ChronoFlex-Adaptive-FPGA-Timekeeper ON BASYS3

Github: https://github.com/dhanush-271/ChronoFlex-Adaptive-FPGA-Timekeeper_Basys3

KOTHAPALLI DHANUSH

1.INTRODUCTION

This project entails the design and implementation of a digital watch on a Basys3 board using Verilog. The watch operates in multiple modes: Real-Time Clock (RTC), Edit Mode, Timer Mode, Stopwatch Mode, and Alarm Mode. Additionally, it features a date-setting and display capability.

The RTC mode displays the current time in a 24-hour format, updating seconds, minutes, and hours in real-time. Edit mode allows users to set both the time and date manually. Timer mode acts as a countdown feature, where users can configure a target duration and monitor the countdown. Stopwatch mode allows the user to measure elapsed time with start/stop and reset control. Alarm mode enables users to set an alert time; a buzzer notifies the user when the real-time clock matches the alarm setting. Lastly, the date feature provides support for viewing and setting the current date, which is accessible via a long press in RTC mode.

The following sections provide a detailed overview of the functionality and implementation of the digital watch.

2.STATES OF OPERATION

The design is composed of six states:

2.1 Real-Time Clock (RTC):

This state functions as a standard clock, displaying the current time in a 24-hour format. The time is updated every second, incrementing the seconds, minutes, and hours accordingly. This mode is the default mode of the watch.

2.2 Edit Mode:

In this state, users can manually set the time. The edit_shift input allows users to switch between setting hours and minutes, and the inc input increments the selected value. The display shows the current selection by blinking the digits being edited. Additionally, the user can also set the date when edit_place is in states 2 or 3. The date includes day and month values and can be edited in a similar fashion to the clock time.

2.3 Timer Mode:

The timer state enables the watch to function as a countdown timer. Users can set the duration using edit_shift and inc inputs. The start_stop input starts or stops the countdown. The display updates to show the remaining time. The maximum duration that can be set is 59 minutes and 59 seconds.

2.4 Stopwatch Mode:

Stopwatch mode is activated after the timer mode. It provides basic stopwatch functionality. When in this mode, pressing the start_stop button begins or pauses the stopwatch. The stopwatch tracks time from 00:00 up to 59:59 and resets when the reset button is pressed. This mode is useful for time tracking without needing to preset any values.

2.5 Alarm Mode:

The alarm mode follows the stopwatch mode. In this mode, users can turn the alarm on or off, and set the alarm time during the stop state using the edit controls. When the current time matches the set alarm time, LED is turned on to simulate a buzzer. The alarm (LED) can be turned off using the start_stop button. This adds practical utility to the watch, allowing the user to be notified at a set time even without an actual audio buzzer.

2.6 Date Display Feature:

Although not a separate mode, the date is a key feature of the watch. Users can long-press the inc button in RTC mode to view the current date on the display. The date includes day and month, and can be set in the edit mode when the edit_place signal is in states 2 or 3. This integration makes the watch more comprehensive as a timekeeping device.

3.CONSTRAINTS OF THE BOARD

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3.1 Push Buttons

reset: Resets all time values (hours, minutes, seconds) to 0 in the edit mode, resets the countdown in timer mode, and resets stopwatch time in stopwatch mode.
mode: Cycles through clock, edit, timer, stopwatch, and alarm states.
edit_shift: Toggles editing position (hours/minutes) in edit mode and (minutes/seconds) in timer mode. Also used in alarm mode and for date configuration.
inc: Increments selected time unit (hours/minutes) in edit mode and (minutes/seconds) in timer mode. Also used for date and alarm time configuration. In RTC mode, long press displays the current date.
start_stop: Starts or stops the countdown in timer mode, starts or pauses the stopwatch in stopwatch mode, and stops the buzzer in alarm mode once triggered.

3.2 LEDs

mode_value: Displays the current mode on the seven-segment display using mode_value[2:0], encoding the active state.

buzzer_led: Acts as a visual alert in alarm mode. When the current time matches the set alarm time, this LED is turned on. It remains lit until the start_stop button is pressed or until the end of that minute, simulating a buzzer.

3.3 Seven-Segment Display

Clock Mode: Displays the current hours and minutes. On long-pressing the inc button, switches to show the current date (day and month).

Edit Mode: Shows hours and minutes or date (day/month), with blinking digits indicating the active field for editing.

Timer Mode: Displays minutes and seconds. It operates based on the timer start/stop state, allowing editing with increment and edit_place inputs in the stop state.

Stopwatch Mode: Displays elapsed time in minutes and seconds. Time increases once start_stop is pressed, and resets with reset.

Alarm Mode: Shows the set alarm time (hours and minutes). Time can be edited in stop state. When current time matches the alarm time, the buzzer_led is activated and can be turned off with the start_stop button.

4.OUTPUT ON THE BASYS BOARD

Drive_link:

https://drive.google.com/file/d/1fSnPEZKsoybbPT9YLK6JAlKtDaetjgsl/view?usp=sharing