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Course : MES

Section : B

Date : 7/March/2024

**Answer to the question number 1 :**

**Number A :**

From the ID : r = 1,

q = 2

Required delay = 10ms

= 10ms

= 10000µs

Given system frequency = 12 MHz

= 12 MHz

So,

Clock period = 1/frequency

= 1/12MHz

= 0.0833µs

**(setting pre-scaler value to 1024)**

**Timer count** = (Required delay/(clock period x pre scalar value))-1

= (1000 µs / (0.0833 µs x 1024))

= 117 – 1

= 116

So, Timer0 is suitable for this application because **Timer0 can count to 256 .**

# The program code for Arduino Uno Board for this solution is given below:

#define PIN\_USED 7

int milisec = 10;

int prescaler = 1024;

int clock\_freq = 12000000/prescaler;

float clock\_period = 1/(float)clock\_freq;

int count = ((milisec\*0.001/clock\_period)-1);

void setup()

{

pinMode (PIN\_USED , OUTPUT);

TCCR1A = 0x00;

TCCR1B = 0x05;

}

void loop()

{

if (TCNT1 >= count) passed

{

TCNT1 = 0;

digitalWrite(PIN\_USED , !digitalRead(PIN\_USED));

}

**Number B :**

Required delay = abc ms

= 463ms x1000

= 463000µs

Given system frequency = 1q MHz

= 12 MHz

So,

Clock period = 1/frequency

= 1/12MHz

= 0.0833µs

As such, **(setting pre-scaler value to 1024)**

**Timer count** = (Required delay/(clock period x pre scalar value))-1

= (463000 µs / (0.0833 µs x 1024))

= 5428 – 1

= 5427

So, Timer1 is suitable for this application because **Timer0 can count to 256** but **Timer1 can count to 65,536**.

# The program code for Arduino Uno Board for this solution is given below:

#define PIN\_USED 7

int milisec = 463;

int prescaler = 1024;

int clock\_freq = 12000000/prescaler;

float clock\_period = 1/(float)clock\_freq;

int count = ((milisec\*0.001/clock\_period)-1);

void setup()

{

pinMode (PIN\_USED , OUTPUT);

TCCR1A = 0x00;

TCCR1B = 0x05;

}

void loop()

{

if (TCNT1 >= count) passed

{

TCNT1 = 0;

digitalWrite(PIN\_USED , !digitalRead(PIN\_USED));

}

}

**Answer to the question number 2 :**

**Number A :**

Here,

tbounce= b ms = 6ms Vth H=2.rV =2.1V VthL = 0.pq V=0.22V Vth = 0.r V = 0.1V

I = pa µA = 24µA

Let,

C = 0.1µF

Vfinal = 5V

**Without Diode:**

# (Discharging)

# R2 = -tbounce / C ln(Vth H/V Final)

# = -6ms / (0.1 µF x ln (2.1V/5V))

So,

= 68.97KΩ ≈ 69KΩ R2 = R2 / 50

= 69kΩ / 50

= 1.38kΩ

And,

C = C X 50

= 0.1µF X 50

= 5µF

**Without Diode:**

# (Charging)

**R** = -tbounce /(C ln (1-(0.22v/5v)))

= -6 / (5 x ln (1-(0.22v/5v)))

= 26.67kΩ ≈ 27kΩ

Now, So,

R = R1 + R2

or, 27kΩ = R1 + 1.38kΩ R1 = 25.62 kΩ

Finally,

C = 5µF

R1 = 25.62kΩ R2 = 1.38kΩ

# The Hysteresis voltage will be,

**VH** = Vth.H -Vth.L

= 0.22V – 2.1V

= **|** -1.88V **|**

= 1.88V

**Number (b) :**

# The software debounce code for Arduino Uno is given below:

const int switchPin = 3;

const int ledPin = 12;

int switchState = LOW;

int lastSwitchState = LOW;

unsigned long lastDebounceTime = 0;

unsigned long debounceDelay = 20;

void setup()

{

pinMode(switchPin, INPUT);

pinMode(ledPin, OUTPUT);

}

void loop()

{

int reading = digitalRead(switchPin);

if (reading != lastSwitchState)

{

lastDebounceTime = millis();

}

if ((millis() - lastDebounceTime) > debounceDelay)

{

if (reading != switchState)

{

switchState = reading;

digitalWrite(ledPin, switchState);

lastSwitchState = switchState;

}

}

}

**Answer to the question number 3 :**

# Flowchart to show the logical flow of the program is given below:

A diagram of a light

Description automatically generated

**The program code for Arduino Uno Microcontroller to operate the door lights based on the switch conditions as per the given constraints is given below:**

const int switchPin = 2;

const int greenLightPin = 3;

const int redLightPin = 4;

bool switchState = LOW;

bool lastSwitchState = LOW;

bool greenLightOn = false;

void setup() {

pinMode(switchPin, INPUT);

pinMode(greenLightPin, OUTPUT);

pinMode(redLightPin, OUTPUT);

}

void loop() {

switchState = digitalRead(switchPin);

if (switchState != lastSwitchState) {

if (switchState == HIGH) {

greenLightOn = !greenLightOn;

if (greenLightOn) {

digitalWrite(redLightPin, LOW);

digitalWrite(greenLightPin, HIGH);

}

else {

digitalWrite(greenLightPin, LOW);

digitalWrite(redLightPin, HIGH);

}

}

delay(20);

}

}

**Answer to the question number 4 :**

Required delay = acd ms = 439ms = 439000µs

Given system frequency = 12 MHz

So,

Clock period = 1/frequency = 1/12MHz = 0.0833µs

As such, **(setting pre-scaler value to 1024)**

**Timer count** = (Required delay/(clock period x pre scalar value))-1

= (439000 µs / (0.0833 µs x 1024))

= 5146 – 1

= 5145

So, Timer1 is perfectly suitable for this application because **Timer0 can count to 256** but **Timer1 can count to 65,536**.

So, this Timer count value (5145) should be loaded in the OCR0A register.

**The Arduino Uno code for Timer1 Interrupts and pre-scaler value of 1024 is given below:**

bool LED\_STATE = 'True';

void setup()

{

pinMode(3, OUTPUT);

cli();

TCCR1A = 0;

TCCR1B = 0;

TCCR1B = 0b00000101;

TIMSK1 = 0b00000010;

OCR0A = 5146;

A

sei();

}

void loop()

{

}

{

TCNT1 = 0;

LED\_STATE = !LED\_STATE;

digitalWrite(3, LED\_STATE