Name: _____ ID# _____

Date Submitted: _____ Lab Section # _____

CSE 2441 – Introduction to Digital Logic Fall Semester 2014

Lab Number 7 – Counters and Displays

100 Points

(To be performed October 23-24, 2014)

CSE 2441 **LABORATORY SESSION 7** **Fall 2014**

COUNTERS & DISPLAYS

(100 POINTS)

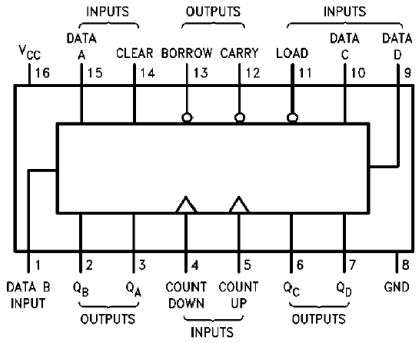
PURPOSE and OUTCOME – To give you experience using a basic binary up/down counter, such as the SN74193, as a component in program counters and accumulators. Once you've successfully completed this exercise, you will have demonstrated the knowledge and skills necessary to design such applications. You will also learn how to display digits on the DE1's seven-segment displays. **You have the option of using ICs in your display decoder designs or using Verilog.**

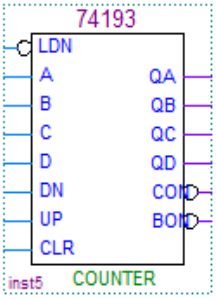
BACKGROUND

Three ICs will be introduced in this exercise – the SN74193, the SN7447, and the SN74185. Each is summarized below. For more detail, refer to a TTL data book or find their datasheets online.

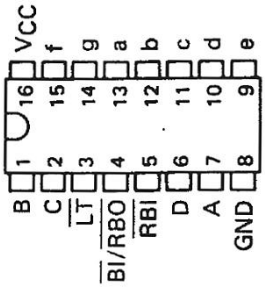
An ***SN74193*** is a four-bit binary up/down counter with the pin-out diagrams shown below. The device counts *up* on the positive edge of a signal applied to the COUNT-UP pin when COUNT-DOWN = logic-1 and counts *down* on the positive edge of a signal applied to the COUNT-DOWN pin when COUNT-UP = logic-1. Another feature of the 74193 is that it can be loaded with 0000 by applying logic-1 to the CLEAR pin. The counter can be loaded with any four-bit binary number by applying the number to the INPUT pins, D,C,B,A, and then applying logic-0 to the LOAD pin. The count value is displayed on pins Q_D, Q_C, Q_B, Q_A. CARRY and BORROW outputs are also available but will not be used in this exercise.

Connection Diagram

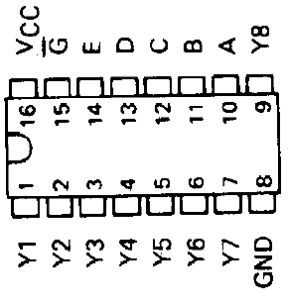




An ***SN7447*** is a BCD to 7-segment decoder with active-low outputs. So input patterns 0000 (0) through 1001 (9) will produce a 7-segment code for displaying the corresponding decimal digit on a common-anode 7-segment display. Input patterns 1010 through 1111 do not represent decimal digits and will produce outputs that are typically not meangingful.



An ***SN74185*** is an integrated circuit for converting unsigned binary numbers to BCD numbers. A single 74185 can be used to convert binary numbers up to six-bits long. Multiple chips can be used for converting larger numbers. Once a number is in BCD form, BCD to seven-segment decoders can be used to drive seven-segment displays. So SN74185s can be used in conjunction with SN7447s to implement binary to seven-segment decoders.



The Program Counter (PC) and the Accumulator (AC) are components of the TRISC processor and will be designed, implemented, and tested in this laboratory. The function of the PC is to hold the memory address where the next instruction to be fetched is stored. The AC functions to hold operands and results of arithmetic/logic operations performed by the arithmetic/logic unit (ALU). An SN74193 can be used in the design of each component.

PRELAB ASSIGNMENT

1. Design a circuit that realizes a four-bit binary up counter using an SN74193 and displays the count on a single DE1 7-segment display (HEX0) on the DE1. **You may use SN7447 and SN74185 ICs for your display decoder or you may write a Verilog model.**
2. Redesign your output circuit from part 1 to display the count in two decimal digits using two 7-segment displays (HEX1 and HEX0) on the DE1. **Again you may use SN7447 and SN74185 ICs or you may write a Verilog model for the decoder.**

LAB ASSIGNMENT

1. Realize your Up Counter with single-digit display on the DE1/Cyclone II and demonstrate that it can count from 0000 through 1111 and back to 0000. Record both the single-digit output results. Use the following pin assignments.

   Count $\rightarrow$ Key1
   Clear $\rightarrow$ Key0
   Count3out .. Count0out $\rightarrow$ HEX1 .. HEX0

2. Repeat 1 for the two-digit display version.