ECE 411 Industry Design Processes: Assignment #6

Due on Monday, November 24, 2014

Faust 2:00pm

To8

K. Lu, C. Halseth, M. Schmidt, M. Downey

https://github.com/DroningOn/ECE411

Homework #6 Due Monday November 24, 2014

Please submit problems into the team wiki homework #6 folder on GitHub as well as a paper copy in class.

Grading Schema:

Your work will be graded on completeness, conformance to design documentation requirements as described in class, and quality and clarity of the individual test cases.

Problem 1:

Create a comprehensive hierarchical test plan for your practicum project. Consult the course lecture notes and textbook for guidelines.

Wireless Feedback Apparatus

Test Plan Documentation

Rev. 20141l.R1

Wireless Feedback Apparatus Revision History		
Date:	Revision	Changes
11-19-2014	**Rev. 201411.R1**	

The information presented in the To8 test documentation in the alpha phase of development. Although this document has been carefully checked and is believed to be accurate, no responsibility is assumed for inaccuracies.

1. Introduction

The purpose of the product test plan is to document how the product will be tested to ensure that it conforms to the project scope and meets the engineering requirements specified in the Product Design Specification (PDS) document.

In Scope

This document addresses the procedures necessary for proper system testing and verification related to the design of the wireless classroom feedback product. The product testing plan includes the following modules described in detail by the PDS.

- Operational Requirements
- Functionality Requirements
- Performance Requirements
- Interface Requirements

Out of Scope

The following items are outside of the scope of the initial project and may be addressed by subsequent practicum design projects.

- Verification of all FCC regulations pertaining to short-range wireless communication devices (47CFR20).
- Characterization of antenna directivity and radiation efficiency
- Six-Sigma Testing Methodology

2. Reference Documents

Refer to the following reference documentation for the detailed documentation about specific testing guidelines and standards.

2.1. Industry Standards

- *FCC guidelines, Radiofrequency radiation exposure limits.*
  - *(47CFR1.1310)*
- FCC Regulations, Title 47- Telecommunications
  - (47CFR20)

2.2. Design Documentation

- Product Design Specifications (PDS)
- Block Level Diagram Document (System Design / Modeling Document)
- Eagle Circuit Schematic
- Eagle Board Layout

    - Top/Bot Layer Reference
    - Bot Layer Reference
    - Dimensions Layer Reference
    - Component Outline Reference
- Bill of Materials (BOM)

2.3. Other Documentation

- Texas Instruments: SLAA276A-October 2006
- Texas Instruments: ECCN 5A002A1A
- Texas Instruments: SLAA465C
- Texas Instruments: SLAU320P
- Texas Instruments: DN024
- Texas Instruments: Introduction to SimpliciTI
- Texas Instruments: SmartRF Studio
- Texas Instruments: CC430F5137

3. Overview of Testing Approach

3.1. Levels of Testing

Levels of testing are implemented to detect and identify problems early in the product development cycle. By modularizing testing, many components may be verified and tested in parallel thereby speeding up product development and reducing development time kinks where teams or team members are left idle. Each level must first be validated and approved by the team or manager before elevating the test to the next level. In this document, three levels of testing are implemented. Each level as well as the test level objects are defined below.

3.1.1. Level 1: Unit Testing

This phase involves testing independent pieces of hardware and software. The unit test is performed to validate the design requirements specified in the PDS. Unit testing generally represents a single aspect of the design and is an easy way to show that the unit satisfies its functional specification.

- Objectives
    - Perform detailed tests of all functional requirements
    - “White” box testing passes
    - “Black” box testing passes
    - Meets all specifications described by PDS

3.1.2. Level 2: Integrated Testing

The integrated testing phase integrates unit modules in order to create more complex components. The purpose of this test is to discover whether the major modules of the overall system operate correctly together.

- Objectives
    - Verify that performance specifications are maintained during integration phase
    - Identify and fix problems prior to system testing

3.1.3. Level 3: System Testing

The system level test is used to determine if the product functions as specified by the PDS. In this phase, testers identify problems encountered in functionality where a given functional input does not produce the expected response.

- Objectives
    - Ensure end device operates as expected and matches the *intention* of the design specification.
    - Verify that functional and performance specifications are met.
    - Verify that all items on test plan are performed successfully.
    - Identify problems with the data

3.2. Operational Description

- Takes 1 of 4 user inputs and wirelessly transmits the selected input to a central hub where a results are serialized and handed off to software. The software takes the serialized data and displays it in graphical form.

