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ECE 4273 - Digital Design Lab

Digital Dance Lab (DDL)

Preliminary Hardware/Software Design Report

Purpose

The proposed design is to create an arcade-style music rhythm game based on the music video game series *Dance Dance Revolution*. An example of this arcade game can be seen in Figure 1. The goal of the game is to tap arrows on the pad using your feet when prompted by audio and graphical indicators. Depending on the timing of the input, you will be given a score for each arrow pressed.

Figure 1: Dance Dance Revolution Machine

We will accomplish this using our LPC1769 microcontroller by interfacing with a serial PlayStation 2 dance pad controller, a speaker output, and a display with a DE-15 VGA Connector. Using the LPC1769, we will play a selected song and display the game mechanics on the monitor connected with a VGA cable.

Software Description

The software will implement the primary function of playing music using the Digital-to-Analog Converter present on the LPC1769. We will generate an analog audio signal and feed the analog out pin to an amplifier and speaker to generate real audio output.

When an input switch is triggered to begin the audio playback, we start a timer which will control all of the audio timings for the audio output and begins the audio playback. Using other inputs, the volume can also be controlled.

A variety of different musical notes will be created by pulsing square waves at varying frequencies. To set the list of notes that will be output when the music is played, we will create an array of notes and define each note with a set amount of time to wait in between pulses. We will implement timing and output logic to allow for multiple channels at the same time to output to the analog output port to generate harmonies and chords. We will also implement a linear feedback shift register with sufficient attack and delay to allow for varying percussion sounds in order to generate the elements needed for our music.

The software will implement the function of displaying a video output to a display using VGA output and sending digital values to the red, green, and blue lines and pulsing the vertical and horizontal syncs at the rate of 31kHz horizontal sync and 60 Hz vertical sync. In order to help keep our timings tightly in sync, we will speed up our processor clock to 100 MHz and use strict timers to ensure that the pixels are written at the correct timings to generate stable images on our display.

The software will implement the function of receiving digital input from a PlayStation 2 Dance Dance Revolution Regular Dance Pad. This dance pad uses a serial interface to send input signals. Using an SPI connection, the LPC1769 will function as the controller, and the dance pad will function as a target.

Hardware Description

As seen in Figure 2, our audio hardware uses a similar schematic from our assignment #5 with the audio amplifier connected with our speaker. However, we added more resistors from our input that reduces our input voltage going to our audio amplifier.

As seen in Figure 3, we designed input button switches to allow for user input to adjust the volume.

As seen in Figure 4, we set up our VGA cable interface with current-limiting resistors for our Red, Green, and Blue pins from the VGA cable onto the LPC1769 microcontroller. We did not use resistors for the Horizontal and Vertical Synchronization wires of the VGA cable. On the DE-15 VGA Connector, all pins other than the Red, Green, Blue, Horizontal Sync, Vertical Sync, and Ground were left unconnected. The DE-15 interface of the VGA connector that we wired our signals to can be seen in Figure 6.

As seen in Figure 5, we will wire our PlayStation2 Dance Pad with an SPI connection to the LPC1769. We will wire SPI IN, SPI OUT, Clock, Attention, Command, and Acknowledge. A pull-up resistor of 1-10k will be set on the Data and Acknowledge lines, as the dance pad has an open collector output on these lines and cannot drive voltages.

