

EG3204 Programmable Electronics lab week 5

Flip-flops and Registers in VHDL

In this weeks lab you will design, test, and simulate an enabled D-type flip-flop (DFF) with reset logic, using behavioural modelling. We will then design, test and simulate 4-bit registers (memory) using a DFF component. Make sure your enabled DFF and 4-bit register designs are in separate Quartus II projects.

1 An enabled flip-flop (DFF) with reset

A D-type flip-flop (DFF) is a sequential circuit used to store a 1-bit binary digit. The simplest form of DFF circuit consists of one input (D) and one output (Q). The enabled DFF with reset logic is commonly used in digital designs. The block diagram and truth table of an enabled DFF with reset signal is shown in Figure 1 and Figure 2 respectively. Figure 1 depicts the interface of an enabled DFF with input ports *Clock*, *Reset*, *EN* and *D* and output port *Q*.

2 A 4-bit register using a DFF

A register consisting of a number of D-type flip-flops can be used as a memory element. For instance, a 4-bit register can be designed using 4 DFFs, as shown in the block diagram in Figure 3.

In Figure 3 the interface of the 4-bit register is described with input ports *Clock*, *Reset*, *EN* and *Din*, and the output port *Dout*. Here the data types *Din* and *Dout* are *STD_LOGIC_VECTOR*. The internal structure, including connectivity and busses is given in Figure 2

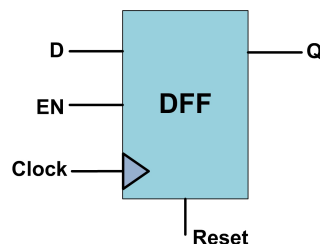


Figure 1: Block diagram of an enabled DFF with reset.




Clock	Reset	EN	D	Q	
-	1	-	-	0	Output will be zero
	0	1	1	1	Q=D
	0	1	0	0	Q=D
	0	0	-	Q	No change

Figure 2: Truth table of an enabled DFF with reset.

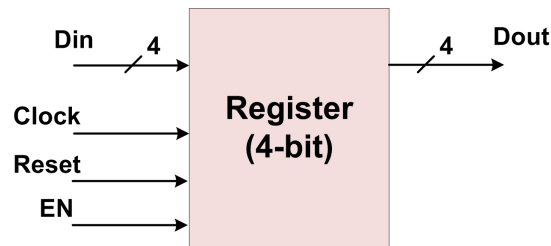


Figure 3: Block diagram of a 4-bit register memory.

3 Test your code in the simulator

For this lab exercise we provide you two test benches — one is for an enabled DFF design and other is for 4-bit register design. You should use these to fully investigate the functional simulation of your RTL designs.

Your task is to design, implement, and test an enabled DFF, and then to use this design to build a 4-bit register. Once you have built your designs and tested them in the simulator, you can try to put them on the board in your own demonstrator application!

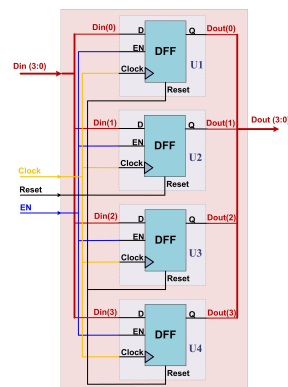


Figure 4: Structural diagram of 4-bit register using a DFF component.