

## **EXPERIMENT 3**

### **3. Macros**

#### **3.1 Objectives**

- Familiarization with circuit macros.
- More familiarization with FPGA board and design tools.
- To build a set of I/O macros for future reference
- To add I/O macros in the library of modules so that they can be used in the future.

#### **3.2 Description**

This lab requires you to

- Build macro of the schematic of the last lab.
- Build macros for input switches and buttons
- Build macros for output LEDs.
- Build a library of input switches and push buttons as well as the output LEDs.
- Functional simulation and implementation of the circuit by replacing the repeating sub-circuits and the input/output terminals with macros.
- Verifying all the I/O macros by connecting an input macro to an output one.

### 3.3 Pre-lab

- In the lab guide, read the section on Creating Macros.
- Bring the schematic of the previous lab (verified and error free).

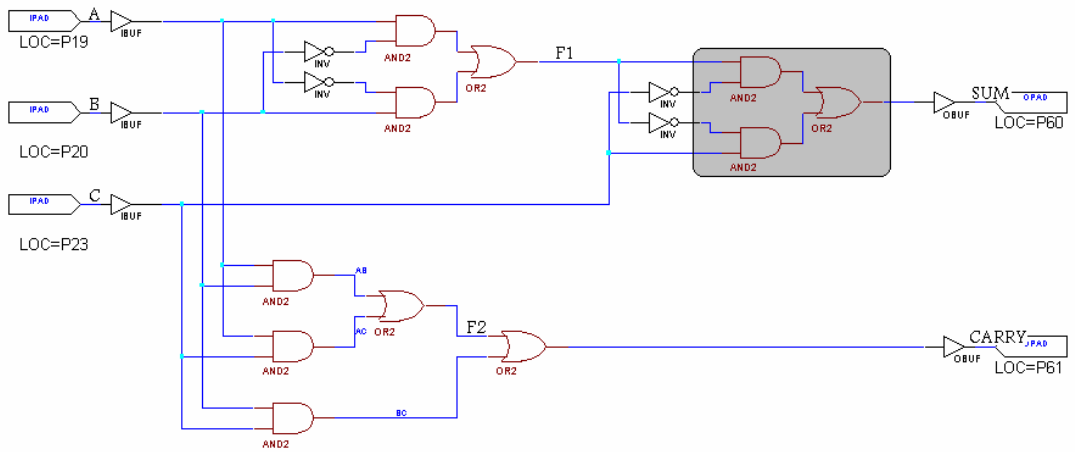
### 3.4 In-lab

The lab requires you to go through all the stages of the design process using Xilinx and Digilab tools. You will be designing and functionally testing your design in Xilinx CAD software. Then you will verify your design on the board as well.

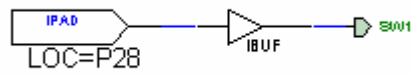
1. Start the Xilinx project manager, configure the device and name the project as lab3.
2. Create schematic for the lab.
  - Start by importing the schematic of Lab2.
  - Create a macro for the circuit bounded by the shaded box shown in Figure 3.1 (Notice that this part is repeated three times in the circuit). Call this macro MACRO31.
  - Redo the circuit replacing the repeated parts with MACRO31.
  - Perform an integrity test. Check to see if there are any warnings and remove them.
  - Open a new schematic.
  - Add an input pad with its input buffers, and constraint it to SW1 (P28) as shown in Figure 3.2.
  - Repeat the last two steps for the other seven switches.
  - Do the same thing for the LED (LD1 to LD8) connecting output buffer to output pads and constraining them to the LDs as shown in Figure 3.3.
  - On a new schematic, connect the eight switch macros to the eight LED macros as shown in Figure 3.4.
3. Verify functionality of the design.
  - Verify that the LED macros follow the state of the switches macros.
4. Implement the design
  - Download the design on Digilab board
  - Verify the design functionality.

### 3.5 Bonus Staff:

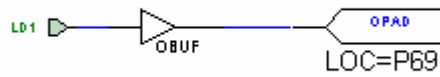
- Analyze the circuit given in Figure 3.1 to find another region where you can use MACRO31.
- Build a two-bit adder using the circuit given in Figure 3.1 as a macro (FA) by connecting them as shown in Figure 3.5.



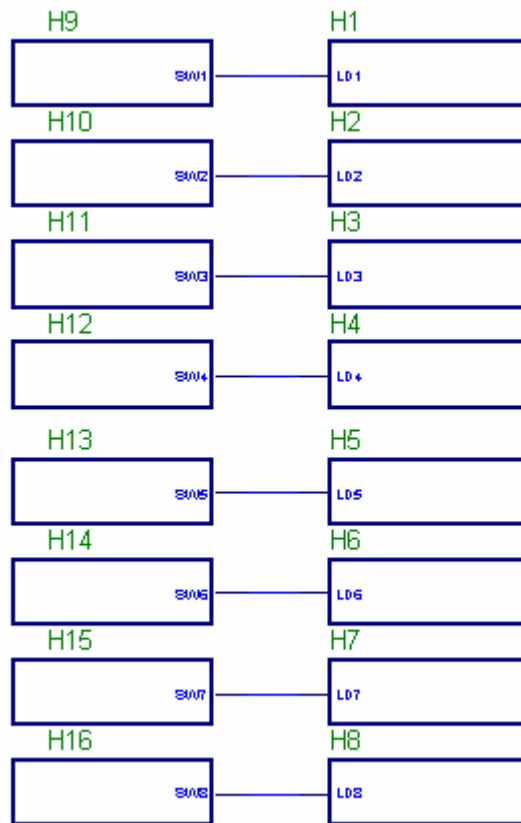
**Figure 3.1: Repeated Sub-Circuits.**



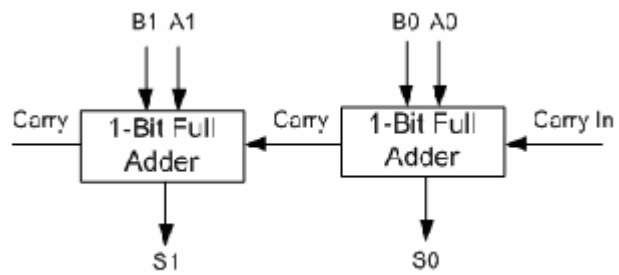
**Figure 3.2: Binding SW1**



**Figure 3.3: Binding LD1**



**Figure 3.4: SW1-8 and LD1-8 Test Macros**



**Figure 3.5: Two-Bit Adder**