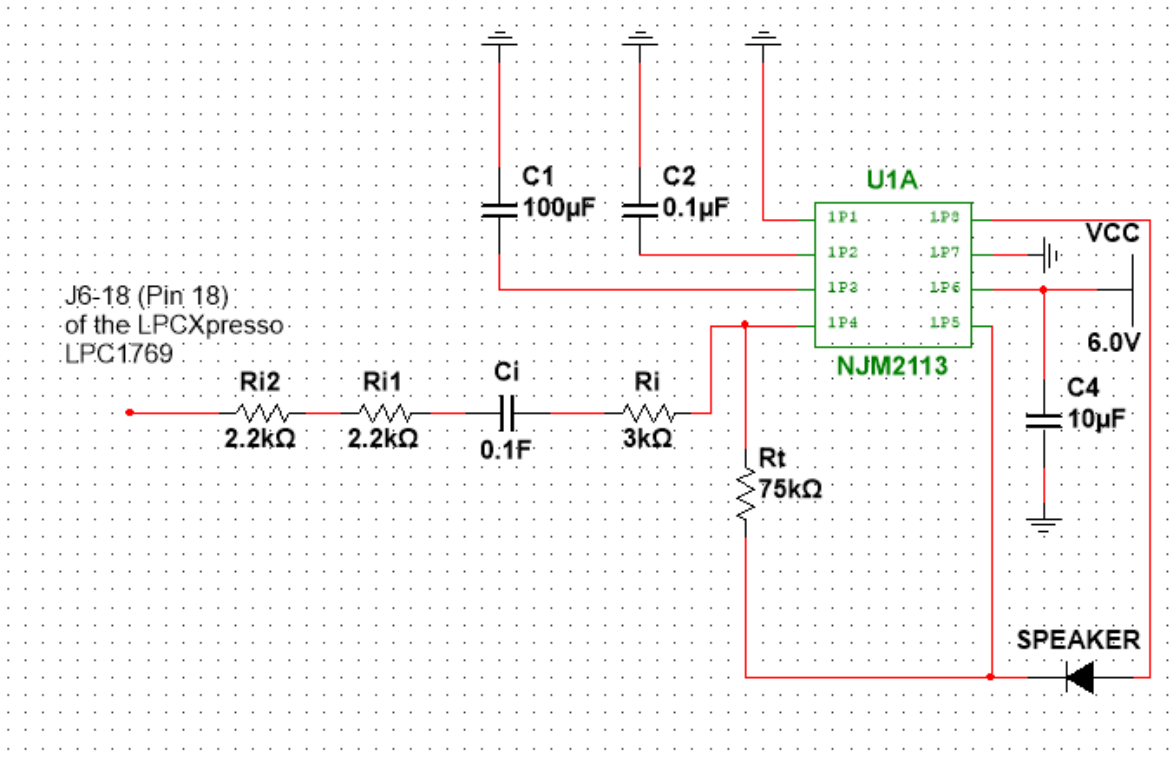

Figure 2: NJM2113 Audio Amplifier Schematic

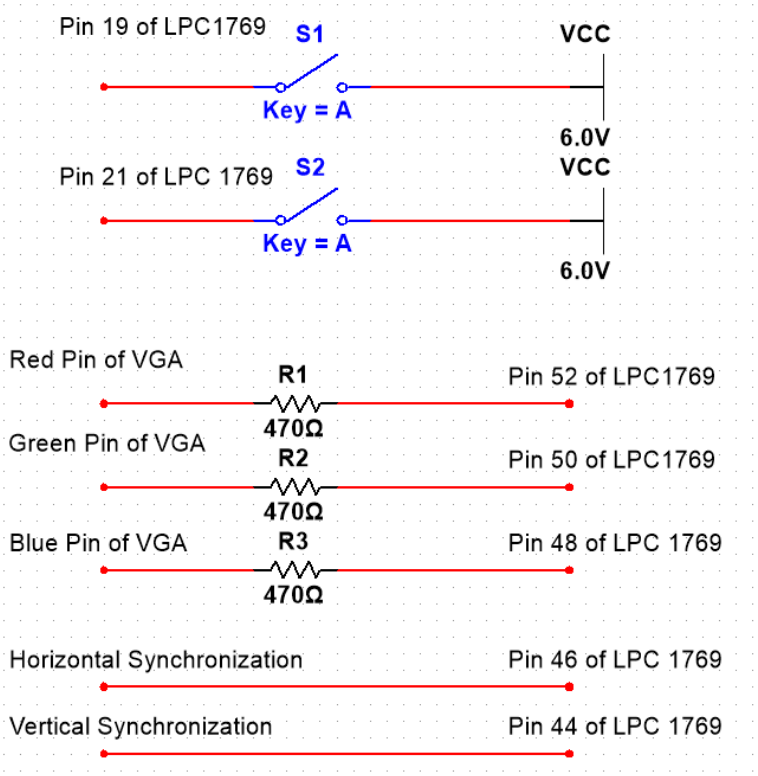

Figure 3: VGA Cable and Volume Switches with LPC1769

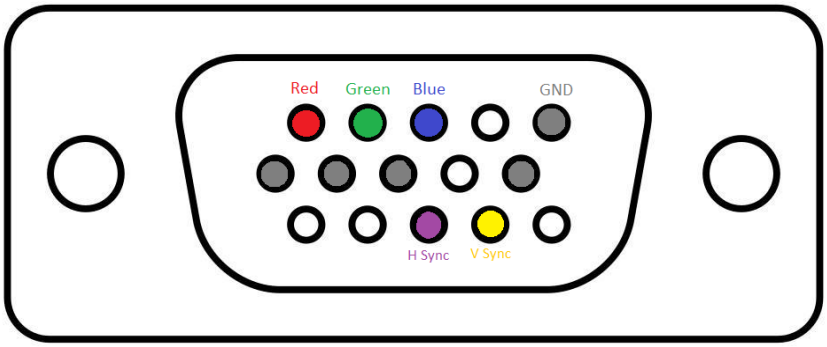

Figure 4: DE-15 VGA Connector Pin Descriptions

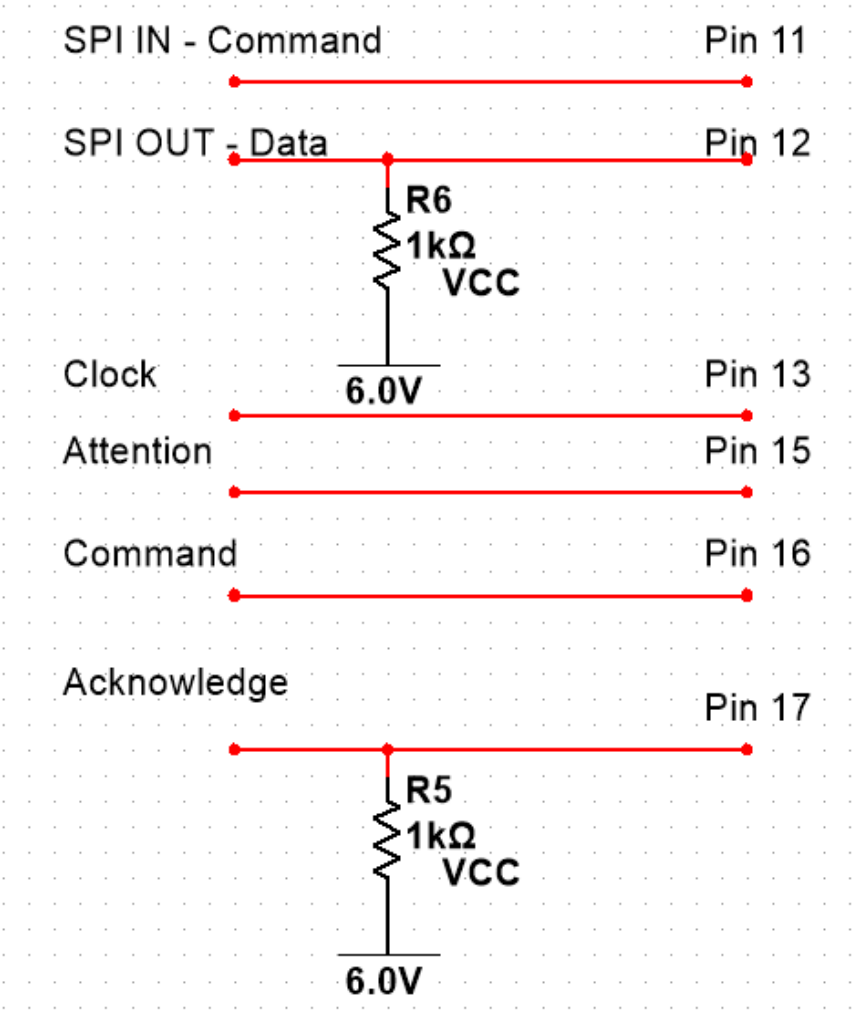

Figure 5: PlayStation 2 Controller Connections with LPC1769

■ APPLICATION CIRCUIT

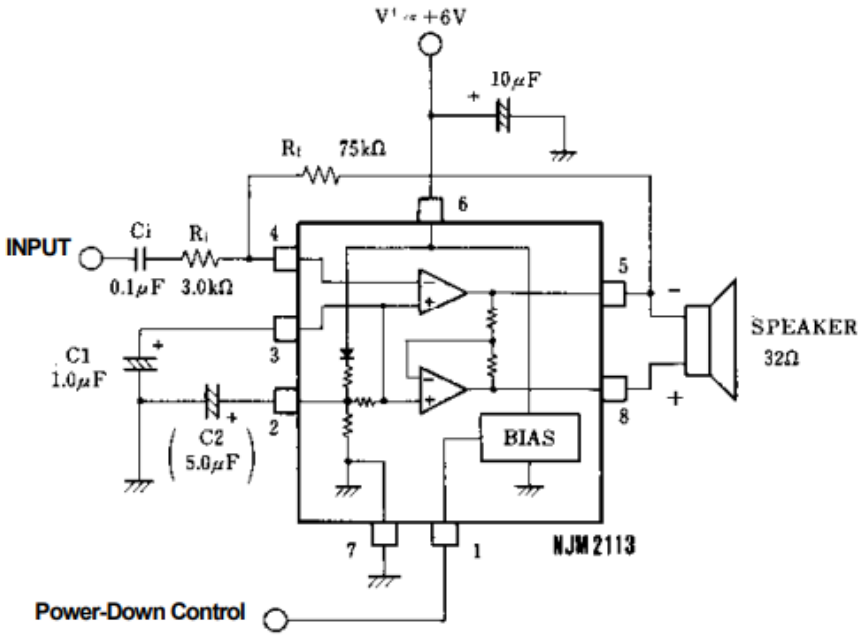

Figure 6: Application Circuit from NJM2113 Data Sheet

Selected Hardware Component Values

For our displays from the VGA cable, the Red, Green, and Blue pins we use 470 ohm resistors. Considering a 75 ohm termination of the VGA cable and a 3.3V output from the LPC1769, the 470 ohm resistor supplies a maximum current of (3.3V/470Ohms), or 7.02mA, and a maximum voltage of (3.3*(75/(470+75))), or 0.45V. These values are intentionally kept lower than the maximum of 0.7Vpp to test our design with a high factor of safety.

For the audio amplifier circuit, we followed the application circuit from the NJM2113 data sheet shown on Figure 6, but we replaced the capacitor C1 with a 100uF capacitor instead of a 1.0uF capacitor in order to improve power supply rejection ratio and used a C2 of 0.1uF instead of 5uF. The additional resistors were added later onto the input of the amplifier, where the values of the resistors were two 2.2k ohms. These resistors were just arbitrary resistor values that we added just to reduce the amount of input voltage.