Maseeh College of Engineering

T01 411 Practicum Project

Synthesizer Glove

System Test Plan

Rev 1

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1.Intro

1.1 This Document

This document is intended to provide a comprehensive test plan for the evaluation of the Glove Synthesizer. All necessary background information has been integrated into the document. If you are familiar with the development of the system you may wish to skip ahead to section 5.

1.2 Conducting Tests

Each individual test is designed to be a stand alone" test, and as such that it can be implemented at any point of the testing procedure. However the organization of the tests have been laid out in the most logical order and should be followed if time permits.

1.3 Records and Result

Blank test record sheets can be found at the end of this document in the appendix. Additionally they are listed on the the repository under the ./tests folder. Please use a physical test sheet during the implementation of testing, copy the information into the on-line forms, and then file the physical copy after test is complete.

2.System Reference

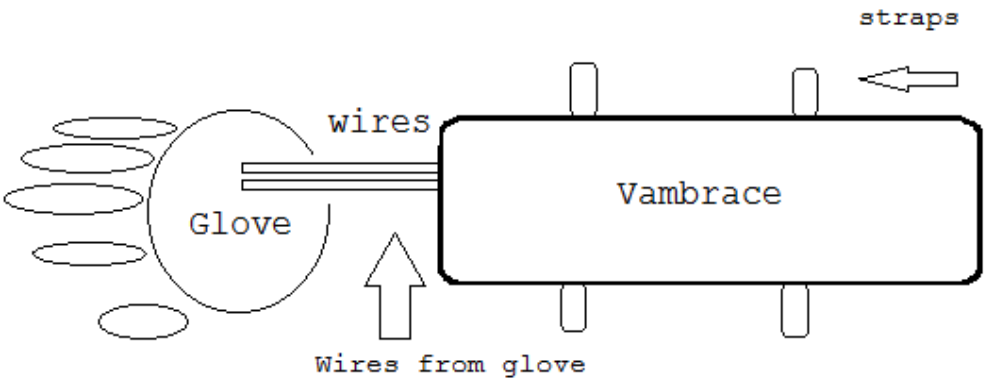
2.1 System Requirements

Marketing Requirements	Engineering Requirements	Justification
5,7	System will be capable of producing tones based on finger contact.	Tone generation by finger contact is intuitive and typical for musical instruments.
5	System will be capable of producing a minimum of 5 frequencies.	With one frequency per finger, this provides a unique frequency for each fingertip.
4,6	System will be capable of altering the produced tones based on the status of at least 2 sensors .	Sensors, like knobs, sliders and buttons are intuitive, easy to use and increase perception of value .
1	The system will use an inexpensive cost micro-controller to produce low resolution sound.	Most low cost micro-controllers do not have analogue outputs so producing 1-bit sound as a base prevents undue reduction to development budget.
2,4	System must be wearable on users hand or forearm.	Placing the system on an arm makes it accessible, portable and easy to use.
3	System will be battery powered and have power consumption of approximately 2.5 Watts.	This makes the system loud enough to enjoy while still offering longer battery discharge times.

Marketing Requirements	
1.	The system should cost less than $25.00 to manufacture.
2.	The system should be wearable and portable.
3.	The system will have low power consumption.
4.	The system should be intuitively controlled.
5.	The system will be capable of producing a variety of tones.
6.	The system should be able to add audio effects to the tones.
7.	The system must be capable of being used on most solid surfaces.

2.2 System Overview

The synthesizer glove is meant to be worn on the right hand/ arm, ending before the elbow. The glove section must be physically plugged into the vambrace before operation. The vambrace itself needs to be secured to the forearm via the included Velcro strap system.

