Requirements Document

Lab 5 – Music Player

# Overview

## Objectives

The objectives of this project are to design, build and test a music player. Educationally, the students are learning how to interface a DAC, how to design a speaker amplifier, how to store digital music in ROM, and how to perform DAC output in the background. Your goal is to play your favorite song.

## Process

The project will be developed using the TM4C123 board. There will be two or three switches that the operator will use to control the music player. The system will be built on a solderless breadboard and run on the usual USB power. The system may use the on board switches or off-board switches. A hardware/software interface will be designed that allows software to control the player. There will be at least three hardware/software modules: the switch input, DAC output, and the music player. The process will be to design and test each module independently from the other modules. After each module is tested, the system will be built and tested.

## Roles and Responsibilities

EE445L students are the engineers and the TA is the client. Students are expected to make minor modifications to this document in order to clarify exactly what they plan to build. Students are allowed to divide responsibilities of the project however they wish, but, at the time of the demonstration, both students are expected to understand all aspects of the design.

## Interactions with Existing Systems

The system will use the TM4C123 board, a solderless breadboard, and the speaker as shown in Figure 5.1. It will be powered using the USB cable. You may use a +5V power from the lab bench, but please do not power the TPA731 or the speaker with a voltage above +5V.

## Terminology

|  |  |
| --- | --- |
| **Term** | **Definition** |
| SSI |  |
| Linearity |  |
| Frequency |  |
| Response |  |
| Loudness |  |
| Pitch |  |
| Instrument |  |
| Tempo |  |
| Envelope |  |
| Melody |  |
| Harmony |  |

## Security

The system may include software from StellarisWare and from the book. No software written for this project may be transmitted, viewed, or communicated with any other EE445L student past, present, or future (other than the lab partner of course). It is the responsibility of the team to keep its EE445L lab solutions secure.

# Function Description

## Functionality

If the operator presses the play/pause button the music will play or pause. If the operator presses the play/pause button once, the music should pause. Hitting the play/pause button again causes music to continue. The play/pause button does not restart from the beginning, but rather from the position that it was paused. If the rewind button is pressed, the music stops and the next play operation will start from the beginning. **There will be a third button that allows the user to cycle between instruments. After the user presses this button, the music module will switch the sound wave to the next wave type.**

There must be a C data structure to hold the music. There must be a music driver that plays songs. The length of the song should be at least 30 seconds and comprise of at least 8 different frequencies. Although you will be playing only one song, the song data itself will be stored in a separate place and be easy to change. The player runs in the background using interrupts. The foreground (main) initializes the player, then executes a do-nothing loop. **There will be no LCD output.** The maximum time to execute one instance of the ISR is xxxx (REPLACE WITH PERFORMANCE MEASURE). You will need public functions Rewind, Play, and Stop, which perform operations like a cassette tape player. The Play function has an input parameter that defines the song to play. A background thread implemented with output compare will fetch data out of your music structure and send them to the DAC.

**There will be a C data structure to hold the song**. **The data structure will consist of a list of frequencies and how long each frequency should be played. The frequencies will change the note being played by changing the reload value for the timer. Each instrument will be represented by 32 data points, and the full wave should be completed a number of times a second as defined by the frequency of the note.** You are free to design your own format, as long as it uses a formal data structure. The generated music must sound beautiful utilizing the SNR of the DAC. Although you only have to implement one instrument, it should be easy to change instruments.

## Scope

Phase 1 is the preparation; phase 2 is the demonstration; and phase 3 is the lab report. Details can be found in the lab manual.

## Prototypes

A prototype system running on the TM4C123 board and solderless breadboard will be demonstrated. Progress will be judged by the preparation, demonstration and lab report

## Performance

The system will be judged by three qualitative measures. First, the software modules must be easy to understand and well-organized. Second, the system must employ abstract data structures to hold the sound and the music. There should be a clear and obvious translation from sheet music to the data structure. Backward jumps in the ISR are not allowed. Waiting for SSI output to complete is an acceptable backwards jump. Third, all software will be judged according to style guidelines. Software must follow the style described in Section 3.3 of the book. There are 3 quantitative measures. First, the SNR of the DAC output of a sine wave should be measured. Second, the maximum time to run one instance of the ISR will be recorded. Third, you will measure power supply current to run the system. There is no particular need to optimize any of these quantitative measures in this system.

## Usability

There will be three switch inputs. The DAC will be interfaced to a 32-ohm speaker.

## Safety

If you are using headphones, please verify the sound is not too loud before placing the phones next to your ears.

# Deliverables

## Reports

A lab report described below is due by the due date listed in the syllabus. This report includes the final requirements document.

## Audits

The preparation is due at the beginning of the lab period on the date listed in the syllabus

## Outcomes

There are three deliverables: preparation, demonstration, and report.