Lab 5: Design of Digital Stop Watch (*counter0to5 and decoder0to5*)

Objective:

* To design a Digital Stop Watch using concepts of digital system partitioning

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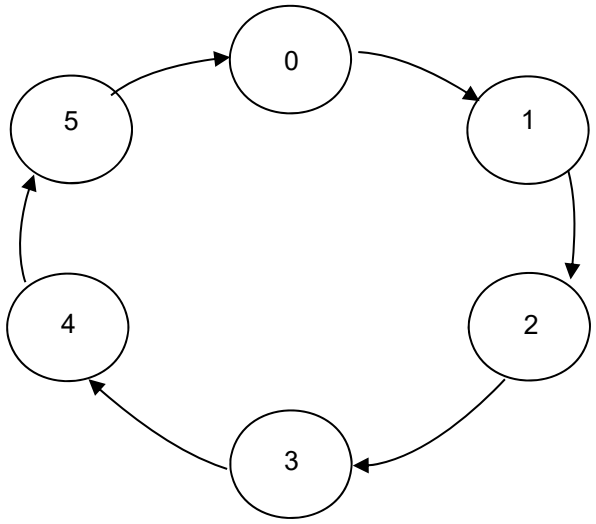
Digital design – *3-bit synchronous counter (counter0to5)*

Step 1

Draw a State diagram corresponding to the counter



State diagram

Step 2

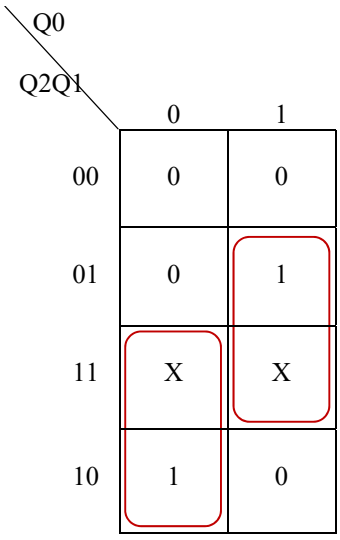
From the State diagram prepare the Transition table

Present State			Next State		
Q2	Q1	Q0	Q2*	Q1*	Q0*
0	0	0	0	0	1
0	0	1	0	1	0
0	1	0	0	1	1
0	1	1	1	0	0
1	0	0	1	0	1
1	0	1	0	0	0
1	1	0	X	X	X
1	1	1	X	X	X

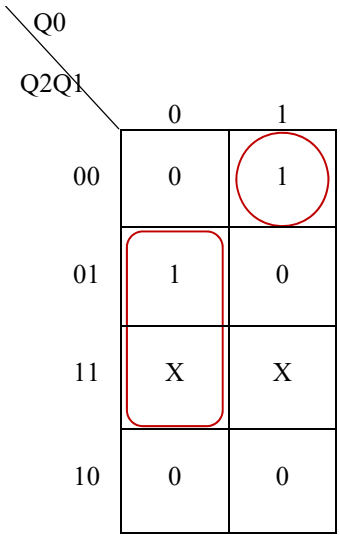
Transition table

Step 3

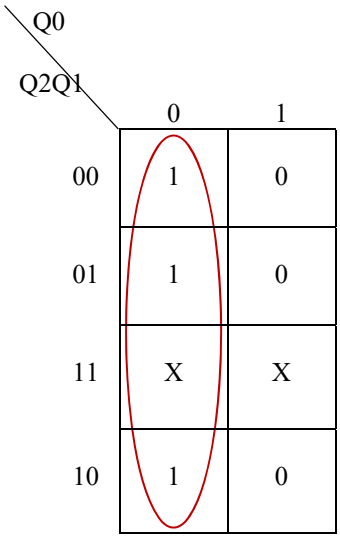
Use K-maps to determine the excitation equations (D/Q*)



