Example 6
Displays, Probes, Buzzers, and Busses

For this example we will simulate a circuit containing several indicators to illustrate how they are used and we will add a bus to the system to simplify the wiring. We will first simulate the system without a bus as shown in Figure E6-1.

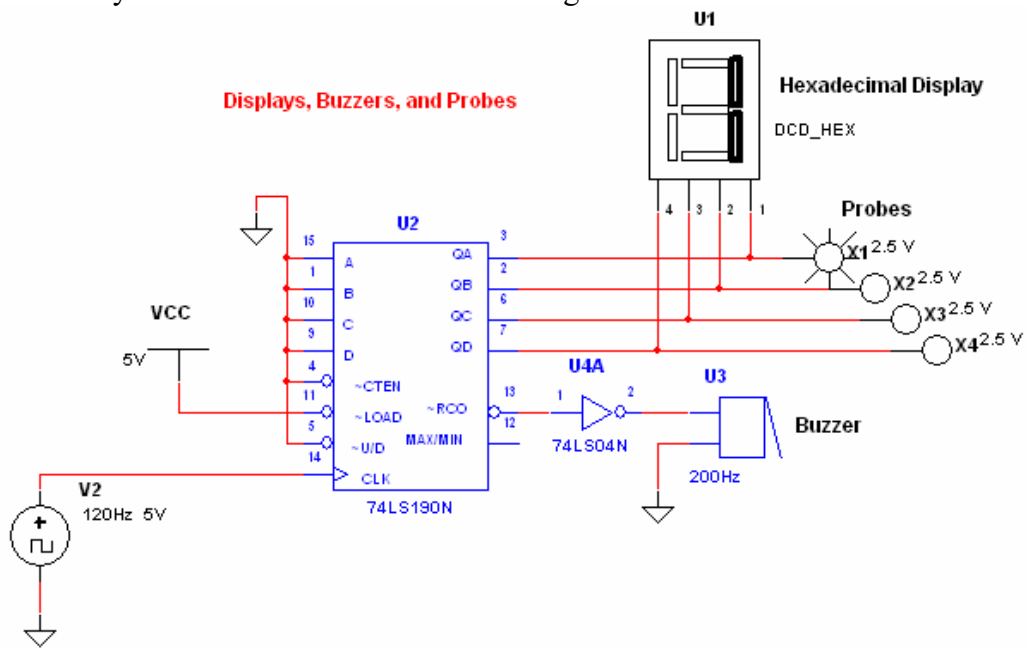

Figure E6-1

This circuit uses a decade counter to illustrate the use of displays, probes, and buzzers.

For this circuit we need two TTL LS components which are the 74LS190 decade counter and one section of a 74LS04 inverter. Select these items from the Parts Bin and place them on the blank screen. Add a Clock Source from the Sources menu of the parts bin and set its frequency to 120Hz and its voltage to +5volts. You will also need a 5 Volt Vcc source and two digital grounds. Your circuit should look like that shown in Figure E6-2.

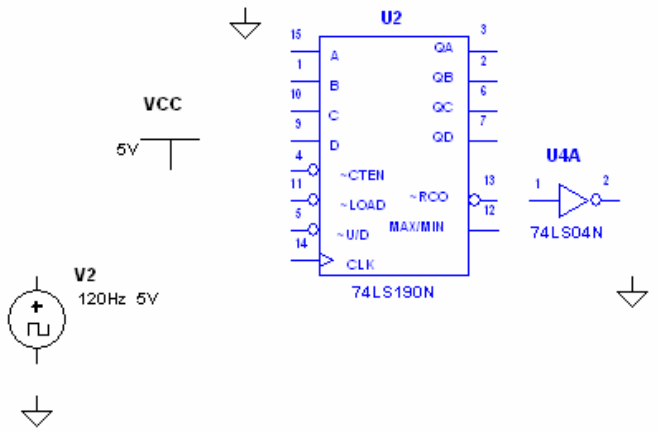

Figure E6-2

The TTL components and the sources have been added.

