Assignment 1A (20 marks) – Lab Week Two (Due: End of your week three's lab period).

Note: You SHOULD be able to complete this by the end of your week TWO's lab period, and I highly recommend that you do so to keep pace with the course lab material.

I advise against upgrading Multisim 13.

A Tutorial Quick Start with Multisim 13

This lab exercise leads you through the circuit design flow in Multisim 13, from schematic capture to simulation. You will design and test a circuit that counts the occurrences of a clock signal on a simple digital counter. This lab work constitutes 20% of Assignment One's overall mark. It is advisable to read the entire lab before commencing it and that you view the on-line video that illustrates the required behaviour of your solution to this lab assignment.

Note: Ensure that you can print from your computer to the printer in the lab, as a printout of your completed schematic capture must be submitted as part of the lab requirements. The instructions for setting up the printer are in the Assignments folder.

PURPOSE OF LAB:

The purpose of this lab exercise is to become familiar with Multisim 13, which we will be extensively using in this course.

MSM13 Directory Structure

Create a folder on one of your hard drives or flash drives called CST8216. Then create a subfolder called Lab2.

Schematic Capture

Save your work OFTEN!

In this section, you will place and wire the components in the circuit shown in Figure 1 below.

After you complete this lab assignment, your schematic capture should look VERY close to the one depicted here.

In fact, you will be assessed on the completeness, neatness and placement of all components, including Student Information.

