

Experiment # 7

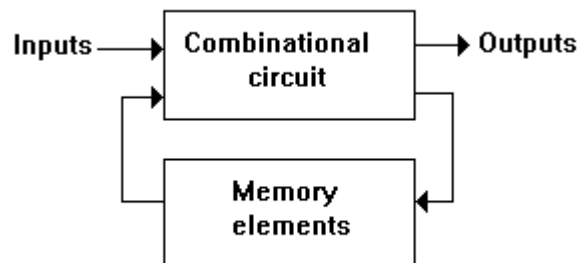
Design of Synchronous Sequential circuit

1- INTRODUCTION:

All circuits encountered in the previous experiments are combinational digital circuits. But in this session we will deal with another kind of digital circuits, the sequential circuits.

The output of a combinational circuit is a function of the present inputs. Only while the output of a sequential circuit is a function of the inputs and the state depending on previous inputs. Sequential circuits are very important in real applications since they form the basis of registers, memories, and state machines.

A block diagram of a sequential circuit is shown below. It consists of a combinational circuit and memory elements which are capable of storing binary information. The binary information stored in the memory elements at any given time defines the state of the sequential circuit. The binary information from the external inputs and the present state stored in the memory elements determine the binary value of the output terminals. The outputs in a sequential circuit are a function of the inputs and the present state of the memory elements. The next state of the memory elements is also a function of the external inputs and the present state. Thus, a sequential circuit is specified by the time sequence of inputs, outputs, and internal states. Sequential circuits may or may not have external outputs.



2- EQUIPMENTS:

Type of IC	description
7473	JK flip flop
7404	inverter
7408	AND gate
7486	XOR gate

3- PROCEDURE:

When designing a sequential circuit, a representation of state transition is required; this can be a state table, a state diagram or a verbal description of the transmission. Some steps are followed throughout the design. These steps are explained in details in the textbook; but here is a summary of these steps:

- 1) Specify the state transmission
- 2) Assign binary values to each state
- 3) Specify the number of required FFs, their type and label them with letters
- 4) Derive the excitation tables
- 5) Simplify the circuit and derive the output functions and the FFs input functions
- 6) Draw the logic diagram
- 7) Implement the circuit and test its operation

Now, follow the design steps mentioned above to design and implement a simple sequential circuit :

a- Specify the state transition

Each state will go to next higher states and then it loops back.

The state table will look like:

Present state		input	Next state	
0	0	0	0	1
0	0	1	0	0
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	0	0
1	1	1	1	1

b- Assign binary values to each state

There are four states, numbered 0,1,2 and 3

c- Specify the number of required FFs, their type and label them with letters

Since there are four states, and each FF can represent two states, then here we need two FFs. We will choose JK FFs. And name them as A and B.

d- Derive the excitation tables

The excitation table lists the required inputs for a certain change in the state, along with the FFs input functions. Before deriving this table, review the excitation table for the JK FF.

Q(t)	Q(t+1)	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

Now, complete the following excitation table for the circuit:

Present state		input	Next state		Flip flop inputs			
A	B	X	A	B	JA	KA	JB	KB
0	0	0	0	1				
0	0	1	0	0				
0	1	0	1	1				
0	1	1	1	0				
1	0	0	1	1				
1	0	1	1	0				
1	1	0	0	0				
1	1	1	1	1				

- e- Simplify the circuit and derive the output functions and the FFs input functions

Use the K-map to derive and simplify the Flip-flop input functions

JB=

KB=

JA=

KA=

- f- Draw the logic diagram

Given the FF input function, draw the logic diagram for the counter.

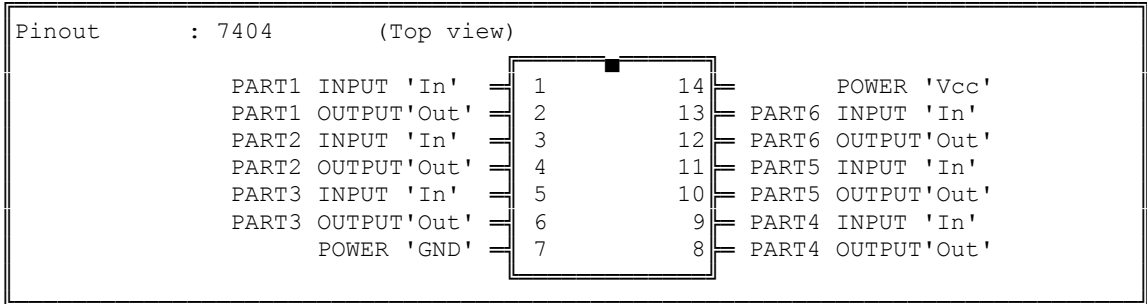
- g- Implement the circuit and test its operation

4- CONCLUSION

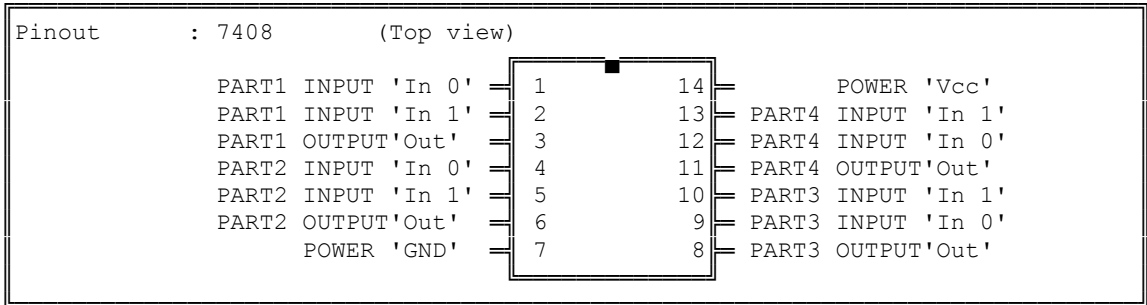
Write your conclusions about the experiment.

Pin-out for ICs

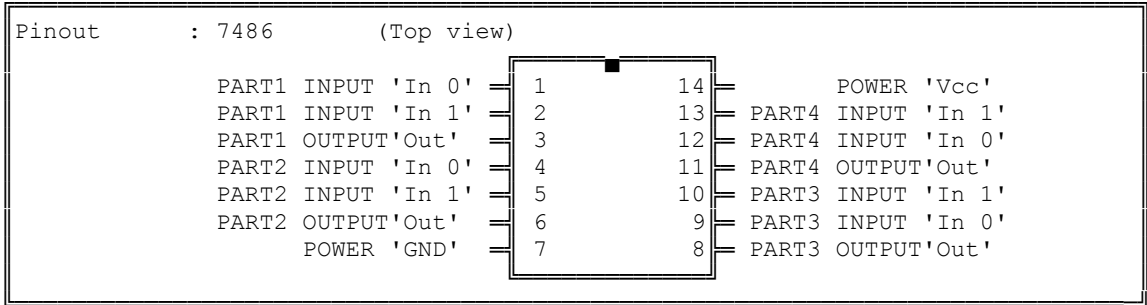
Function : INVERTER



Function : 2-input-AND Gate



Function : 2-inpt XOR Gate



Function : JK flip flop

