HARE Project Test Plan

Team 13

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1.0 INTRODUCTION

The Hackable Audio Real-Time Effects (HARE) Project is an audio device that is intended to process audio signals from a guitar or other musical instrument and output to an audio amplifier. The unit allows for users to both program and upload C code that models various audio effects for audio signal modification. This test plan document is intended to allow the developers of the HARE Project to quickly and efficiently bring the unit up to being a fully functional device.

1.1 Objectives

This test plan outlines the testing process and indicates each of the individual test cases to be performed. All associated reference documentation necessary to perform tests are provided explicitly or are given via links.

1.2 Scope

The goal of this test plan is to test each subsequent module of the board design and integrate them into a single system for full system test. Functional tests will be done in order to ensure voltage and current levels meet specifications and initial power up of the microcontroller will allow for programming. Once the MCU is verified for working conditions on the PCB, the input / output pass through will be tested. The overall goal is to have a working version of the board and completed unit for demonstration by December 7th 2017.

1.3 Conduct of the Systems Test

The tests described in this document will be performed using various test equipment by the team members of HARE Project. Functional checks will first be performed during PCB build up by verifying the power supply is providing necessary voltage and current levels to the board's power plane. The MCU power up will include testing to ensure the device can be programmed. Once the power up checks are complete the rest of the board will be populated in stages to verify that each portion of the unit is functional. Once module testing and integration is complete a signal pass through will be performed by uploading a clean signal program to the MCU, utilizing a musical instrument (guitar) as input, and output the signal to an audio amplifier.

1.4 Recording of Results, Witnessing, and Authority

Test results will be recorded and uploaded to the team's github page at https://github.com/k2nxf/hareproject under the project wiki test plan section. Test equipment will aid in the recording of processes and witnessing will be done by individual team members or with multiple team member working together.

1.5 Reference Documents

This test plan assumes the product meets requirements specifications as presented in the Product Design Specification as seen on github at https://github.com/k2nxf/hareproject/wiki/Product-Design-Specification.

1.5.1 Datasheets

Datasheets used for reference purpose during testing includes those for Atmel ATmega328P microcontroller, FTDI FT232R USB to serial UART interface, MCP4921 12-bit DAC with SPI interface, and ISSI IS62 64Kx8 serial SRAM with SPI interface. The datasheets for each of these devices can be found below:

- Atmel ATmega328P - http://www.atmel.com/Images/Atmel-42735-8-bit-AVR-Microcontroller-ATmega328-328P_Datasheet.pdf
- FTDI FT232R - http://www.ftdichip.com/Support/Documents/DataSheets/ICs/DS_FT232R.pdf
- Microchip MCP4921 - http://www.mouser.com/ds/2/268/21897a-70809.pdf
- ISSI IS62 - http://www.mouser.com/ds/2/198/IS62-65WVS0648FALL-BLL-1147350.pdf

1.5.2 Design Documents

The schematic and board layout are to be used during testing as cross reference material with the PCB. These documents are Eagle CAD files that can be found on the team's github page at https://github.com/k2nxf/hareproject/tree/master/schematics and are listed as:

- HARE - Master Schematic v1.0.brd
- HARE - Master Schematic v1.0.sch

1.5.3 Additional Software

- We assume that the same software version will have cross platform functionality (i.e. Windows 10 version of Eagle CAD v8.4.0 is compatible with Linux version of Eagle CAD v8.4.0)
- Eclipse IDE for C/C++ Developers Version: Neon.3 Release (4.6.3)

- AVR Eclipse Plugin 2.4.0
- Eagle CAD v8.4.0 or higher

2.0 HARE PROJECT OVERVIEW

2.1 Definition of Terminology

- LDR: Light Dependent Resistor
- VCA: Voltage-Controlled Amplifier
- VCF: Voltage-Controlled Filter
- PWM: Pulse-Width Modulation
- DAC: Digital to Analog Converter
- ADC: Analog to Digital Converter
- MCU: Microcontroller Unit
- SPI: Serial Port Interface
- USB: Universal Serial Bus
- DSP: Digital Signal Processing

3.0 PRETEST PREPARATION

3.1 Test Equipment

- Tektronix TDS 2014C Four Channel Digital Storage Oscilloscope
- Tektronix AFG 3102 Function Generator
- Tektronix RSA 2203-A Real-TIme Spectrum Analyzer
- Tektronix DMM 4030 Digital Multimeter
- GW Instek GPS-3303 DC Power Supply

3.2 Test Setup and Calibration

- All testing personnel require access to a working computer
- Computers used will need Eclipse IDE (See 1.5.3) installed and working
- Eclipse IDE will need the avr-gcc plugin installed (See 1.5.3)
- All test personnel must possess the knowledge/skill level of senior undergraduate ECE students or higher
    - Must be able to operate the listed test equipment
    - Must be able to troubleshoot a circuit during PCB build up

4.0 System Tests

4.1 Functional Tests

4.1.1 - Power Jack and LED Indicator

4.1.1.1 - Objectives: Ensure that the power plane has power and that the Power LED indicator functions properly.

