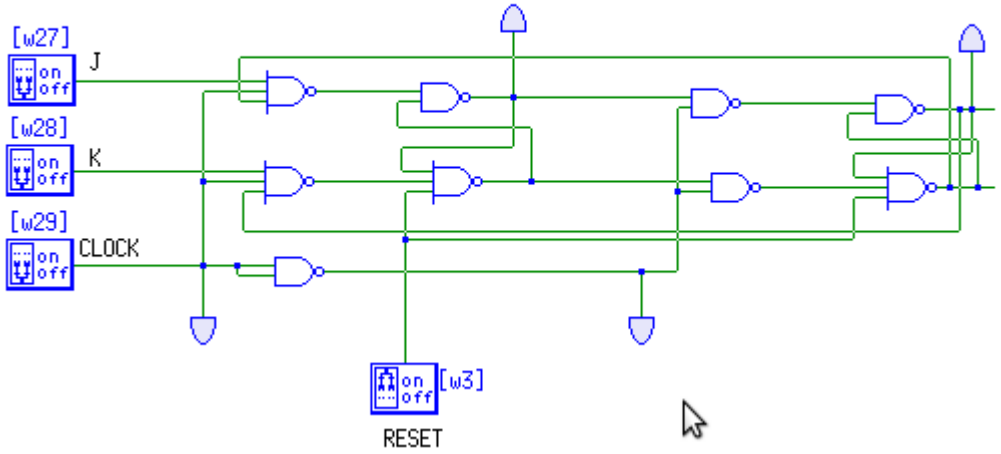
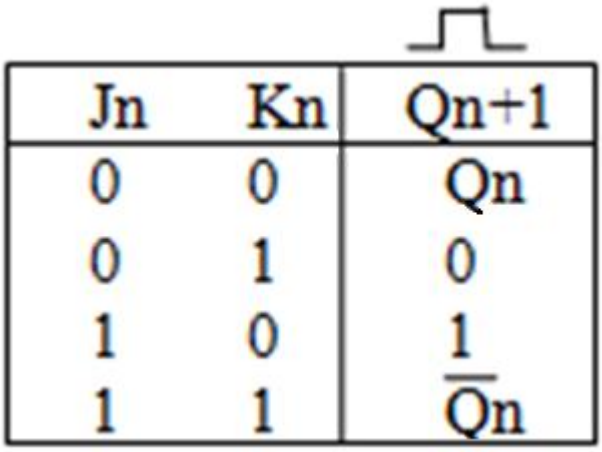
CS220 Computer Architecture
Digital Logic Design
Practical 5

PART A

Implement the Master-Slave J-K flip-flop circuit described in class. Attach switches to the J and K inputs and to the clock input. Attach LEDs to the master output stage and to the slave output stage and to the clock inputs on the master and slave sides. Verify that the flip flop obeys the characteristic table given below.





Jn	Kn	Qn+1
0	0	Qn
0	1	0
1	0	1
1	1	$\overline{Qn}$

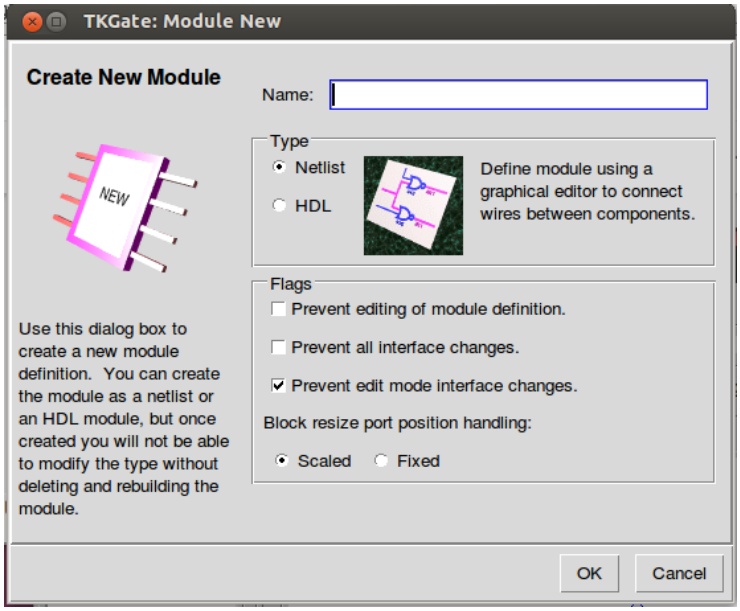
Notes:

When the simulator is running, the flip-flop output LEDs appear in yellow as their initial state cannot be determined. Add an extra switch (the reset switch) and connect it as a third input to the NAND gates generating Qinv in both the master and slave sides of the flip-flop. When the reset switch is at logic 0, Qinv will be forced to logic 1 and Q will be forced to logic 0 – our initial state. Once the flip-flop is initialised, set the reset switch to logic 1 so that it doesn't interfere with the operation of the circuit. The reset operation only needs to be done when starting the simulation, i.e. on power up.

