# Automated Hearing Test

**Guided Project Instructor Set**

nPoints
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Figure 1 Example Hearing test system

**Related Core Concepts:**

*Mini Mixer*

*React!*

*"Rigorous hearing tests are performed for individuals joining the armed forces as well as airplane pilots and police officers."*

## Learn It!

A hearing test is a means to determine if a patient is experiencing hearing loss. There are several types of hearing tests help determine different forms of hearing loss. A trained audiologist will perform different types of tests based on a patients hearing performance. Some hearing test require the patient to respond to sound coming into the ear drum or sound against the skull while other don't require a patients response at all. Hearing tests are necessary for individuals of all ages. Proper hearing is necessary in young children during speech development and for overall comprehension. Rigorous hearing tests are performed for individuals joining the armed forces as well as airplane pilots and police officers.

In this module you will design a hearing test that will be a reliable indication of the hearing range of a patient, using a Pushbutton switch and LabVIEW.

## Build It!

**Task 1:** Build a button circuit using a pull up resistor configuration and the 5V power line of your acquisition device; wire the output of your circuit to AI0. Design your circuit to draw between 1 and 5mA of current when the button is pushed. You may also use any additional circuitry to debounce your button.



Figure 2 Example push button circuit

### Guiding Questions:
- Explain a hardware solution to switch bouncing. Why doesn't a FET switch exhibit the bouncing behavior?
- What issues are introduced when either a hardware or software solution is implemented for debounce? Explain what should be considered when designing your debounce solution.
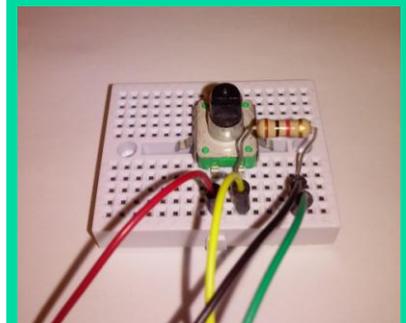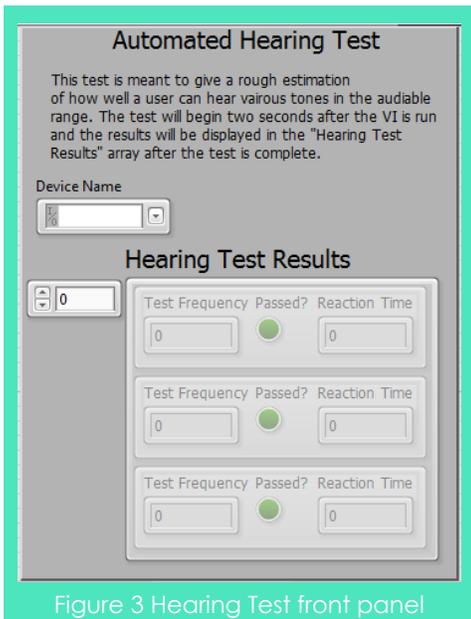
Figure 3 Hearing Test front panel

**Task 2:** Create code that can take in an array of data and randomize the order of the elements. Make sure the code can take any size array and make sure all of the elements from the input array are in the output array. Write a second piece of code that can generate an array of random numbers between one and three that is the same size as the first array you created. These two arrays will serve as the generated test points. The first will hold the frequencies of the tone you would like to generate and the second will hold the duration of time between each tone.

**Guiding Questions:**
- Is there a LabVIEW function that can randomize array elements?
- How do you map one range of numbers to a different range of numbers? Is there a linear equation that can help define this?

**Task 3:** Create code that continuously acquires data from AI0 and keeps a history of the data acquired. The code should also iterate through the arrays created in the previous task, create a sine wave of the frequency specified by the frequency array, output that signal to the Audio Output port of your myDAQ for a half a second and wait the amount of time specified by the duration array before generating the next tone. The acquisition should keep running until the arrays of been iterated through.

**Guiding Questions:**
- How can you control the duration of your acquisition? What would be you acquisition stopping condition?
- How can you make sure every tone is generated? Where will the duration time come into play in your loop?
- What should the sample rate, number of samples and generation mode be in order to output the tone for the desired amount of time?
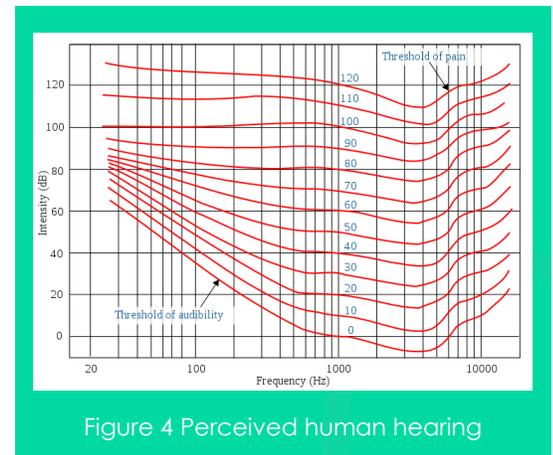


Figure 4 Perceived human hearing

**Task 4:** Create code that uses the acquired data from the push button input as well as the duration times between your tones to determine if the user pressed the button after hearing the tone. Use this information to also determine how fast the user reacted to the tone being played. Create a display of your results showing the frequency of the tone that was generated, whether or not the user responded to that tone being played and how long it took them to respond. Run your hearing test on various users.

**Guiding Questions:**
- Were there any trends you noticed in your results?  Could all test subjects hear the same range of frequencies?  Was there anything consistent between all test subjects?
- Reflect specifically on the headphones used in your tests.  If you had time and tools, how would you validate whether your headphones were producing monotones at the desired frequencies?

## Expand it!

- Add a level of analysis to your hearing test by playing a single tone multiple times at different volumes until the user responds.
- Incorporate multiple buttons in your test set up to allow the user to specify which ear they think the sound is coming from, add functionality to play different tones to different ears.
- Add functionality to process the data statistically in order to draw conclusions pertaining to a trend in the data.

## Research It!

**Now Hear This!**

http://www.oem.msu.edu/userfiles/file/News/v12n3.pdf

**Hearing Test**

http://en.wikipedia.org/wiki/Hearing_test