DALHOUSIE UNIVERSITY
Department of Electrical & Computer Engineering
Digital Circuits - ECED 2200

Experiment 3 - Decoders, Encoders, and Multiplexers

Objectives:

Using Quartus II:
1. To simulate and implement a 2-4 decoder
2. To design, simulate and implement a 4-2 encoder
3. To design, simulate and implement a Multiplexer (MUX)

Theory:

Decoders
The basic function of a decoder is to detect the presence of a particular combination of bits at the inputs and indicate the presence of that particular set of bits by outputting a specified output level. Typically a decoder with n input lines requires 2^n output lines to decode every possible combination of bits.

Encoders:
An encoder performs the opposite function of a decoder. An encoder takes an input on one of its 2^n input lines and converts it to a coded output with n lines.

Multiplexers:
A multiplexer or MUX is a device that allows digital information from several different sources on different input lines to be routed onto a single line. A basic MUX has several input lines, several data select lines or control signals and one output signal. The input that gets selected to pass to the output is determined by the control signals.

Part 1. Analysis of a Decoder

Procedure:
Construct the circuit as shown on page 3. In this circuit X & Y are the encoded inputs and A, B, C, D are the decoded outputs. For this circuit
1. Simulate and construct the truth table.
2. Implement the 2-4 decoder, and test it completely.

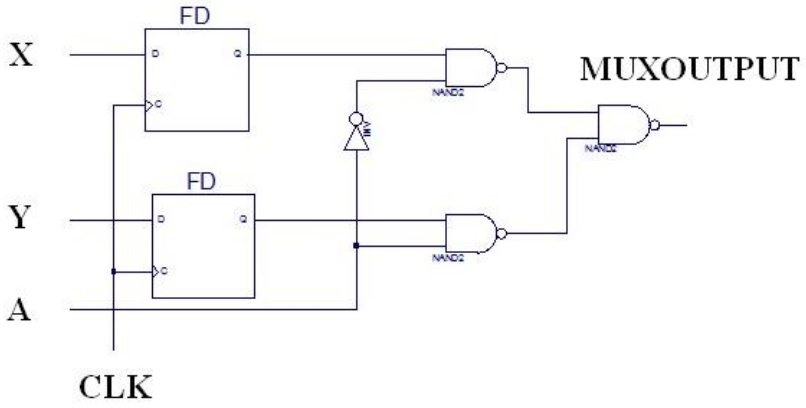
Part 2. Design a 4-2 Encoder

Procedure:
Design a 4-2 encoder. In this circuit A, B, C, D are the four inputs and X & Y are the encoded outputs. The circuit should take an input on one of its 4 input lines and converts it to a coded output with 2 lines.
1. Construct the truth table.
2. Use a K-map to determine the circuitry involved in the encoding process.
3. Simulate, implement, and test your encoder.

Part 3. Design of a MUX

Procedure:

Construct the circuit as shown below. In this circuit X & Y are input data lines and A is the control signal used to select the input X or Y. MUXOUTPUT is the multiplexed output. Two Flip_Flop components are added between the input lines and the NAND gates. The symbols can be found by selecting 'dff' component in the Primitives->Storage folder.



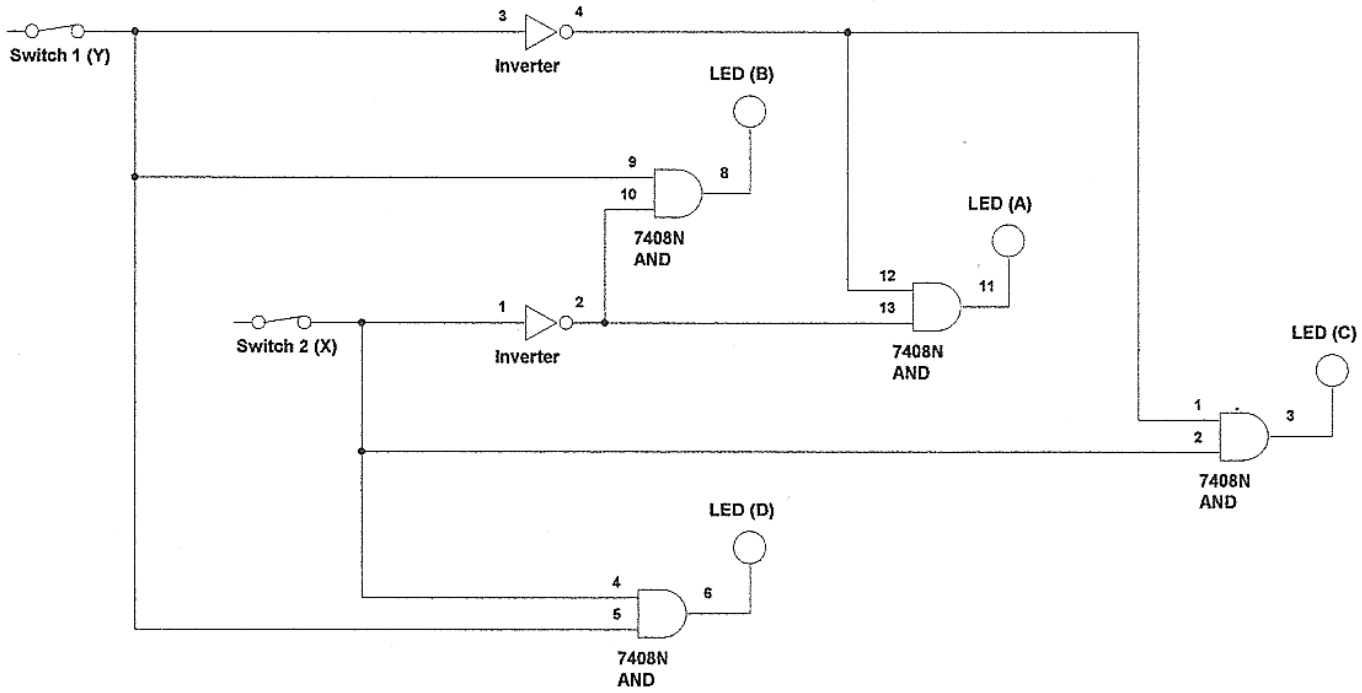
For this circuit:

1. Connect X, Y and A to the switches, and CLK to the 50 kHz clock input.
2. Simulate and implement the circuit.

Note: to simulate the flip flops you will need to manually set the time resolution for the simulation. In the command window in Questasim, run the command "Vsim work.tut_1 -t 1ps" or "vsim -t 1ps work.tut_1"

3. Vary the inputs and control signal to determine which data input line gets activated by different control signal. Is the circuit performing as a multiplexer? Explain.
4. Try toggling a selected input. For instance, have control switch A low and toggle input switch X a few times at a fast pace. Does the system output always follow the high or low implied by the input switch?
5. Now go back to the schematic diagram of the circuit, change the frequency of the CLK signal to 1 Hz. Repeat Steps 2-4. Does the system output always follow the high or low implied by the input switch? What is the function of the flip-flops?

2-4 Decoder



Vcc = 5V at Pin 14 on each IC
Ground is at Pin 7 on each IC

Title: Digital Circuits		
Laboratory 3		
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