PART B - User Defined Modules in TKGate

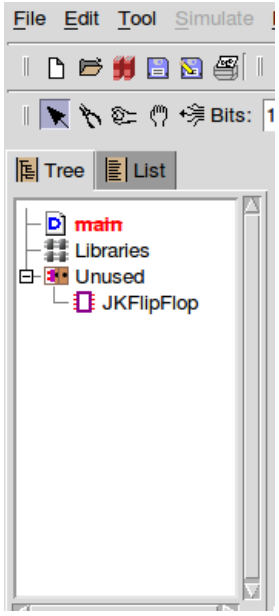
A **module definition** consists of two parts, an **implementation**, and an **interface**. The implementation is the "contents" of the module, that network of gates that make up its function, and the interface defines the external port connections and the appearance of module instances including the size of module instances on screen and the port positions. Module definitions can be manipulated using the "New...", "Delete...", "Copy...", "Rename..." options from the "Module" menu.

Modules can be used to create hierarchical designs. To create a module, go to the module menu and select “New”.



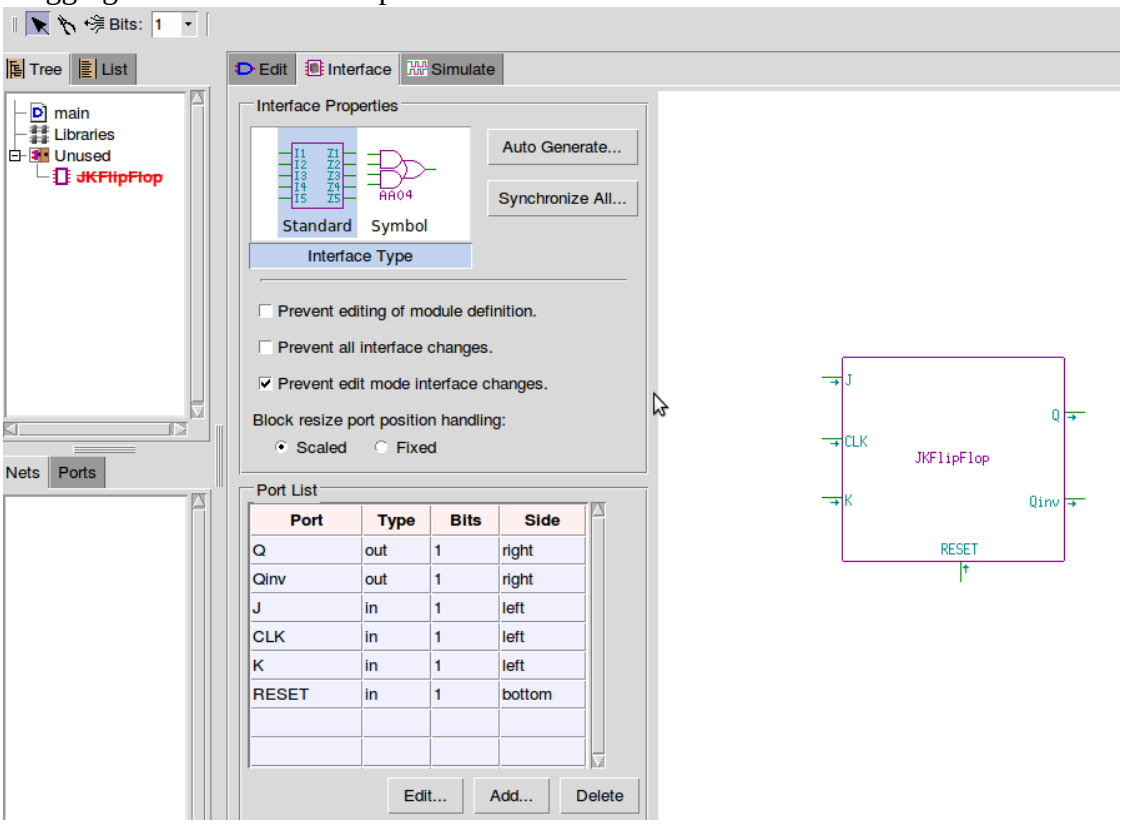
Enter a module name (e.g. JKFlipFlop) and press return to create an instance of a module with that name.

You can use any of the module names listed in the "Modules" list on the left part of the TKGate screen, or create a new module type by entering a new name.



Editing the Module Interface

Double Click on the JKFlipFlop component and select the Interface Tab on the edit window. You can resize the module's box by dragging the corners. Add ports to the interface and name them as described below. Note the Q and Qinv ports are output ports and the rest are input ports. You can move the port positions on the module by dragging them to the desired position in the edit window.



