BOEING
NFC PART VERIFICATION SYSTEM

Project Proposal

ECE 445

Jinjoo Nam - Alper Olcay - Vigneshwar Karthikeyan

TA: Kevin Bassett

February 6, 2013

Table of Contents

I. INTRODUCTION

- **i** Statement of Purpose 3
- **ii** Objectives 3
  - Goals 3
  - Functions 3
  - Benefits 3
  - Features 3

II. DESIGN

- **i** Block Diagrams 4-5
- **ii** Block Descriptions 6
  - NFC Reader / Smartphone 6
  - NFC Tags 6
  - Microcontroller Integrated Circuit 6
  - Temperature Sensor 6
  - Memory 6

III. BLOCK LEVEL REQUIREMENTS AND VERIFICATION

- **i** Performance Requirements 7
- **ii** Verifications 7
  - Test Procedures 7
- **iii** Tolerance Analysis 8

IV. COST AND SCHEDULE

- **i** Cost Analysis 9
  - Labor 9
  - Parts 9
  - Others 9
  - Total Cost & analysis 9
- **ii** Schedule 10-11

I. Introduction

i. Statement of Purpose

Near field communication (NFC) is a technology that is relative to Radio Frequency Identification (RFID), Bluetooth, and WIFI technologies. The major difference between these technologies and NFC is that NFC readers work at short-ranges about 4 inches. Regardless of the short-range, NFC has a big advantage compared to other technologies as it does not always require specialized devices. Nowadays, NFCs are embedded in smartphones with NFC tags which allows access to many functionalities. The current part-verification system used by Boeing is based on RFID, which is costly and functions read-only. For this reason, Boeing desires to develop a prototype parts tracking system utilizing smartphone and NFC tag technology. Boeing defined identifying the technical advantages and constraints that may limit or expand the use of NFC as a part marking technology. Thus, our goal in project is to satisfy the wants and needs of Boeing by focusing onto accurate, easy-access, and effective usage of NFC in part-verification. Our NFC system will provide two-way communication between the reader and tags, and establish read and write functions. Furthermore, the project will satisfy the requirements for accuracy, easy-access, and cost efficiency by cutting down the required equipment to be mainly smartphones and tags which contain specific information about a particular part.

ii. Objectives

❖ Goals

- Ensuring the demands of Boeing are met.
- Establish the two-way communication between NFC reader and NFC tags.
- Add storage capabilities to the existing NFC tags.
- Provide additional modulation such as a temperature sensor to verify the conditions of the storage.

❖ Functions

- Wireless communication between NFC reader (smartphone) and tags
- Software application system to track data from tags.
- Custom levels of accessibility to data on tags.

