IMPLEMENTATION OF RANDOM NUMBER GENERATOR IN VAMAN ESP

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FWC22120 IITH-Future Wireless Communications Assignment-6

Contents

1 Problem

(GATE2021-QP-EC)
Q.46 The propogation delay of the exclusive-OR(XOR) gate in the circuit in the figure is 3ns.The propogation delay of all the flip-flops is assumed to be zero.The clock(Clk) frequency provided to the circuit is 500MHz.

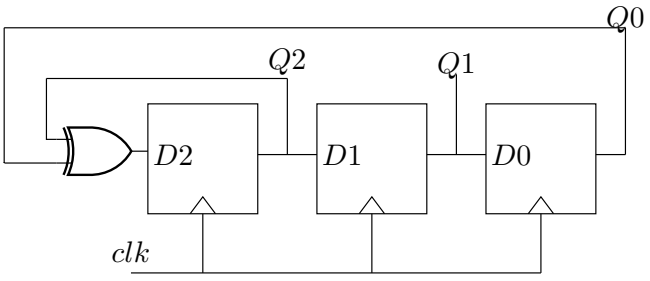

Figure 1: Circuit

Starting from the initial value of the flip-flop outputs $Q2Q1Q0 = 111$ with $D2 = 1$,the minimum number of triggering clock edges after which the flip-flop outputs $Q2Q1Q0$ becomes 1 0 0*(in integer)* is ___

2 Introduction

A random number generator using D flip-flops is a simple digital circuit that generates a sequence of random binary numbers.To implement this type of random number generator, we use a series of D flip-flops connected in a feedback

loop. The output of each flip-flop is fed back into the input of the next flip-flop,creating a circuit that generated a sequence of random binary values.

The feedback loop creates a delay in the circuit,which causes the circuit to exhibit unpredictable behavior.This unpredictable behavior results in a sequence of random binary values. The length of the delay can be adjusted to control the randomness of the output.

3 Components

Components	**Value**	**Quantity**
Breadboard		1
USB-C Cable		1
Vaman		1
Seven Segment Display	Common Anode	1
Decoder	7447	1
Flip Flop	7474	2
Jumper Wires		39

Table 1: Components

3.1 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 Setup

1. Connect the Vaman to the Laptop through USB.
2. There is a button and an LED to the left of the USB port on the Vaman.There is another button to the right of the LED.
3. Press the right button first and immediately press the left button.The LED will be blinking green.The Vaman is now in bootloader mode.

4.1 Steps for Implementation

1. Connect the USB-UART pins to the Vaman ESP32 pins according to Table

VAMAN LC PINS	UART PINS
GND	GND
ENBe	ENB
TXD0	RXD
RXD0	TXD
0	IO0
5V	5V

Table 2: Set Up

2. Flash the following setup code through USB-UART using laptop

https://github.com/Marikundam/fwc/tree/main/latexmath/vaman/esp32/codes/src/code6.cpp

```
svn co https://github.com/Mariku     ndam/fwc/tree/main/latexmath/vaman/esp32/codes/setup
cd  setup
pio run
pio run -t upload
```

after entering your wifi username and password (in quotes below)

```
#define STASSID "..." // Add your network credentials
#define STAPSK  "..."
```

in src/code6.cpp file

3. You can notice that vaman will be connnected to the network credentials provided above.Connect your laptop to the same network ,You should be able to find the ip address of your vaman-esp on laptop using

```
ifconfig
nmap -sn 192.168.85.209
```

where your computer's ip address is the output of ifconfig and given by 192.168.85.x

4. Login to termux-ubuntu on the android device and execute the following commands:

```
proot-distro login debian
cd  /data/data/com.termux/files/home/
mkdir iot
svn co https://github.com/Marikundam/fwc/tree/main/latexmath/vaman/esp32/codes
cd codes
```

5. Assuming that the username is harshitha and password is marikundam, flash the following code wirelessly

https://github.com/Marikundam/fwc/tree/main/latexmath/vaman/esp32/codes/src/code6.cpp

through

```
pio run
pio run -t nobuild -t upload --upload-port ip$_$addres$_$of$_$esp
```

where you may replace the above ip address with the ip address of your vaman-esp.

