CSCI-297 EMBEDDED SYSTEMS

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Voice recorder and Playback using Z8 Board

ABSTRACT:

This project describes how to record and playback sound using the Z8F6403, with A/D converter, D/A converter, a microphone and a speaker.

INTRODUCTION:

This project shows the A/D converter for sound conversion from analog to digital and records the sound and the Pulse Width Modulation (PWM) for D/A converter to convert the digital recorded sound into analog for playback.

The **Analog-to-Digital converter (ADC)** converts an analog input signal into 10-bit digital data. The ADC method used by Z8 is sigma-delta conversion. The features of the sigma-delta conversion include:

- 12 analog input sources are multiplexed with general purpose I/O ports.
- Interrupt upon conversion.
- Internal voltage reference generator.

The **Digital-to-Analog conversion** is accomplished using the PWM feature of the Z8 board. In the PWM method the digital input sets pulse width of the signal, which is output to a single GPIO pin. The

output of the GPIO pin is proportional to the width of the ON pulse of the PWM signal, which is proportional to the digital input. The number of GPIO pins is therefore unrelated to the number of bits that the DAC unit supports. This feature affords excellent scalability of DAC unit.

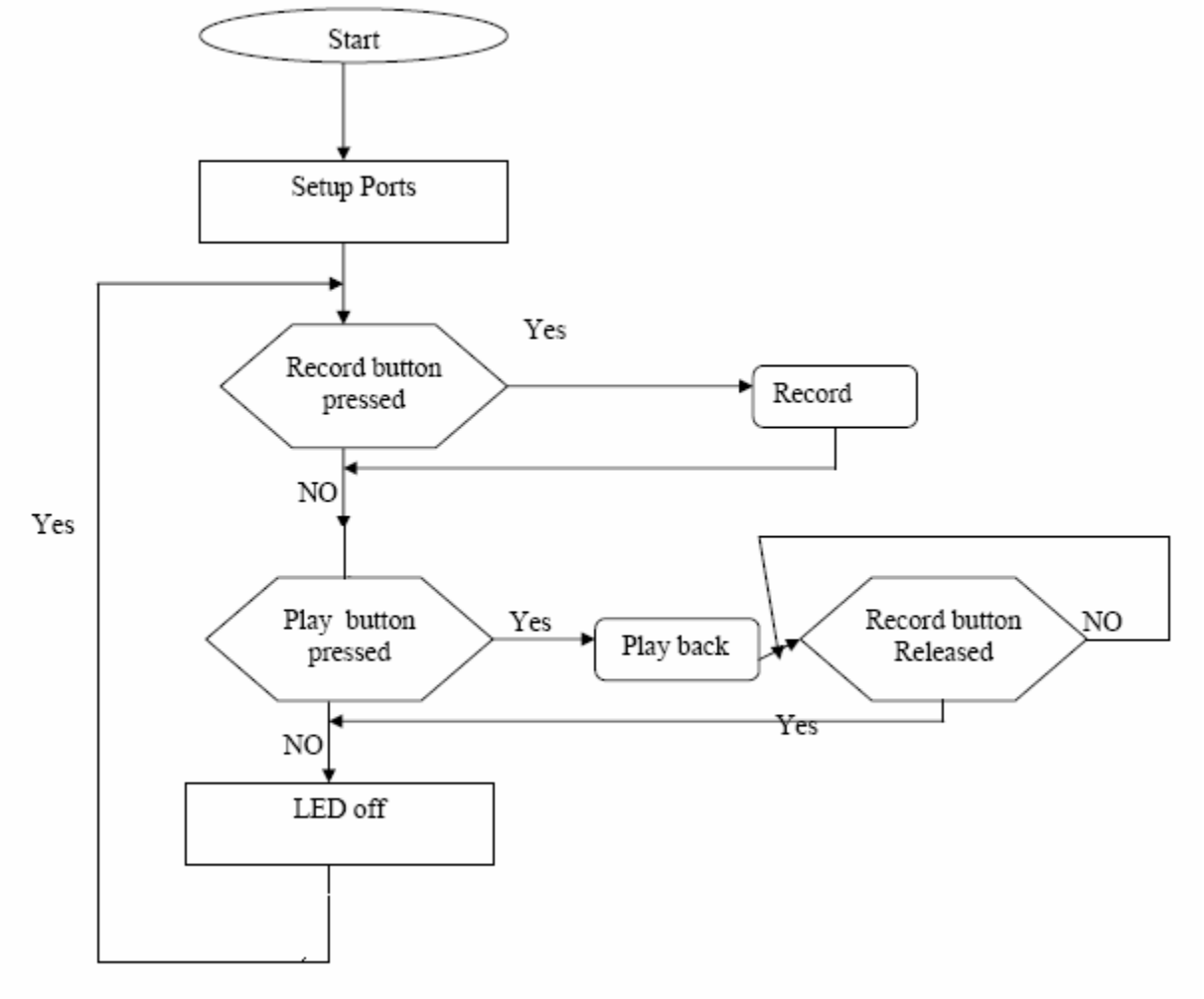
The PWM method requires a dedicated timer (an on chip peripheral) operating in the PWM mode, and requires a number of PWM clock cycles for the output filters to reach a steady average output. Therefore, the PWM method requires settling time that prevents it from being used in applications where digital inputs are received before an averaging of the signals can occur.