Q2* = D2 = Q2.Q0B + Q1.Q0



Q1* = D1 = Q1.Q0B + Q2B.Q1B.Q0



Q0* = D0 = Q0B

Digital Stop Watch – *counter0to5*

Reference Lab 3 to complete *counter0to5*

1. Draw the ***counter0to5*** circuit as shown in Figure 5.1.

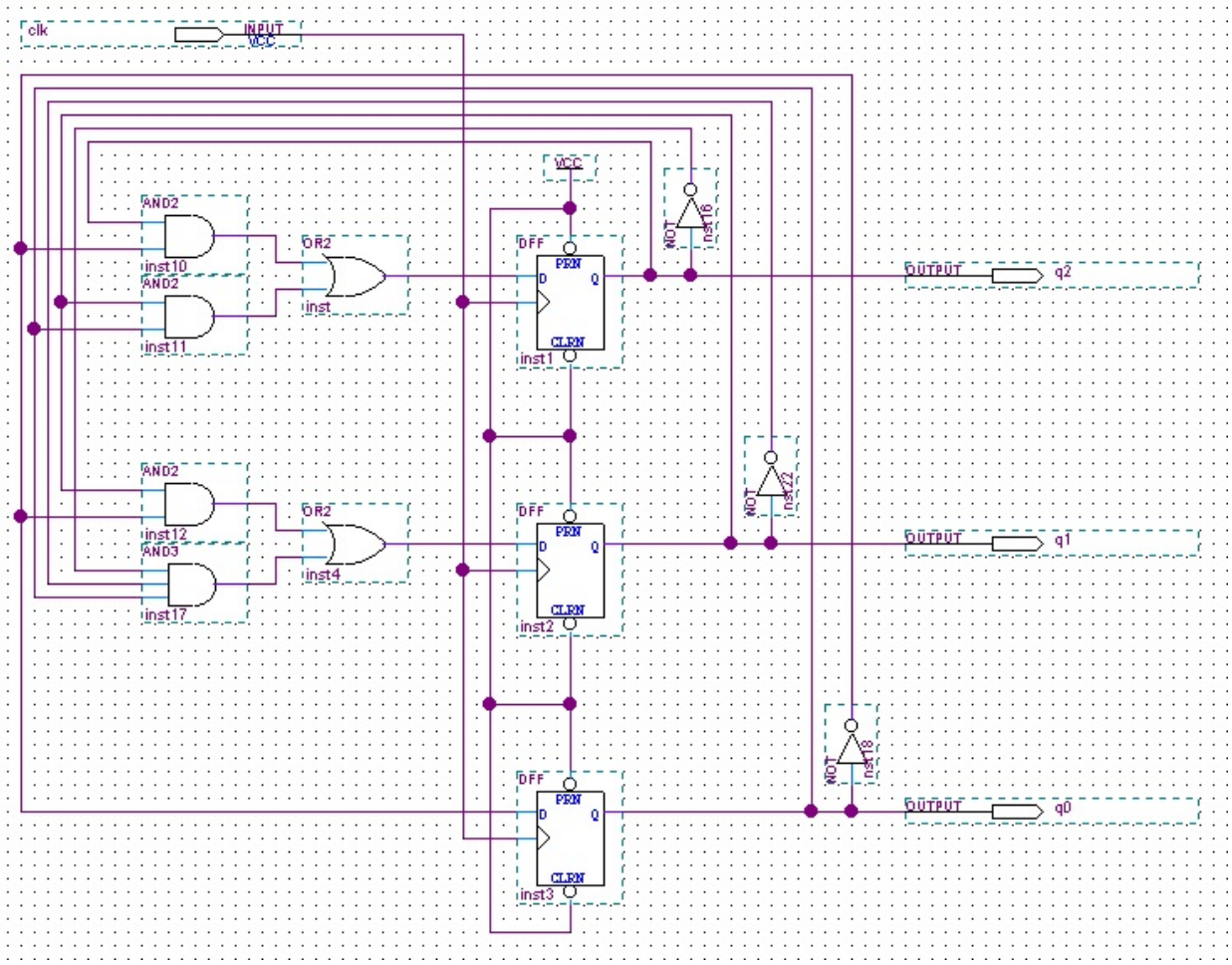


Figure 5.1 *counter0to5* circuit

Symbols used: and2, and3, or2, not, dff and vcc

Pins used: input and output

Input pin name: clk

Output pins names: q2, q1 and q0

2. Create symbol for the ***counter0to5*** circuit and complete the circuit as shown in Figure 5.2 and Click ***File > Save***. Compile the circuit and ensure no error. Ignore warning/s.