Add the three indicators as the next items. Click on the indicators icon on the Parts Bin and select the Hex Display item and select the part named DCD_HEX. (All of the displays are somewhat idealized. The hex display shows a seven segment hex number that corresponds to the logic level on its four input pins. No power supply is necessary. Likewise the other two displays have no power

connection and light up when the input terminals are activated.) Place the hex display on the screen. Select a Buzzer from the same indicator menu and place it on the screen. Double click on the buzzer to set its voltage trip level. Set this voltage to 3 volts. You can also set a current level but we won't use that feature for this example. Click on the red probe and place four of these on the circuit diagram. Each of these has a trip point for being on or off which defaults to 2.5 volts.

Connect the wires to your circuit and get a final circuit similar to that shown in Figure E6-1.

Note that for the hex display the least significant bit is pin 1 and the most significant bit is pin 4. For the 74LS190 counter the least significant bit is pin 3 and the most significant bit is pin 7. You might be tempted to flip the hex display horizontally by right clicking on it and selecting "flip horizontal" since this would place the least significant bit closer to that of the counter's least significant bit and result in less wire crossover. But if you do this with the display, Workbench also flips the display so the numbers displayed will appear as if you were looking at it from behind.

For a real circuit it's unlikely that you will have a circuit like this connected to a 120Hz clock source. If you did things would change so fast that you would be unable to see them. But if you slow the clock down to a reasonable rate such as 10Hz the simulation takes a very long time.

Simulate your finished circuit and verify that it does count upward from 0 to 9, that the probes do indicate the binary state of the output lines, and that the buzzer actually buzzes when the counter rolls over from 9 back to 0.

Adding a Bus

Before you add a bus to the system you will need to rearrange the hex display and the probes and delete the wires which the bus will replace. Rearrange your circuit to look something like that shown in Figure E6-3. To add the bus, click on *Place→Place Bus* from the menu at the top of the screen. Adding the bus is like adding a wire. Click on the starting point and click on first corner and double click at the end point. The bus will be drawn to be a series of lines between your clicks. If you double click on the completed bus you'll see that it has only one parameter which you can change and that's the reference ID. This defaults to the name bus for this example but you can make it anything you like. Note that a bus need not look continuous. You can place another bus anywhere else in the circuit and give it the same reference ID. Workbench then takes it to be the same set of lines. This allows you to draw complicated connections without having to drag the bus all over the diagram.

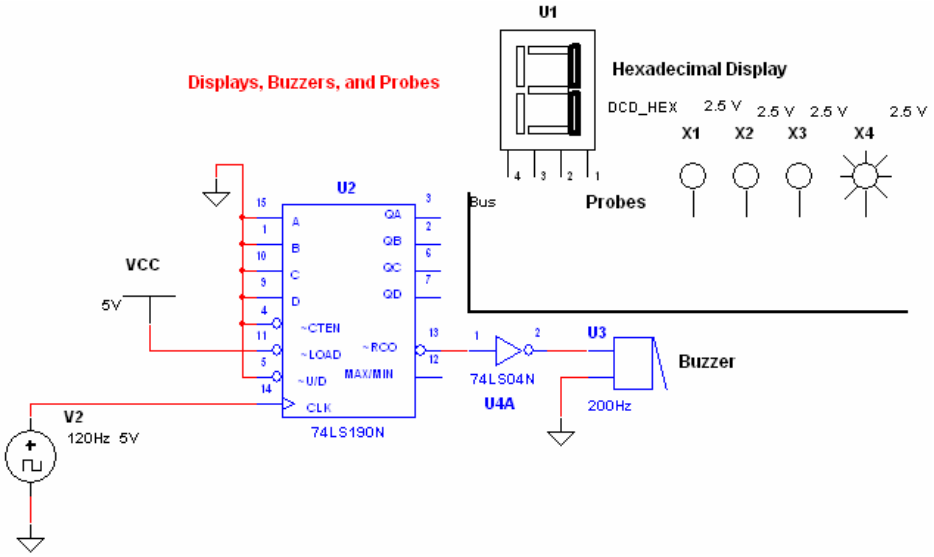

Figure E6-3

The hex display and the probes have been rearranged and the wires connecting them have been replaced with a bus.