PROJECT HARDWARE PARTS:

1. Z8F6403 which had inbuilt A/D converter and D/A converter.
2. A micro-phone.
3. A loudspeaker.

Discussion of the project:

The project mainly is as follows:

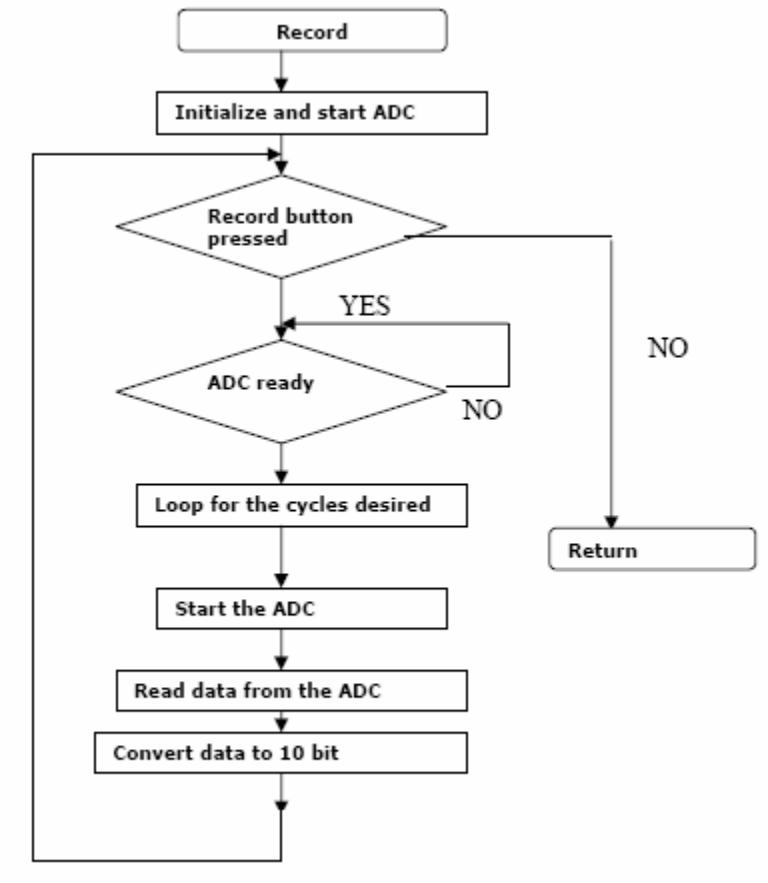


In the main loop the two pushbuttons, sw2 and sw3 are scanned. If one of them is pressed the LED is turned ON to show that the system is busy, and the corresponding subroutine is called.

During the main loop the LED is OFF to indicate that the system is running idle.

RECORD:

The record subroutine is as follows:



The record subroutine consists of the set up of ADC and an empty loop, which is performed as long as the record button is pressed. The ANA0 pin is used in this project as the input of the voice. In the ADC control and status register the ADC is enabled and set to single conversion mode, interrupts enabled and interrupt flag is cleared. The A/D conversion is also immediately started. The first conversion takes longer than the following conversions after this time the ADC interrupt occurs, indicating that the conversion is finished and the result can be read out of the ADC data register.

The analog signal from the micro-phone is sampled to a frequency; this frequency should be same as the PWM frequency.

