HW/SW Co-Design
Lab3_Scoreboard Assignment
Solution 2

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1 INTRODUCTION

This report gives a brief introduction how to used hardware-software co-design to implement basketball scoreboard with Digilent Nexys 3 board.

In our design, we've build a Microblaze-based hardware platform with adding some Xilinx standard IP cores (including TFT, PS2, and Timer, etc.) to implement the scoreboard's deign based on FIBA Basketball rules.

- ❖ **The main hardware components used are as blow:**
  - o PS2 Keyboard and a USB cable
  - o VGA Monitor and a cable
  - o Digilent Nexys 3 Board and Digilent USB cable (for download and debug)
- ❖ **Some key IP Cores used in the design**
  - o XPS PS2 Interface   v1.01.b
  - o XPS Timer/Counter   v1.02.a
  - o XPS TFT   v2.01.a
  - o XPS Interrupt Controller   v2.01.a

Figure 1. Shows the hardware components interconnection diagram. Figure 2. Shows the graphic user interface on the VGA monitor.
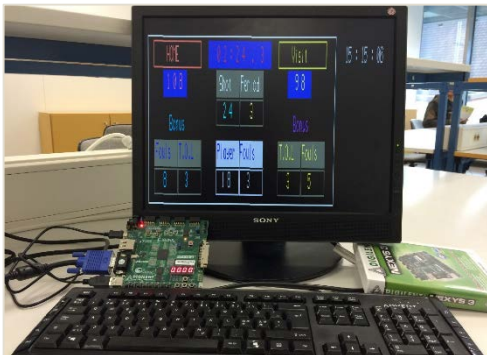

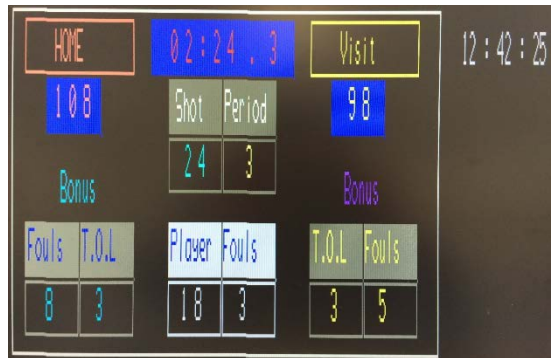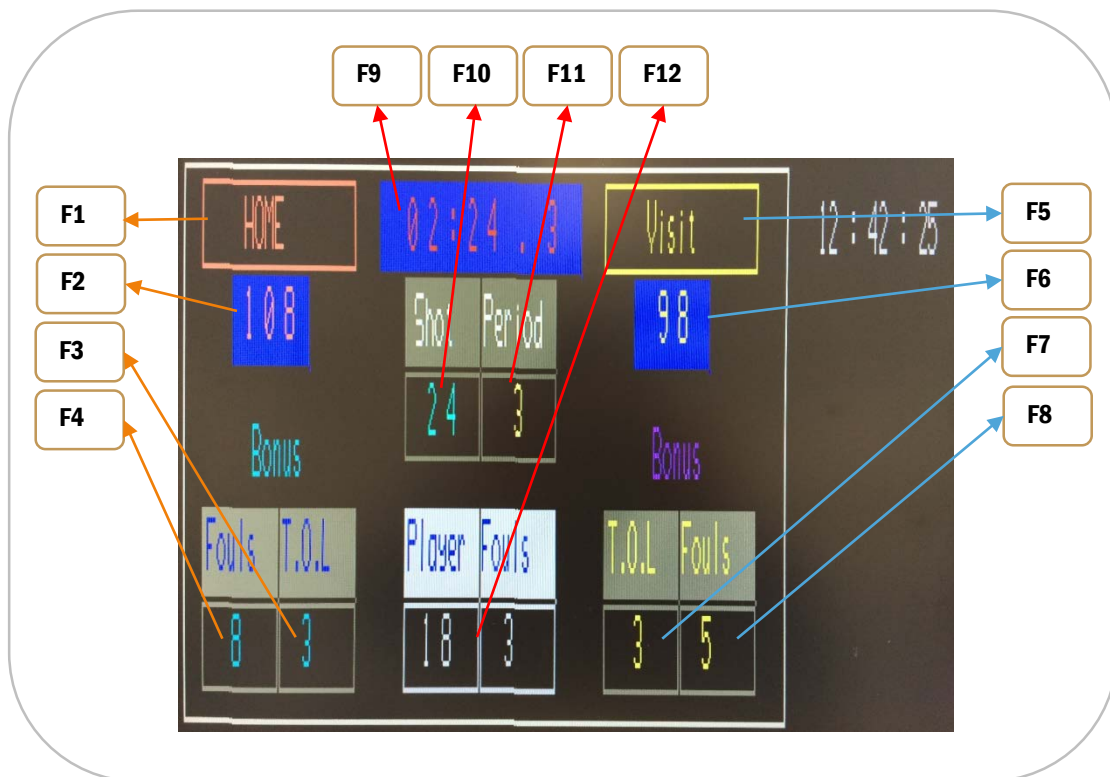Figure 1. Hardware components interface diagram