For this example connect the counter to the bus by connecting a wire to one of the counter outputs and connecting the other end to the bus. When you do this you will get a pop up screen that asks you to give the wire a name. In Figure E6-4 the wire is being named QB and one wire QA has already been named.

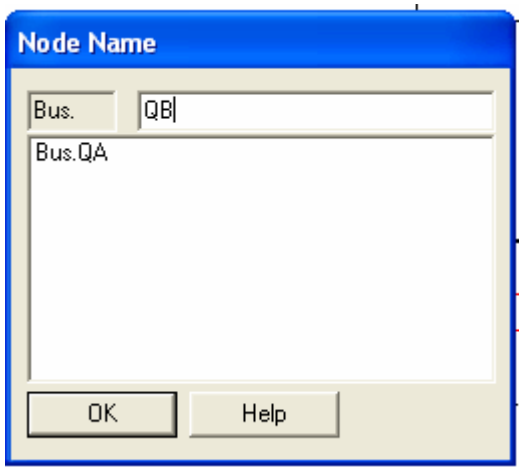

Figure E6-4

This pop up screen appears when you connect a wire to the bus. You can name the bus line or you can select a name already chosen.

For this example our bus will have only four wires and we will name them QA, QB, QC, and QD after the four outputs of the counter. After you connect the counter to the bus similarly connect the hex display and the probes as shown in Figure E6-5. Note that you should be careful to get the bits in the right order. In our case QA is the least significant bit and QD is the most significant bit.

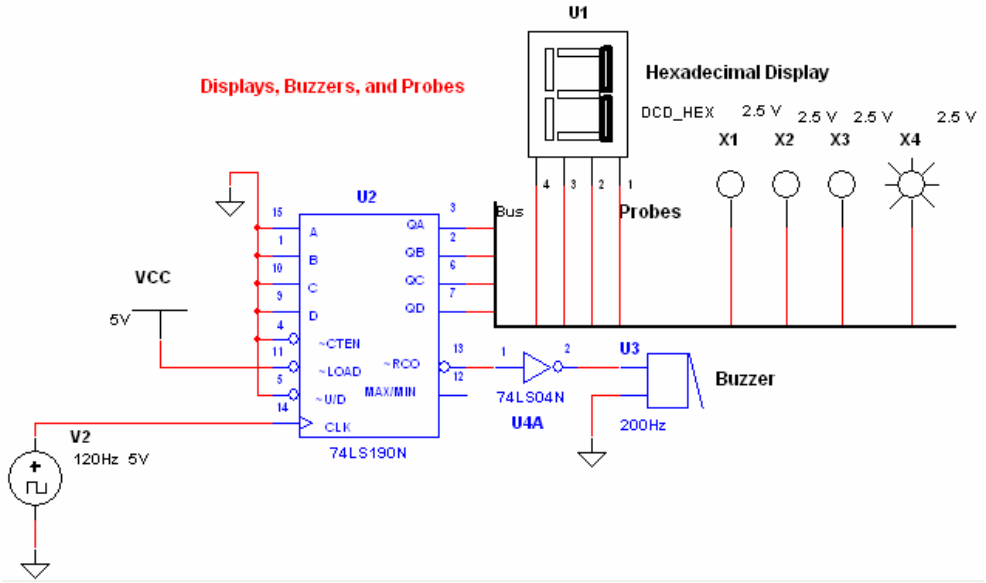

Figure E6-5

The circuit with a bus replacing the wiring connections.

Finally, simulate your circuit to verify that it works as before.