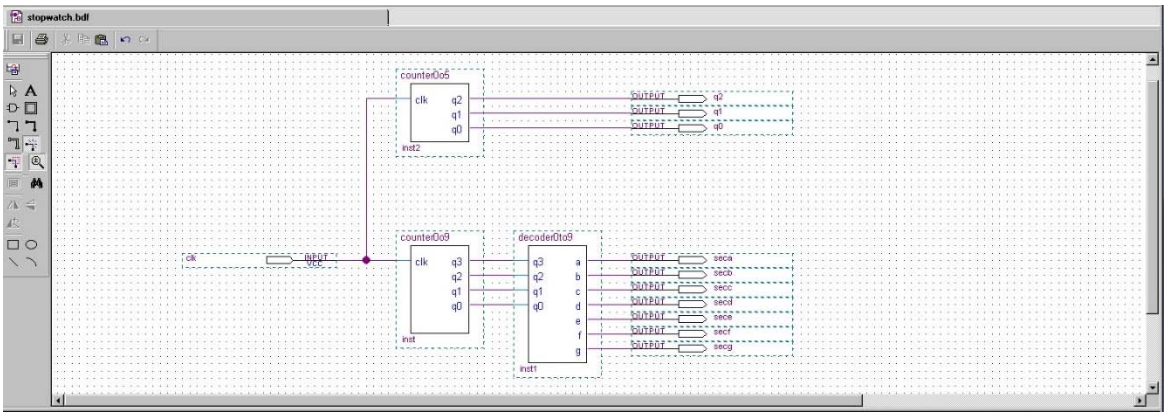


Figure 5.2 *stopwatch.bdf* with *counter0to9, decoder0to9 and counter0to5* symbols connected

3. Update/edit the stopwatch Vector Waveform File – ***stopwatch.vwf*** to test the *counter0to5* circuit as shown in Figure 5.3. (Refer to Lab 1 if you have forgotten how to create/edit Vector Waveform File).