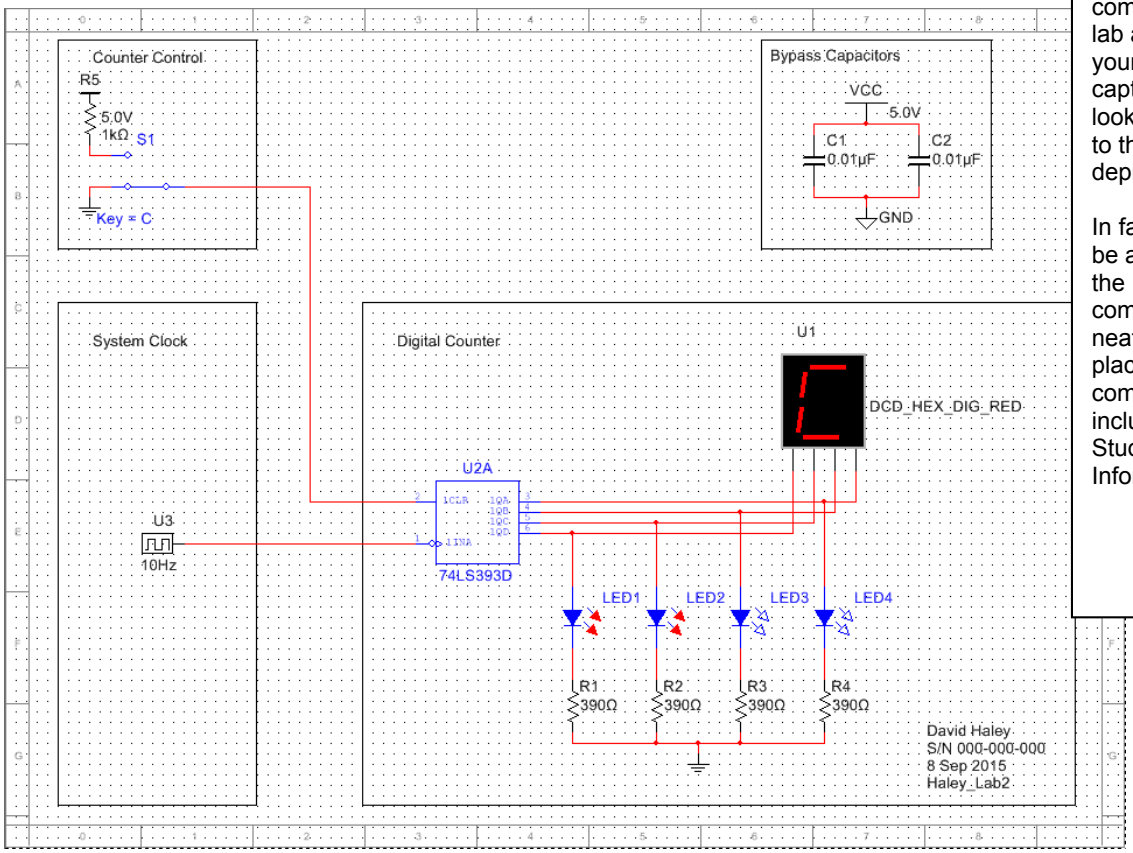


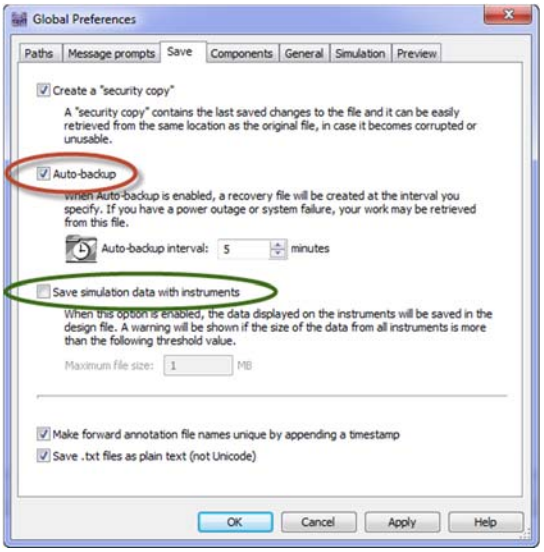
Figure 1. Digital Counter System

Saving the File

When you first launch Multisim, the program opens a blank file on the workspace called “Design1”.

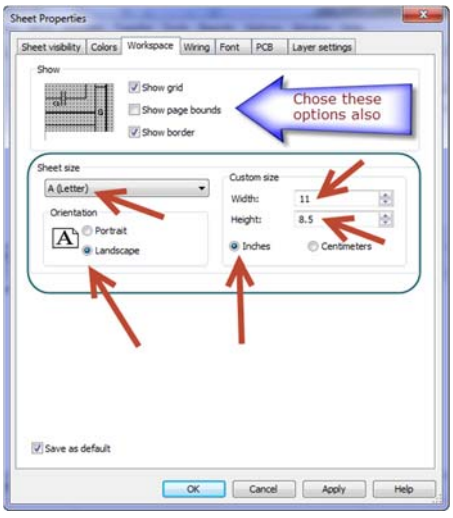
To save the default file with a new name:
Select File/Save to display a standard Windows Save dialog.
Navigate to your CST8216\Lab2 folder, and enter **<your last name> + "_Lab2"** as the filename, and click on the Save button – i.e. **Haley_Lab2**.

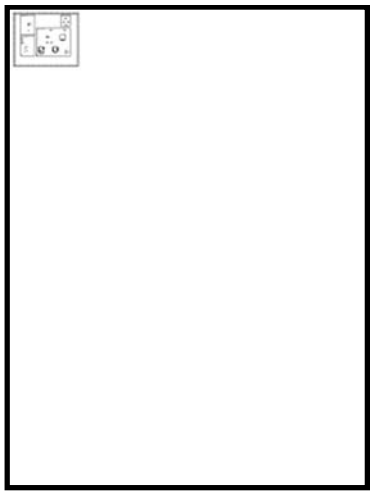
To guard against accidental loss of data, you can set up a timed auto-backup and a "Security Copy" of the file. Use the menu item ***Options → Global Preferences -> Save*** tab to do so. At the same time, you are selecting ***Auto-backup***, deselect ***Save simulation data with instruments*** as we will not use this feature in this course.



Setting the Correct Sheet Properties

In order to ensure that your schematic capture will correctly print on 8 ½” x 11” in as a full-sized Landscape document, check the Sheet Properties using menu item **Options → Sheet Properties → Workspace→ Sheet Size t**o ensure that the following settings have been selected; otherwise, you may end only being able to print a unreadable, microscopic version of your schematic capture like example below. At this time, chose the other indicated options as well.





Placing the Components – Digital Counter Section

We will now build our schematic capture by placing the components on the blank schematic capture worksheet.

From the menu select **Place→Component** to display the **Select a Component** browser, navigate to the DCD_HEX_DIG_RED 7 segment display shown in Figure 2 below and click OK.

