Lab 9

Last time for the circuit simulator!

In this lab, you will work with RAM and ROM chips. Follow the steps below to create some circuits:

1. The RAM chip has $2 \leq$ address line bits ≤ 24 and $N = \{1..32\}$ data lines (bit width). The number of data lines (bit width) signifies the number of bits that are stored at each location (address). The location of the data is determined by the address lines. The address bit width indicates how many data items the chip can store. For example, if the address bit width is 5 and the data bit width is 4, then the chip stores 32×4, meaning that there are 32 locations (2^5) each storing a 4-bit data value.

   The data lines are used for both reading data from the chip and writing data to the chip. Note that a *controlled buffer* is needed so that input/output signals do not conflict with one another. In addition, it has a load/store line (`ld`), a chip select line (`sel`), clock input ($\wedge$), and a reset line (`clr`). These lines must have the desired input (0 or 1) to enable the relative function.

   The ROM chip is similar, except that there is no way to write to it. You can, however, set its values via a right mouse click and `Edit Contents`.

2. Try out the RAM chip. Create one that has 4 address lines and 8 data lines. The rightmost address line represents $2^0 = 1$ and the leftmost address line represents to $2^3 = 8$ In all, you will have $2^4 = 16$ memory locations. With 8 data lines, you will be able to store an 8-bit value in each of those 16 locations.

   Now build a circuit so that the user can choose an address, choose the data, and then store the data. Conversely, the data should be loaded to an output component. Use the switches and one of the output methods that we have used previously to help with these items. New hardware includes modifying a Pin to have multiple bits, an LED Matrix to display output, a Splitter to split a data line into its constituent bits, and a Controlled Buffer.

   Store a 1 at location 7 and 15 at location 10, and then load the 7 to the output device.

   _____ Show me your result.

3. Now that you know how to manually set the data in RAM, create a circuit to store/display things more automatically. Create a ROM chip and store $2, 4, 6, ..., 20$ into the first 10 locations. Connect this to a RAM that has 4 address lines and some circuitry so that when the user flips a switch, all 10 values are copied from ROM and stored into 10 consecutive locations in RAM, **starting at a location given by the user**.[1] You might find the bit generator (i.e., the clock) useful for this. Also note that you know how to add items and how to count (previous labs). Again, you need some output circuitry so that you can check what the RAM contains.

   _____ Show me your result.

[1] This is challenging! You may want to start at location 0 first, and then modify the circuit to include the user location.