

Laboratory Assignment #6

Objectives

The objective of this lab is to leverage intellectual property you have previously developed to implement a talking clock with an embedded processor system in an FPGA. Your design will “run” on the Spartan-3E Starter Kit board. The clock is based on a vintage talking clock called the “Vox Clock” which was available from Radio Shack. Although you are required to follow the design specifications, you are encouraged to be as creative as possible to differentiate your design from that of others and improve your grade relative to your peers.

In the simplest implementation, the hardware work may be minimal – as easy as integrating your functional hardware results from previous lab assignments. The main task is then one of software – to write software in PicoBlaze assembly to implement the desired behavior.

This is a group project; the instructor will assign groups. Each group is responsible for a single clock implementation. Groups are allowed to use modules from any and all group members to complete this assignment. The development effort should be partitioned to allow group members to work in parallel, where possible.

When you successfully complete this lab, you will have completed a substantial synchronous digital system design which you might consider a small system on a chip.

Clock Specification (Courtesy of RadioShack)

Micronta VOX Clock 2
(630-0903)

Operation

Faxback Doc. # 48837

Operation Modes

The clock has four operation modes. Each time the [MODE] key is pressed, the operation mode advances in the following order:

- (Normal Mode)
- (Countdown Timer Mode) - Chime, "minutes" to announce the countdown time
- (Alarm Time Set Mode) - "Pip, pip, pip..." Continuous long tones
- (Time Set Mode) - "Pi, pi, pi, pi" (four short tones)

After setting the time, the present time will be announced.

Setting the Time

Select the time set mode by pressing the [MODE] key.

Each time the HOUR key is pressed, the hour advances by one hour, and the Clock announces it. To change the hour from two to four, for example, push HOUR twice; you will hear the hour announcements "three" and "four". Release HOUR when the voice announces the correct hour.

NOTE: As soon as you press the HOUR key, the Clock stops counting, and the minutes and the seconds are reset to 0. If the MIN key is pressed before the HOUR key, the Clock will stop counting and seconds will be reset to 0.

Each time you set the minute key, the minute advances by one minute. To advance in an increment of 10 minutes at a time, press and hold MIN key.

Adjust the Clock one minute ahead of the actual time and release the key. Press the [MODE] key to return to normal mode. As soon as the [MODE] key is pressed, the Clock starts counting.

Press the talk key to check or confirm the time set.

NOTE: When the Clock goes into the time set mode, the pip sounds at one second intervals until you press a key. Unless you make another entry within five seconds, the pip sound starts again. If one minute elapses before a key is pressed, the Clock automatically returns to the normal mode and starts counting time.

Zero Second Adjustment

You can easily adjust the second count to zero. Set the Clock to the time set mode. Then press the talk key without operating HOUR or MIN. The second is set to 0 without minute advance, and the Clock returns to normal mode.

NOTE: When the Clock is announcing the pre-alarm or alarm time, press the talk key once to interrupt the announcement, and then press it again to reset the second count.

Setting the Alarm

Select the alarm set mode. Set the alarm time in the same manner as you set the time. Press the HOUR and/or MIN until you get the hour and/or minute you want the alarm announcement to be made.

Pressing either HOUR or MIN key will automatically set the alarm function on. Use the talk key to check/confirm the alarm time set. Press [MODE] twice to return the Clock to normal mode. This will happen automatically after one minute if no other key is pressed. The alarm will be announced in any mode, except when you are setting the time (and the clock count is stopped).

The MIN key turns the alarm function on or off in the normal mode and during the timer operation. When you set the alarm on, the pre-set alarm time will be announced. When you set it to off, two short tones will be heard.

Five minutes before the alarm time, a chime sounds followed by the words "five minutes to xxxxx". At the alarm time the chime sounds again, followed by "It's now xxxxx" and a melody, which plays for 12 seconds.

To stop the alarm announcement, press the talk key.

The alarm will sound at the same time every day unless you change the alarm time or turn the alarm function off.

Countdown Timer Operation

Select the timer mode. Use the HOUR and MIN keys to set or change the countdown time. You can pre-set up to 12 hours and 59 minutes. To start the timer, press the talk key.

After the start of the countdown, the Clock announces the remaining time every 10 minutes, then every minute when less than 10 minutes remain until the pre-set time.

