Assignment-5

1) Introduction

In this lab we have used PWM for Brightness control from previous lab and implemented a type of Finite State Machine(FSM) for digit rotation from right to left in a circular way.

2) Implementation Design

Implementation for Brightness control is modified a little bit compare to previou lab implementation because in this case brightness of any 7 segment LED display is not fixed instead brightness corresponding to each digit has 4 level of brightness where 4 levels are decided by 2 bit value or basically 2 switches.

As there are 4 digit whose brightness are to be setup using 8 switches similarly to change input 4 digit we have to use all 16 switches for that. Now as 8 switches are common for brightness control of digits or for changing the 4 digits , to decide which operation users want can be decided by two Pushbuttons.

Pushbuttons switch :

It is an electrical switch actuated by a person's hand motion.

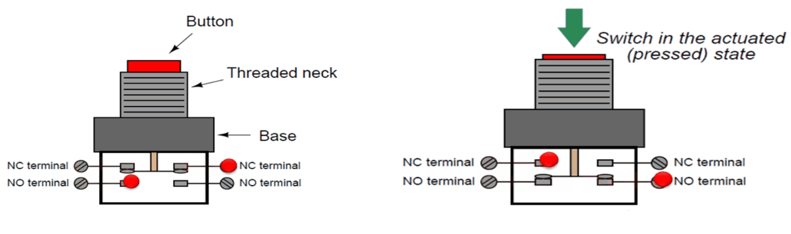
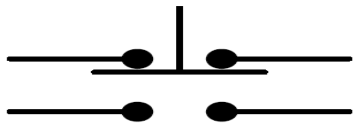


Fig 1 : Working of Push Button



$Fig\ 2:\ Symbol\ of\ Push\ button$

$Some\ important\ concept\ related\ to\ push\ button$

$Debounce:$

$Push\ button\ always\ got\ the\ mechanical\ property\ of\ bouncing\ state$
$within\ microseconds.$

$Fig\ 3:\ Figure\ describes\ the\ debouncing\ output\ result\ when\ pushbutton\ is\ pressed.$

$When\ we\ pull\ down\ the\ push\ button\ from\ high\ to\ low\ state.\ It\ bounce\ back$
$to\ high\ and\ low\ a\ few\ times\ before\ it\ settles\ at\ proper\ output.\ In\ order\ to\ avoid$
$in\ such\ a\ bouncing\ state,\ we\ need\ to\ create\ a\ debounce\ logic\ circuit.$

$Condition\ for\ debouncing\ used\ in\ our\ case:\ To\ ensure\ well\ working\ of\ Push$
$button, we\ checked\ for\ 10\ consecutive\ times\ during\ rising-edge\ of\ clock$
$that\ push\ button\ signal\ value\ to\ be\ "1"\ for\ it\ to\ consider\ it\ a\ stable\ signal.$
$If\ the\ given\ condition\ is\ not\ fulfilled\ then\ we\ will\ reset\ the\ counter\ value\ to\ be\ 0.$

$Let\ me\ now\ define\ the\ Finite\ State\ Machine\ (FSM)\ for\ digit\ rotation\ w.r.t\ boolean\ condition\ to\ be\ satisfied\ to\ be\ in\ a\ particular\ state.$

$We\ have\ define\ a\ integer\ variable\ "counter"\ \ initialise\ to\ "0"\ which\ is\ increment\ by\ 1\ in\ every\ rising\ \ -\ edge\ of\ clock.$

$Let\ S_1, S_2, S_3\ and\ S_4\ be\ state\ of\ digit\ \ on\ 7\ segment\ LED\ display\ from\ left\ to\ right\ respectively.$

Boolean Condition	L_1	L_2	L_3	L_4
0 ≤ (Counter mod 400000000)< 100000000	S_1	S_2	S_3	S_4
100000000≤(Counter mod 400000000) < 200000000	S_2	S_3	S_4	S_1
200000000 ≤ (Counter mod 400000000)< 300000000	S_3	S_4	S_1	S_2
300000000 ≤(Counter mod 400000000)< 400000000	S_4	S_3	S_2	S_1

$Table\ 1:\ \ Rotation\ related\ table\ for\ FSM\ as\ per\ boolean\ condition$

$Note:\ a)\ L_1\ denotes\ the\ leftmost\ 7\ segment\ LED\ display\ ,\ L_2\ is\ on\ right\ of\ L_1\ L_3\ is\ on\ right\ of\ L_2\ and\ L_4\ denote\ the\ rightmost\ 7\ segment\ LED\ display$

