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ECE 411

# Test Plan: 'The Speed Demon'

*(Modular Speedometer System)*

*Document rev. 1*

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# 1. Introduction

The Speed Demon modular speedometer system is a small device intended for use by riders of skateboards, bicycles, and other wheeled personal transport not already equipped with integrated speed metering. Using a Hall effect sensor and a magnet affixed to the side of a wheel, the Speed Demon can provide the end user with speed data for safety or performance. This test plan document is intended to help technicians or engineers through the process of assembling and testing the main PCB and attached modules to ensure proper functionality of the device.

## 1.1 Objectives

This document will outline testing procedures with the goal of safely bringing up each section of the main board and testing functionality. This document does not describe specific build instructions, pinout information, or reference designators for components. This information is available on the schematic and board layout (see 'Reference Material' section).

## 1.2 Testing Strategy

Each section of the hardware will be tested individually for functionality, in an order that preserves circuit dependencies (e.g. power supply first). After each section has been tested individually, integration testing will be performed. Finally, the device can be tested for accuracy and proper operation.

The software test cases have a hierarchy for which the goal is to confirm the functionality of the device while integrating software components. We will begin testing each software component one by one. After each component is tested, integration testing can begin until we reach the final product. Testing will be done by simply loading programs to observe the desired functionality of each test. Please refer to "Software Test Diagram" in section 1.3 to view the hierarchy of the test.

## 1.3 Reference Material

- project\_requirements\_v2.0 (10/23/17)
- Speed Demon Schematic, v.1 (11/27/17)
- Speed Demon Layout, v.1 (11/27/17)
- MCU\_pinout\_v1.3 (11/13/17)
- Software Test Diagram (11/29/17)

# 2. Test Items

## 2.1 Equipment

- Current-limiting DC power supply
- High-speed oscilloscope (Tektronix MSO 4104 or similar)
- Digital multimeter
- Skateboard/longboard
- Vehicle with cruise control
- Speed Demon PCB
- Speed Demon sensor module and board-side header connector
- Speed Demon 5-way switch breakout board
- Organic LED (OLED) Screen (Vishay OLED-008N002A-LPP5N00000)
- 20 standard female-to-female jumper wires
- Skate safety equipment

## 2.2 Personnel

- Two testers (technician skill level or higher), familiar with all laboratory equipment.
- Speed test requires a competent skater and a licensed driver.

## 3. Features to be Tested

- User program
  - Wheel parameterization routine
  - 5 way button navigation
- Input capture (speed)
- OLED display
- Raw speed capability (as fast as can be safely accomplished in lab)

## 4. Features not to be Tested

- Battery life information
- Waterproofing
- Physical shock

## 5. Approach

The test cases below are listed in order by test ID. Follow this order to maintain order of circuit dependencies.

### 5.1 Test Setup

The current-limiting DC power supply, oscilloscope, and multimeter are all available in the PSU capstone lab.

