Test Plan: ‘The Speed Demon’

*(Modular Speedometer System)*

*Document rev. 1*

# 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.

## 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).

## 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

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| --- | --- | --- |
| 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 |

**A.Appendix**

# A.1TestCaseDocuments

A.1.1BTC1

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | BlackBoxWhiteBox |  |
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|  | |
| 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 | Expected Result | 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. |  |  |  |  | | |
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| TestWriter | | Nathaniel Dusciuc | | | | | | |
| TestCaseName | | Power on circuit test | | | | TestID | 1.1 | |
| Description | | Verify the on button behavior. | | | | Type | BlackBoxWhiteBox |  |
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|  | |
| 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 | | | | | | |
| Step | Action | Expected Result | 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 |  |  |  |  | | |
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| Test Writer | | Nathaniel Dusciuc | | | | | | |
| Test Case Name | | USB power defeat circuit test | | | | Test ID | 1.2 | |
| Description | | Verify correct logic output levels when USB is plugged in and when it is not plugged in. | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | 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. | | | | | | |
| Additional Equipment | | Oscilloscope, Current limiting power supply | | | | | | |
| Step | Action | Expected Result | 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. |  |  |  |  | | |
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| Test Writer | | Nathaniel Dusciuc | | | | | | |
| Test Case Name | | Charge controller test | | | | Test ID | 1.3 | |
| Description | | Verify the charge controller is outputting | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | 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. | | | | | | |
| Additional Equipment | | Oscilloscope, Current limiting power supply | | | | | | |
| Step | Action | Expected Result | 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. |  |  |  |  | | |
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| Test Writer | | Nathaniel Dusciuc | | | | | | |
| Test Case Name | | Button debounce/functionality test | | | | Test ID | 1.4 | |
| Description | | Verify that all 5 button presses provide a clean steady logic 0 at their respective GPIO pins. | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | 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. | | | | | | |
| Additional Equipment | | Oscilloscope, Current limiting power supply | | | | | | |
| Step | Action | Expected Result | 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. |  |  |  |  | | |
| 2 |  |  |  |  |  |  | | |
| 3 |  |  |  |  |  |  | | |
| 4 |  |  |  |  |  |  | | |
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\*UP = pin 39, Down = pin 40, Right = pin 41, Center = pin 42, Left = pin 43

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| Test Writer | | Nathaniel Dusciuc | | | | | | |
| Test Case Name | | Sensor module test | | | | Test ID | 1.5 | |
| Description | | Verify that the sensor module is sensing the magnetic field and outputting the correct logic levels. | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | 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 | | | | | | |
| Additional Equipment | | Magnet, Oscilloscope, Current limiting power supply | | | | | | |
| Step | Action | Expected Result | 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 |  |  |  |  |  |  | | |
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| Test Writer | | Nathaniel Dusciuc | | | | | | |
| Test Case Name | | MCU hardware test | | | | Test ID | 1.6 | |
| Description | | Check proper electrical characteristics of MCU, check functioning of crystal oscillator. | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | Time |  | |
| Setup | | Place MCU on main PCB and all related circuitry. Connect a 5v power supply limited to 10mA to the battery input terminal. | | | | | | |
| Additional Equipment | | Oscilloscope, Current limiting power supply | | | | | | |
| Step | Action | Expected Result | 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 |  |  |  |  | | |
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\*Pins 9,24,36,48

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| Test Writer | | Linyi | | | | | | |
| Test Case Name | | ST-Link Interface Verified | | | | Test ID | 2.0 | |
| Description | | Make sure the ST-link can connect the computer and MCU, and successfully download the code. | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | Time |  | |
| Setup | | Correctly connect the ST-Link to the board, then read the MCU from uVersion and load a simple ToggleLED procedure. | | | | | | |
| Additional Equipment | |  | | | | | | |
| Step | Action | Expected Result | 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. |  |  |  |  | | |
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| 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 | BlackBox  WhiteBox |  |
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|  | |
| 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. | |  |  |  |  | | |
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| 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 |  |
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|  | |
| 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. |  |  |  |  | | |
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| Test Writer | | Linyi | | | | | | | |
| Test Case Name | | User Program Integration Test #2 | | | | Test ID | 2.3 | |
| Description | | Verify that the user can operate the bottom then setting the system correctly. | | | | Type | BlackBoxWhiteBox |  |
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| Tester Information | | | | | | | | |
| Name of Tester | |  | | | | Date |  | |
| Hardware Version | |  | | | | Time |  | |
| Setup | | Download the User program to the MCU and test Up, Down, Left, Right and Select bottom separately. | | | | | | |
| Additional Equipment | |  | | | | | | |
| Step | Action | Expected Result | 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 next mode |  |  |  |  | | |
| 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  Select: do nothing |  |  |  |  | | |
| 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. |  |  |  |  | | |
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| 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 |
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|  |
| 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. | |  |  |  |  | |
|  | | |  | |  |  |  | |