a 3.7V lithium polymer battery with protective plate. It is provided with many properties to prevent battery explosion, such as over charge, over discharge, over current, over voltage protection circuit, short circuit protection, and over temperature protection. Performance test mainly tests discharge current and voltage using a 5V gear motor at battery voltage loss of 3.2V (alarm voltage is 3.3V).

##### 4.3. Communication Detection

Communication detection focuses on testing the data transmission between RFID reader and Android Software. The communication device is a bluetooth connecting device. The following terms are mainly tested:

(1) Whether or not the communication command sent out by Android mobile phone resembles with that received by RFID reader;

(2) Whether or not the command sent out by Android mobile phone agrees with the response of RFID reader;

(3) Whether or not the communication command sent out by RFID reader consists with that received by Android mobile phone;

(4) Whether or not the communication distance of RFID reader and mobile phone bluetooth is normal in a range of 5m-10m.

Through the detection above and the identification on different RFIDs, the correctness of card number identification can be judged. Besides, the transmission rate based on bluetooth transmission protocol should be tested.

##### 4.4. Function Test

Function test mainly regards the inspection on operation and representation state of RFID reader, i.e. work and standby state, switch state, and bluetooth transmission information state. It is to test the function integrity and state representation accuracy.

##### 4.5. Appearance Test

The size of reader should be firstly detected using vernier caliper generally. Appearance error is allowed in 1mm; shell contact gap should be lower than 1mm. Secondly, material (mainly uses resin) is inspected. Processing precision should be controlled in  $\pm 0.15\text{mm}$ . Moreover, the after-use hand feeling effect should be recorded.

The tests above are repeated from several links and all aspects. Specific test problems are continuously modulated and solved step by step to basically meet the expected design

requirements. Meanwhile, individual function modules should be optimized to improve the design.

## 5. Conclusion

Mobile life is considered as a major theme in the future. In the technology times with smart phone as the carrier, people can use mobile phone to realize the education, entertainment, life support etc.. The grafting of RFID technology in smart phone creates a more convenient life for people. This study discussed the integration of smart phone and RFID technology. Based on the identification and visualization of embedded RFID on terminal smart phone, a RFID reader was designed and tested in detail to realize the process from design to completion. However, due to the paper limits, this study do not give a specific explanation on some aspects, such as communication protocol and RFID information security protection [7]. It is expected to be further researched in the following studies.

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