Figure 2. Graphic User Interface on VGA (640 x

- ❖ **The main software tools we used as below:**
  - o Xilinx Platform Studio version 14.7 (EDK_P.20131013) NT64
  - o Xilinx SDK version 14.7 (SDK_P.20131013).

2 BASIC USER GUILD

1) Keyboard function layout description

Opt keys for home team

Opt keys for visit team

Opt keys for others

Number and letter keys for general input

Operation confirm/finish

Game /shot clocks start/stop/pulse/resume etc.
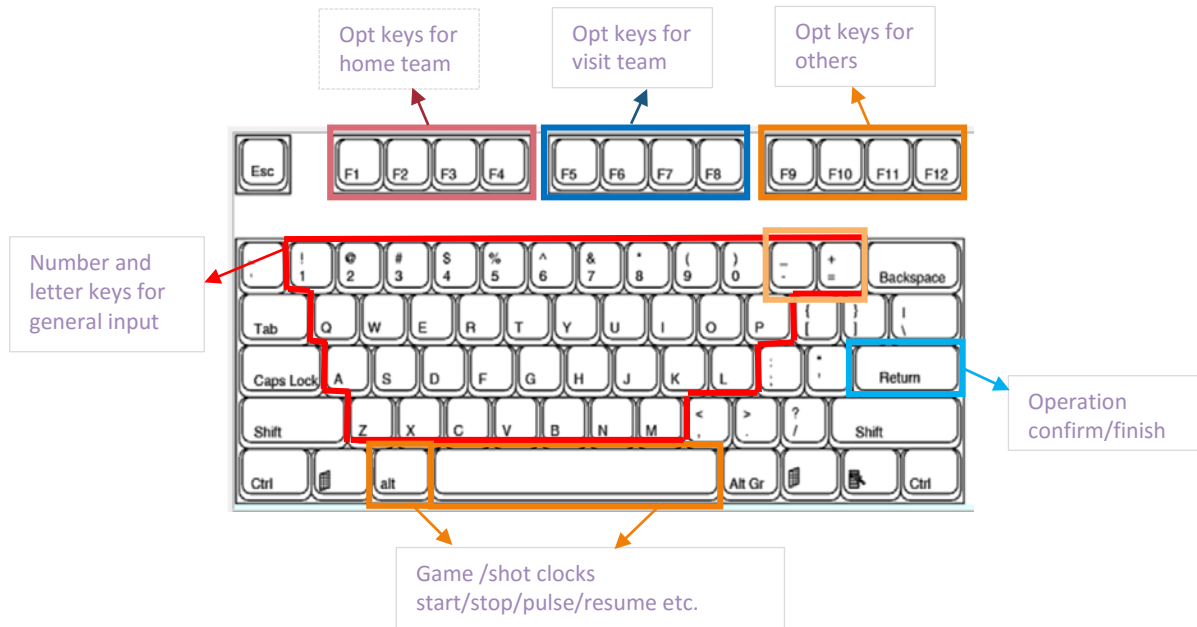
2) Operations for Home Team