3.3. Definition of Terminology

1. MCU : Microcontroller Unit
2. ID : Identification
3. DUT : Device Under Test
4. GUI : Graphical User Interface
5. Exhaustive Test: Testing approach in which all possible combinations of scenarios, use cases, and test cases are used in testing
6. Battery Lifetime: Total duration that a satellite unit can operate on a single, fully-charged CR2032 battery.
7. ISM Band Region 2: The unlicensed band from 902MHz to 928MHz.

3.4. Computation Methods

3.4.1. Power Consumption

- Device Current Consumption:
    - $I_{average} = I_{Standby}\, x\, Ratio_{Standby} + I_{Active}\, x\, Ratio_{active} + I_{Peripheral}\, x\, Ratio_{Peripheral}$
- Total Average Current Consumption:
    - $AvgI_{total} = AvgI_{Standby} + AvgI_{Peripheral} + AvgI_{Active}$
- Battery Lifetime
    - $CR2032\ uAh/AvgI_{total}$
        - $230000uAh/AvgI_{total}$

4. Pretest Preparation

4.1. Test Equipment

- Agilent Vector Network Analyzer
- Agilent 2-Channel Oscilloscope
- Fluke Multimeter
- Computer with Python installed
- Keithly Micro-ammeter
- CC430 DevKit
    - ECE 411 Project Satellite Unit
    - Base Station

4.2. Test Setup and Calibration

- Load firmware to MCU
- Install CR2032 to power Satellite unit
- Install "serial" and "Tkinter" python module

5. System Tests

The system TestID format shall be as follows: Level# - X(Test Type)
Level#-TestTypeLetter XX - HardwareRev-Software Rev

- **Level 1: Unit Testing**
    - Functional Testing
        - L1-F01-A-A: Visual Inspection of reflowed boards
        - L1-F02-A-A: Radio Frequency ISM Band Test
        - L1-F03-A-A: Current Consumption Test
        - L1-F04-A-A: MCU LED Response Test
        - L1-F05-A-A: GUI Functionality Test
    - Parametric Testing
        - L1-P01-A-A: RF Scattering Parameters
        - L1-P02-A-A: RSSI
        - L1-P03-A-A: Power output (dBm)
    - Reliability Testing
        - L1-R01-A-A: Button Press Counter
        - L1-R02-A-A: Tx Packet Counter
        - L1-R03-A-A: Real-Time Packet Parsing
        - L1-R04-A-A: Data Storage Validation Test

- **Level 2: Integration Testing**
  - Functional Testing
    - L2-F01-A-A: Transmit Packet Test
    - L2-F02-A-A: Integrated Power Consumption Test
    - L2-F03-A-A: Return to Sleep Mode Test
    - L2-F04-A-A: Populate Network Test
    - L2-F05-A-A: Interface Python GUI to Base Station
    - L2-F06-A-A: Connect to Network on Reset
    - L2-F07-A-A: Connect to Network on Power Up
    - L2-F08-A-A: Connect to Network after Loss of Power
  - Parametric Testing
    - L2-P01-A-A: RSSI
    - L2-P02-A-A: Connectivity
- **Level 3: System Testing**
  - Functional Testing
    - L3-F01-A-A: Button Press Indicator
    - L3-F02-A-A: Usability Test
    - L3-F03-A-A: End to End Hardware
    - L3-F04-A-A: GUI Statistics Report
    - L3-F05-A-A: GUI Start/Stop Polling
    - L3-F06-A-A: GUI New Dataset
  - Use Testing
    - L3-T01-A-A: User Input Test
    - L3-T02-A-A: Ease of Use Test
  - Reliability Testing
    - L3-R01-A-A: Repeatability Test
    - L3-R02-A-A: Battery Lifetime
    - L3-R03-A-A: Channel Noise Connectivity Test

Problem 2:

Create detailed test case descriptions for four tests included in your test plan.