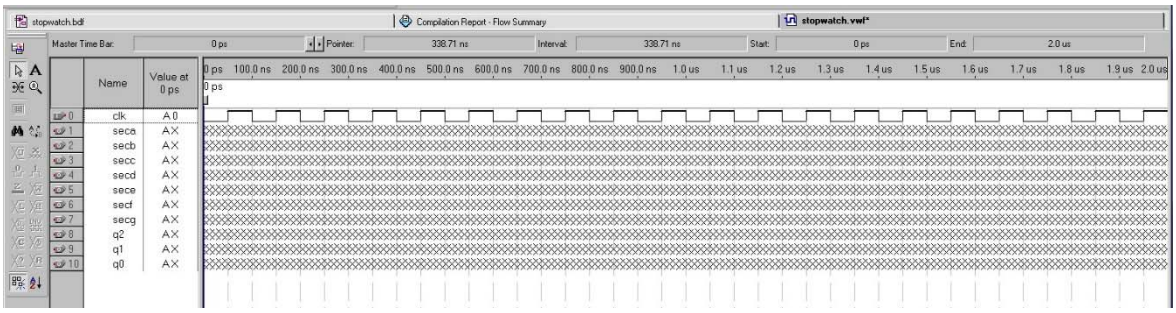


Figure 5.3 *stopwatch* Vector Waveform File

4. Simulate the circuit to obtain results as shown in Figure 5.4.

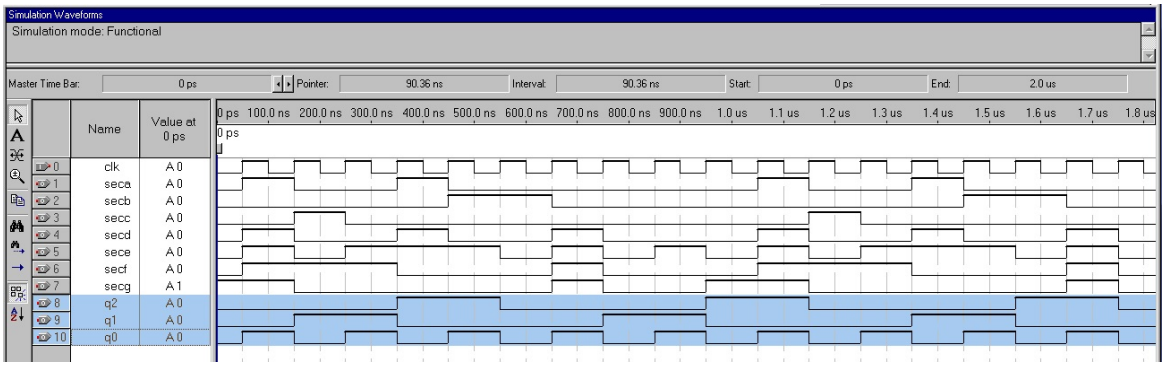
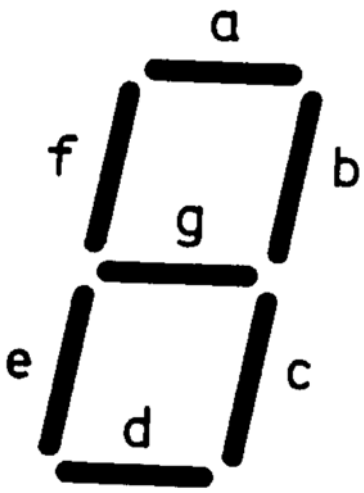
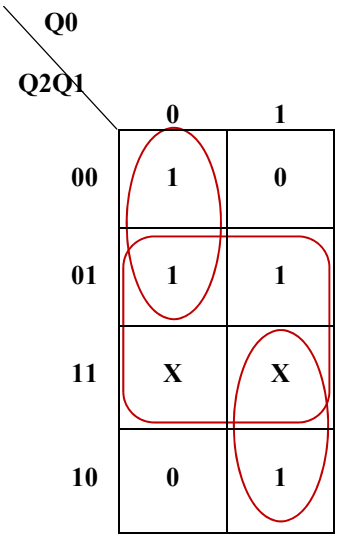


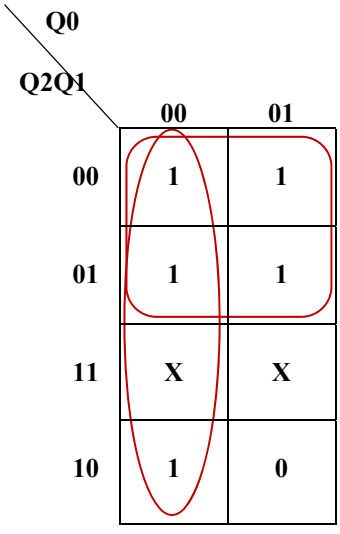
Figure 5.4 *stopwatch* (*counter0to5*) waveform