You can press the talk key anytime to confirm the remaining time. At the pre-set time, you will hear two chimes and the words 'time is up'. The Clock then returns to normal mode if you press no other keys after the time stops.

On-The-Hour Announcement

Press the HOUR key in the normal mode or during the timer operation to toggle an on-the-hour time announcement on and off. When set to on, you will hear a longer sound. When set to off, you will hear a short tone.

The announcement will be made every hour on the hour when set to on.

The Clock does not make the on-the-hour announcement in the time set or alarm set modes.

Priority of Announcements

Your Voice Clock observes the following hierarchy in its announcements (in case you have set several announcements for the same time):

- 1) Alarm time announcement (automatic)
- 2) Pre-alarm announcement (automatic)
- 3) Time-up announcement (automatic)
- 4) Countdown timer pre-announcement (automatic)
- 5) Countdown timer announcement (manual)
- 6) Operation (manual) Time set, on-the-hour announcement on/off, alarm on/off, MODE key operations, etc.
- 7) Present time announcement (manual)

Project Proposal

The group must generate and submit a short project proposal in PowerPoint. The purpose of this proposal is to document your plans for the instructor and to illustrate that you have an initial concept of how you might implement the clock. You should also include a rough work breakdown and task assignments, so that it is clear “who is doing what” for this project. Once your project is approved by the instructor, you should begin implementation in earnest.

Free Advice

Do not delay; start implementing immediately. You must implement the baseline features described in the clock specification. Try to differentiate your implementation for a better score.

The first thing the team should do is integrate all the necessary hardware components and verify that PicoBlaze can control them properly. Write multiple, simple test programs to exercise each hardware component of the system. You are not required to submit these, but you will be asked to provide them if you ask for assistance debugging some aspect of your design and the correctness of the hardware is called into question. Use the switches, LEDs, and LCD display as tools for debugging.

With known good hardware, the project then becomes a matter of software...

Laboratory Hand-In Requirements

This lab requires a group proposal to be submitted before work is started. The proposal need not look professional, but must communicate relevant project information. The proposal must be submitted in a

single electronic file. Use of Microsoft PowerPoint is required. The only acceptable file format for submission is PPT (not PPS, and not PDF). Paper submissions are not accepted.

This lab also requires a group presentation. The presentation must be submitted as a professional-looking document in a single electronic file. Use of Microsoft PowerPoint is required. The only acceptable file format for submission is PPT (not PPS, and not PDF). Paper submissions are not accepted. You will need overhead transparencies for presentation in class unless you have access to your own projector. The body of the presentation must be written in English and contain the following sections:

- Title page containing group number, student names, the lab title, and the date.
- Introduction containing a brief summary of the problem the group set out to solve and your final results. Please include a table or chart that shows each group member's initial work assignment and some measure of how much was completed.
- Design details documenting how the group achieved the final result. This is the most important part of the lab presentation. Illustrate understanding of the project and explain how it was implemented.
- Final results. Include information such as maximum frequency, resource usage, etc...
- Conclusion containing a brief summary and constructive criticism of the lab.

The presentation should be no more than eight pages, total. Budget four pages for the design detail and then one page for each of the other sections outlined above. The goal is to have a presentation that lasts about twelve minutes. Do not include project source code listings in the presentation. Do not waste valuable "presentation space" reproducing information that the audience already knows. For example, regurgitating information about previous lab assignments is a waste of space because everyone already knows what they were. Try to avoid huge "paragraphs" of text, keep it short and simple and use graphics where appropriate to illustrate.

Once your group has completed a working design and created a presentation, prepare for the presentation and demonstration process. During the scheduled final exam time, all groups will give their presentations. Following the presentations, all groups will exhibit their hardware, and the class as a whole will rotate through the room to evaluate.

Prior to the scheduled final exam time, your group must submit the entire project directory and presentation in the form of a compressed ZIP archive. The presentation must be in the project directory with the file name l6_group#.ppt. Use WinZIP to archive the entire project directory, and name the archive l6_group#.zip. For example, if I were responsible for group three, the submission name would be l7_group3.zip and contain l7_group3.ppt. Then email the archive to the instructor. Only WinZIP archives will be accepted.

No late submissions are accepted. You are advised to submit your archive well in advance of the scheduled final exam time. If your circuit is not completely functional, you should write a presentation documenting what you have accomplished and demonstrate what you have implemented to receive partial credit.