4.1.1.2 - Resources:
- Multimeter
- HARE main board
- 9V wall wart or power supply

4.1.1.3 - Test Cases:

VCC_TEST - Vcc power plane test
PWR_LED - PWR LED Functionality

4.1.2 - Power supply voltage and current levels

4.1.2.1 - Objectives: Ensure that the power supply voltage levels are at correct nominal voltages (9V for Vcc and 5V for +5V) and the current draw is below 500mA.

4.1.2.2 - Resources: Digital Multimeter, HARE main board, power supply

4.1.2.3 - Test cases:

VCC_RAIL - Vcc rail voltage test
5V_RAIL - +5V rail voltage test
CURRENT_DRAW - Current draw test

4.1.3 - MCU Program mode indicator

4.1.3.1 - Objectives: Ensure that the Program mode indicator LEDs function properly showing the current mode of the ATmega328p

4.1.3.2 - Resources: PC, USB A to B Cable, HARE Mainboard

4.1.3.3 - Test Cases:

STD_MCU_LEDS - Standard mode MCU Indicators test
PROG_MCU_LEDS - Programming mode MCU Indicators test

4.2 Subsystem Tests

4.2.1 Input/Output Signal Pass through

4.2.1.1 Test Objectives

Ensure that the signals presented as inputs for both the input and output circuitry can provide an ample amount of gain needed to ensure the amount of signal necessary for sampling by the ADC and signal recovery from the DAC due to losses through the system. Harmonic distortion of the amplifier stages should also be measured to ensure minimal aliasing in the ADC system.

4.2.1.2 Resources:
- Function generator
- DC power supply

- Oscilloscope w/ FFT capabilities

4.2.1.3 Test cases:

INPUT_TEST - Gain and harmonics test for input circuitry
OUTPUT_TEST - Gain and harmonics test for output circuitry

4.2.2 LDR Resistance Test

4.2.2.1 Test Objectives

The purpose of this test is to determine how much current through an LED paired with a light dependent resistor (LDR) translates into measurable resistance. For the project, a pulse-width modulated (PWM) LED will be use to control specific parameters of the analog voltage-controlled hardware. This test will provide information on how much current needs to be supplied to the controlling LED in order to effectively control the analog hardware.

4.2.2.2 Resources

- Digital multimeter (DMM)
- DC power supply

4.2.2.3 Test Cases

LDR_RES - LDR Resistance Test

4.2.3 Voltage Controlled Amplifier test

4.2.3.1 Test Objectives

The purpose of this test is to verify how much of the signal can be shunted to ground. The amount of signal shunted to ground will be determined by the output from the MCU to the amplitude LDR.

4.2.3.2 Resources

- Oscilloscope
- Function generator

4.2.3.3 Test Cases

VCA_SHUNT- Voltage Controlled Amplifier test

4.2.4 Voltage Controlled Filter Test

4.2.4.1 Test Objectives

This test is to determine the how the cutoff frequency changes as the control voltages changes. This is to be accomplished by injecting a signal into the VCF starting with a frequency of 100 Hz and increasing the input frequency in steps of 100 Hz while monitoring the output on an FFT display. The input is increased until a -3 dB change is observed.

4.2.4.2 Resources
- Function generator
- DC power supply
- Oscilloscope w/ FFT capabilities

4.2.4.3 Test Cases
VCF_TEST - Voltage-controlled filter test

4.2.5 DSP pass through test
4.2.5.1 Test Objectives
This test is to ensure that when the MCU is running the “Clean” DSP program that the input signal matches the output signal.
4.2.5.2 Resources
- Eclipse IDE
- Oscilloscope
- Function generator

4.2.5.3 Test Cases
DSP_PASSTHROUGH - DSP Pass through test

4.3 Overall Function System Test
4.3.1 Test Objectives
To test the overall the functioning of the H.A.R.E. system i.e. Power, programmability, and test when given input signal an output signal is heard.
4.3.2 Resources
- Musical instrument input
- Amplifier output
- PC
- USB type A to USB type B Communication Cable
- 9V Wall Wart

