ME 6705 / AE 6705 - Introduction to Mechatronics

Lab Assignment 3

Producer/Consumer Architecture

1 Objective

The main objective of this lab is to build a system that monitors for loud noise exposure. You will use LabVIEW, a myRIO, a microphone, two 7-segment displays, and a breadboard. You will gain experience in implementing a producer-consumer architecture and how to sample and analyze data on-demand.

2 Setup

This lab requires the following:

- A National Instruments myRIO microcontroller
- Microphone with audio jack (found in the NI myRIO Starter Accessory Kit in the Mechatronics lab, don't take out of lab)
- Two 7-segment displays (found in the NI myRIO Starter Accessory Kit in the Mechatronics lab, don't take out of lab)
- A breadboard

3 Problem Statement

This lab is divided into two tasks:

1. **Task 1:** Alter the provided Lab 3 LabVIEW template that uses producer-consumer architecture to read data from the microphone. In the producer loop, you will de-queue the data, plot the data, and measure the Peak-to-Peak voltage, and the RMS voltage of a signal over a set point "Sampling time (s)".
2. **Task 2:** Using the RMS voltage measured in Task 1, the consumer loop will notify the user of permissible exposure time to the noise until hearing loss occurs. Reference an array of data corresponding to continuous dB values, then update the two 7-segment displays with the permissible exposure time in minutes.

4 Deliverables and Grading

This lab is worth 100 points. This lab is done in a team of two. To get credit for this lab assignment you must:

1. Demonstrate proper operation of your program to TAs or instructor during office or demo hours. Go to the back panel and explain your logic that drives the program. You must demonstrate your program prior to the due date to receive credit. (100 points)
2. Submit your code to Canvas. Your code should be a zip file of your LabVIEW project. This code will not be graded, but no submission will result in a zero for the lab.

5 The LabVIEW program specifications

Your program must use the Lab 3 LabVIEW template, and must satisfy the following:

- Read audio data in the producer loop.
- Display sound data as a data plot based on the "seconds to record" variable.
- Calculate the peak-to-peak voltage amplitude, and the RMS value for the recorded data in the plot.
- Display permissible exposure time on the two 7-segment displays.

6 Task 1 Details

Build a LabVIEW program that uses a producer-consumer architecture to read data from the microphone. Use the Lab 3 LabVIEW template. In the producer loop, you will read the sound data, analyze the array of data to determine peak amplitude (in dB), and place that peak amplitude value in the queue.

- Before the producer loop:
    1. Open up the AudioIn/Left channel using the low-level function "Smart Open.vi"
- Inside the producer loop:
    1. Read the AudioIn/Left and index the array at index 0 (that is referencing the single channel you opened)
    2. Place the value read into a "Lossy Enqueue Element"
    3. Wire the error through the Read.vi, and exit the producer loop to the "Reset myRIO.vi"
- Inside the consumer loop, in the left flat sequence structure:
    1. Read the user-input of "seconds to record (s)" and provide a time delay.

2. Create an "acquiring data" LED on the front panel, and set this LED to True.

- Inside the consumer loop, in the right flat sequence structure:

1. Get the queue by using the block "Get Queue Status" (with return elements set as True).
2. Plot data corresponding to "seconds to record (s)" (i.e. if you request 2 seconds, you will pull 2 seconds worth of data from the queue). Note: remember that queues operate first-in-first-out! Samples per second = 4000. dt of the producer loop is 250 microseconds. dt of the consumer loop is 10,000 microseconds.
3. Check to see if number of samples to query from the queue is greater than 100,000 samples (this is the buffer size of the queue). If so, turn on front panel LED "Request Exceeds 100,000 samples".

- Inside the consumer loop, outside of the flat sequence structure:

1. Use the VI "Amplitude and Level Measurements" to measure the peak-to-peak, and the RMS value.

7 Task 2 Details

Below is a table summarizing permissible exposure time to various averaged sound amplitudes. For example, if a rock concert is playing music at 100 dB, you will start to damage your hearing in just 15 minutes.

Continuous dB	Permissible Exposure Time
94 dB	60 minutes
97 dB	30 minutes
100 dB	15 minutes
103 dB	7.5 minutes
106 dB	4 minutes
109 dB	2 minutes
112 dB	1 minute
115 dB	0.5 minute

Create a subVI that artificially converts the RMS voltage measured in Task 1 into dB. **This conversion will be arbitrary (will NOT align with actual scaling of the microphone), so you don't damage your hearing for this lab.** Take a measurement of the RMS voltage for a somewhat loud noise (play a sound through your phone speaker, or yell into the microphone). This measured RMS voltage will correspond to the largest Continuous dB in the table above (115 dB).

According to the table, a measured RMS voltage (or Continous dB value) will correspond to a Permissible Exposure Time. Update the two 7-segment displays with the permissible exposure time in minutes.

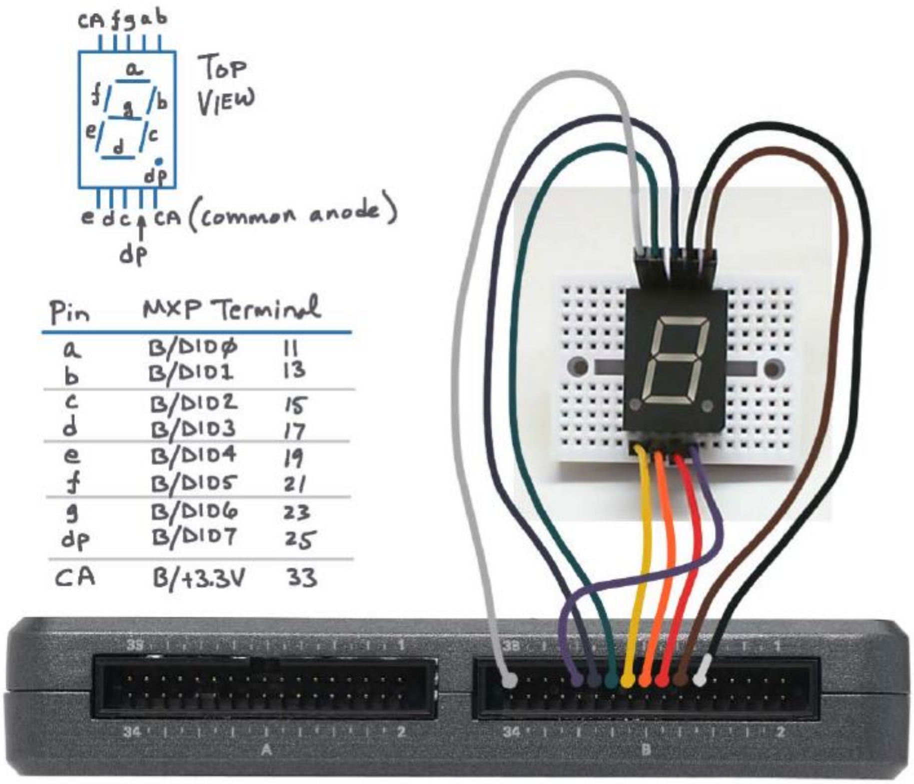

Figure 1: Wiring for one 7-segment display