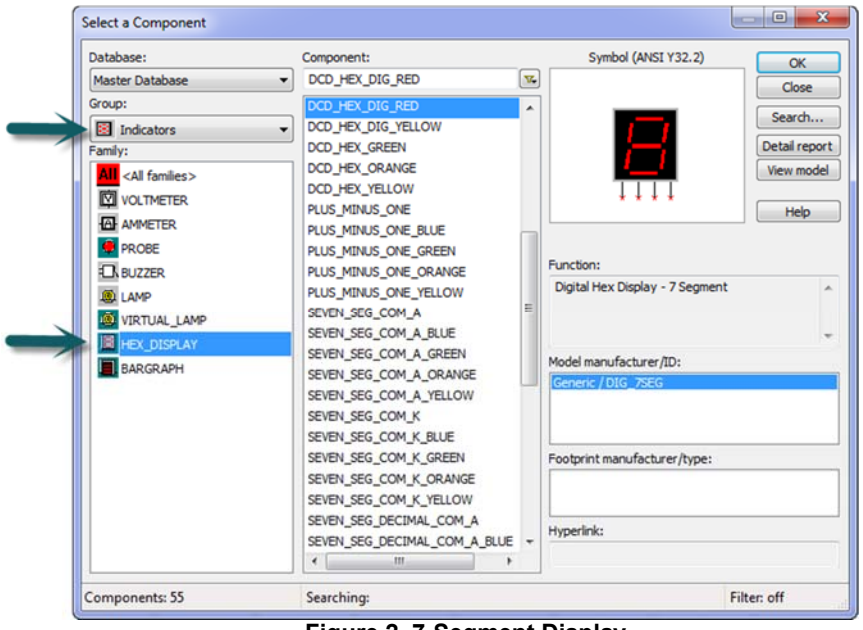
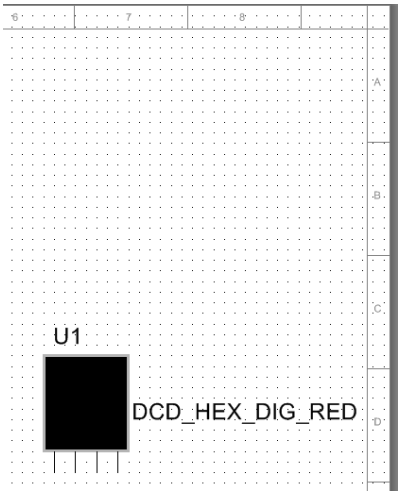
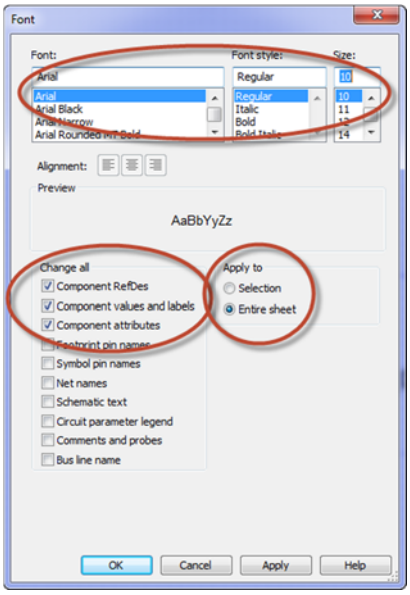


Figure 2. 7-Segment Display

The component appears as a “ghost” on the cursor. Note that this 7 segment display is unique because it decodes and displays values (hence DCD). More on this later in the course!

Moving your cursor, place the component in the position noted on the previous page (and magnified here), then left-click to place the component. Since the font size is a bit too large, right-click on the component and then set up the font to Arial, Regular, 10. At the same time, complete the configuration as per the circled values in the dialogue box.





Now, place the remaining components in the Digital Counter area as shown in Figure 33 on the next page, noting that the paragraphs ***immediately following*** that Figure 4 on the next page contain detailed instructions on how to locate the required components in the component database.