❖ Benefits

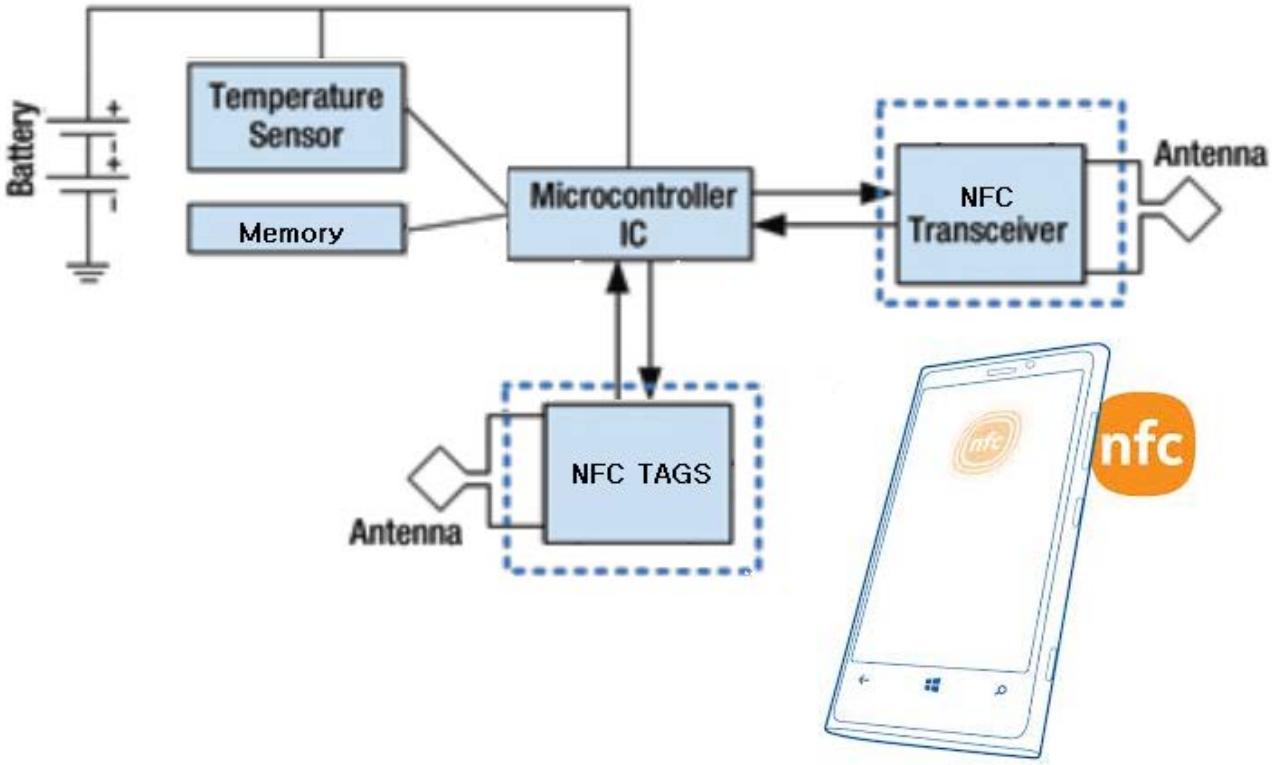
- No need for specialized readers for part verification.
- NFC chips provide more security than existing RFID technologies
- Cheaper than existing RFID verifications systems.

❖ Features

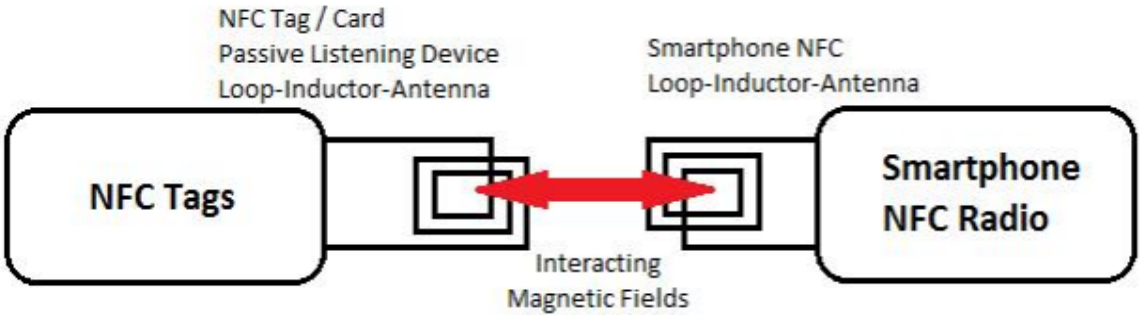
- 13.56 MHz is the operating frequency of the system
- Expected operating range to be between 2cm ~ 5cm.
- Expected bit rate between 106 to 848 kbit/s