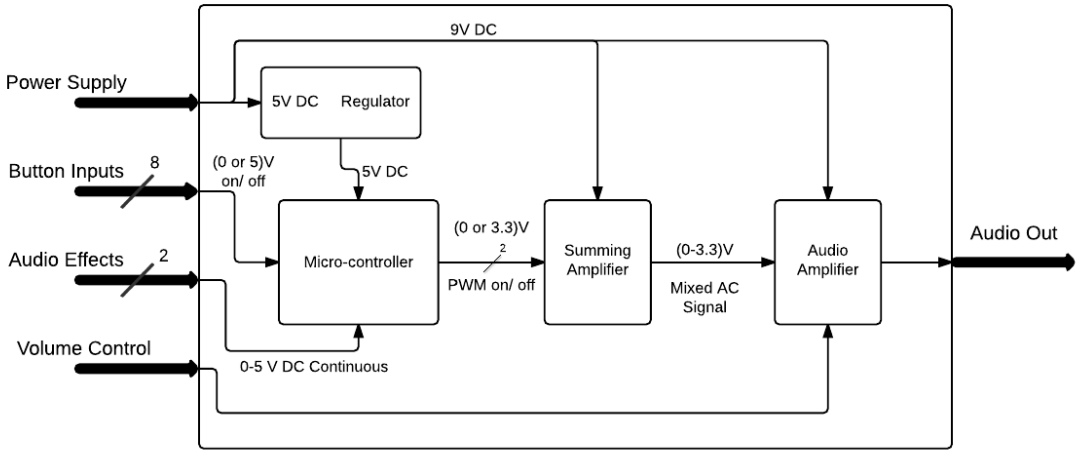


2.3 Block Diagrams and Design Docs

An overview of the system and interaction between system modules is given over the next several pages.

Note: *The UML design document is listed separately on the project repository and is included here as an insertion for reference, and as such are not considered pages of this document.*

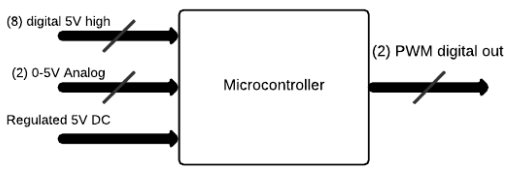
Synthesizer Glove: Level 1 Design Diagram



Level 1 Synthesizer Glove Design

Module: 5V DC Regulator	

Inputs: ● **Power Supply:** 9V battery
Output: ● **DC Out:** Regulated 5V DC signal
Functionality: ● The input signal enters a 9 to 5 V linear DC to DC voltage regulator. ● The signal is then smoothed using a capacitor >= 10µF. ● The signal is then filtered through a passive RC low-pass filter.

Module: Microcontroller	

Inputs:

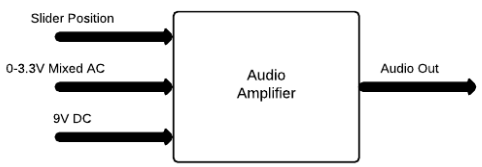
- **Digital 5V High:** 8 total digital signals with a 5V logic high. 3 signals from the vambrace control unit, and 5 signals from the push buttons in the glove.
- **0-5V Analog:** 2 analog signals ranging from 0 to 5 volts from the vambrace control unit.
- **Regulated 5V DC:** Regulated 5V DC voltage from the voltage regulator block for power.

Output:

- **PWM Digital Out:** 5 total pulse width modulated signals outputting to the summing amplifier.

Functionality:

- Produce one or two simultaneous pulse width modulated tones (PWM) based on programmed glove button pushes.
- Shift tones to the next scale up or down, programmatically assigned to the buttons on vambrace unit.
- Read two individual analog voltages based on a two axis joystick. One voltage will shift the programmed PWM tones up and down by pitch, and the other by tone.

Module: Audio Amplifier	

Inputs:

- **Slider Position:** The output of a slider potentiometer controlling the output gain of the amplifier.
- **0-3.3V Mixed AC:** The 0-3.3V mixed AC output of the summing amplifier.
- **9V DC:** 9V DC output of the battery for power.

Output:

- **Audio Out:** An amplified 0-3.3V PWM mixed AC signal.

Functionality:

- Amplifies the 0-3.3 V PWM tones produced by the microcontroller and added together by the summing amp based on the position of the slider potentiometer.

Module: Summing Amplifier	

Inputs: ● **9V DC:** 9V DC output of the battery for power. ● **PWM 0-3.3V Digital:** up to six 0-3.3V PWM tones generated by the microcontroller.
Output: ● **0-3.3V Mixed AC:** 0-3.3V mix of two PWM tones.
Functionality: ● Outputs the sum of the first two generated PWM tones produced by the microcontroller. Only two tones can be played simultaneously.

