MIT World Peace University

Digital Electronics and Computer Architecture
Second Year B. Tech, Semester 3

Design a sequence detector to detect the bit sequence 110 using Mealy Machine.

Practical Report
Assignment 6

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December 2, 2022

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1 Objectives

1. To learn Finite State Machine
2. To understand Moore and Mealy Machine
3. To learn and implement Sequence Detector

2 Problem Statement

Design a sequence detector to detect the bit sequence 110 using Mealy Machine.

3 ICs Used

1. IC7408 (AND Gate)
2. IC7476 (Dual Master Slave JK Flip Flop)

4 Platform Used

Digital Trainer Kit

5 Theory

5.1 Application of state machine

A state machine is any device storing the status of something at a given time. The status changes based on inputs, providing the resulting output for the implemented changes. A finite state machine has finite internal memory.

They are used in applications where distinguishable sates exist. Each state can lead to one or multiple states and can also end the process flow. A state machine relies on user input and its original state calculation to determine to which state to go to next.

5.2 Comparison Mealy Machine with Moore Machine

5.2.1 Mealy Machine

1. Output depends on the present state as well as present input.
2. Mealy machine places its output on transition.
3. Less number of states are required.
4. Asynchronous output generation.

5.2.2 Moore Machine

1. Output depends only upon the present state.
2. Moore machine also places its outputs on transition.
3. Moore states are required.
4. Synchronous output and state generation.

5.2.3 Sequence detector circuit

A sequence detector is a sequential circuit that outputs certain data when a particular pattern of bits sequencitally arrives at its data input.

5.3 Involved Truth Tables

5.3.1 AND Gate

A	B	Q
0	*0*	*0*
0	*1*	*1*
1	*0*	*1*
1	*1*	*1*

5.3.2 Function Table of the IC7476

Function Tables:

Inputs					Outputs	
$\overline{PRE}$	$\overline{CLR}$	CLK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H †	H †
H	H	⎍	L	L	Q_0	$\overline{Q}_0$
H	H	⎍	H	L	H	L
H	H	⎍	L	H	L	H
H	H	⎍	H	H	Toggle	

† This configuration is nonstable; that is, it will not persist when wither preset or clear returns to its inactive (high) level.