4.3.3 Test Cases
SYS_LAUNCH - Overall Function System Test

Test Writer: Adam Oester

Test Case Name:	Input signal pass through	Test ID #:	INPUT_TEST
Description:	The user sends in a known input signal (100 Hz, 1 kHz and 10 kHz) to the input op-amp set to a known gain (Unity, 3, 6, and 9). The user then records both the input and the output signal for analysis.	Type:	black box

Tester Information

Name of Tester:		Date:	
Hardware Version:	HAREproject Rev 1.0	Time:	
Setup:	HARE guitar pedal main board with at least the input circuitry populated. Function generator and oscilloscope channel 1 hooked-up to the op-amp input and oscilloscope channel 2 hooked-up to the input circuitry output.		
Special instructions:	Hook input and output up to oscilloscope, use function generator to create known analog input signal, ensure to record gain setting and capture oscilloscope screen capture		

Step	Action	Expected Result	Pass	Fail	N/A	Comments
1	1 kHz input signal at unity gain	Clean output signal @ 1 kHz +/- 50 Hz with no distortion or harmonics. Ensure signal has unity gain.				
2	100 Hz input signal at unity gain	Clean output signal @ 100 Hz +/- 50 Hz with no distortion or harmonics. Ensure signal has unity gain.				
3	10 kHz input signal at unity gain	Clean output signal @ 10 kHz +/- 50 Hz with no distortion or harmonics. Ensure signal has unity gain.				
...	...	...				
12	10 kHz input signal at gain of	Clean output signal @ 10 kHz +/- 50 Hz with no distortion or harmonics. Ensure signal has gain of 9.				
Overall Test Result:						

<table>
<tr><td colspan="8">Test Writer: Zack C.W.</td></tr>
<tr><td colspan="2">Test Case Name:</td><td colspan="2">LDR Resistance Test</td><td colspan="2">Test ID #:</td><td colspan="2">LDR_RES</td></tr>
<tr><td colspan="2">Description:</td><td colspan="2">This will test the resistance of the LDR output as the voltage increases from 0V to 5V increasing the light emitted by the LED. The current range maximum is 30 mA. This will test the resistance range of the photoresistor in accordance with the voltage level and current passing through an LED: blue, yellow, red, and white.</td><td colspan="2">Type:</td><td colspan="2">black box</td></tr>
<tr><td colspan="8">Tester Information</td></tr>
<tr><td colspan="2">Name of Tester:</td><td colspan="2">Abram Morphew, Ryan Fallis</td><td colspan="2">Date:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Hardware Version:</td><td colspan="2">HAREproject Rev 1.0</td><td colspan="2">Time:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Setup:</td><td colspan="6">Variable voltage supply should be hooked up to the LED side of the LDR and be set to 0V to start. A DMM will be attached to the two legs of the photoresistor on the other side of the LDR, measuring the resistance as the LED begins to illuminate proportionally with the input voltage.</td></tr>
<tr><td colspan="2">Special instructions:</td><td colspan="6">With the variable power supply powering the LED there will be no light illuminating the photoresistor so the resistance of the photoresistor should read approximately 1 Megohm. Set the supply to 0V and limit the current to 30mA output. Turn the supply’s output on and record the first resistance value at 0V, it should read approximately 1 Megohms. Using steps of 0.1V increase the supply’s output till it reaches 5V, record the resistance at each step. This will be performed a total of 4 times, once for each LED.</td></tr>
<tr><td>Step</td><td>Action</td><td>Expected Result</td><td>Pass</td><td>Fail</td><td>N/A</td><td colspan="2">Comments</td></tr>
<tr><td>1</td><td>Power On</td><td>Approximately 1 Megohm reading on DMM as voltage is at 0V and there is no light emitted by the LED.</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>2</td><td>Step Voltage</td><td>Resistance reading on DMM should decrease disproportionately as supply voltage increases to 5V and the LED emits more light with each step.</td><td></td><td></td><td></td><td colspan="2">Record the resistance reading at each step.</td></tr>
<tr><td>3</td><td>LED change</td><td>Change measured LED to an unmeasured LED.
Repeat steps 1, 2, and 3 till all 4 LED’s have been tested.</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="3">Overall Test Result:</td><td></td><td></td><td></td><td colspan="2"></td></tr>
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