1 Goal
The student will further develop concepts learned in the modules by conducting experiments with RFID tags and readers.

2 Assessment
A student should:

- Be able to read and write data to/from a tag
- Know that tag orientation affects read range
- Know that read range varies with power
- Know the nominal read range for a given power and antenna gain
- Know what materials shield UHF passive tags
- Know about passwords in Gen2

3 Equipment
- Reader with antenna, preferable a linear polarized antenna such as a patch antenna
- Antenna stand
- Tag stand
- Several tags
- PC to communicate with reader

4 Software
- Reader software

5 Prelab

5.1 Preparation
- Read help file for TagSense reader available at website
- Review TagSense documentation available at website
- Read help file for Intel reader available at website
5.2 Prelab Questions
Answer the following questions and turn in before the lab.

1. Describe the main mistake that can damage a reader. (2 pts.)

2. How many bits is the EPC in Gen2? (2 pts.)

3. How many bits is the TID in Gen2? (2 pts.)

4. What is the suggested default Q value that is listed in the Gen2 specification? (2 pts.)

5. How many sessions does Gen2 define? Describe each of them. (8 pts.)

6. Calculate the power in milliwatts for each of the following. (2 pts each)
   a. 30 dBm
   b. 25 dBm
   c. 20 dBm
   d. 15 dBm
   e. 10 dBm
6 Experiments

6.1 Experiment 1: Reading/Writing a Tag

6.1.1 Configuration

- Place a tag near the antenna of the reader and start the program that controls the reader.

6.1.2 Exercise

- Read and record the EPC and TID model numbers of three tags.
  EPC1: ________________________________________________________________
  TID1: ________________________________________________________________
  EPC2: ________________________________________________________________
  TID2: ________________________________________________________________
  EPC3: ________________________________________________________________
  TID3: ________________________________________________________________

- Rewrite/Change a tag’s EPC number. Record the EPC number below, write your names on the tag, and turn in the tag.
  EPC: ________________________________________________________________

- Determine and record the default Q value of the reader.
  ________________________________

- Determine the reader session that is being used by the reader.
  ________________________________

6.2 Experiment 2: Tag orientation

6.2.1 Exercise

- Determine the best tag orientation for the maximum read range. Describe it. Is the antenna pattern vertical or horizontal?

- Determine the best tag orientation for the minimum read range. Describe it. Is the antenna pattern vertical or horizontal?
6.3 Experiment 3: Distance and Power

6.3.1 Exercise

- For three different tags, determine the EPC number and maximum read range. Describe the tag orientation.
  
  o Tag1
    - EPC: 
    - Distance: 
  
  o Tag2
    - EPC: 
    - Distance: 
  
  o Tag3
    - EPC: 
    - Distance: 

- Record the power of the reader and the maximum read range.
  
  Power: 
  Maximum read range: 

- Determine the gain of the antenna.
  
  Antenna gain: 

- Pick one tag. Make sure you start with low power values and increase it, not starting at a high power level and decreasing it.
  
  o Set the power to a very low value and determine the maximum read range.
    
    - Power level: 
    - Maximum read range: 
6.4 Experiment 4: Shielding

6.4.1 Configuration
- Various materials such as aluminum foil, cardboard, and a water bottle with an RFID tag are available.

6.4.2 Exercise
- Determine if aluminum foil prevents the reader from reading a tag. Experiment with placement and distance.

- Determine if the human body prevents the reader from reading a tag. Experiment with placement and the distance.

- Determine if cardboard prevents the reader from reading a tag. Experiment with placement and distance.

- Rotate the water bottle with the RFID tag and determine if the water prevents the reader from reading a tag. Experiment with orientation and distance.

6.5 Experiment 5: Hacking the Access Password

6.5.1 Configuration
- The student(s) will be provided with a tag with an access password that is unknown to them. The instructor will give a hint on the range of the password.

6.5.2 Exercise
- Determine the access password of the tag and record the EPC number and password below.
  EPC ______________________________________________________

  Password ______________________________________________________
6.6 Experiment 6: Create an Experiment
Create an experiment. Complete the Configuration and Exercise sections.

6.6.1 Configuration

6.6.2 Exercise
7 Checklist

- Turn in questions from Prelab.
- Complete all experiments.
- Complete and turn in Feedback sheet.
- Notify instructor lab is complete.
- Write and turn in lab report.
8 Lab Report
Each team should write one lab report. Use the format described below.

8.1 Title Page
The first page is the title page and needs to contain the name of the experiment, names of lab partners, and the date.

8.2 Abstract
A good abstract is a concise (250 words) summary of the objective, key findings, significance, and major conclusions. The purpose of the abstract is to permit the reader to determine whether they need to read the rest of the document.

8.3 Introduction
The introduction states the objective of the experiment and gives the reader sufficient background to understand the rest of the document.

8.4 Method and Equipment
Tell the reader what was done and how it was accomplished. Describe the test procedure. There are usually several subsections. The work should be written in third person passive voice like “The ball was hit using a baseball bat.” not in active voice like “I hit the ball using a baseball bat.” Avoid using the word “I” in a formal document. Avoid using the word “we” although it can be used sparingly.

8.5 Results
Summarize the data collected and the statistical treatment of the data. Results should be summarized in the form of figures and tables. Use past tense to describe the results (The experiment showed...).

8.6 Conclusions
Evaluate and interpret the implications of the results. Use present tense to discuss the results and to present conclusions (The data indicate...).

8.7 References
A particular style for references should be chosen and followed. I prefer the IEEE citation style like below, but others are acceptable. Be consistent. Below is an example of a journal, book chapter, and conference paper.


8.8 Appendix
Place things like the completed lab and source code here.
9 Feedback

- Complete this form after completing the lab exercises and turn it in with the lab report.
- Do not put your name on the form and keep it separate from the lab report.

- What did you like about the lab?

- What did you dislike about the lab?

- Make a suggestion on how to improve the lab.
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