## 5.2 Outline

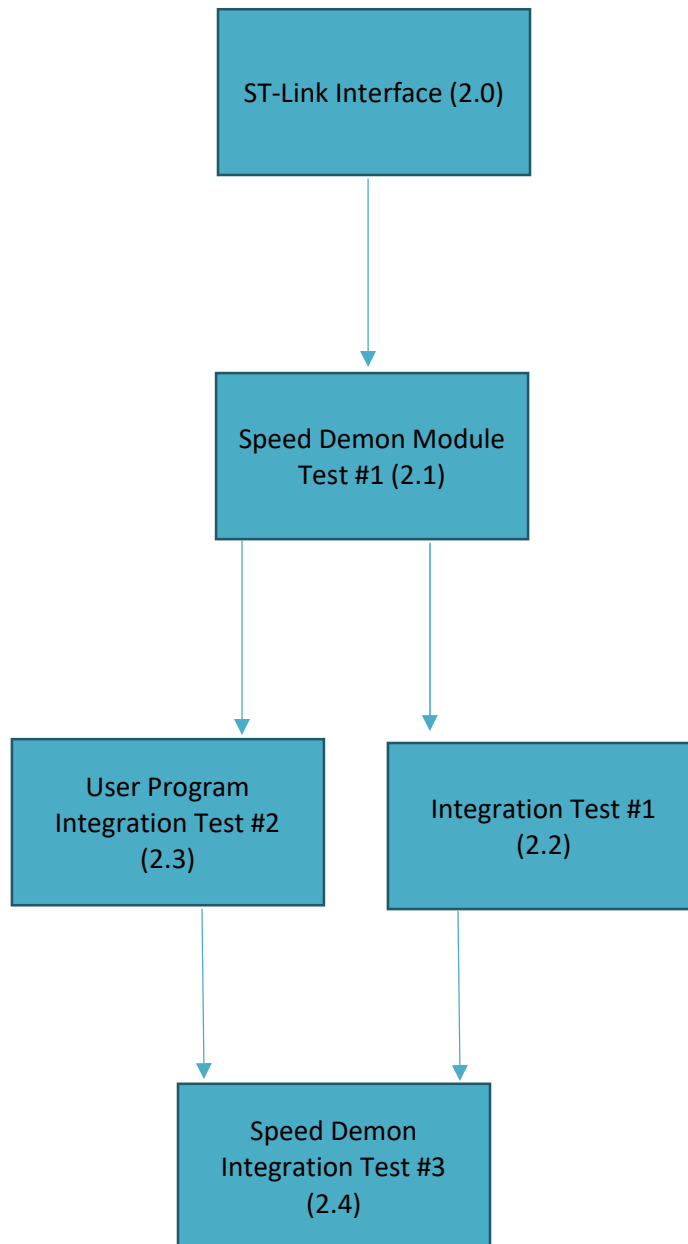
### 5.2a Component Testing

Test Performed	Description	Test ID
Power Regulator Test	Verify correct voltage/current output across range of voltage inputs.	1.0
Power On Circuit Test	Verify correct on button behavior	1.1
USB Power Defeat Circuit Test	Verify plugged USB power disables device power	1.2
Charge Controller Test	Verify charge controller outputs current and cuts off properly	1.3
Button Debounce/Functionality Test	Verify correct logic output for button presses	1.4
Sensor Module Test	Verify that the sensor module is sensing the magnetic field and outputting the correct logic levels.	1.5
MCU Hardware Test	Check proper electrical characteristics of MCU, check functioning of crystal oscillator.	1.6

### 5.2b Integration/Software Testing

ST-Link Interface	Make sure the ST-link can connect the computer and MCU, and successfully download the code.	2.0
Speed Demon Module Test #1	This test will send a string to the OLED to be displayed. Hex file is located under oled_test/MDK-ARM/oled_test/oled_test.hex.	2.1
User Program Integration Test #2	Verify that the user can operate the bottom then setting the system correctly.Hex file is located under user_program_test/MDK-ARM/user_program_test/user_program.hex.	2.2
Speed Demon Integration Test #3	Test case confirms device is actually calculating speed. Hex file is located under speedDemon/MDK-ARM/speedDemon/speedDemon.hex.	2.3

### 5.3 Software Test Diagram



## A. Appendix

### A.1 TestCase Documents

#### A.1.1 BTC1

TestWriter		Nathaniel Dusciuc				
TestCaseName		Power regulator test			TestID	1.0
Description		Verifying voltage levels of power rails and voltage regulator, over a range of supply voltages from 3.3v to 5v.			Type	<div>BlackBox</div> <div>WhiteBox</div>
TesterInformation						
NameofTester					Date	
HardwareVersion					Time	
Setup		Populate all the power circuitry hardware on the PCB. Connect a 5v power supply limited to 50mA max to the battery input terminal. Connect voltage probe to power rail.				
AdditionalEquipment		Oscilloscope, Current limiting power supply				
Step	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Apply logic 1 to the enable pin (p5) on the power regulator (U3).	3.3v on power rail and current consumption in single-digit mA range.				
2	Change power supply to 3.3v	Approximately 3.3v on power rail.				
3	Increase current limit of power supply to 150mA.	Approximately 3.3v on power rail and no major change in current consumption.				
4						

TestWriter		Nathaniel Dusciuc				
TestCaseName		Power on circuit test			TestID	1.1
Description		Verify the on button behavior.			Type	<div>BlackBox</div> <div>WhiteBox</div>
TesterInformation						
NameofTester					Date	
HardwareVersion					Time	
Setup		Place button header on PCB and connect button breakout board to main PCB. Connect a 5v power supply limited to 50mA max to the battery input terminal. Attach probe to the enable pin (p5) of the power regulator (U3).				
AdditionalEquipment		Oscilloscope, Current limiting power supply				
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Center button press (short)	Logic 1				
2	Center button press (short)	Logic 1 (no change)				
3	Center button press (long)	Logic 0				
4						



TestWriter		Nathaniel Dusciuc				
TestCaseName		USB power defeat circuit test		TestID	1.2	
Description		Verify correct logic output levels when USB is plugged in and when it is not plugged in.		Type	BlackBox	
					WhiteBox	
TesterInformation						
NameofTester				Date		
HardwareVersion				Time		
Setup		Connect a 5v power supply limited to 50mA to the battery input terminal. Connect voltage probe to power rail. Turn on power by pressing the center button.				
AdditionalEquipment		Oscilloscope, Current limiting power supply				
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Connect 5V power to USB inlet.	GND on power rail.				
2	Disconnect USB power.	3.3v returns to power rail after a short delay.				
3	Connect 4.0V power to USB inlet.	GND on power rail.				
4						