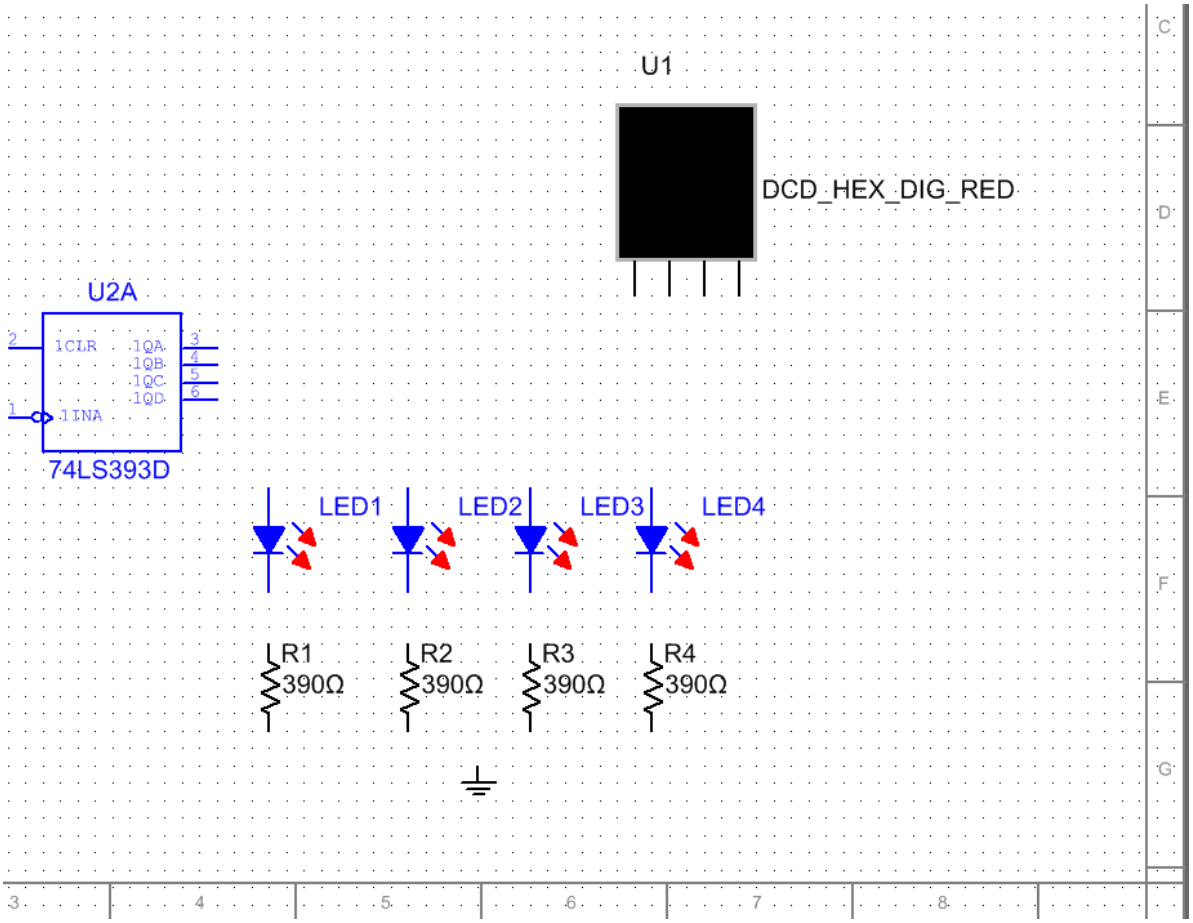


Figure 3. Digital Counter Components Layout

Locating the Components

The various components for the Digital Counter can be found by searching in the database as illustrated in the following figures.

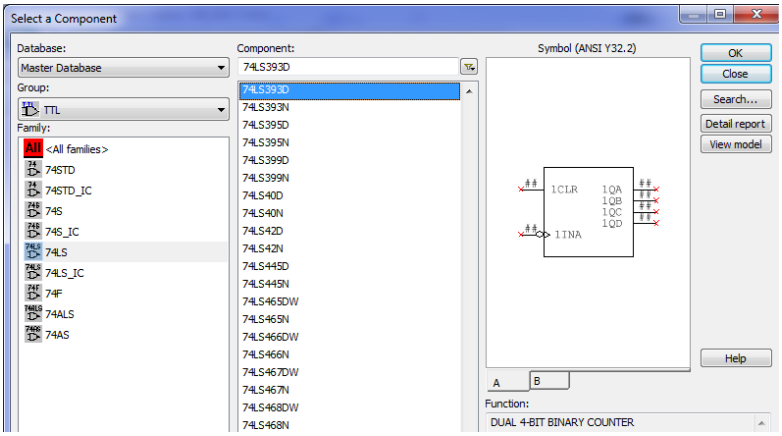


Figure 4. 74LS393D Dual 4-Bit Binary Counter

When you click OK to select the Dual 4-Bit Binary Counter, the following selection box appears. Since we only require one counter, click on **A** and place the counter on the schematic capture.

Once you have done that, click cancel when the following selection box appears.

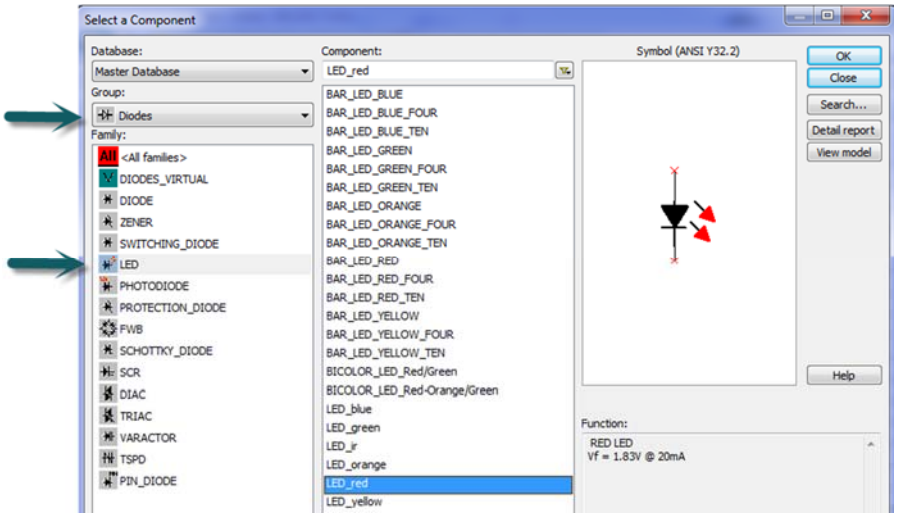
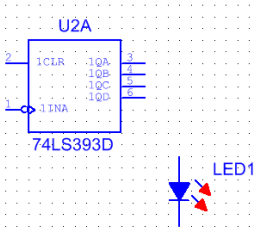


Figure 5. Red LED

Hint: After you place the first RED Light Emitting Diode (LED) on the schematic capture, you can "cut and paste" the remaining LEDs using <ctrl><c>, <ctrl><v> keystrokes.