II. Design

i. **Block Diagram**



Block Diagram 1. Overall Block Diagram



Block Diagram 2. NFC Tag & Reader Inductive Coupling_1

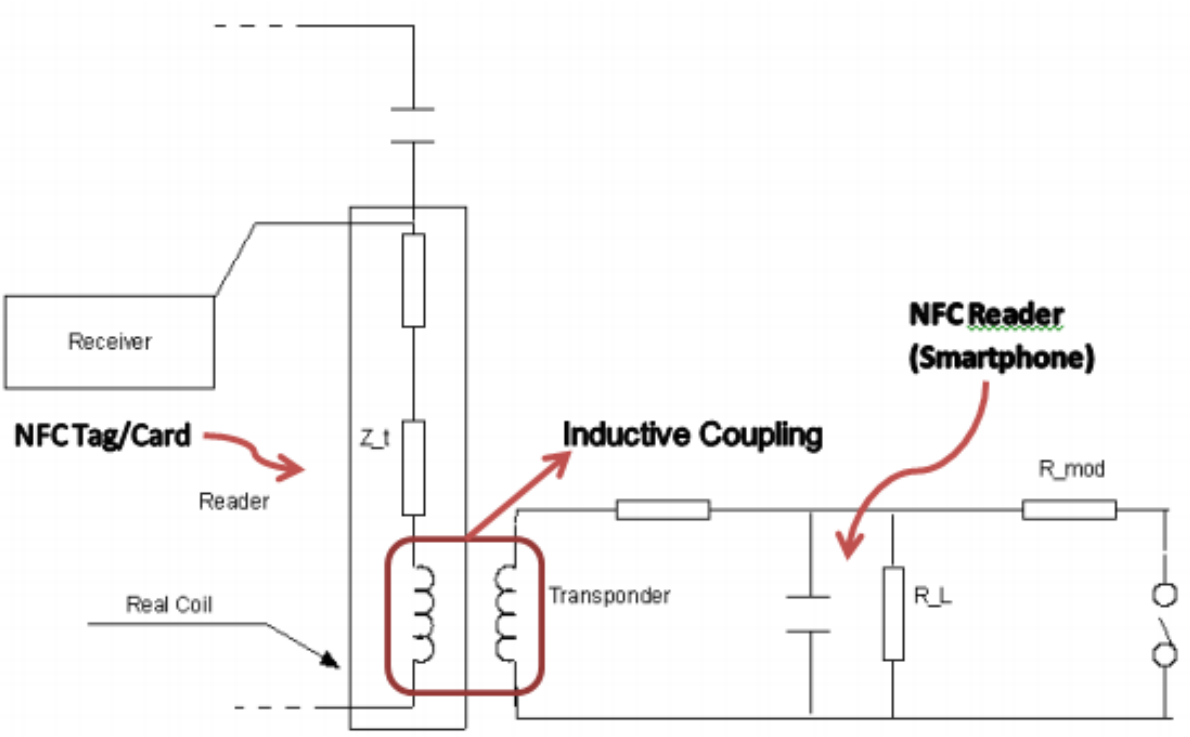
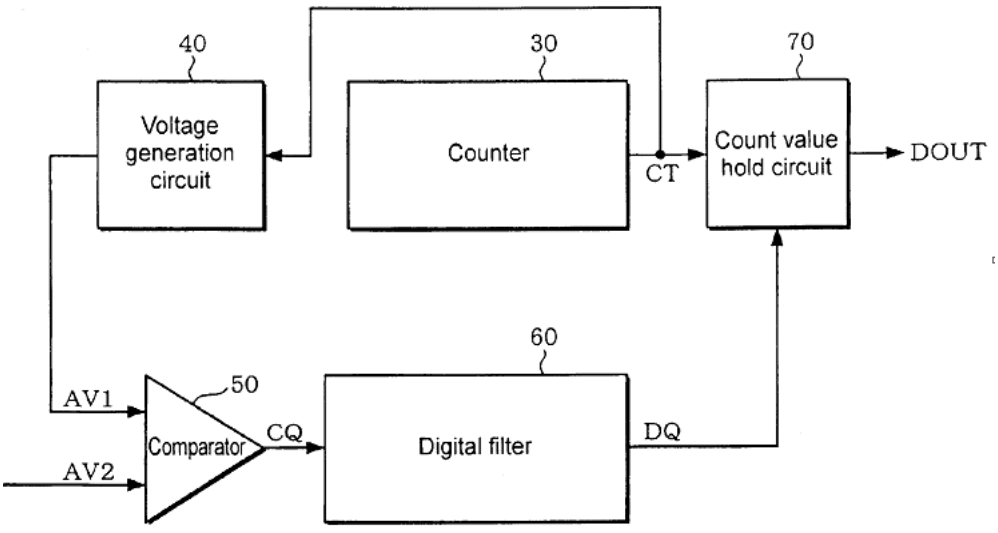


