EE447 Term Project Preliminary Report

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### Introduction

Project is the design of a basic sound recorder with a speaker in order to play the record. The length of the record will be maximum of 3 second which utilizes the all of the user accessed memory. Audio recorder triggered by push button. Sound is sampled with 8 kHz frequency at ADC. After recording audio is played. The play frequency is varied between 2 kHz and 10 kHz. Samples are converted to voltage by a DAC. The communication between the microprocessor and DAC is utilized with I2C protocol. The required power for speaker is supplied by a amplifier. It amplifies the sound signal to a 2.5W. A 2.5W speaker converts voltage to a sound waves.

### Block Diagram



Figure 1: Block diagram of system

### State Diagram



Figure 2: State diagram of system

### Sub-Modules

#### Microphone

#### In the project the MAX9814 is used.The MAX9814 is a low-cost, high-quality microphone amplifier with automatic gain control (AGC) and low-noise microphone bias. Due to these features this microphone is preferred. It converts sound waves to electrical signal.

#### Microcontroller

In the project TM4C123GXL board is used. It consists of a TM4C123GH6PM microcontroller. The ADC, timer and I2C features of TM4CGH6PM is used.

#### ADC

TM4C123GH6PM has 2 ADC cores with 10 input pins. It converts signals to 12 bit samples. Internal FIFO memory holds the samples after conversion. It can get samples up to 1 million samples per second. The trigger of the ADC can be software, timers, analog comparators or GPIO. In the project ADC is used for converting electrical sound signals to 12 bit numbers. Also the play rate of the sound is varied with an potentiometer. The output of the potentiometer is sampled in order to change the play rate.

#### SRAM Memory

TM4C123GH6PM has a 32 kilobyte user accessible SRAM Memory. The samples get from ADC are stored at the SRAM memory until the playing of the sound. A sample is roughly a 1.5 byte. If a 8 kilo sample per second rate is used at ADC the recording data rate makes 12 kilobyte per second. If 32 kB memory is available at the microcontroller this means roughly a 3 second recording can be made.

* + 1. Timer

TM4C123GH6PM has 6 general purpose timers. These timers can be configured as 16 bit or 32 bit. The timers are used in the project for triggering I2C communication and triggering ADC operation for sampling of sound signals. In the requirements the sampling rate is stated as 8 kHz thus the timer is set accordingly as periodic when recording is triggered. Also the play rate is stated as 2-10 kHz in the requirements thus the timer for triggering I2C communication is set between 2-10 kHz according to the reading from ADC. This timer triggered when the recording finishes as periodic.

#### I2C

TM4C123GH6PM has 3 I2C drivers which utilizes varying pins. I2C driver of the microcontroller has the capability of transmitting data up to 3.3 Mbps at the high speed mode. In the project microcontroller used as master in the communication. The samples get from ADC are sent to DAC by using

#### DAC

MCP4725 is a 12 bit DAC with I2C interface. It receives data through I2C protocol up to 3 Mbps. It has non-volatile EEPROM for control registers. It converts 12 bit data to a voltage between VCC-0 V. DAC used for playing the sound.

#### Amplifier

In the project PAM8302A is used as amplifier. It has capability of providing 2.5W power for speaker circuitry. By the help of the amplifier, required current for driving the speaker is supplied.

#### Speaker

A 2.5 W 8 ohm speaker is used as sound converter. In order to convert output voltage to sound waves this module is used.

### Conclusion

As observed the project consists of hardware and software parts, software parts includes the initialization of microcontroller and from the trigger to the end operation control of the hardware. The user programmable memory is only capable of 32 kbyte of data. Which is equal to the 20 kilo samples. If 8ksps is applied this makes roughly 3 second recording. The ARM Cortex M4 instruction set is used in order to program the microcontroller. The hardware parts includes the DAC, amplifier and microphone boost circuitry. The microphone circuitry has the sound input and the analog voltage output while the DAC has the I2C protocol input and the analog signal output. The amplifier circuitry has both analog input and outputs.