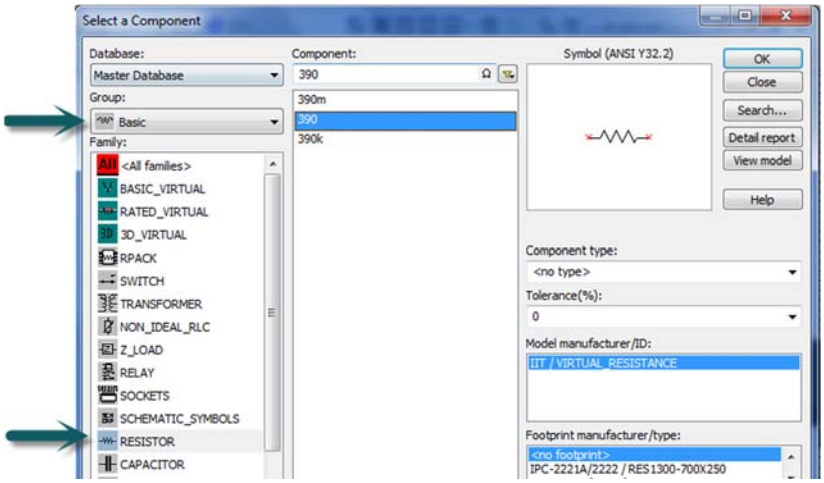


Figure 6. 390 Ω Resistor

As you place the 390Ω (where Ω is the symbol for ohms) resistors, rotate each of them to a vertical orientation using **Ctrl-R** as you move it to the desired location. Note that you can also "cut and paste" the resistors using <ctrl><c>, <ctrl><v> keystrokes.

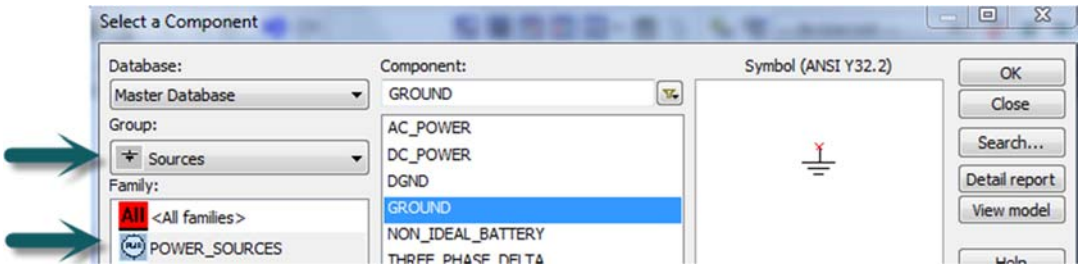


Figure 7. GROUND

Once you have placed all of the Digital Counter components, draw a rectangle around that section of the system diagram and label it "Digital Counter" as illustrated in Figure 8 below. To place the rectangle, from the menu use ***Place → Graphics → Rectangle***, and to insert the text, use ***Place → Text***.