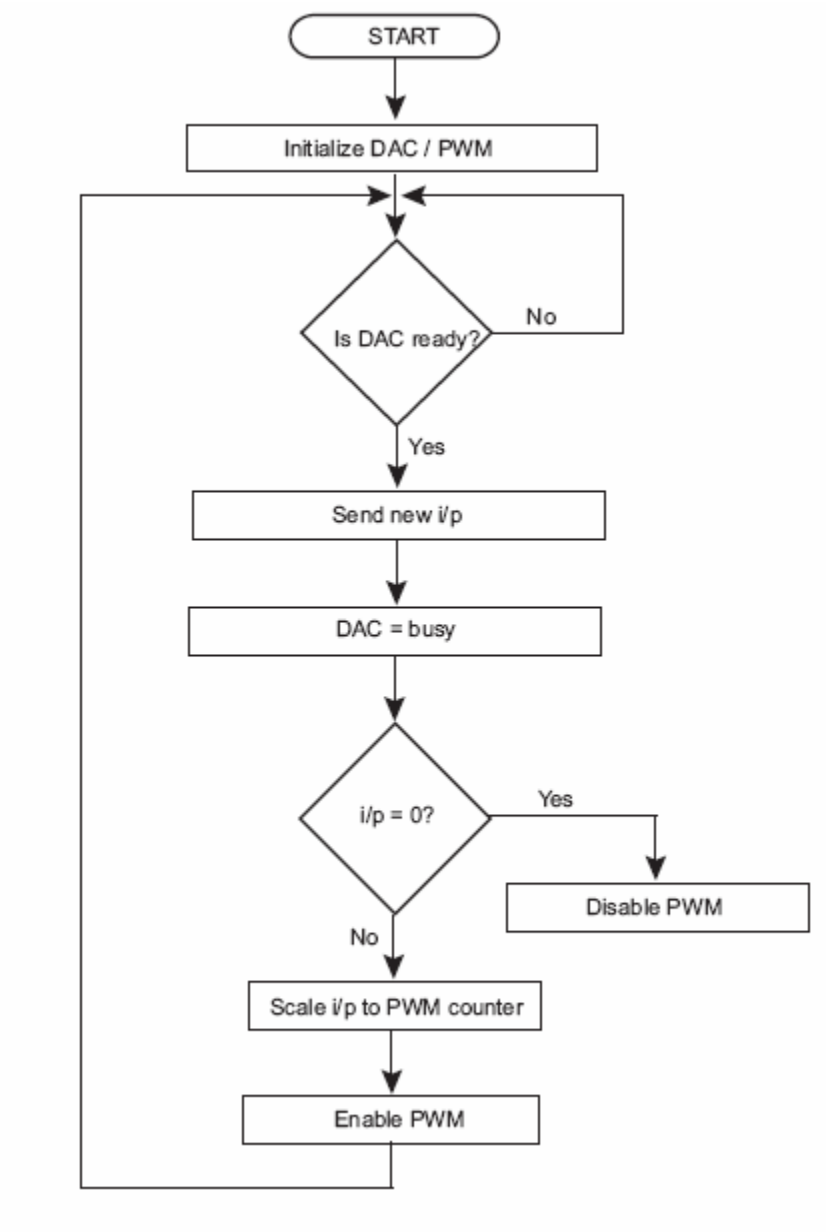
Single conversion mode of the ADC is used to convert the analog input from microphone into digital output. The ADC performs a single analog to digital conversion on the selected analog input channel. After completion of the conversion the ADC shuts down. The steps for setting up the ADC and initiating a single-shot conversion are as follows:

1. Enable the desired analog inputs by configuring the general purpose I/O pins for alternate function. This configuration disables the digital input and output drivers.
2. Write to the ADC control register to configure the ADC and start the conversion.
3. A single-shot conversion requires 5129 clock cycles to complete. If a single shot conversion is requested from an ADC power down state, the ADC uses extra 40 clock cycles to power up before beginning the 5129 conversion clock cycles.
4. When the conversion is complete, the ADC control logic writes the 10-bit digital data to ADC data registers and an interrupt occurs stating that the conversion is complete.
5. If the ADC remains idle for 160 consecutive system clock cycles then ADC is automatically powered down.

PLAYBACK:

In the playback subroutine, the digital data is read and modulate the PWM as a 10-bit PWM to get analog data back. To get the highest possible frequency the PWM clock divider is set to 1.

The PWM flow-chart is given below:



The software implementation to achieve a digital-to-analog conversion using the PWM method is based on Scaling of the DAC digital input, Accommodating the 0x00 digital input and response time before next digital input can be processed.

Scaling of the DAC digital input:

The digital input is scaled to appropriate levels according to the PWM reload value.

Accommodating the 0x00 digital input:

For a PWM generator, the pulse width of 0x00 does not have any meaning. For Z8 Encore! XP MCU, setting the PWM registers with the value 0x00 results in a full-scale output. Therefore, for a digital input of 0x00, the timer PWM is disabled, resulting in an output of 0volts.

Response time:

The DAC output does not change instantaneously according to the DAC input variations. The time constant of the RC filter, which is the response time, determines the time during which the PWM reload value and the digital input must not be changed.

REFERENCES:

1. Z8 Encore! User manual.
2. ADC conversion using Z8 Encore!
3. Digital to analog converter using PWM in the Z8 Encore!
4. Instructor slides.