3.Pretest Preparation

3.1 Test Equipment

The following list of items are indexed by a number which is then used a unique identifier for indicating which test will require its(the item listed by that number) use.

1. 9-Volt battery
2. Digital multimeter
3. Oscilloscope
4. Wave form generator
5. DC power supply
6. Female to female jumper wires
7. AVR Dragon Board
8. Windows computer with AVR Studio or Linux machine with avrdude
9. Assembled Synthesizer Glove

3.2 Tester Qualification Level

E Engineer: Full or part time engineer

EI Engineering Intern: engineering student in their junior or sophomore year of electrical, computer, or software engineering.

GI General Intern: [prospective entry level employee, must posses basic computer skills and have completed electrical safety certification.]

T Temporary Worker: included seasonal hires, high school interns and general clerical workers.

3.3 Test Setup

The following table shows test to equipment item pairing.

Test			**Equipment**	Tester
#	Section	Name	#'s used	Q-level
SG-UT-1	4.1.1	Power Supply	1,2,6	GI
SG-UT-2	4.1.2	Programming Header	1,2,5,6,7,8	EI
SG-UT-3	4.1.3	Volume Control	1,3,4,5,6	EI
SG-UT-4	4.1.4	Digital Inputs	1,2,5,6	GI
SG-UT-5	4.1.5	Base Tones Generation	1,3,5,6,7,8	EI
SG-UT-6	4.1.6	Signal Summing Circuit	1,2,3,4,6	EI
SG-UT-7	4.1.7	Base Tone Set Switch	1,3,5,6,7,8	EI
SG-UT-8	4.1.8	Thumb-stick	2,5	GI
SG-UT-9	4.1.9	Analog Voltage Read	5,6,7,8	EI
SG-UT-10	4.1.10	Tone/ Pitch Alterations	5,6,7,8	EI
SG-IT-1	4.2.1	Power Test	9	T
SG-IT-2	4.2.2	Tone Test	9	T
SG-IT-3	4.2.3	Shift Test	9	T
SG-IT-4	4.2.4	Effects Test	9	T

4.System Tests

4.1 Unit Tests

4.1.1 Power Supply

Module	5V DC Regulator
Inputs	8-12 Volts DC *Typical:*9V Battery
Outputs	Regulated 5V DC signal
Functionality	The input signal enters a 9 to 5 V linear DC to DC voltage regulator. The signal is then smoothed using a capacitor $\leq 10\mu F$. The signal is then filtered through a passive RC low-pass filter.
Test	SG-UT-1

Test Writer: Nathan Bryant						
Test Case Name	Power Supply Verification Test				**Test ID#**	SG-UT-1
Description	Determine that the power supply is providing 4.8-5.1V DC				**Type:**	☑ white box ☐ black box
Tester Information					**Q-level**	GI
Name of Tester:					**Date:**	
Hardware Ver:					**Time:**	
Setup	Connect the linear regulator to the variable DC power supply at JP2-1, then connect DMM to the output at JP2-2					
Step	**ActionAction**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	Set power at 9V, turn on	Power supply should come on with no errors. DMM reads 5V				
2	Attach the load device to JP2-2	DMM Readings should not fall below 4.8V				
Overall test results:						

4.1.2 Programming Header

This white box test checks voltage levels at programming header pins, then verifies that data packets can be sent and received from MCU.

4.1.3 Volume Control

Module	Audio Amplifier
Inputs	9 Volts DC 0-3.3V mixed AC output of the summing amplifier
Outputs	0-9V mixed AC audio signal
Functionality	The PWM signal is amplified or attenuated up or down to desired listening level through the positional adjustment of the volume control potentiometer
Test	SG-UT-3

Test Writer: Nathan Bryant						
Test Case Name		Volume Control Test			**Test ID#**	SG-UT-3
Description		Verify Variable gain of final amplifier stage			**Type:**	☑ white box ☐ black box
Tester Information					**Q-level**	EI
Name of Tester:					**Date:**	
Hardware Ver:					**Time:**	
Setup		Connect waveform generator, oscilloscope, 9V DC, and jumper volume control potentiometer to final amp				
Step	**ActionAction**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	Set WFG at 300mV AC output	Minimum audio out $\leq 50mV$ maximum audio out $\leq 9V$				
2	Set WFG at 1V AC output	Minimum audio out $\leq 150mV$ maximum audio out $\leq 9V$				
Overall test results:						