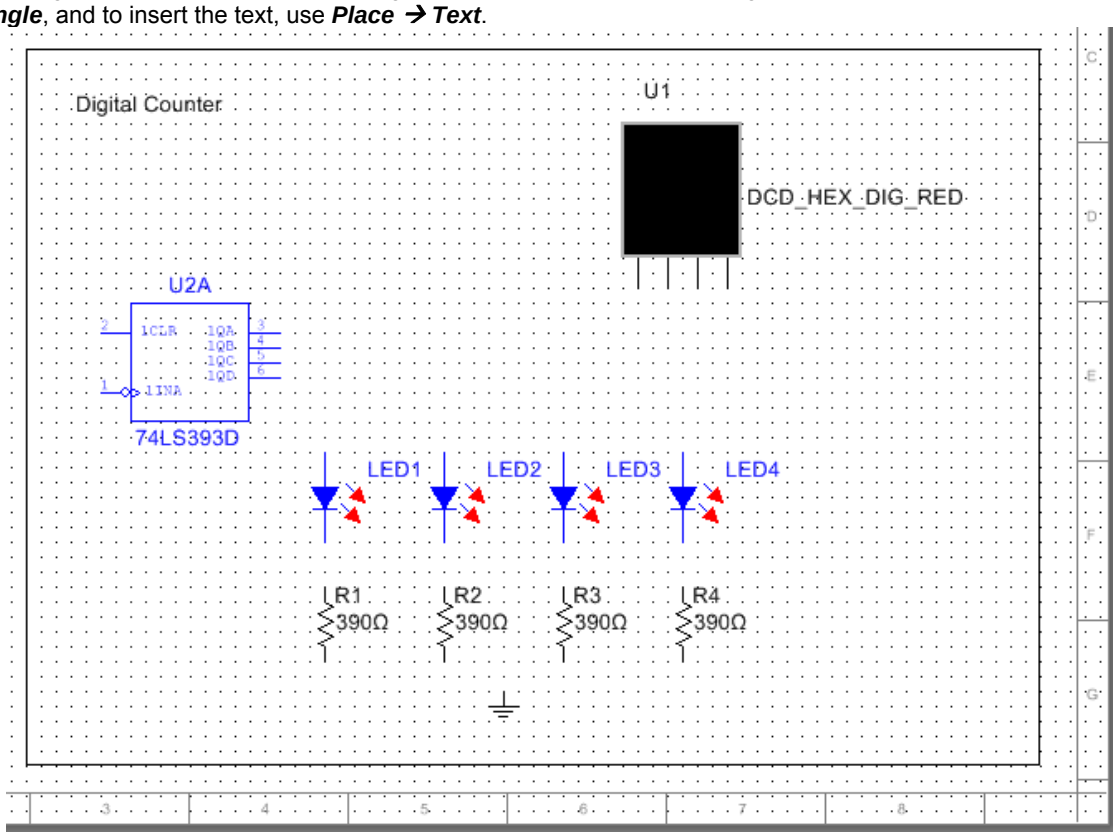


Figure 8. Unwired Digital Counter Components

Placing the Components – Bypass Capacitors Section

Next, we will construct the Bypass Capacitors section in the upper right-hand side of the schematic capture as depicted in Figure 1 on page 1 and Figure 9 to the right. To do so, create a new area on the schematic capture, place its components as shown, then place a rectangle around the section and label it.

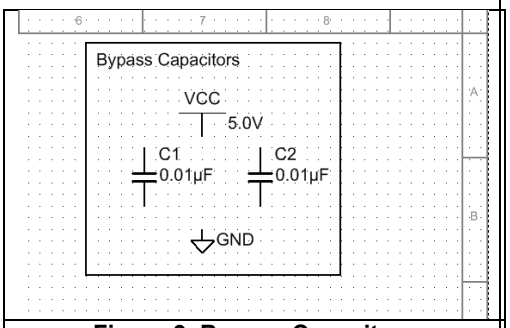


Figure 9. Bypass Capacitors

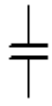
Here are the locations for the components in the Master Database:

The VCC power source 

➔ Group: Sources, Family: POWER_SOURCES, Component: **VCC**

The Digital Ground 

➔ Group: Sources, Family: POWER_SOURCES, Component: **DGND**

The 0.01µF Capacitors 

➔ Group: Basic, Family: CAPACITOR, Component: **0.01µF**

Note that "µ" stands for micro, which is the multiplier 10^{-6}.

Note: The VCC power source  , and the Digital Ground  symbols MUST be placed on EVERY Multisim 12 schematic capture; otherwise, your design may not correctly function!

Placing the Components – System Clock Section

Next, we will construct the System Clock section in the lower left-hand side of the schematic capture as depicted in Figure 1 on page 1 and Figure 10 to the right. To do so, create a new area on the schematic capture, place its component as shown, then place a rectangle around the section and label it.

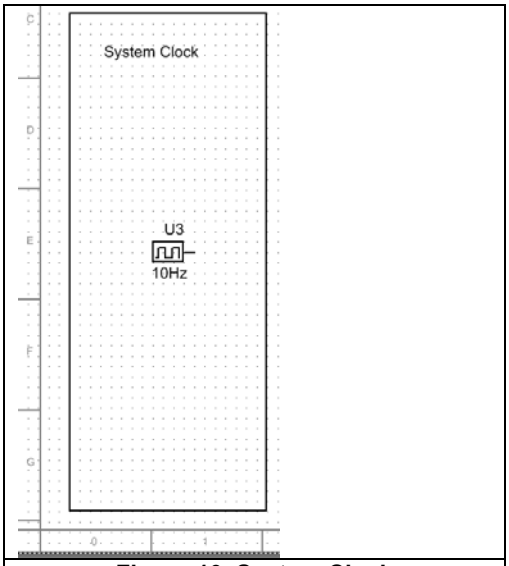


Figure 10. System Clock

Here is the locations for the component in the Master Database:

Digital Clock 

➔ Group: Sources, Family: DIGITAL_SOURCES, Component: **DIGITAL_CLOCK**

Note: Change the frequency of the DIGITAL_CLOCK to 10 Hz by double-clicking on it and changing the frequency from **1k** to **10.** If you successfully changed the frequency, your schematic capture should reflect the one in Figure 10.