Editing Module Implementations

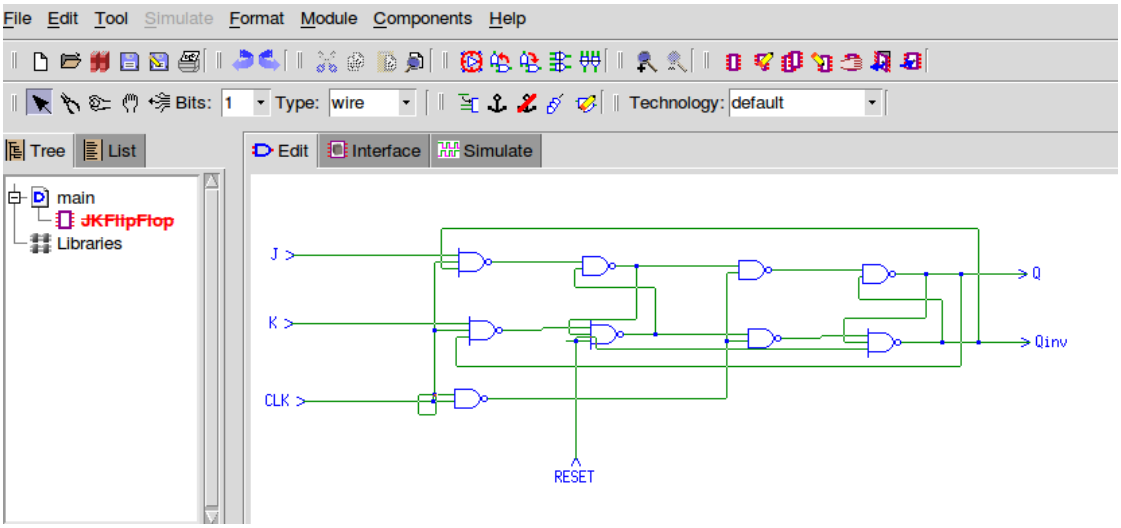
To edit the contents of a module, double click on the module name from the "Modules" list on the left portion of the main window and select the Edit Tab on the edit window. Note: Do not create your implementation in the "main" edit window, but in the "JKFlipFlop" module edit window!!

Within the module you can use any of the gates you would use at a higher level including more module instances. **In the case of this JKFlipFlop module, you should create the circuit constructed in PART A of this lab. (Yep – Build it Again)**

In place of the switches and LEDs you used in PART A, you must create "module inputs" and "module outputs" from the components/module pop up menu and add them to the circuit in the module's edit window.

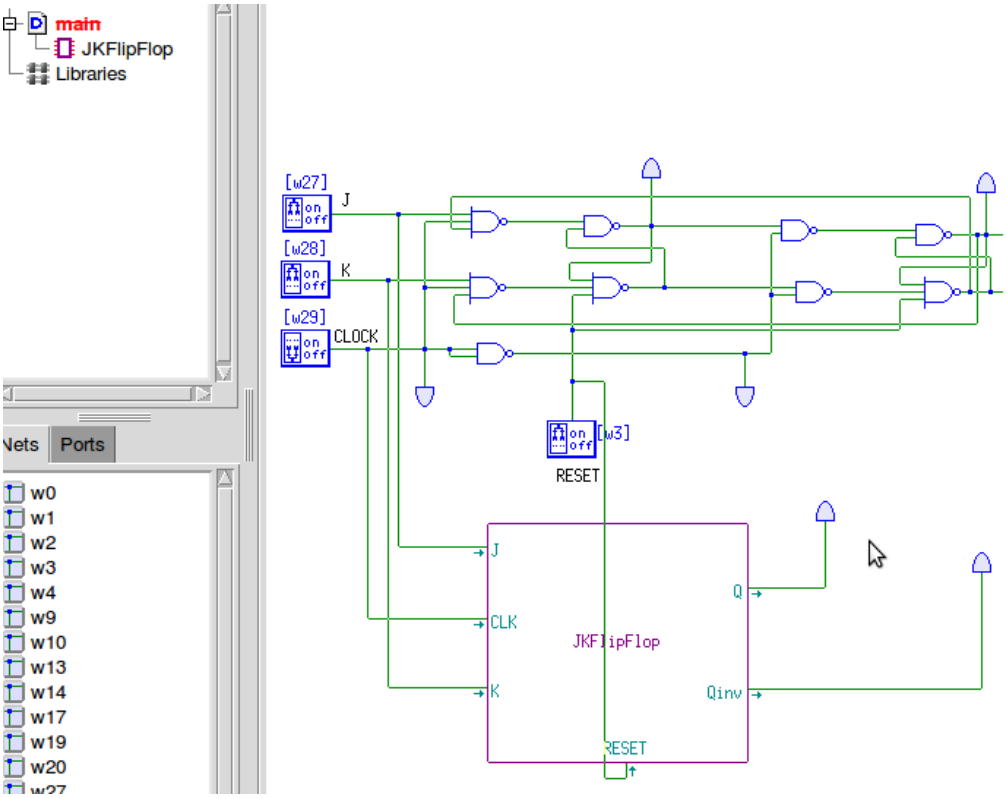
Make sure that you use the same names for the inputs and outputs that you used when defining the interface, including the same upper or lower case.

When you are finished the implementation, it should look like the image overleaf.



Using User Defined Modules

Once you have created the module JKFlipFlop you should test an instance of the module to ensure it works in accordance with its characteristic table. You can drag an instance of it into the circuit you used in part A and connect to the same switches. The flip-flop Q output (on the top right) should be the same as the module Q output for different input combinations.



PART C:

Assuming your JKFlipFlop module is working, implement a 2-bit synchronous counter using two instances of this module, constructed as shown below. The output of the counter should be displayed on a decimal counter.