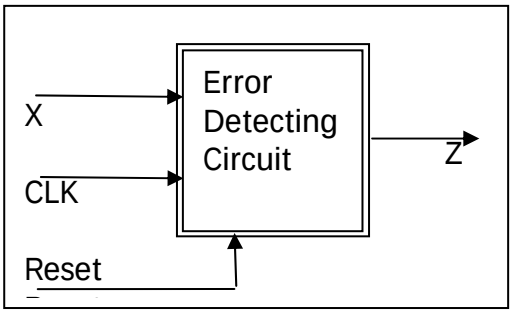
Mealy Machine

Example 1

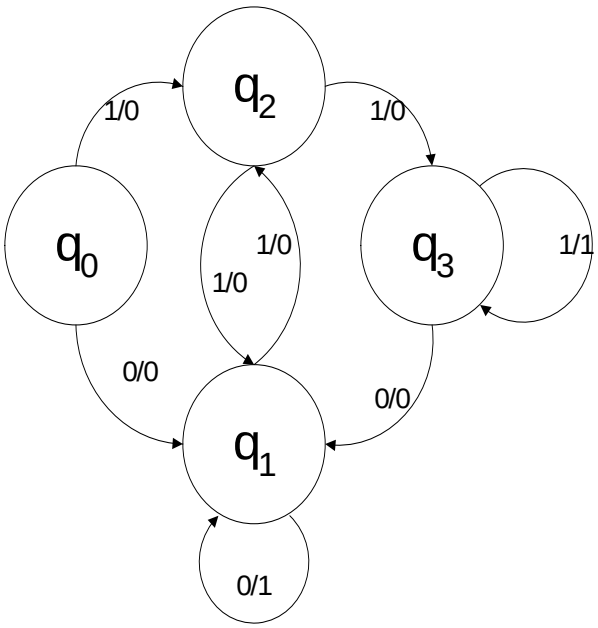
Design an error detector for the following sequential circuit. The circuit has a single input x and a single output z. Data arrive serially on x synchronized with the clock. The output z (an error) should be "1" whenever two consecutive zeroes or three consecutive ones appear on line x. Implement the circuit using D, JK, RS and T flip-flops.



Examples of input/output

x	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	1
z	0	1	0	0	1	1	1	0	1	1	0	0	1	0	1	0
clk	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑

State Diagram:



State assignment
Assign the following state arbitrary:
q_0=00
q_1=01
q_2=10
q_3=11

State Transition Table :

Present state	Next state, output	
	x=0	x=1
$y_1\ y_0$	$y_1\ y_0$ / z	$y_1\ y_0$ / z
0 0	0 1, 0	1 0, 0
0 1	0 1, 1	1 0, 0
1 0	0 1, 0	1 1, 0
1 1	0 1, 0	1 1, 1

$$\text{error} = z = \bar{y}_1 y_0 \bar{x} + y_1 y_0 x$$

D, JK, T, RS Transition Table:

present→next state	D	J			K		T	R			S	
0→0	0	store reset	0 0	0	0 1	x	0	store reset	0 1	x	0 0	0
0→1	1	set invert	1 1	1	0 1	x	1	set set	0 0	0	1 1	1
1→0	0	reset invert	0 1	x	1 1	1	1	reset reset	1 1	1	0 0	0
1→1	1	store set	0 1	x	0 0	0	0	store set	0 0	0	0 1	x

State transition table of the circuit to design

Present state	Next state	
	x=0	x=1
$y_1\ y_0$	$y_1\ y_0$	$y_1\ y_0$
0 0	0 1	1 0
0 1	0 1	1 0
1 0	0 1	1 1
1 1	0 1	1 1

1. D-FF implementation

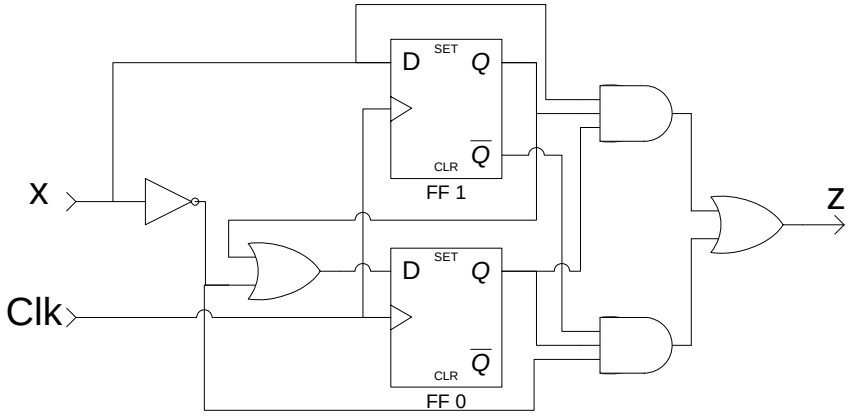
$y_1\ y_0$ \ x	0	1
00	0	1
01	0	1
11	0	1
10	0	1