Digital design – 7 segment decoder (*decoder0to5)*

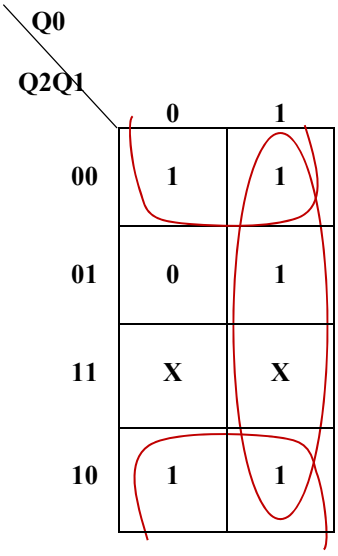




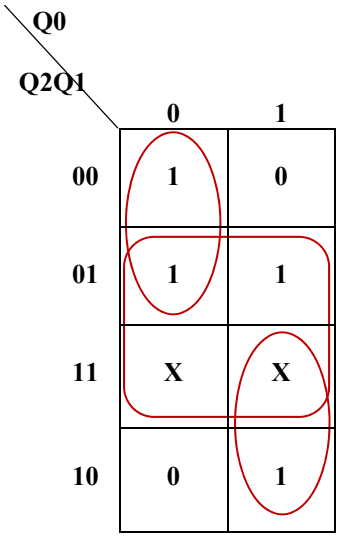
a = Q2Q0 + Q1 + Q2BQ0



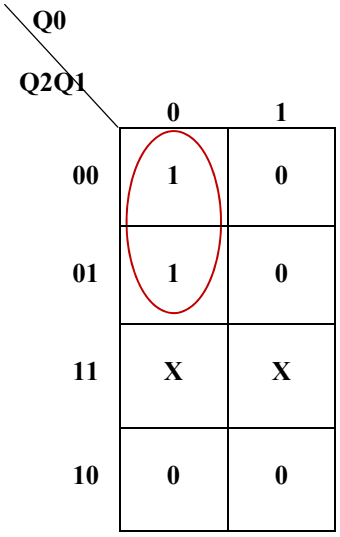
b = Q2B + Q0B



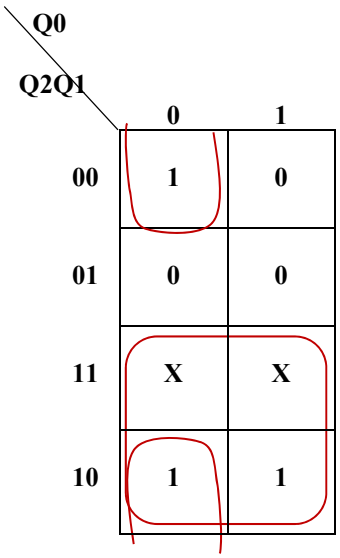
c = Q1B + Q0



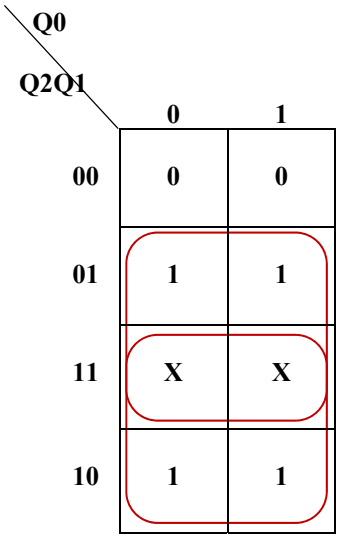
d = Q2BQ0B + Q2Q0 + Q1



e = Q2BQ0B



f = Q2 + Q1BQ0B



g = Q2 + Q1

Digital Stop Watch – *decoder0to5*

Reference Lab 3 to complete *decoder0to5*

1. Draw the ***decoder0to5*** circuit as shown in Figure 5.5.

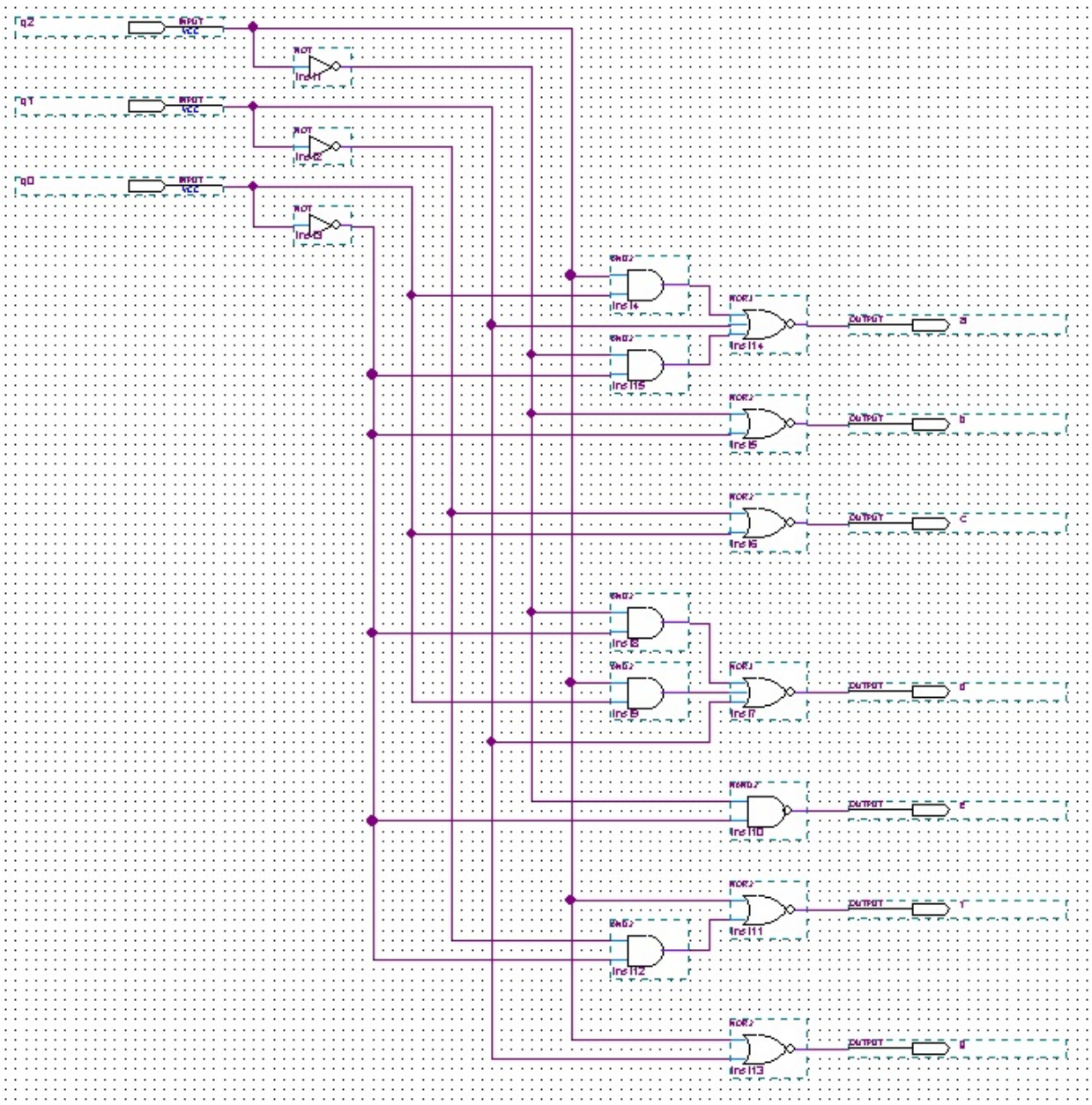


Figure 5.5 *decoder0to5* circuit

Symbols used: and2, nand2, nor2, nor3 and not