5 Implementation

A 7474 IC which has 14 pins and can store two seperate binary values.So we consider two IC's since we have three values and connect the D inputs of each flip-flop to the input signals of 7447 IC . Later interface 7447 IC to seven segment display for the output. The CLK input is used to trigger the flip-flop,and the Q output is used to read the stored value.When a positive edge is detected on the CLK input,the current value on the D input is stored in the flip-flop. The boolean expression of the D flip-flop is $Q(t+1) = D$

5.1 Truth table

Present State			Flip-Flop input			Next State		
Q2	Q1	Q0	D2	D1	D0	Q2'	Q1'	Q0'
1	1	1	0	1	1	0	1	1
0	1	1	1	0	1	1	0	1
1	0	1	0	1	0	0	1	0
0	1	0	0	0	1	0	0	1
0	0	1	1	0	0	1	0	0
1	0	0	1	1	0	1	1	0
1	1	0	1	1	1	1	1	1

Table 3: Truth Table

5.2 K-map

Since $Q' = D$,we find the k-maps for D as outputs

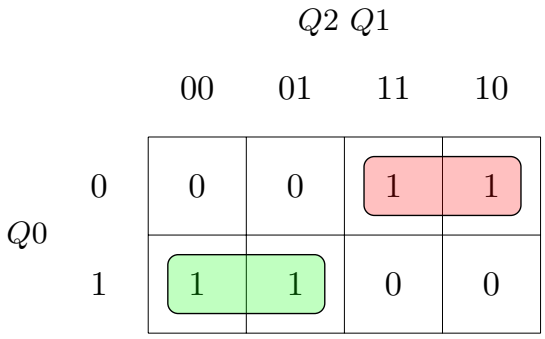

Figure 2: For D2

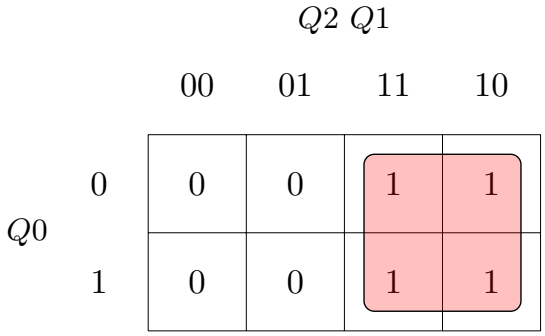

Figure 3: For D1

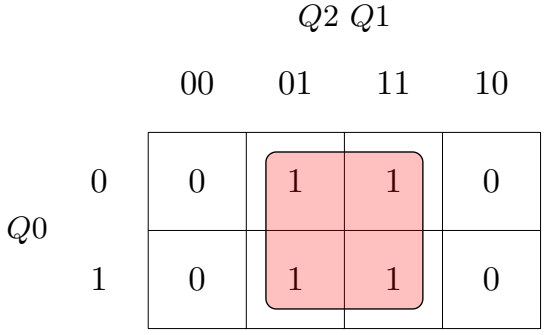

Figure 4: For D0

5.3 Boolean Equation

By solving the K-maps above we obtain as follows :

$$D2 = \overline{Q2}Q0 + \overline{Q0}Q2 \tag{1}$$
$$D1 = Q2 \tag{2}$$
$$D0 = Q1 \tag{3}$$

6 Hardware

1. Make the connections between the seven segment display and the 7447 IC as shown in Table3

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

Table 4: 7447

2. Connect the Vaman,7447 and the two 7474 ICs according to Table4

	INPUT			OUTPUT			CLOCK		5V			
	Q0	Q1	Q2	Q0'	Q1'	Q2'						
Vaman	IO16	IO17	IO18	IO12	IO13	IO14	IO15					
7474	5	9		2	12		CLK1	CLK2	1	4	10	13
7474			5			2	CLK1	CLK2	1	4	10	13
7447				7	1	2			16			

Table 5: Connections

3. Make the other D input pins of 7474 grounded and supply 5V and GND from the Vaman as well.
4. When the clock edge is trigerred we observe display of random numbers.

7 Software

Now write the following code and upload in vaman to see the results.

```
#include<Arduino.h>

//Declaring all variables as integers

int D0,D1,D2,CLK;
int Q0,Q1,Q2;

//Creating a function

void ref(int D0,int D1,int D2,int CLK){
        digitalWrite(12,D0);
        digitalWrite(13,D1);
        digitalWrite(14,D2);
        digitalWrite(15,CLK);
}

//the setup function runs once when you press reset or power the board

void setup(){
        pinMode(12,OUTPUT);
        pinMode(13,OUTPUT);
        pinMode(14,OUTPUT);
        pinMode(15,OUTPUT);
        pinMode(16,INPUT);
        pinMode(17,INPUT);
        pinMode(18,INPUT);
}

//the loop function runs over and over again

void loop(){
        digitalWrite(15,HIGH);
        delay(1000);
```

```
        Q0=digitalRead(16);
        Q1=digitalRead(17);
        Q2=digitalRead(18);
        D2=(Q2&&!Q0) || (Q0&&!Q2);
        D1=(Q2);
        D0=(Q1);

        digitalWrite(15,LOW);

        ref(D0,D1,D2,CLK);
}
```