

# Embedded Systems I

## Lab 1: Connecting ICs and Basic Logic Circuits with LEDs

### Description:

In this lab you will learn how connect simple standard ICs for some basic logic and to combine logic ICs in order to drive external components such as LEDs. As an example we will use multiplexers will bring down the number of required output pins of  $\mu$ C boards.

### Tasks:

1. Some theory about the 74HCxxx IC family.  
In this task you should make yourself familiar with the documentation.  
(Remark: Please do not go overboard - 10 Minutes is a good period of time to spend on this particular task)
  - Search the Internet for the data sheets of following ICs:
    - 74HC04 (NOT)
    - 74HC08 (AND)
    - 74HC573 (8xLatch)
    - 74HC237 (DeMux 3-8)
  - Find in the data sheets:
    - What is the function of each of the ICs?
    - What input voltage should be applied to the IC inputs?
2. Theory: Circuits with the IC 74HC08
  - Sketch a basic circuit with input signals A, B and output signal  $C=A \text{ AND } B$ . Add a truth table.
  - Sketch a basic circuit with 4 input signals A, B, C, D and an output signal  $E=A \text{ AND } B \text{ AND } C \text{ AND } D$ . Add a truth table.
3. Practice: Build the two circuits from Task 2 with the Digilent Waveforms (DW) board. For each circuit, validate the truth tables by setting some of the inputs and by checking the outputs with the DW board.

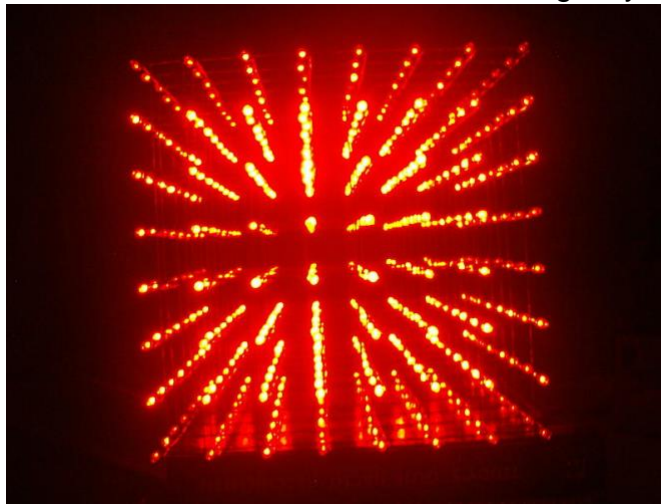
4. Some thoughts on how to control an LED matrix.  
Assume an 8x8 LED matrix with red low power LEDs with following properties:  $U_F = 2V$ ,  $I_F = 6mA$



Figure 1: Example of a LED matrix

- How many output pins of a  $\mu C$  would you need in order to control all LEDs individually? Does this make sense?
  - Applying an Latch with 8 outputs to drive the LEDs, how many latches do you need for all 64 LEDs?
  - Download the data sheet of the 74HC573 (8xLatch)
  - Draw a simple circuit for connecting 8 LEDs to the latch.
  - The 74HC573 offers the possibility to store data. Describe how the input signals of the latch look like to store 8-bit data.
  - Draw a simple circuit for driving all LEDs of the 8x8 matrix with latches.
  - How many output pins of a  $\mu C$  do you need now?
5. Practice: Use the DW board to build parts of the circuit from the previous task.
- Use the 74HC573 to build an 8-LED driver part of the circuit from the previous task
  - Apply different inputs to the circuit and describe the outputs
6. Using latches and demux to control and drive multiple outputs. As we have seen in the previous lab, using 8 output lines to enable particular latches works fine. Since we are mostly interested in updating the data stored in a single latch, we can save output lines using a demultiplexing circuit to control the latches.
- How many output lines do you need now?
  - Sketch a circuit for controlling the matrix with your proposed method, using the latches from above

7. Using the 74HC237 demux
  - Download the data sheet
  - Describe what this circuit does
  - How can we apply the 74HC237 to our circuit from previous tasks?
  - Update/ sketch a diagram
8. (Optional) Using the DW board
  - Use the 74HC237 to build an 8-LED part of the circuit from Task 1
  - Apply different inputs to the circuit and describe the outputs
9. (Optional) 3D LED Cube
  - Describe how we could extend the circuit to drive an 8x8x8 LED cube.
  - Sketch a basic circuit
  - How can we control the entire LED cube using only 8 latches?



*Figure 2: Example of a 8x8x8 LED cube*