TestWriter		Nathaniel Dusciuc				
TestCaseName		Charge controller test		TestID	1.3	
Description		Verify the charge controller is outputting		Type	BlackBox	
					WhiteBox	
TesterInformation						
NameofTester				Date		
HardwareVersion				Time		
Setup		Connect a 3.3v power supply limited to 50mA in series with a current probe connected to the battery input terminal. Turn on power by pressing the center button.				
AdditionalEquipment		Oscilloscope, Current limiting power supply				
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Connect a 5V power supply to the USB power inlet.	.Current flowing toward the “battery” power supply.				
2	Raise the “battery” power supply voltage to 5V.	Current flow reduces as “battery” power supply approaches 4.95v and then shuts off above 4.95v.				
3	Reduce the “battery” power supply voltage to 3.3V	Current begins to flow again when the “battery” power supply voltage drops below 4.85v.				
4						

TestWriter		Nathaniel Dusciuc				
TestCaseName		Button debounce/functionality test		TestID	1.4	
Description		Verify that all 5 button presses provide a clean steady logic 0 at their respective GPIO pins.		Type	BlackBox	<input type="checkbox"/>
					WhiteBox	<input type="checkbox"/>
TesterInformation						
NameofTester				Date		
HardwareVersion				Time		
Setup		Populate debounce circuitry and the pull-up resistors for the button. Connect a 5v power supply limited to 50mA. Turn on power by pressing the center button.				
AdditionalEquipment		Oscilloscope, Current limiting power supply				
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Connect voltage probe to GPIO pins* and press button.	Logic steps from high to low with no voltage bounce.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

\*UP = pin 39, Down = pin 40, Right = pin 41, Center = pin 42, Left = pin 43

TestWriter		Nathaniel Dusciuc				
TestCaseName		Sensor module test		TestID	1.5	
Description		Verify that the sensor module is sensing the magnetic field and outputting the correct logic levels.		Type	BlackBox WhiteBox	
TesterInformation						
NameofTester				Date		
HardwareVersion				Time		
Setup		Connect a 5v power supply limited to 50mA to the battery input terminal. Turn on power by pressing the center button. Populate sensor header and circuitry. Connect sensor module to sensor header on main PCB. Connect voltage probe to MCU pin 29				
AdditionalEquipment		Magnet, Oscilloscope, Current limiting power supply				
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Place neodymium magnet in front of sensor module (If no result use the other pole of the magnet).	Logic low.				
2	Remove magnet	Logic high.				
3						
4						

TestWriter		Nathaniel Dusciuc				
TestCaseName		MCU hardware test		TestID	1.6	
Description		Check proper electrical characteristics of MCU, check functioning of crystal oscillator.		Type	BlackBox WhiteBox	
TesterInformation						
NameofTester				Date		
HardwareVersion				Time		
Setup		Place MCU on main PCB and all related circuitry. Connect a 5v power supply limited to 10mA to the battery input terminal.				
AdditionalEquipment		Oscilloscope, Current limiting power supply				
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Slowly increase current limit of power supply to 55mA.	The current being supplied should not exceed 50mA.				
2	Connect voltage probe to power pins*.	3.3v dc without ripple or deviation.				
3	Connect voltage probe to pin 1	0.6*supply voltage (v)				
4	Connect voltage probe to pin 5 or 6.	8MHz signal				

\*Pins 9,24,36,48

TestWriter		Linyi				
TestCaseName		ST-Link Interface Verified		TestID	2.0	
Description		Make sure the ST-link can connect the computer and MCU, and successfully download the code.		Type	BlackBox WhiteBox	
TesterInformation						
NameofTester				Date		
HardwareVersion				Time		
Setup		Correctly connect the ST-Link to the board, then read the MCU from uVersion and load a simple ToggleLED procedure.				
AdditionalEquipment						
Ste	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Connect the ST-Link to the board, including SWDIO, SWCLK, GND and RESET.	MCU should be connect to the computer by ST-link, We can see chip information on ST-Link Utility.				
2	Check if uVersion have connected to the ST-Link	The uVersion can also read the MCU information				
3	Connect a LED to the output pin. Load a Toggle LED code to the MCU.	The LED should be lighted on.				
4						

