

Getting Started with Design Works¹

This tutorial provides step by step instructions to draw a circuit for the function $F = A \overline{B} \oplus BC$ as a running example to explain how to use the software. Observe that the circuit implementing this function uses two AND gates, one exclusive OR gate and two inverters.

1. Start *Design Works*: It's on the start menu and is a desktop icon.
2. **Placing devices**: The *parts palette* contains a list of all the parts in all the libraries. It is simply a list of all the items, mostly logic devices, that *Design Works* knows about. If the parts palette is not visible, click on **View → Parts Palette**.

NOTE: The numbered devices in the library are generic and provide the configuration that is typical for most manufacturers. The labeling and simulation characteristics can be adjusted to match the various device families on the market.

 - a. Locate the 7408 in the parts list and double click on it. It contains four 2-input AND gates. Move the cursor into the circuit window, position the image in the center of the circuit window and click. Press the spacebar or click on the arrow to return to Point mode.
 - b. Repeat the above step with the 7404, which contains six inverters, and with the 7486, which contains four 2-input exclusive OR gates.
3. Go to the course web site and locate the data sheets for the 7408 and the 7447 chips. Find the diagram that shows what each of the pins on those chips do. (Usually Vcc = +5V and Gnd = 0V.)
4. **Making signal connections and wiring the circuit**: There are several ways to connect signals. Most connections are made with the pointer. For this case, one needs to position the pointer near an output of one of the gates and drag toward the input of another gate. Alternatively, one can simply move two parts close together, such the input pins of one just touch the output pins of the other. The signal lines should flash briefly indicating a logical connection has been made. Throughout, observe the effects of `ctrl` and `tab` keys.
5. Position the pointer near the output of one of the inverter outputs and drag toward an input of an AND gate.
6. Similarly, structure the circuit for function F by making connections between:
 - a. The output of the AND gate that was used in the previous step and an input of an exclusive OR gate.
 - b. The output of another AND gate and the other input of the previous exclusive OR gate.
7. **Input Devices**: The input devices are found in the `demolib.clf` library and include such items as switches, a clock, power (5V) and ground.
 - a. Place three Binary Switch devices on the circuit window. These will be used for the A, B and C inputs to the circuit. When in Point mode, clicking on a switch causes it to move between 0 and 1. In order to move the switch, the shift key must be used.

¹ Inspired by: Design Works 4: Interactive Circuit Design Software: by Capilano Computing Systems

- b. Draw signal connections from the Binary Switches to the inputs of the inverter and of the AND gates appropriately to implement the function F.
8. **Naming Signals:** The *Design Works* simulator has been running continuously simulating the effects of the circuit, but so far no results have been displayed.
 - a. Choose the **text icon** in the **Tool Palette**. Use the pencil to insert the name “C” on the signal line that connects the binary switch device to the C input of the AND gate. The C signal now appears in the timing window.
 - b. Similarly, use the pencil to insert the names “A” and “B” appropriately.
 - c. Use the <> and >< buttons in the simulation controls tool bar and observe how they affect the time scale of the Timing window.
 - d. Examine the effect of the other buttons in that tool bar.

Note: the step button advances the simulation to the next time at which there is some circuit activity, not necessarily by a uniform time unit.
9. **Probe Device:** It allows viewing of signals that would not otherwise be shown (e.g. internal lines).
 - a. Place a Binary Probe in the circuit window so that it makes a signal connection with the output of the AND gate that produces $A \overline{B}$. The probe output will be updated immediately.
10. **Setting Device Parameters:** Selecting any device in the circuit and then choosing **Simulation Params** in the **Simulate** menu allows advanced specifications and controls of the device.
11. Save the work and exit.