$b)\ \ Similar\ logic\ is\ followed\ for\ rotation\ of\ digit\ brightness.$

3) *Simulation Waveform*

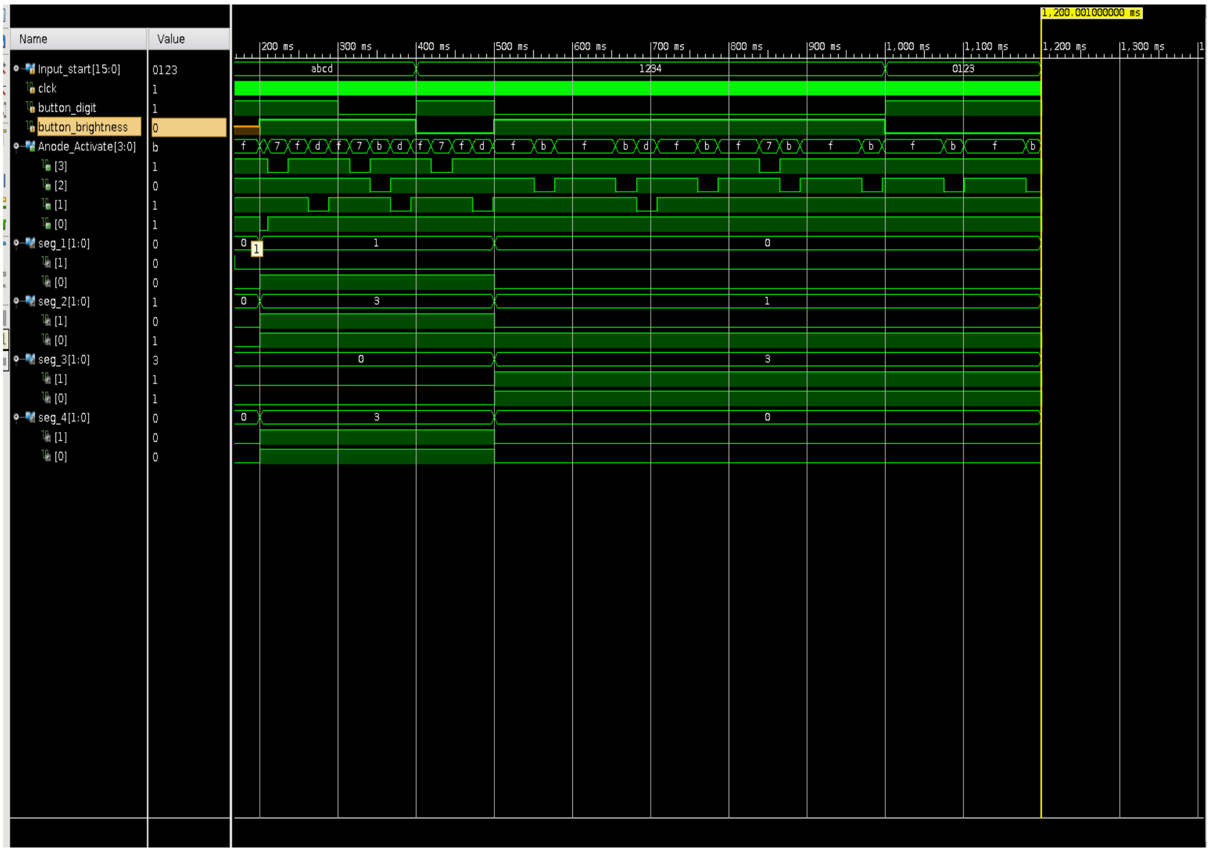


Fig 4 : Waveform of 4 segment LED display with rotation and brightness

4) Digital Circuit for 4 − digit 7 Segment Display with rotation and brightness

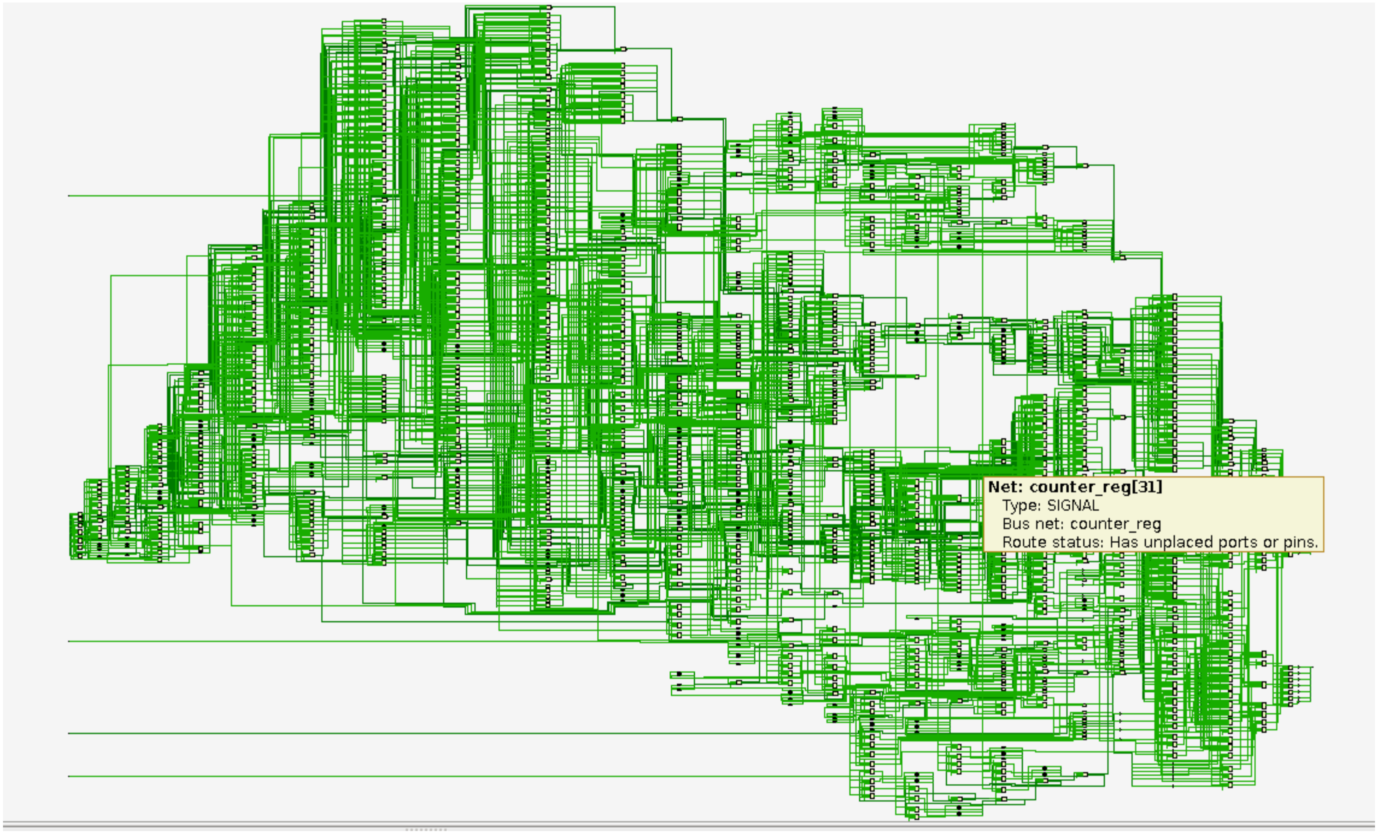


Fig 5 : Complex Digital circuit for LED brightness control and rotation of digit

5) *Resource Utilisation*

a) LUT Memory =0
b) LUT logic = 709
c) DSP =0
d) Flip Flops =150
e) BRAM = 0

6) *Some other relevant diagram for resource utilisation*

