Hearing Aid Redesign: Test Plans

ELECTRICAL TESTING

Table of Contents:

Specification Summary:

Spec	Specification	Dir.	Units	Marginal	Ideal	Measured Value	Pass/Fail
S1	Lowest level of sound detected	min	dB	<60	<30		
S2	Frequencies amplified	max	Hz	300-7000	85-8000		
S3	Maximum amplification	target	dB	85-95	90		
S4	Levels of volume adjustment	max	levels	5	20		
S5	Time to charge earpiece	min	minutes	<60	<30		
S7	Connects to standard USB 2.0	target	yes/no	yes/no	yes		
S12	Battery life at max. Amplification	max	hours	>16	>48		

Hearing Aid Redesign: Test Plans
EE 1: Switch Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal
S4	Levels of Volume Adjustment	20	5

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

___ Switch
___ MC56F8006 Evaluation Kit
___ USB power cable
___ USB TAP cable

Sections

- Part 1 – Test Volume Up and Down Interrupt
- Part 2 – Test Next and Previous Mode Interrupt
- Part 3 – Test Standby Interrupt
- Part 4 – Test Functionality of each Button Press

Hearing Aid Redesign: Test Plans
EE 1: Switch Test

Date Completed _____

Performed By _____

Part 1 – Test Volume Up and Down

___ 1. Solder wires to the switch

___ 2. Connect the volume up and down switches to the designated input pins on the eval board

___ 3. Flash the switch test software onto the Eval Board

___ 4. Press the volume up button

___ 5. Observe the volume up LED turns on and off when the button is pressed

___ 6. Press the volume down button

___ 7. Observe the volume down LED turns on and off when the button is pressed

Summary of Data

Did the volume switches correctly interact with the eval board? Yes _____ No _____

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 1: Switch Test

Date Completed _____

Performed By _____

Part 2 – Test Mode Next and Previous

___ 1. Solder wires to the switch

___ 2. Connect the mode next and previous switches to the designated input pins on the eval board

___ 3. Flash the switch test software onto the Eval Board (If needed)

___ 4. Press the mode next button

___ 5. Observe the mode next LED turns on and off when the button is pressed

___ 6. Press the mode previous button

___ 7. Observe the mode previous LED turns on and off when the button is pressed

Summary of Data

Did the mode switches correctly interact with the eval board? Yes _____ No _____

Testing Part 2 Sign Off _____ Date_____

Hearing Aid Redesign: Test Plans

EE 1: Switch Test

Date Completed _____

Performed By _____

Part 3 – Test Standby

___ 1. Solder wires to the switch

___ 2. Connect the standby switch to the designated input pins on the eval board

___ 3. Flash the switch test software onto the Eval Board (If needed)

___ 4. Press the standby button

___ 5. Observe the standby LED turns on and off when the button is pressed

Summary of Data

Did the standby switch correctly interact with the eval board? Yes _____ No _____

Testing Part 3 Sign Off _____ Date_____

Hearing Aid Redesign: Test Plans
EE 1: Switch Test

Date Completed _____

Performed By _____

Part 3 – Test Switch Functionality

___ 1. Solder wires to the switch

___ 2. Connect all of he switches to the evaluation board

___ 3. Flash the hearing aid software to the evaluation board

___ 4. Press the volume up and down buttons

___ 5. While debugging the code observe that the volume variable goes up and down

___ 6. Press the mode next and previous

___ 7. While debugging the code observe the mode variable changes accordingly

___ 8. Press the standby button

___ 9. While debugging the code observe that the code appropriately goes into standby mode

Summary of Data

Did the switch function as intended? Yes _____ No _____

Testing Part 4 Sign Off _____ Date_____

Hearing Aid Redesign: Test Plans

EE 2: Speaker Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal
S2	Frequencies Amplified	85 – 8000 Hz	300 – 7000 Hz

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

___ Speaker
___ Breadboard
___ Signal Generator
___ Signal Generator Test Leads

Sections

- Part 1 – Determine Min Input to Speaker
- Part 2 – Speaker Functionality: Lowest Frequency Heard
- Part 3 – Speaker Functionality: Highest Frequency Heard