Pins used: input and output

Input pin name: q2, q1 and q0

Output pins names: a, b, c, d, e, f and g

2. Create symbol for the ***decoder0to5*** circuit and complete the circuit as shown in Figure 5.6 and Click ***File > Save***. Compile the circuit and ensure no error. Ignore warning/s.

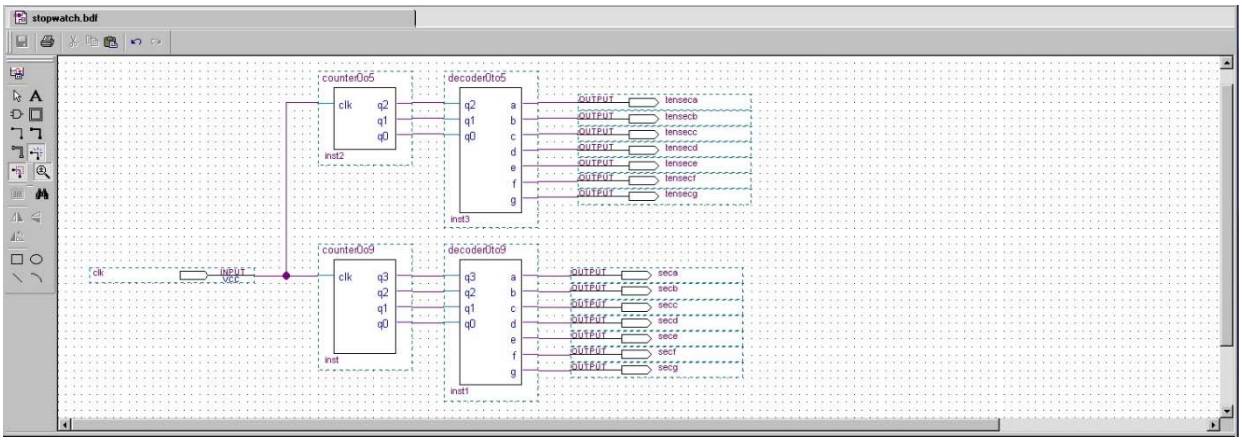


Figure 5.6 *stopwatch.bdf* with *counter0to9, decoder0to9, counter0to5* and *decoder0to5* symbols connected

3. Update/edit the stopwatch Vector Waveform File – ***stopwatch.vwf*** to test the *decoder0to5* circuit as shown in Figure 5.7. (Refer to Lab 1 if you have forgotten how to create/edit Vector Waveform File).