Key	Function	Description	Example
F1	Setup the **name** of home team	First press F1, then following press up to 6 letters and finally press Enter to confirm the input to change the name of home team	If you want to set the home team name to "China", ✓ First press F1 ✓ Then press 'C' 'H' 'I' 'N' 'A' continuously ✓ Finally press Enter If you input wrong letter, want correct it, you can re-press F1 then do it again.
F2	Change the **score** of home team	First press F2, then press 1 or 2 or 3, then the score the home team will be increased by 1 or 2 or 3 accordingly. If press '-', the score will be decreased by 1 for each press. After finish the changes, press Enter or any other F# keys or Esc to quit the operation. Note that the score range from 0 to 199.	If you want to increase the score of home team by 3 ✓ First press F2 ✓ Then press 3 or press 1 then 2 or 2 then 1 or repeated press 1 for 3 times. ✓ Finally press Enter If you make a mistake to over increase the score, you can press '-' to decrease it many times to correct number, then finally press Enter.
F3	Change **T.O.L** of home team	First press F3, then press key '+' to increase 1 by each press or press key '-' to decrease 1 every time. Press Enter or other F# keys or Esc to quit the operation. Notes that T.O.L range for period 1&2 is from 0 to 2, for period 3&4 is from 0 to 3.	If you want add one T.O.L for the home team, ✓ First press F3, ✓ Then press '+', ✓ Finally press Enter or any other F# keys to close the operation.
F4	Change **Fouls** of home team	First press F4, then press key '+' to increase 1 by each press or press key '-' to decrease 1 every time. Press Enter or other F# keys or Esc to quit the operation.	If you want add one Fouls for the home team, ✓ First press F4, ✓ Then press '+', ✓ Finally press Enter or Esc or any other F# keys to close the operation.

3) Operations for Visit Team

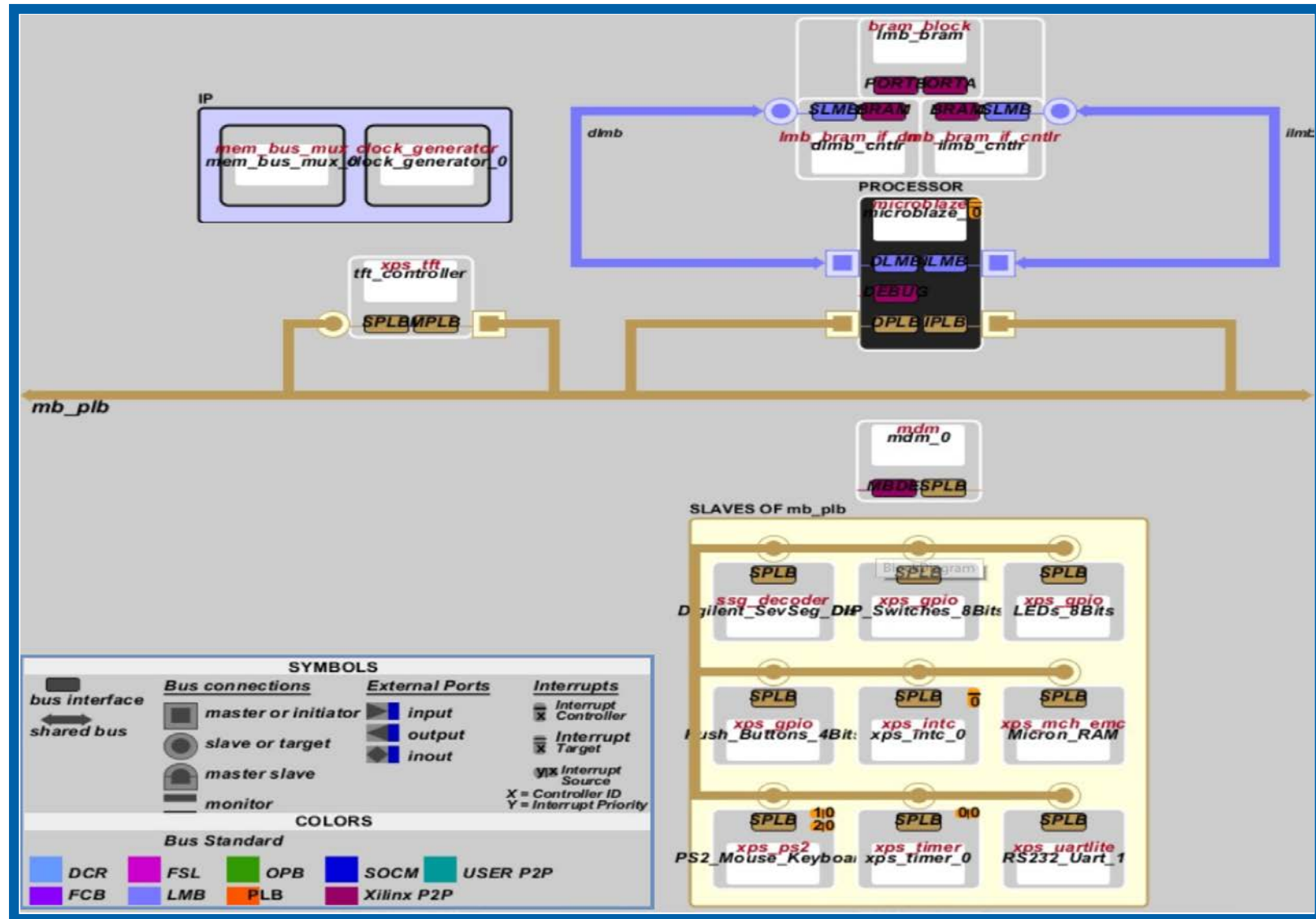| Key	Function	Description	Example
F5	Setup the **name** of visit team	Operation process is the same with F1	Refer to F1's example
F6	Change the **score** of visit team	Operation process is the same with F2	Refer to F2's example
F7	Change **T.O.L** of visit team	Operation process is the same with F3	Refer to F3's example
F8	Change **Fouls** of visit team	Operation process is the same with F4	Refer to F4's example