Hearing Aid Redesign: Test Plans
EE 2: Speaker Test

Date Completed _____

Performed By _____

Part 1 – Determine Min Input to Speaker

___ 1. Solder wires to the speaker

___ 2. Connect the speaker to VDD and GND

___ 3. Connect the data line of the speaker to the signal generator

___ 4. Set signal generator to a mid range frequency 1-2 kHz and lowest amplitude

___ 5. Observe if the speaker is outputting a tone, or sound

___ 6. If no sound heard up the amplitude a slight amount, x = _____,

___ 7. Keep repeating steps 5 and 6 until a sound can just be heard

___ 8. Vary frequency to observe the speaker output at this level but different frequencies

Summary of Data

Frequency (Hz)	**Amplitude ()**

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 2: Speaker Test

Date Completed _____

Performed By _____

Part 2 – Speaker Functionality: Lowest Frequency Heard

___ 1. Solder wires to the speaker (Ensure this is correct from previous part)

___ 2. Connect the speaker to VDD and GND (Ensure this is correct from previous part)

___ 3. Connect the data line of the speaker to the Signal Generator

___ 4. Set signal generator to a mid range value 1-3 kHz and the amplitude found above

___ 5. Observe the speaker output

___ 6. Lower the frequency of the signal generator

___ 7. Repeat steps 5 and 6 until the speaker no longer produces an audible noise.

Summary of Data

Lowest Frequency Output by Speaker _____

Testing Part 2 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 2: Speaker Test

Date Completed _____

Performed By _____

Part 3 – Speaker Functionality: Highest Frequency Heard

___ 1. Solder wires to the speaker (Ensure this is correct from previous part)

___ 2. Connect the speaker to VDD and GND (Ensure this is correct from previous part)

___ 3. Connect the data line of the speaker to the Signal Generator

___ 4. Set signal generator to a mid range value 1-3 kHz and the amplitude found above

___ 5. Observe the speaker output

___ 6. Raise the frequency of the signal generator slowly

___ 7. Repeat steps 5 and 6 until the maximum rating of the speaker is reached or the ideal frequency is reached.

Summary of Data

Highest Frequency Output by Speaker _____

Testing Part 3 Sign Off _____ Date_____

Hearing Aid Redesign: Test Plans

EE 3: Sound Processing Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal
S2	Frequencies Amplified	85 – 8000 Hz	300 – 7000 Hz
S3	Maximum Amplification	90 dB	85-95 dB

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

___ MC56F8006 Evaluation Kit
___ USB power cable
___ USB TAP cable
___ Matlab

Sections

- Part 1: Test sound processing algorithm on known signal from Matlab
- Part 2: Test sound processing with signal generator

Hearing Aid Redesign: Test Plans
EE 3: Sound Processing Test

Date Completed _____

Performed By _____

Part 1 – Test sound processing with signal from Matlab

___ 1. Hard code signal into software

___ 2. Flash code onto evaluation board

___ 3. Set a break point after the signal is finished being processed before being output

___ 4. Run the code

___ 5. Take and plot the output of the sound processing algorithm in Matlab

___ 6. Compare the result to the initial signal

Summary of Data

Did the sound processing algorithm modify the signal? Yes _____ No _____

Was the signal Amplified? Yes _____ No _____

Are modifications to the algorithm needed? Yes _____ No _____

Place Wave forms here

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 3: Sound Processing Test

Date Completed _____

Performed By _____

Part 2 – Test Sound Processing with Signal Generator

___ 1. Attach signal generator to the ADC ports of the eval board

___ 2. Flash code onto evaluation board

___ 3. Set a break point after the signal is finished being processed before being output

___ 4. Run the code

___ 5. Observe that the ADC interrupt LED goes on when interrupt is generated.

___ 6. Take and plot the output of the sound processing algorithm in Matlab

___ 6. Compare the result to the initial signal

Summary of Data

Did the sound processing algorithm modify the signal? Yes _____ No _____

Did the ADC interrupt Trigger Yes _____ No _____

Was the signal Amplified? Yes _____ No _____

Are modifications to the algorithm needed? Yes _____ No _____

Place Wave forms here

Testing Part 2 Sign Off _____ Date_____

Hearing Aid Redesign: Test Plans

EE 4: Microphone Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal
S1	Lowest Level of Sound Detected	< 30 dB	<60 dB

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

___ Directional Microphone
___ Omni-Directional Microphone
___ Breadboard
___ Oscilloscope
___ Oscilloscope Probes

Sections

- Part 1 – Microphone Functionality: Normal speaking voice
- Part 2 – Microphone Functionality: Whisper
- Part 3 – Measure the output of the microphone

Hearing Aid Redesign: Test Plans
EE 4: Microphone Test

Date Completed _____

Performed By _____

Part 1 – Microphone Functionality: Normal speaking voice Test

___ 1. Solder wires to the microphones

___ 2. Connect the microphones to VDD and GND

___ 3. Connect the data lines of the microphones to the Oscilloscope

___ 4. Talk at a normal speaking level (approx. 60 dB)

___ 5. Observe oscilloscope output to obtain a quantifiable measurement of the microphones

___ 6. Save capture of oscilloscope to verify that it can pick up normal speech

Summary of Data

Place capture of microphone waveforms here to prove functionality at a normal speaking level