Test Writer: Michael Schmidt						
Test Case Name:		Packet Parser Testing			Test ID #:	L1-R03-A-A
Description:		Simulate incoming packets to verify proper sorting. Ensures parser properly sorts packets into User ID and answer.			Type:	white box x black box
Tester Information:						
Name of Tester:					Date:	
Software Version:		Rev. A			Time:	
Step	Action	Expected Result	Pass	Fail	Comments	
1	Create list with single packet as input argument	Parser creates dictionary with one element with the User ID as the key and the User answer as the value				
2	Create list with multiple packets as input argument	Parser creates dictionary with the same number of elements as packets in the list each with the User ID as the key to the corresponding User answer as the value				
3	Create list with Multiple packets As input argument With some packets Having the same User ID	Parser creates a dictionary with the same number of elements as unique User ID's. the User answer value in the dictionary should correspond the most latest answer in the list for that User ID				
4	Use "Packet Spew" Program to simulate Real-Time packet Stream	Parser parses packets in real time and Updates the dictionary by either creating new entries with new User ID's or updating current entries with User ID's currently in the Dictionary.				
Overall Test Results						

Test Writer: Kyle B. Lu			
Test Case Name:	Current Consumption (sleep, active MCU + Radio)	Test ID #:	L1-F03-A-A
Description:	Test total current consumption of DUT during normal button press event.	Type:	White Box: [x] Black Box: [ ]
Tester Information: Electronics technician skills required.			
Tester Name/Sig:	/	Date:	
Hardware Version:	Rev A.	Time:	
Setup:	Power off, Firmware Loaded		

Step	Action	Expected Result	Pass	Fail	Comments
1	Install uA current meter in battery current path.	N/A			
2	Install battery and measure sleep current consumption	I: (1uA, , 1mA)			
3	Disconnect power and current sense meter	N/A			
4	Install precision 1% sense resistor in battery current path	N/A			
5	Measure voltage differential using 2-channel oscilloscope	~1-100mV			
6	Record the current during the active MCU+radio state	~10-100mA			
Overall test results:					

Test Writer: Christopher A. Halseth					
Test Case Name:	Button Press Indicator		Test ID #:		L3-F01-A-A
Description:	Exhaustive testing of all possible user inputs.		Type:		White Box ☐ Black Box ☒
Tester Information: Electronics technician skills required.					
Tester Name/Sig:	/		Date:		
Hardware Version:	Rev. A		Time:		
Setup:	Rev. A firmware loaded on satellite and base. Devices reset and wirelessly synced, verified by pushing any button on satellite and not seeing all LED's blink five times.				
Step	Action	Expected Result	Pass	Fail	Comments
1	Press A	LED A blinks twice.			
2	Press B	LED B blinks twice.			
3	Press C	LED C blinks twice.			
4	Press D	LED D blinks twice.			
5	Press AB	LED A or B blinks twice.			
6	Press AC	LED A or B blinks twice.			
7	Press AD	LED A or B blinks twice.			
8	Press BC	LED A or B blinks twice.			
9	Press BD	LED A or B blinks twice.			
10	Press CD	LED A or B blinks twice.			
11	Press ABC	LED A or B or C blinks twice.			
12	Press ABD	LED A or B or D blinks twice.			
13	Press ACD	LED A or C or D blinks twice.			
14	Press BCD	LED B or C or D blinks twice.			
15	Press ABCD	LED A or B or C or D blinks twice.			
Overall test results:					

Test Writer: Christopher A. Halseth					
Test Case Name:	End to End Hardware Functional		Test ID #:		L3-F03-A-A
Description:	Verifies proper serial output from base station when satellite button is pressed.		Type:		White Box ☐ Black Box ☒
Tester Information: Electronics technician skills required.					
Tester Name/Sig:	/		Date:		
Hardware Version:	Rev. A		Time:		
Setup:	Rev. A firmware loaded on satellite and base. Devices reset and wirelessly synced, verified by pushing any button on satellite and not seeing all LED's blink five times. Serial console with connection open to base for monitoring and configure console for hex values. Press any key (A,B,C,D) on satellite and record address (first eight hex values) in step 1 comments. Output format will be 0xAAAAAAAADD, with A representing address and D data. Ensure address does not change during test.				

Step	Action	Expected Result	Pass	Fail	Comments
1	Press A	Console output 0xAAAAAAAA00			
2	Press B	Console output 0xAAAAAAAA01			
3	Press C	Console output 0xAAAAAAAA02			
4	Press D	Console output 0xAAAAAAAA03			
Overall test results:					