Figure 4.1: Magnetically coupled reader and transponder circuit, showing the transformed transponder impedance "Z_t.

Block Diagram 3. NFC Tag & Reader Inductive Coupling_2



Block Diagram 4. Block Diagram from Temperature Sensor

ii. Block Description

The main components in the design are NFC tags, NFC reader, and Microcontroller Integrated Circuits. NFC reader, which is the smartphone, reads the NFC tags by going through the microcontroller. Microcontroller not only interacts between the tags and the reader but also contains the temperature sensor and memory which allows read and write functions.

❖ NFC Reader / Smartphone

The main function of NFC Reader/Smartphone is to accumulate the data from the NFC tag and the temperature sensors through the mobile application. NFC Reader would be able to identify and display the data about parts - such as the specification, instruction, and the conditions - through the NFC tag and the temperature sensors. It would also display any related information about the accessibility of the particular part on which the tag is placed.

❖ NFC Tags

NFC tags hold the specific data which will be transmitted to the NFC Reader (which will be a smartphone in our project). NFC tags would have both read and write functions, so employees read the tag to access tracking information and verify parts, and write on the tag to confirm their access to the tag and to note any changes they might make on the part.

❖ Microcontroller Integrated Circuit

Microcontroller interconnects the communication between NFC tags and NFC Reader. It collects the data from the NFC tags and temperature sensor and encode digitally for NFC Reader. It is powered by the coupling power system.

❖ Temperature Sensor

Temperature sensor helps to track the parts along their route to their destination. Storage conditions are very important to protect high value parts, so it is critical to track the temperature of the part. Temperatures that are measured by this sensor will be logged into the memory with the help of the microcontroller IC, and will be accessible to the smartphone application, so employees can make sure that the part has no defects.

❖ Memory

Memory is used to store the data that is logged by the temperature sensor, and any additional information that may be written by the employees who have access to the tag.

III. Requirements and Verification

i. Requirements

- **Software Application on Smartphone**
  Create a custom application that is capable of reading data from the tags for assessing validity of parts and writing new data to the tags.
- **NFC Tags**
  Test to see if the tag has both the read and write features when interacting with the Smartphone reader. The tags should be accessible in the range of 2-5cm.
- **Memory**
  Check the increased storing capability of the tags using the microcontroller integrated circuit.
- **Temperature Sensor**
  Should be capable of measuring extreme temperatures from -55 to 125 Degrees Celsius.

ii. Verification

- **Software Application on Smartphone**
  Verify that the smartphone is reading the data from the tags and displaying the specifications of the part to the user by testing the NFC reader on tags.
- **NFC Tags**
  Verify that the tags are operational and use the smartphone application.
- **Memory**
  Store to the memory using the smartphone applications and use both the read and write capabilities to test for full functionality.
- **Temperature Sensor**
  Verify that the sensory stores the information to be provided to the user in the cases where extreme temperatures are reached. Test by exposing sensor to extreme ranges and verify it properly stores this data for user to retrieve.

❖ Test Procedures

1. The block diagram in Figure 1 will be tested by verifying the connection between the components of the tag and the receiver. Following that the read and write capabilities of the IC is going to be tested by writing an access mark on the tag and reading it to bring the according information to the smartphone screen.