Placing the Components – Counter Control Section

Next, we will construct the Counter Control section in the upper left-hand side of the schematic capture as depicted in Figure 1 on page 1 and Figure 11 to the right. To do so, create a new area on the schematic capture, place its component as shown, then place a rectangle around the section and label it.

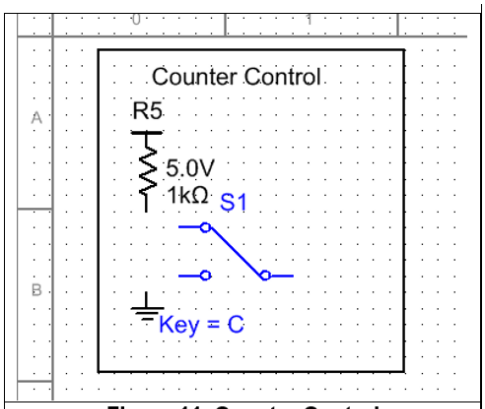
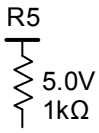
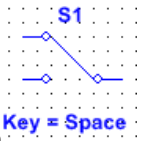


Figure 11. Counter Control

Here are the locations for the components in the Master Database:

The VCC power source/pull up resistor 

➔ Group: Basic, Family: RATED_VIRTUAL, Component: **PULLUP_RATED**

The Single Pole Double Throw (SPDT) switch 

➔ Group: Basic, Family: Switch, Component: **SPDT**

After placement, right-click on the SPDT switch and select Flip Horizontal to obtain the correct orientation of the switch. Since switch S1 is used to Enable/Clear the counter, we must change default name to a more meaningful one; in this case ***Key = C*** (C for Clear) by double-clicking on S1's ***Key = Space*** and changing the "Key for toggle" value to "C."

The Ground 

➔ Group: Sources, Component: **GROUND**

The Unwired Digital Counter System

Your unwired Digital Counter System should now look like the schematic capture in Figure 12 below. If it does, then you are ready to wire the circuit. If not, ensure all components, names, rectangular blocks, etc. are correctly placed/aligned before continuing.

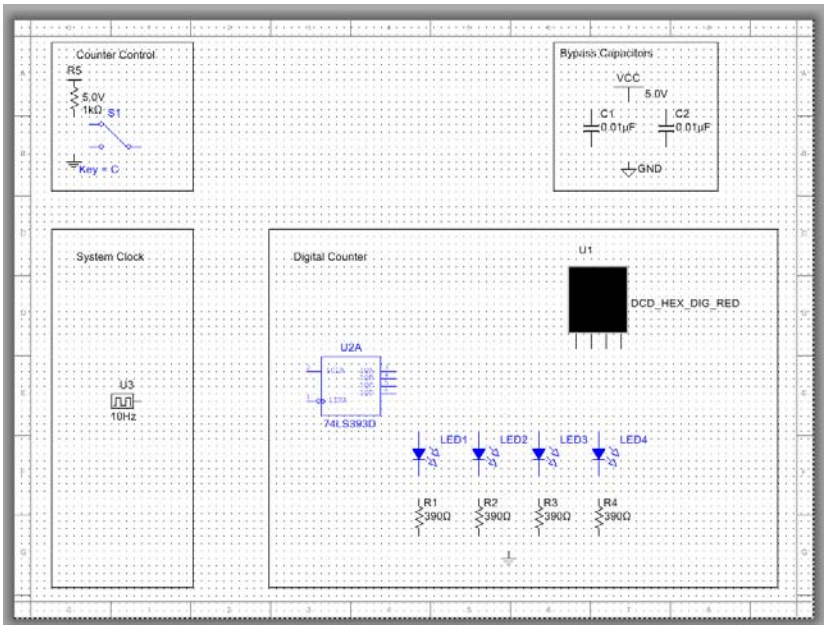


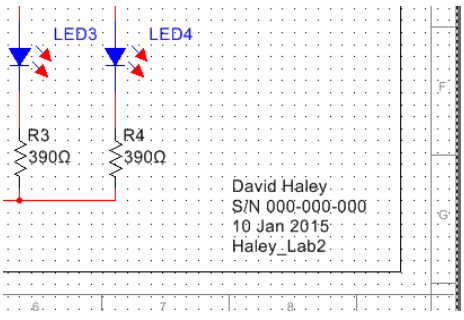
Figure 12. Unwired Digital Counter System

Wiring the Digital Counter System

Multisim is modeless; there is no need to toggle between wiring and part placement modes. As soon as your cursor is over a pin, Multisim knows you want to wire and the pointer changes to a crosshair.