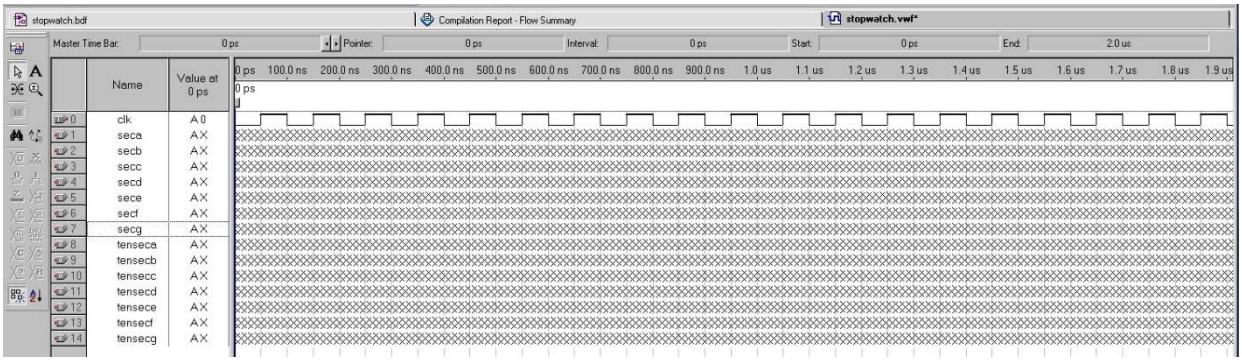


Figure 5.7 *stopwatch* Vector Waveform File

4. Simulate the circuit to obtain the results as shown in Figure 5.8. Verify the decoder0to5 outputs using Table 5.1

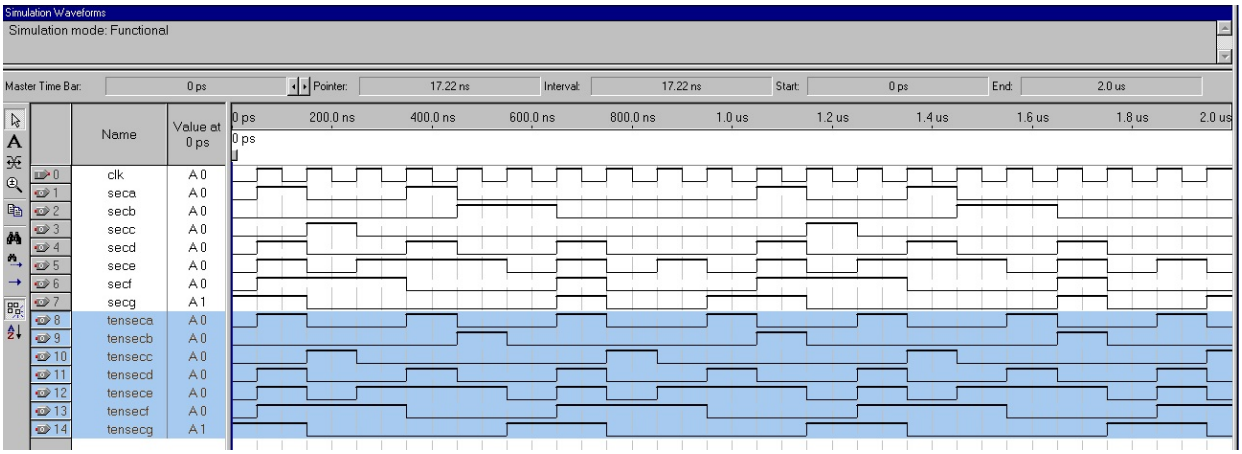


Figure 5.8 *stopwatch* (*counter0to5*) waveform

Count	*0*	*1*	*2*	*3*	*4*	*5*
Time	*0ns*	*100ns*	*200ns*	*300ns*	*400ns*	*500ns*
tenseca	0	1	0	0	1	0
tensecb	0	0	0	0	0	1
tensecc	0	0	1	0	0	0
tensecd	0	1	0	0	1	0
tensece	0	1	0	1	1	1
tensecf	0	1	1	1	0	0
tensecg	1	1	0	0	0	0

Table 4.1 Expected *decoder0to5* outputs