Summary

Resource	Utilization	Available	Utilization %
LUT	709	20800	3.41
FF	150	41600	0.36
IO	30	106	28.30

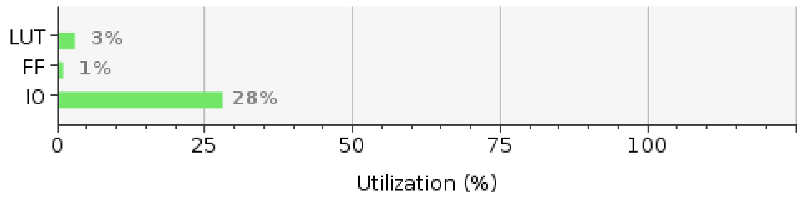


Fig 6 : Summary

Primitives

Ref Name	Used	Functional Category
LUT6	234	LUT
LUT3	220	LUT
LUT1	198	LUT
FDRE	150	Flop & Latch
CARRY4	133	CarryLogic
LUT2	119	LUT
LUT5	83	LUT
LUT4	42	LUT
IBUF	19	IO
OBUF	11	IO
BUFG	1	Clock

Fig 7 : Primitives

Hierarchy				
Name	Slice LUTs (20800)	Slice Registers (41600)	Bonded IOB (106)	BUFGCTRL (32)
LED_scrolling_brightness	709	150	30	1

Fig 8 : Hierarchy

7) *Some photographs of FPGA Board*