4) Game Operation Keys

Key	Function	Description	Example
F9	Setup **Game clock**	Can set 5 types of game timers 1. 20 Min before game start 2. 15 Min Half-time interval 3. 10 Min each period 4. 5 Min each extra period 5. 2 Min first and second half	✓ First press 9 ✓ Then press different number key of '1' or '2' or '3' or '4' or '5' to select one from 5 types of game timers. ✓ Then press enter or other F#
F10	Set **Shot clock**	Can set 3 types of time out. 6. 60-0 sec time-out 7. 24-0 sec control time 8. 14-0 sec re-control time	✓ First press F10, ✓ Then press different number key of '1' or '2' or '3' to select one from 3 types of time-out ✓ Then enter or other F#
F11	Change **Period**	Set period number from 0,1,2,3,4 to E	Frist press F11, Then press + or – to increase or decrease period, if it is greater than 4, will display 'E'
F12	Change **Player & Fouls**	Used to set player's number, and his fouls	✓ First press F12, ✓ Then input 3 numbers (the first 2 numbers stand for the player's number, the last number stands for his fouls) ✓ Finally press enter or other F# key to quite
Space	Start/Pause/Resume	Used to start, pause or resume game timer	If the game timer no equal to 0, first press, will kick off the timer, second press, will pause it, then resume …
Alt	Start/Pause/Resume	Used to start, pause or resume shot clock	If the shot clock no equal to 0, first press, will kick off the timer, second press, will pause it, then resume …

5) Common associative Keys

Key	Function	Description	Example
Enter	Confirm and finish on-going operation	Used to confirm number inputs or finish the on-going F# operation.	Refer to these examples of F1~F12
' + '	Increase 1 for every press in on-going operation	Used to increase 1 by each press during on-going F# operation to change sores, fouls, or T.O.L data.	Refer to these examples of F2, F3, F4, and so on
' - '	Decrease 1 for every press in on-going operation	Used to increase 1 by each press during on-going F# operation to change sores, fouls, or T.O.L data.	Refer to these examples of F2, F3, F4, and so on

4   SOFTWARE ARCHITECTURE

Will provide if needed in future.

5   PROBLEMS

No.	Description	Solutions
1	VGA display should be on 640 x 480 resolution, but it displays repeated rows.	Tried many different methods but not resolved yet. Some same cases online and potential solutions suggested: https://forum.digilentinc.com/topic/1188-nexys3-vga-output/#comment-4050 https://forums.xilinx.com/t5/Embedded-Development-Tools/xps-tft-problem-VGA-displays-repeated-rows/td-p/164338
2	XPS 14.7 NT64 always collapse on Win10 when you try to create a new project	Resolved: By first using NT32 version to create the project files and folder, then switch to NT64 version again (after close NT32 version) to open the new created project by the click the recent project in the menu.
3	A few game rules have not been implemented yet	We will implement them in future.

6   APPENDIX

1. Hardware design files

2. Software source code

7   REFERENCE

[1] XST User Guide for Virtex-6, Spartan-6, and 7 Series Devices.
   https://drive.google.com/file/d/0B4tlwM6TYaj3Mzh3dXhKbXdQZkU/view?usp=sharing
[2] Creating a Custom Peripheral and adding it to a Microblaze Embedded System
[3] Building an Embedded Processor System on Xilinx Nexys3 FPGA: A Tutorial