2. The power system will be tested by the means of a multimeter, in order to make sure that the inducing effect is providing the necessary power to the tag and the temperature sensor. Firstly, a bench power source is going to be used to verify the circuitry on the tag is functional, then the coupling power system will be tested under an expected load.

3. The temperature sensor is going to be calibrated to room temperature, and it will be first heated and then cooled to make sure that it is giving out voltages in the expected range and with the expected incremental value. After its integration into the tag, the heating and cooling process will be repeated to test the integration of the temperature sensor and the smartphone.

iii. **Tolerance Analysis**

The main factor in tolerance analysis is the software component. It is critical for the software to present accurate data in terms of the individuals who have accessed the tag and other critical information. In order for the system to be of use, the incoming data should be 100% accurate.

Temperature analysis is very prone to error, however it is not critical to have it 100% accurate. For most parts, there is a desirable storing temperature range, which is usually close to room temperature. For that reason, 5% error is considered acceptable. Our goal is to make sure that we stay in that error range.

Any additional circuitry added to deal with ongoing issues will also be prone to error, depending on the nature of the addition. As in the temperature analysis, our goal would be to keep that error percentage below 5%.

IV. Cost and Schedule

i. Cost Analysis

❖ Labor

Name	Hourly Rate	Total Hours Invested	Total = HR x Hours Invested x 2.5
Alper O. Olcay	$ 40.00	150	$ 15,000
Jinjoo Nam	$40.00	150	$ 15,000
Vigneshwar Karthikeyan	$ 40.00	150	$ 15,000
Total		450	**$45,000**

❖ Parts

Parts	Quantity	Unit Cost	Part Number	Cost
Samsung Galaxy S3 Smartphone	1	$ 560.00	NXP: PN65 (NFC CHIP)	$ 560.00
RCL Components			-	$ 40.00
NFC Tags	5	$ 14.99	Tectiles ETC-TT1G6NGSTA	$ 74.95
Debugging Equipment	1	$ 30.00	-	$ 30.00
Altera DE2 Board	1	$ 495.00	Altera Cyclone II 2C35 FPGA	$ 495.00
Temperature Sensor Pack	20	$ 1.59	DS18B20	$ 31.80
Batteries	5	$ 0.80	-	$ 4.00
Total				**$ 1,235.75**

❖ Grand Total

Section	Cost
Labor	$ 45,000
Parts	$ 1,235.75
Total	**$ 46,235.75**

ii. **Schedule**

Week	Tasks	Responsibility
4-Feb	Finalize and hand in proposal	All
	Determine which NFC tags are to be bought and order them	Alper
	Verify the need of additional circuit modifications	Vigneshwar
	Design preliminary NFC application	Jinjoo
11-Feb	Start designing the circuit component	Jinjoo
	Design preliminary version of the temperature sensor	Alper
	Design preliminary version of the security system	Vigneshwar
18-Feb	Start designing the smartphone application	All
	Add the accessibility component to the application	Vigneshwar
25-Feb	Design Reviews	All
	Build the temperature sensor	Alper
	Build the accessibility and security system	Vigneshwar
4-Mar	Design preliminary version of the coupling power system	Jinjoo
11-Mar	Begin integration of app to hardware component	All
	Build the power system	Jinjoo
18-Mar	Design preliminary integration of hardware and application	All
25-Mar	Mock-up Demos	All
	Assemble PCB	Alper
1-Apr	Request First Revision PCB	Vigneshwar
	Test the power system	Jinjoo
8-Apr	Request Final Revision PCB	Vigneshwar
	Test the temperature sensor	Alper
	Test the accessibility system	Vigneshwar

15-Apr	Run a test with all the components involved	All
	Fix remaining issues	Jinjoo
	Work on presentation and demo	Alper
	Prepare Final Paper	All
22-Apr	Demos	All
29-Apr	Final Presentations	All
	Final Papers Due	All
	Checkout/Awards	All