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans

EE 4: Microphone Test

Date Completed _____

Performed By _____

Part 2 – Microphone Functionality: Whisper Test

___ 1. Solder wires to the microphones (Ensure this is correct from previous part)

___ 2. Connect the microphones to VDD and GND (Ensure this is correct from previous part)

___ 3. Connect the data lines of the microphones to the Oscilloscope

___ 4. Talk at a whisper(approx. 30 dB)

___ 5. Observe oscilloscope output to obtain a quantifiable measurement of the microphones

___ 6. Save capture of oscilloscope to verify that it can pick up speech at a whisper

Summary of Data

Place capture of microphone waveforms here to prove functionality at a whisper speaking level

Testing Part 2 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 4: Microphone Test

Date Completed _____

Performed By _____

Part 3 – Measure the output of the microphone

___ 1. Solder wires to the microphones (Ensure this is correct from previous part)

___ 2. Connect the microphones to VDD and GND (Ensure this is correct from previous part)

___ 3. Connect the data lines of the microphones to the Oscilloscope

___ 4. Talk at varying levels of speech

___ 5. Observe oscilloscope output to obtain a quantifiable measurement of the microphones

___ 6. Save capture of oscilloscope to verify that it can pick up speech at a whisper

___ 7. Record the max voltage levels of the microphones output to determine the operating range of the microphone. This is useful to not harm electronics later on in the system

Summary of Data

Place capture of microphone waveforms here to prove functionality at a whisper speaking level

Maximum voltage reading: Normal Level: _____

Maximum voltage reading: Low Level _____

Maximum voltage reading: High Level _____

Testing Part 3 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans

EE 5: Battery Charger Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal
S5	Time to charge Earpiece	<30	<60
S7	Connects to Standard USB 2.0 Port	Yes	Yes/No

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

___ Battery Charger IC
___ Batteries
___ Breadboard
___ Multimeter

Sections

- Part 1: Test Battery Charger for Correct Operation

Hearing Aid Redesign: Test Plans

EE 5: Battery Charger Test

Date Completed _____

Performed By _____

Part 1 – Test Battery Charger for Correct Operation

___ 1. Wire up the charger circuit on the breadboard

___ 2. Connect the batteries

___ 3. Double check that the circuit is correct

___ 4. Apply the correct input voltage to the circuit

___ 5. Probe the circuit with the multimeter checking test point voltages

___ 6. Measure the batteries during charging to see if they are in fact charging

___ 7. Discharge the batteries to simulate circuit operation.

___ 8. Repeat steps 4 – 7 for multiple charge cycles

Summary of Data

Did the battery charging circuit charge the batteries? Yes _____ No _____

Were we able to optimize the circuit at all? Yes ____ No ____
If so what was optimized:

What was the time to charge the earpiece? _____

Are we able to charge over USB 2.0? Yes _____ No _____

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 6: Bandpass and Pre-Amplification Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

- ___
- ___
- ___
- ___
- ___

Sections

- Part 1: Test the Bandpass Filter and Pre-Amplifier

Hearing Aid Redesign: Test Plans
EE 6: Bandpass and Pre-Amplification Test

Date Completed _____

Performed By _____

Part 1 – Test Battery Charger for Correct Operation

___ 1.

___ 2.

___ 3.

___ 4.

___ 5.

___ 6.

___ 7.

___ 8.

Summary of Data

Did the battery charging circuit charge the batteries? Yes _____ No _____

Were we able to optimize the circuit at all? Yes ____ No ____
If so what was optimized:

What was the time to charge the earpiece? _____

Are we able to charge over USB 2.0? Yes _____ No _____

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans

EE 7: System Test

Date Completed _____

Performed By _____

Specifications Tested

Specification	Description	Ideal	Marginal
S1	Lowest Level of Sound Detected	< 30	< 60
S2	Frequencies Amplified	85 – 8000 Hz	300 – 7000 Hz
S3	Maximum Amplification	90 dB	85-95 dB
S4	Levels of Volume Adjustment	20	5
S7	Connects to USB 2.0 Port	Yes	Yes/no
S5	Time to Charge Earpiece	< 30	< 60
S12	Earpiece Battery Life at Max Amplification	> 48	> 16

Revision History

Revision	Description	Date
1	Document Created	03/14/13

Equipment

___ MC56F8006 Evaluation Kit
___ USB power cable
___ USB TAP cable
___ Directional Microphone
___ Omni-Directional Microphone
___ Speaker
___ Battery Charger Circuit
___ Switch
___ Filtering and Amplification Circuit

Sections

- Part 1: Test for S1
- Part 2: Test for S2
- Part 3: Test for S3
- Part 4: Test for S4
- Part 5: Test for S7
- Part 6: Test for S5
- Part 7: Test for S12

