Fundamental Combinational Blocks

Topics

- Multiplexers
- Behavioral simulation

Problems

Part I

1. *[Paper and pencil]* Write the truth table, derive the Boolean equations and draw the logic diagram, based on logic gates, of a Mux 2:1 with the interface shown in Fig.1.

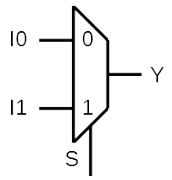

Fig. 1 - 2:1 multiplexer interface.

2. *[Quartus Prime]* Using the *Quartus Prime* software, create a new project named "MuxDemo", with a top-level entity with the same name as the project. Create a new file for a schematic diagram called "Mux2_1.bdf" to implement the multiplexer based on logic gates, accordingly to the logic diagram of the previous point. Create a symbol for the "Mux2_1" module, so that it can be used in a schematic diagram, and save it with the name "Mux2_1.bsf".

3. *[Quartus Prime]* Create a new file for a schematic diagram called "MuxDemo.bdf" that will act as the top-level of the project, instantiate the multiplexer built in the previous point and connect it to input and output ports.

4. *[Quartus Prime]* Perform the behavioural simulation of the multiplexer, applying input stimulus to evaluate conveniently its operation.

5. *[Paper and pencil]* Create a 16:1 multiplexer using the 2:1 multiplexer as a building block. Its interface is shown in Fig. 2. Draw the logic diagram of the 16:1 multiplexer based on 2:1 multiplexer modules. How many bits has the selection signal "S"?

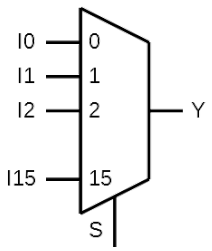

Fig. 2 - 16:1 multiplexer interface.

6. *[Quartus Prime]* Create a new file for a schematic diagram called "Mux16_1.bdf" to implement the 16:1 multiplexer, accordingly to the logic diagram of the previous point. Create a symbol for the "Mux16_1" module, so that it can be used in a schematic diagram, and save it with the name "Mux16_1.bsf".

7. *[Quartus Prime]* Create a new file for a schematic diagram called "MuxDemo2.bdf" and select it as the new top-level of the project, instantiate the 16:1 multiplexer built in the previous point and connect it to input and output ports.

8. *[Quartus Prime]* Perform the behavioural simulation of the 16:1 multiplexer, applying input stimulus to evaluate conveniently its operation.

Part II

Consider the following Boolean function:

$$f(A,B,C,D)=A + C'\cdot D + B\cdot D' + B'\cdot D + B'\cdot C$$

1. *[Paper and pencil]* Draw the corresponding Karnaugh map and determine the first canonical form of the function *f(A,B,C,D)*.

2. *[Paper and pencil]* Create an implementation of *f(A,B,C,D)* based on a 16:1 multiplexer, the independent variables (not inverted) and the '0' and '1' constants.

3. *[Quartus Prime]* Create a new file for a schematic diagram called "MuxDemo3.bdf" and select it as the new top-level of the same project used in *Part I*, instantiate a 16:1 multiplexer, as drawn in the previous point, to implement *f(A,B,C,D)*.

4. *[Quartus Prime]* Simulate "MuxDemo3.bdf" and check its behavior for all the possibilities of the *f(A,B,C,D)* truth table.