Implementation of Boolean Logic by using Arduino with AVR Assembly

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FWC22120 IITH-Future Wireless Communicatons Assignment-1

Contents

1 Problem

(Gate EC-2021)

Q.31. The propogation delays of the XOR gate, AND gate and multipleer (MUX) in the circuit shown in the figure are 4 ns,2 ns and 1 ns, respectively.

If all the inputs P,Q,R,S and T are applied simultaneously and held constant,the maximum propogation delay of the circuit is
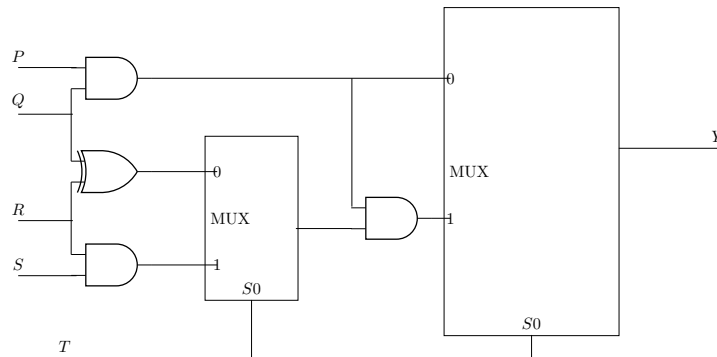

Figure 1: Circuit

1. 3 ns

2. 5 ns

3. 6 ns

4. 7 ns

2 Intoduction

In the given circuit,the output of first multiplexercan be considered as the input to the second multiplexr so that the second multiplexer can be analyzed using 7447 IC for the implementation of output(expression) of the second multiplexer.Since the 7447 IC is just a seven segment display decoder, the output expression of the multiplexer can be given to the LSB representing

pin(7) of the IC so that the output on the deisplay will represent the required answer (0 or 1) with the inputs of the given circuit (P,Q,R,S,T) being given at random.

3 Components

Component	Value	Quantity
Resistor	220 Ohm	1
Arduino	UNO	1
Seven Segment Display		1
Decoder	7447	1
Jumper Wires	M-M	20
Breadboard		1

Table 1: Components

3.1 Arduino

The Arduino Uno has some ground pins,analog input pins A0-A3 and digital pins D1-D13 that can be used for both input as well as output.It also has two power pins that can generate 3.3V and 5V.Inthe following exercises, we use digital pins,GND and 5V .

3.2 Seven Segment Display

The seven segment display has eight pins, a,b,c,d,e,f,g and dot that take an active LOW input,i.e. the LED will glow only if the input is connected to ground.Each of these pins is connected to an LED segment.The dot pin is reserved for the LED.

4 Hardware

1. Make connections between the seven segment display and the 7447 IC as shown in Table2.

7447	$\bar{a}$	$\bar{b}$	$\bar{c}$	$\bar{d}$	$\bar{e}$	$\bar{f}$	$\bar{g}$
Display	a	b	c	d	e	f	g

Table 2: seven segment

2. Connect Vcc of the IC and COM of the display to 5V and the GND pins of the IC and display to the Ground of arduino.

5 Software

1. Now make the connections as per Table3.

7447	D	C	B	A
Arduino	5	4	3	2

Table 3: Connections

2. In the truth table in Table4, P,Q,R,S,T are inputs and Y is output.

P	Q	R	S	T	Y
x	x	0	x	x	0
x	x	x	0	x	0
0	0	x	x	1	0
x	x	1	1	0	1
1	1	1	1	x	1

Table 4: Truth Table

3. The k map for this truth table will be a five variable map.So, two k maps can be drawn with one map having one input variable as zero and the other k map having that input variable as one as shown below.

Figure 2: For Y

4. Since, 7447 is a Seven Segment Display decoder,A represents the LSB and D represents the MSB. So giving the input to A displys either 0 or 1 on the Display.

5. Since, the output of the mux is either 0 or 1, this output of mux i.e, Y can begiven as input to A of the 7447 IC so that the the output of the mux can be observed directly on the display.

6. The boolean expression for the output (Y) of the second mux with the inputs (P,Q,R,S,T) will be simplified as

$$Y = RS(\overline{T} + PQ) \tag{1}$$

Now execute the following code and upload in arduino to realize the Boolean logic for A with y being the input to A.

```
.include "/sdcard/arduino/fwc/assembly/m328Pdef.inc"
ldi r16,0b01111100
out DDRD,r16
ldi r17,0b11111111
out PORTD,r17
ldi r16,0b00000001
out DDRB,r16

loop:
 in r17,PIND

;Taking T
ldi r24,0b00000100
mov r18,r17
and r18,r24
ldi r25,0b00000010
loopt:
lsr r18
dec r25
brne    loopt
.DEF T =r18

;Taking S
ldi r24,0b00001000
mov r19,r17
and r19,r24
ldi r25,0b00000011
loops:
lsr r19
dec r25
brne    loops
.DEF S =r19

;Taking R
ldi r24,0b00010000
mov r20,r17
and r20,r24
ldi r25,0b00000100
loopr:
lsr r20
```

```
dec r25
brne    loopr
.DEF R =r20

;Taking Q
ldi r24,0b00100000
mov r21,r17
and r21,r24
ldi r25,0b00000101
loopq:
lsr r21
dec r25
brne    loopq
.DEF Q =r21

;Taking P
ldi r24,0b01000000
mov r22,r17
and r22,r24
ldi r25,0b00000110
loopp:
lsr r22
dec r25
brne    loopp
.DEF P =r22

ldi r23,0x00
ldi r24,0x00
ldi r26,0x00
ldi r27,0x00
ldi r28,0x00
.DEF A1 = r23
.DEF A2 = r24
.DEF A3 = r26
.DEF A4 = r27
.DEF A5 = r28

mov A2,S
mov A3,R
and A2,A3
mov A4,Q
mov A5,P
and A4,A5
and A4,A2
mov A1,T
com A1
mov A2,S
mov A3,R
and A3,A2
and A1,A3
or A1,A4
out PORTB,A1

rjmp loop

Start:
rjmp Start
```