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 1 – Test for S1

___ 1. Flash the latest code to the evaluation board

___ 2. connect all of the subsystems together

___ 3. Ensure batteries are charged, charger circuit is correct, and amplification and filtering is in place

___ 4. Check that the microphones and speaker are connected, as well as the switch.

___ 5. Place the microphones and speaker inside of the audiologist test equipment

___ 6. Run a low sound scenario on the audiologist test equipment

___ 7. Compare the result of the low sound scenario to that of a known good hearing aid

Summary of Data

Were we able to detect sound in the low sound scenario? Yes _____ No _____

Are modifications to the algorithm needed? Yes _____ No _____

Place Result Graph he

Testing Part 1 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 2 – Test for S2

___ 1. Flash the latest code to the evaluation board

___ 2. connect all of the subsystems together

___ 3. Ensure batteries are charged, charger circuit is correct, and amplification and filtering is in place

___ 4. Check that the microphones and speaker are connected, as well as the switch.

___ 5. Place the microphones and speaker inside of the audiologist test equipment

___ 6. Run a scenario that will test at the limits of the frequency ranges to see hearing aid response

___ 7. Compare the result of the scenario to that of a known good hearing aid

Summary of Data

Were we able to amplify the necessary frequencies? Yes _____ No _____

Are modifications to the algorithm needed? Yes _____ No _____

Place Result Graph here

Testing Part 2 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 3 – Test for S3

___ 1. Flash the latest code to the evaluation board

___ 2. connect all of the subsystems together

___ 3. Ensure batteries are charged, charger circuit is correct, and amplification and filtering is in place

___ 4. Check that the microphones and speaker are connected, as well as the switch.

___ 5. Place the microphones and speaker inside of the audiologist test equipment

___ 6. Set mode to max gain

___ 7. Run a scenario and observe the maximum gain of the hearing aid

___ 8. Compare the result of the scenario to that of a known good hearing aid

Summary of Data

Were we able to meet the maximum amplification? Yes _____ No _____

Are modifications to the algorithm needed? Yes _____ No _____

Place Result Graph here

Testing Part 3 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 4 – Test for S4

___ 1. Flash the latest code to the evaluation board

___ 2. connect all of the subsystems together

___ 3. Ensure batteries are charged, charger circuit is correct, and amplification and filtering is in place

___ 4. Check that the microphones and speaker are connected, as well as the switch.

___ 5. Place the microphones and speaker inside of the audiologist test equipment

___ 6. Run a scenario that will test at the limits of the frequency ranges to see hearing aid response

___ 7. Compare the result of the scenario to that of a known good hearing aid

Summary of Data

Were we able to amplify the necessary frequencies? Yes _____ No _____

Are modifications to the algorithm needed? Yes _____ No _____

Place Result Graph here

Testing Part 4 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 5 – Test for S7

___ 1. Connect all of the subsystems together

___ 2. Ensure batteries are uncharged, charger circuit is correct, and amplification and filtering is in place

___ 3. Check that the microphones and speaker are connected, as well as the switch.

___ 4. Plug the USB Cable into the battery charger

___ 5. Measure the battery voltage as the charging begins

Summary of Data

Did the Batteries start charging? Yes _____ No _____

Did they hold a charge Yes _____ No _____

Testing Part 5 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 6 – Test for S5

___ 1. connect all of the subsystems together

___ 2. Ensure batteries are uncharged, charger circuit is correct, and amplification and filtering is in place

___ 3. Check that the microphones and speaker are connected, as well as the switch.

___ 4. Plug the USB Cable into the battery charger

___ 5. Measure the battery voltage as the charging begins, start timing

___ 6. When batteries are fully charged stop timing. Record time to charge

Summary of Data

Was the time to charge acceptable? Yes _____ No _____

What was the time to charge? _____

Testing Part 6 Sign Off _____Date_____

Hearing Aid Redesign: Test Plans
EE 7: System Test

Date Completed _____

Performed By _____

Part 7 – Test for S12

___ 1. Connect all of the subsystems together

___ 2. Ensure batteries are fully charged, charger circuit is correct, and amplification and filtering is in place

___ 3. Check that the microphones and speaker are connected, as well as the switch.

___ 4. Set hearing aid to a mode that will use the most power

___ 5. Measure the battery voltage and plug them into the hearing aid

___ 6. Start timing, and monitor the battery voltage

___ 7. When the batteries are fully drained stop timing

___ 8. Record the worst case battery life

Summary of Data

Was the battery life of the hearing aid acceptable? Yes _____ No _____

What was the battery life in this worst case? _____

Do changes need to be made to extend the battery life? Yes _____ No _____

If so list any possible changes here:

Testing Part 6 Sign Off _____Date_____