Hardware block

The Quartus Prime environment allows for the construction of hardware modules/blocks, which enable the "encapsulation" of a combinational or sequential circuit, or parts thereof, into a submodule. Hardware modules are equivalent to functions in programming languages, where a function allows for the "encapsulation" and invocation of a portion of source code with the appropriate parameters. A hardware module serves a similar purpose in the Quartus Prime environment as a Subsystem in the Matlab/Simulink environment.

*Hardware module based on a *.bdf file*

1. To create a new hardware module, you need to add a new schematic file (bdf) to the project: **File** -> **New…** -> **Block Diagram/Schematic File**.
2. In the next step, save the file with an appropriate name (e.g., **FullAdder.bdf**). **The file name will also serve as the symbol name for the hardware module.**
3. Next, you need to build the schematic by assigning symbolic names to the input/output ports (these names will subsequently appear on the symbol of the created hardware module). Below (Fig. 1) is an example of a full adder schematic, with inputs ***A***, ***B***, and ***Cin***, and outputs ***Sum*** and ***Cout***.

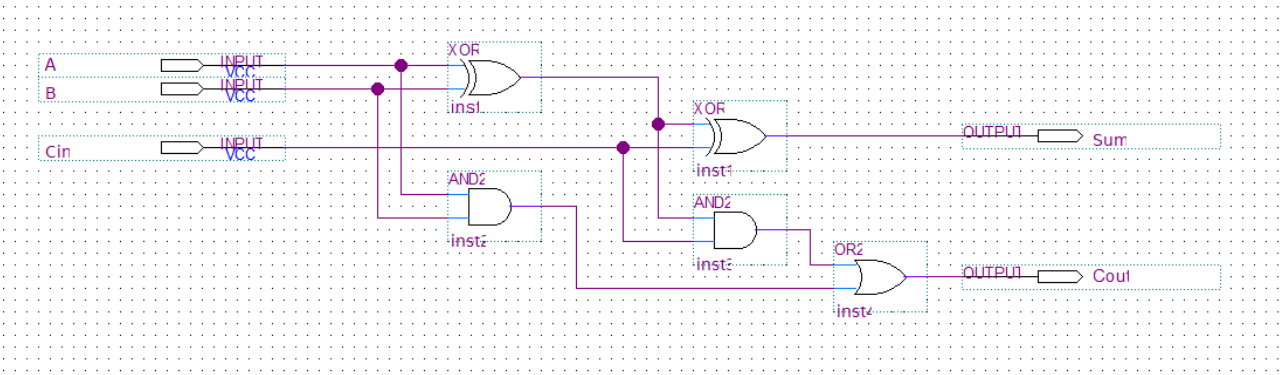

Fig. 1: Logic diagram of a full adder circuit

4. To create the module and the associated symbol, save the contents of the file (Ctrl + S), and then click: **File** -> **Create/Update** -> **Create Symbol Files for Current File**.

5. Next, navigate to the main file (**Top.bdf**). Select the symbol representing the circuit (hardware module) from **Symbol Tool** -> **Libraries**: **Project** (Fig. 2).