4.1.4 Digital Inputs

Module	Digital Input Buttons
Inputs	Human touch
Outputs	5 volts DC for the duration of the touch (momentary)
Functionality	The input signals are created by depressing single pole (on /off) momentary switches, located at the tips of all 5 finger of the right hand
Test	SG-UT-4

Test Writer: Nathan Bryant						
Test Case Name	Button Test			**Test ID#**	SG-UT-4	
Description	Determine that each button is providing appropriate logic level response			**Type:**	☑ white box ☐ black box	
Tester Information				**Q-level**	GI	
Name of Tester:				**Date:**		
Hardware Ver:				**Time:**		
Setup	Connect the glove to the first 10 pins of the JP1 header then connect 9V power at JP2-1 and piezoelectric buzzer across test points 22-26					
Step	**ActionAction**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	Turn on power	No sound is present				
2	Press button 1	Buzzer is now audible				
3	Repeat step 2 with buttons 2-5	Buzzer should be audible				
Overall test results:						

4.1.5 Base Tones Generation

This white box test will verifies that the base scale (notes) is set to the correct frequencies. Stub-¿ DC power supply into MCU -¿ single tone code -¿ stub DOS

4.1.6 Signal Summing Circuit

This white box test checks the input vs output of the summing circuit. Stubs can be used, waveform generator, power supply, DMM.

4.1.7 Base Tone Set Switch

In this white box test the tester verifies that the mainline function, which is loaded with the base scale, changes when "shift register" button is used. Can be done at debug level on computer.

4.1.8 Thumb-stick

Module	Analog Thumb-stick
Inputs	5V DC
Outputs	Line 1; adjustable continuous 0- 5V DC signal Line 2; adjustable continuous 0- 5V DC signal
Functionality	The regulated 5 volt signal is split over two separate linear potentiometers
Test	SG-UT-9

Test Writer: Nathan Bryant						
Test Case Name		Thumb-stick positional test			**Test ID#**	SG-UT-8
Description		Determine that the return voltage from the thumb-stick is continuous 0-5V			**Type:**	☑ white box ☐ black box
Tester Information					**Q-level**	GI
Name of Tester:					**Date:**	
Hardware Ver:					**Time:**	
Setup		Connect the thumb-stick to the test board and power with 5V DC then connect the DMM to the board out jumper 1				
Step	**ActionAction**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	Turn on power	DMM should read 5V				
2	Slowly push stick upward	DMM display should indicate a continuous decrease in voltage				
3	Repeat step 2 stick down	DMM display should indicate a continuous decrease in voltage				
4	move DNMM to jumper 2	DMM should read 5V				
5	Repeat steps 2-3 w/ left to right	DMM display should indicate a continuous decrease in voltage				
Overall test results:						

4.1.9 Analog Voltage Read

This test verifies that the MCU is correctly interpreting analog voltage in. Stubs can be used; variable power supply, led array etc.

4.1.10 Tone/ Pitch Alterations

This white box test verifies that the code which controls PWM (OCR etc) is changed when the when a new value is read from ADC. Stub used, text(value load), led array, write to text

4.2 Integration Tests

4.2.1 Power Test

This black box test confirms that the system is unresponsive when turned off, and that some functionality exists when on. Requires assembled system

4.2.2 Tone Test

This black box test confirms that at least 5 unique tone are created as fingers are pressed.

4.2.3 Shift Test

This black box test confirms that when the "shift register" buttons are used 5 new unique tone are now heard.

4.2.4 Effects Test

This black box test confirms that the use of the thumb-stick creates an audible difference in tone and/ or pitch.

5. Appendix

Test Writer:			
Test Case Name		**Test ID#**	
Description		**Type:**	☐ white box ☐ black box
Tester Information		**Q-level**	
Name of Tester:		**Date:**	
Hardware Ver:		**Time:**	
Setup			

Step	**ActionAction**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1						
2						
3						
4						
5						
6						
7						