TestWriter	Andrew Capatina					
TestCaseName	Speed Demon Module Test #1				TestID	2.1
Description	This test will send a string to the OLED to be displayed. Hex file is located under oled_test/MDK-ARM/oled_test/oled_test.hex.				Type	<div>BlackBox</div> <div>WhiteBox</div>
TesterInformation						
NameofTester	Andrew Capatina				Date	
SoftwareVersion	1.0				Time	
Setup	Use V2 programmer to upload code on the MCU. OLED will be wired using 8 wire interface. Then confirm the OLED is displaying the string to be shown.					
AdditionalEquipment	Hardware: Laptop, ST-Link V2 programmer, and ST-Link Utility application.					
Step	Action	Expected Result	Pass	Fail	N/A	Comments
1	Click "File" then "Open" and select the appropriate hex file.	Shall be prompted "opened successfully" and given a checksum.				
2	Under "Target", click "Connect"	ST-Link Utility shall generate no errors and warnings.				
3	Under "Flash", click "Download".	Build Output shall show "download successful".				
4	Execute	OLED display shall display "speed:" on the first line then "S" on the second.				

TestWriter	Andrew Capatina					
TestCaseName	Speed Demon Integration Test #1			TestID	2.2	
Description	Verify input capture is properly capturing period. Test confirms the timer is properly counting based upon the prescaler settings. Hex file is located under count_test/MDK-ARM/count_test/count_test.hex.	Type	BlackBox			
			WhiteBox			
TesterInformation						
NameofTester	Andrew Capatina			Date		
SoftwareVersion	1.0			Time		
Setup	Use V2 programmer to upload code on the MCU then observe the behavior of counter using OLED. OLED shall be wired through 8 wire interface.					
AdditionalEquipment	Hardware: Laptop, ST-Link V2 programmer, and ST-Link Utility application.					
Step	Action	Expected Result	Pass	Fail	N/A	Comments
1	Click "File" then "Open" and select the appropriate hex file.	Shall be prompted "opened successfully" and given a checksum.				
2	Under "Target", click "Connect".	IDE shall load flash memory contents along with Device ID.				
3	Under "Flash", click "Download".	Build Output shall show "download successful".				
4	Execute	OLED shall display count of 1000 for each second.				



Test Writer		Linyi				
TestCaseName		User Program Integration Test #2	TestID	2.3		
Description		Verify that the user can operate the bottom then setting the system correctly.	Type	BlackBox		
				WhiteBox		
TesterInformation						
NameofTester			Date			
HardwareVersion			Time			
Setup		Download the User program to the MCU and test Up, Down, Left, Right and Select bottom separately.				
AdditionalEquipment						
Stc	Action	ExpectedResult	Pass	Fail	N/A	Comments
1	Download the User Program to MCU.	Show information about enter the radius.				
2	In the User Setting Mode, try to use all the button	Check if the button function act like below:  Up and Down: change the number Left and Right: change the position Select: Save the radius and jump to				
3	Try all the button when is not in User Setting Mode	Check if the button function act like below:  Up and Down: change the speed unit Left and Right: change the mode				
4	Try change the mode back to User Setting Mode, and enter another radius to verified the code again	Enable to re-enter the User Setting Mode and change the radius.				

TestWriter	Andrew Capatina					
TestCaseName	Speed Demon Integration Test #3				TestID	2.3
Description	Test case confirms device is actually calculating speed. Hex file is located under speedDemon/MDK-ARM/speedDemon/speedDemon.hex.				Type	BlackBox WhiteBox
TesterInformation						
NameofTester	Andrew Capatina				Date	
SoftwareVersion	1.0				Time	
Setup	Use V2 programmer to upload code on the MCU. Then confirm OLED is displaying the speed. Test participant will ride a skateboard with the device attached. Vehicle will be set to cruise control while test participant holds onto vehicle. Speed will be able to be observed on OLED.					
AdditionalEquipment	Hardware: Laptop, ST-Link V2 programmer, and ST-Link Utility application.					
Step	Action	Expected Result	Pass	Fail	N/A	Comments
1	Click "File" then "Open" and select the appropriate hex file.	Click "File" then "Open" and select the appropriate hex file.				
2	Under "Target", click "Connect"	IDE shall generate no errors and warnings.				
3	Under "Flash", click "Download".	Build Output shall show "download successful".				
4	Enter radius of wheel.	Entered radius shall be shown on OLED.				
5	Attach device to skateboard using clamps.	Device shall be fixed securely such that it won't fall off the skateboard.				
6	Vehicle shall begin driving and maintaining a speed of 5 mph.	Device shall read 5 mph.				
7	Vehicle shall begin driving and maintaining a speed of 5 mph.	Device shall read 10 mph.				