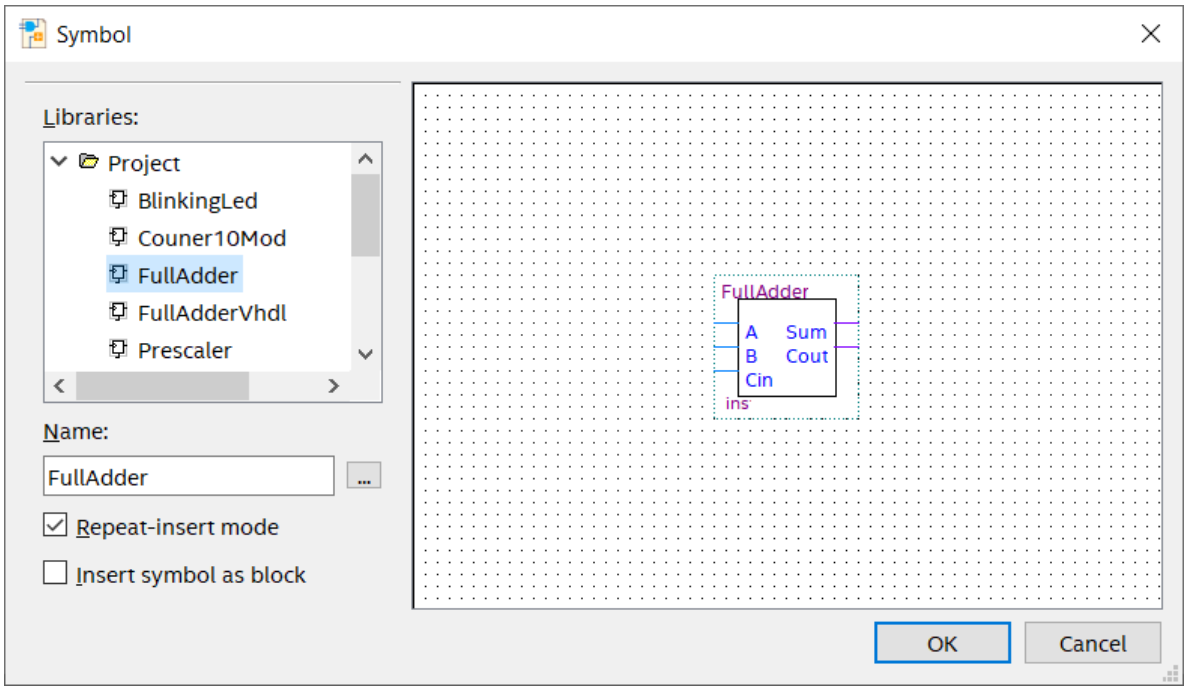

Fig. 2: Inserting a combinational circuit as a hardware module

6. Connect the inputs and outputs of the hardware module to the corresponding input/output ports of the FPGA device as shown in Fig. 3.

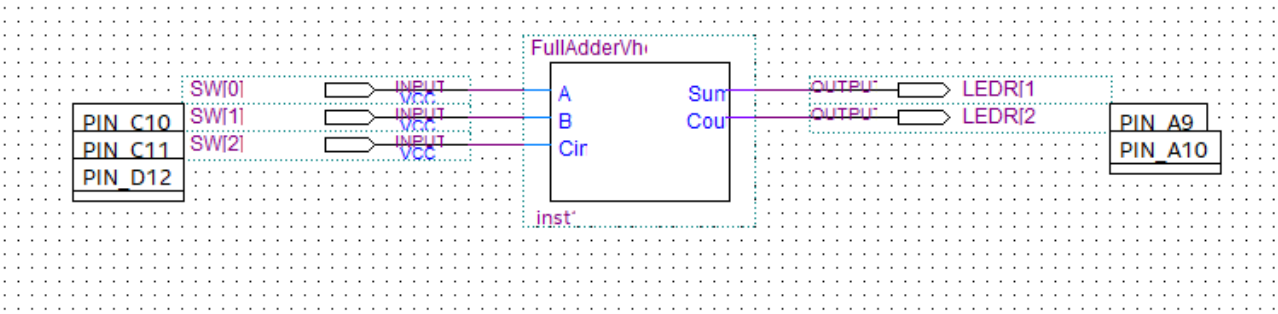

Fig. 3: View of the hardware module (symbol) in the main file

7. Start the compilation and program the FPGA device.

8. If you change the interface of the module (by adding or removing inputs/outputs), you must update the symbol again: **File** -> **Create/Update** -> **Create Symbol Files for Current File**.

Hardware module based on source code file
**.vhd / *.vhdl / *.v / *.sv*

1. Copy the source code file of the module to the project directory.
2. Add the file to the project by clicking on **Project -> Add/Remove Files in Project...**, then specify the source code file and click **Add**. The file should appear in the list.
3. Open the file so that the source code is visible on the screen.
4. Create the module and the associated symbol by selecting **File -> Create/Update -> Create Symbol Files for Current File** and save the *.bsf file in the default location (in the project directory).
5. Insert the symbol representing the module into the top-level bdf file using the tool: **Symbol Tool -> Libraries: Project**.
6. Connect the inputs and outputs of the hardware module to the corresponding input/output ports of the FPGA device.
7. Start the compilation and program the FPGA device.