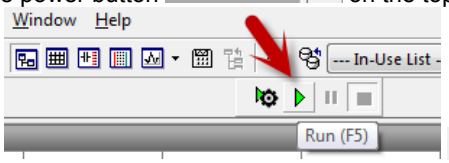
To wire the circuit:

- Click on a pin on a component to start the connection and move the mouse. A wire appears, attached to your cursor.
- Click on the destination pin to finish the connection. Multisim automatically and intelligently places the wire.
- You can manually control the flow of the wire by clicking on points as you move the mouse. Each click "fixes" the wire to that point.
- Finish wiring the circuit, and then insert your Student Information: Name, Student Number, Date, and File Name in the lower right hand corner of the drawing as illustrated below, substituting your own particulars.



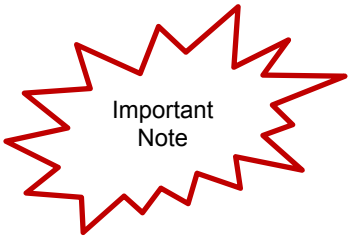
Simulation of the Digital Counter System

In this section, you will simulate the design.

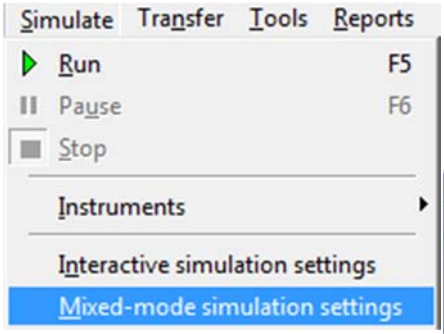
After ensuring that you have changed the frequency of the DIGITAL_CLOCK to 10 Hz, "run" the simulated design by clicking on the power button  on the top right-hand side of the schematic capture, or by clicking on the Green Arrow 

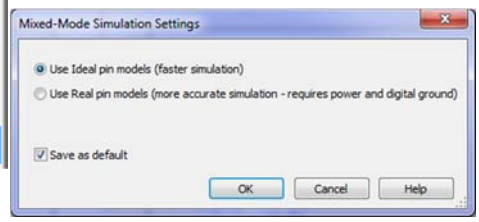
 on the menu bar, or by pressing the **F5** key on your keyboard.

Determine by investigation what functionality S1, controlled by the “C” key, has on this design, and what how the values displayed on the LEDs correlate with the values displayed on the HEX Display.



If the LEDs do not work, stop the simulation and then make the following **Simulate** configuration change in Multisim:





Assignment 1A (20 marks) – Lab Week Two Hand-In Sheet

Name: _____ ***Circle Your Lab Day/Time***

Student Number: _____ ***Tue: 10 – 12 Wed: 1 – 3 Wed 3 – 5 Fri 2 – 4***

Instructions

Prior to the lab, print out this hand-in sheet and fill in your name, student number and lab section in the space provided above.

Then, complete the following not later than the end of ***your*** week three's lab period. (**Note: You SHOULD be able to complete this by the end of your week TWO's lab period, and I highly recommend that you do so).**

a. Demonstrate the completed and functional schematic capture of the Digital Counter to your course professor. **Note: Ensure that your solution is functional before you do your formal demonstration. If you solution is not functional for whatever reason, ask me for help.**
b. Create a portfolio folder (your professor will provide this to you) – write your name, student number and lab day/time on the label.
c. Staple and place both this completed sheet and a printout of your schematic capture into your portfolio folder.

Evaluation of the Digital Counter System

Your completed and functional schematic capture will be evaluated as follows. The total below will form 20% of your mark for Assignment One. Ensure that your submission works 100% before demonstrating as there are no "second chances" after correcting errors/omissions or sloppy work. I suggest you read the "Notes" below this table before you demonstrate your solution.

Item	Marks	Comments
IN-LAB EVALUATION – Demonstration		
Simulation Correct	/8	Count correctly displays on both the HEX Display and LEDs. Wires do not detach while simulation is running and a component is moved.
POST-LAB EVALUATION – Assessment of submitted Schematic Capture		
Layout Correct (your schematic capture layout should very closely resemble the one in Figure 1 on page 1)	/8	All components in correct location, titles and borders correctly located, wiring is neat.
Student Information correct	/4	Complete and correctly located on schematic capture.
Total	/20	

Professor's Initials _____ and lab submission date/time:

NOTES:

1. ***Be forewarned that the submission of "sloppy work" in CST8216 is unacceptable. If your components are ill placed, rectangular boxes or labels are missing, and/or the wiring looks like "spaghetti" (similar to "spaghetti code" in programming), then your lab mark will reflect your poor effort.***

2. ***If when running the simulation you can click on the components and have the wires detach, then you likely did not apply the configuration changes specific in Lab Week One. As such, go back and apply them before you demonstrate your submission.***