**EE 316 Computer Engineering Junior Lab (Spring 2023)**

**Design Project 1**

* **Specification:** SRAM basedProgrammable Counter
* **Lab Demonstration Due Date:** January 31, 2023
* **Written Report Due Date:** February 2, 2023

**Parts List:**

1. Altera DE2-115 Board
2. A breadboard and five 5K resistors
3. A 19-Key Keypad

Design a SRAM based "programmable 8-bit counter of arbitrary sequence" that runs on a one Hz clock. Note that the DE2-115 board has a 2 Mbyte (1M x 16) of fast asynchronous SRAM.

The SRAM address is 18-bit long (needed for 256K memory locations of 16-bit wide). Theoretically, the arbitrary counter sequence (of 16-bit) can be 256K long. However, since we do not have time to manually "program" the counter, we will restrict to a length to 256. In other words, the project will use memory addresses from 0x00000 to 0x0000F. Additionally, we can choose =0 or 1 and =1 or 0 to write/read to upper or lower bytes, respectively. For simplicity we will refer to the address as from 0x00 to 0xFF with the understanding that the rest of the higher order address bits are always 0s.

Note: we will refer to the six 7-segment displays on the DE2 board by the names: HEX5 to HEX0. (See documentations on the DE2 system CDROM in the box or in Moodle).

Other specifications are the following:

* System will use a power-on reset to initialize the content of the SRAM by loading a default data sequence from a 1-Port ROM. The 256 x 16 bit ROM will be built using Quartus II’s Megawizard plug-in Manager and a memory initialization file “sine.mif” (posted on Moodle). The counter should also use a reset button (KEY0) to reload the default sequence into the SRAM.
* The counter can be programmed manually using a keypad attached to the DE2 board via the 40 pin ribbon cable and a bread board.
* When the design in downloaded in the Cyclone IV FPGA, the counter will be in the operation mode and the 7-seg displays (HEX3-HEX0) will show the contents of the SRAM at address 0x00. The address will be displayed on HEX5 & HEX4.
* The "shift-key" on the keypad is used to toggle between (a) the programming mode and (b) the operation mode. In mode (a), the LED named LEDG0, on the DE2 board, will be “off”. In mode (b), LEDG0 will be “on” indicating the counter is in the “operation” mode.
* If the counter is not programmed and in the operation mode, the counter cycles through the addresses of the SRAM in the forward direction and displays the default contents of the SRAM at one second interval.
* When the counter is in the programming mode, the “H” key is used to toggle between two modes: (1) SRAM address setup mode and (2) SRAM data mode.
* In the SRAM address setup mode, when any of the numbers between 0-9 and A-F is pressed on the keypad, HEX4 will display its HEX value. If the second such key is pressed, the digit occupying HEX4 location will move to HEX5 location and the new value will be shown at HEX4. The 8-bit number represents an SRAM address.
* In the data mode, when any of the numbers between 0-9 and A-F is pressed on the keypad the right most 7-segment display HEX0 will display its HEX value. If the second such key is pressed, the digit occupying HEX0 location will move to HEX1 location and the new value will be shown at HEX0. If the third and the forth key press with shift the display to the left until HEX3 through HEX0 will show a 16-bit binary number. This number will be used as a data that will be loaded into the SRAM.
* In the programming mode, when the "L" key is pressed (once), the 4 digit HEX data displayed on HEX3 down to HEX0 will be loaded in to the SRAM memory address location displayed on HEX5 – HEX4.
* When the SRAM data modification is done, a shift-key press will toggle to the operation mode. The 7-seg displays (HEX3- HEX0) will show the 16-bit content of the SRAM memory at address location 0X00 of which will be displayed on HEX5 - HEX4.
* The counter will begin counting only when the "H" key is pressed. During this time, HEX5 – HEX4 will cycle through the address locations from 0X00 to 0XFF and the contents of the SRAM will be shown on HEX3- HEX0. Pressing the H key in the operation mode will enable and disable the counter.
* In the “operation” mode, the key “L” can be used to toggle the direction of the counter, between the forward and the backward directions.

**Teams:**

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| --- | --- | --- | --- | --- | --- | --- |
| **Team 1** | **Team 2** | **Team 3** | **Team 4** | **Team 5** | **Team 6** | **Writer** |
| Kubicka | LaBlue | Morris | Skinner | Ernesto | Mathew |  |
| Graham | Pamela | Cameron | Shawn | Kaili | Isabelle |  |
| Jacob | Nelson | Nathan | Zander | Keith | Ella |  |

Report: You should investigate if the parts used in this project are [RoHS](https://www.rohsguide.com/) compliant.