$$y_1^+ = D_1 = x$$

$y_1\ y_0$ \ x	0	1
00	1	0
01	1	0
11	1	1
10	1	1

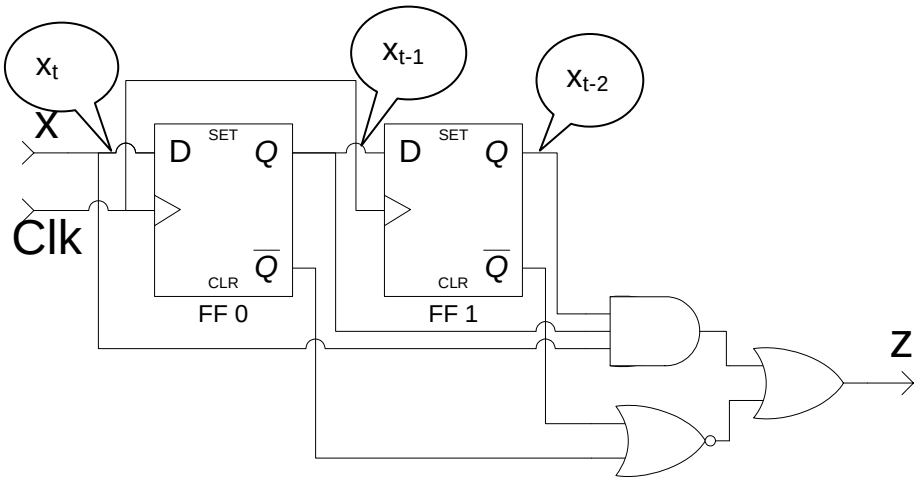
$$y_0^+ = D_0 = \bar{x} + y$$

Circuit Diagram of implementation with a D-Flip Flop



OR: Directly from Specification:

X_t =Present Input, X_{t-1} Previous input, X_{t-2} two clock passed previous input



2. JK-implementation

$y_1\ y_0$ \ x	0	1
00	0	1
01	0	1
11	x	x
10	x	x

$$J_{y_1} = x$$

$y_1\ y_0$ \ x	0	1
00	x	x
01	x	x
11	1	0
10	1	0

$$K_{y_1} = \overline{x}$$

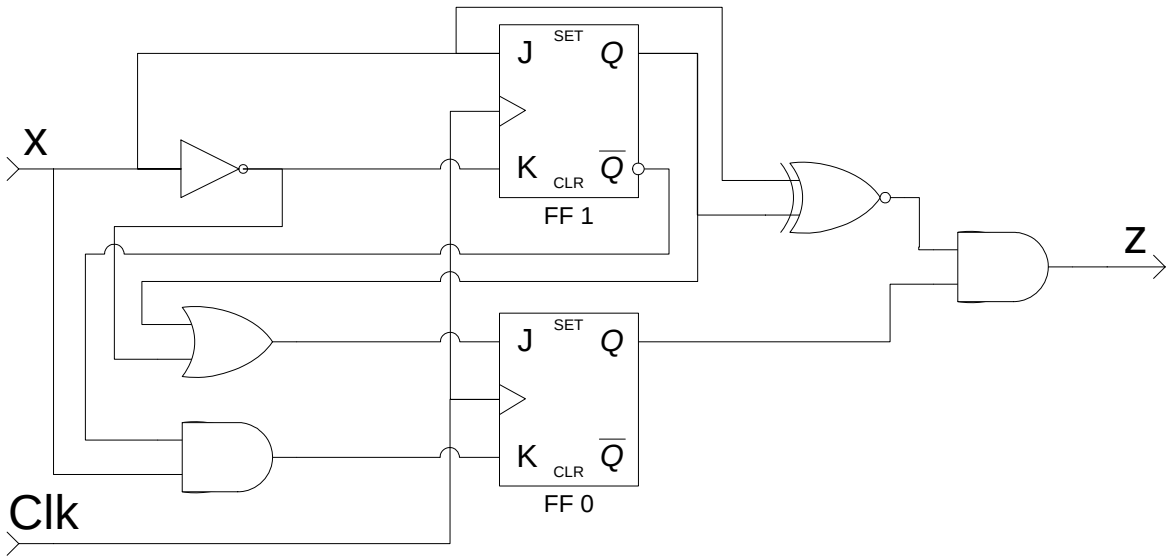
$y_1\ y_0$ \ x	0	1
00	1	0
01	x	x
11	x	x
10	1	1

$$J_{y_0} = \overline{x} + y_1$$

$y_1\ y_0$ \ x	0	1
00	x	x
01	0	1
11	0	0
10	x	x

$$K_{y_0} = x\overline{y}_1$$

Circuit Implementation



3. T-implementation

$y_1\ y_0$ \ x	0	1
00	0	1
01	0	1
11	1	0
10	1	0

$$T_1 = \bar{x}y_1 + x\bar{y}_0$$

$y_1\ y_0$ \ x	0	1
00	1	0
01	0	1
11	0	1
10	1	0

$$T_0 = \bar{x}y_0 + x\bar{y}_0 = x \oplus y_0$$

Circuit Implementation