Figure 1: Function Table for IC 7476

6 Pin Diagrams of ICs Used

6.1 Pin Diagram of IC7476

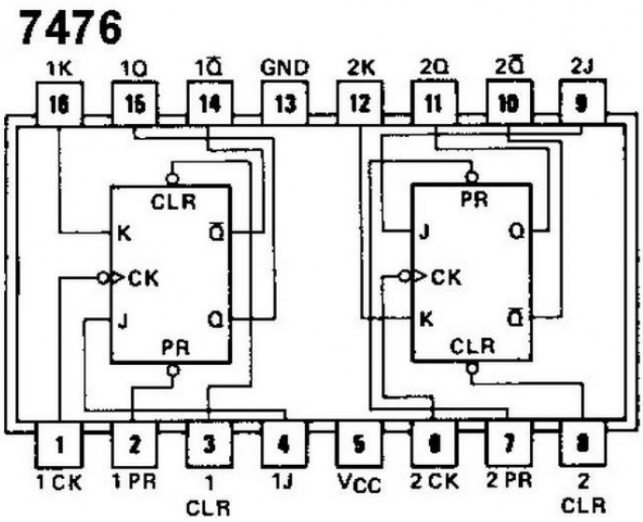


Figure 2: Pin Diagram for IC 7476

6.2 Pin Diagram of IC7408

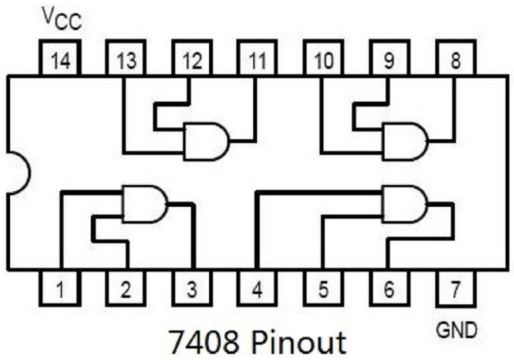


Figure 3: Pin Diagram for IC 7408

7 Design and Implementation

7.1 State Diagram

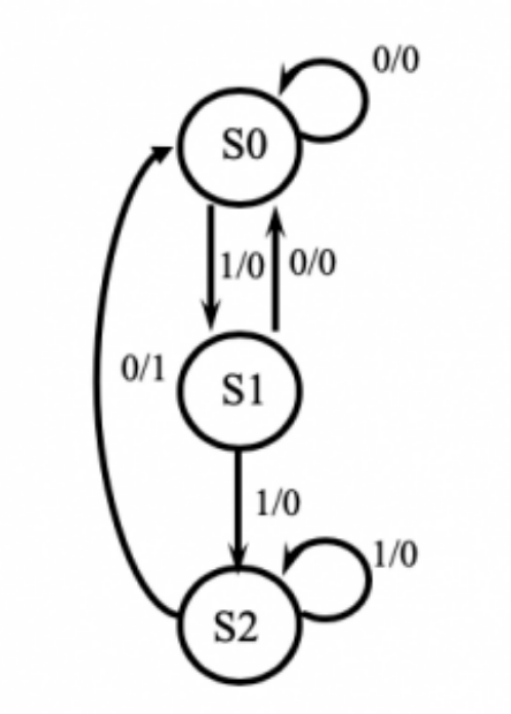


Figure 4: State Diagram

7.2 State Transition Table

Present State		**Input Next State**			**Flip Flop Input**				**Output**
Qa	**Qb**	**X**	**Qa+1**	**Qb+ 1**	**Ja**	**Ka**	**Jb**	**Kb**	**Y**
0	0	0	0	0	0	X	0	X	0
0	0	1	0	1	0	x	1	x	0
0	1	0	0	0	0	x	x	1	0
0	1	1	1	0	1	x	x	1	0
1	0	0	0	0	x	1	0	x	1
1	0	1	0	1	x	1	1	x	0
1	1	0	x	x	x	x	x	x	x
1	1	1	x	x	x	x	x	x	x

7.3 State Assignment

A = 00 B = 01 C = 10

8 K-Maps

		Q_BQ_A = 00	01	11	10
1	0	0	0	1	0
	1	X	X	X	X

$$J_A = Q_{a+1}X$$

		Q_BQ_A = 00	01	11	10
1	0	0	X	X	X
	1	X	X	X	X

$$K_A = 1$$

		Q_BQ_A = 00	01	11	10
1	0	0	1	X	X
	1	0	1	X	X

$$J_B = X$$

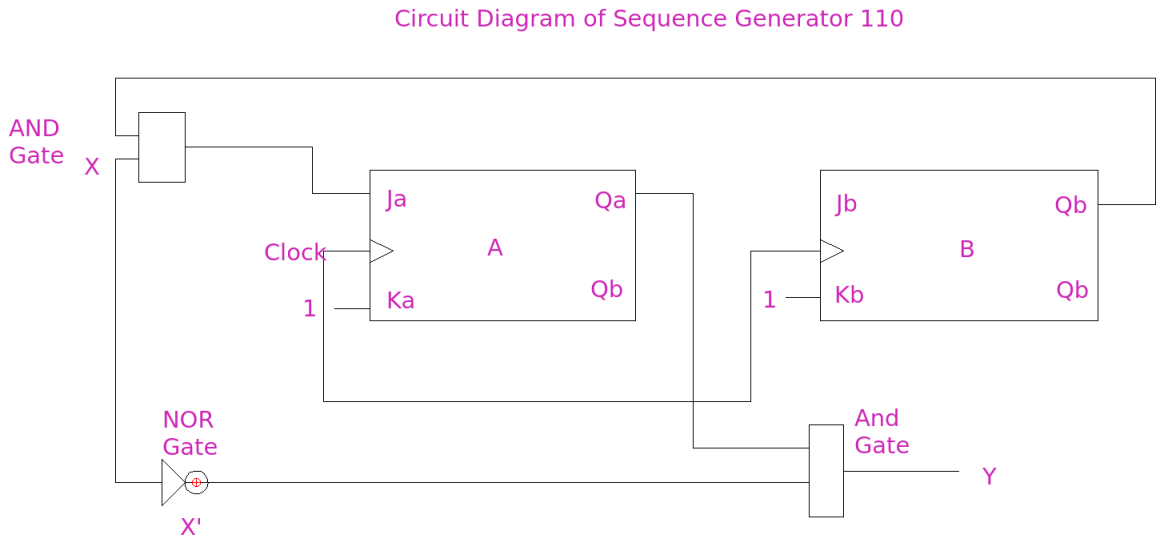
		Q_BQ_A = 00	01	11	10
1	0	X	X	X	X
	1	X	X	X	X

$$K_B = 1$$

		Q_BQ_A			
		00	01	11	10
1	0	0	0	0	0
	1	1	0	X	X

$$Y = Q_a\bar{X}$$

9 Circuit Diagram



10 Procedure

1. Draw state diagram
2. Make a state table
3. Apply state reduction if required
4. Assign states
5. Re-write the state table using states assigned
6. Prepare state transition table
7. Use k-maps to find inputs to Flip Flop
8. Draw the circuit diagram.

11 Conclusion

Thus, we have learnt a about Working of Mealy Machines. State diagrams, transition diagrams and conversion of K-maps to Boolean expressions were also studied. We have also learnt how to design a Mealy Machine using the above mentioned concepts.

12 FAQs

1. What is Sequence Detector?

   A sequence detector is a sequential circuit that outputs 1 when a particular pattern of bits sequentially arrives at its data input. The figure below shows a block diagram of a sequence detector. It has two inputs and one output. The inputs are the clock used to synchronize the functionality of the circuit and the data input.

   Sequence detector is of two types:

   - Overlapping
   - Non-Overlapping

   In an overlapping sequence detector, the last bit of one sequence becomes the first bit of the next sequence. However, in a non-overlapping sequence detector, the last bit of one sequence does not become the first bit of the next sequence. In this post, we'll discuss the design procedure for non-overlapping 101 Mealy sequence detectors.

2. What are applications of Sequence Detector?

   - Sequence detectors are used in the decoding equipment on the ground to provide "flags" which indicate the beginning (or end) of a data block (e.g., a TV frame).
   - They can be used to detect if a bunch of states in a circuit occur in a particular desired pattern.