

PH435 Lab 5

Sankalp Gambhir
180260032

October 27, 2020

1. Simple Square Pulse Generator

The following circuit was used to generate the square waves. The mismatched values were due to unavailability of matching capacitors. Resistors were adjusted accordingly. The time period is simply proportional to the capacitors and resistors connected together.

$$T = 0.69RC \quad (1)$$

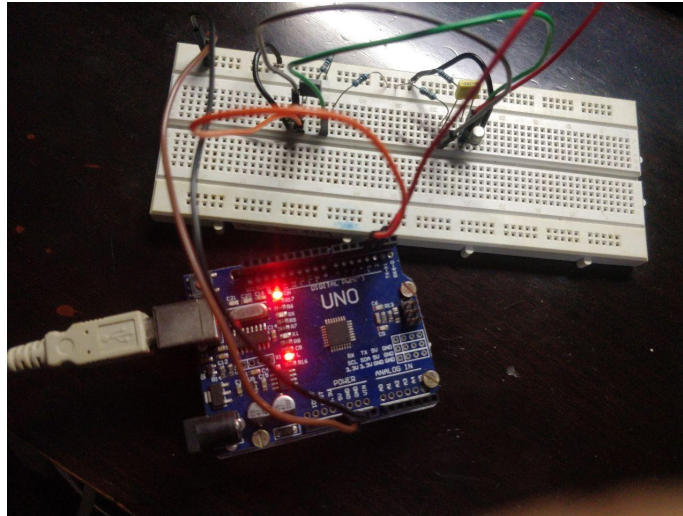


Figure 1: Connected Arduino

The circuit simulation is as in [Figure 3](#)

2. Average speed of a motor

Code works, see [Figure 6](#). I observed a frequency of about **663 Hz**, which is reasonably close to the expected 720Hz from simulation.

The state transition diagram is as follows

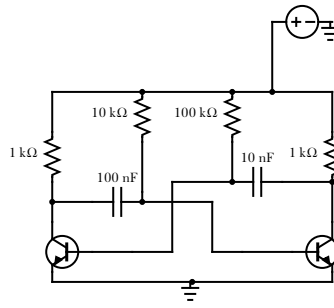


Figure 2: Oscillator

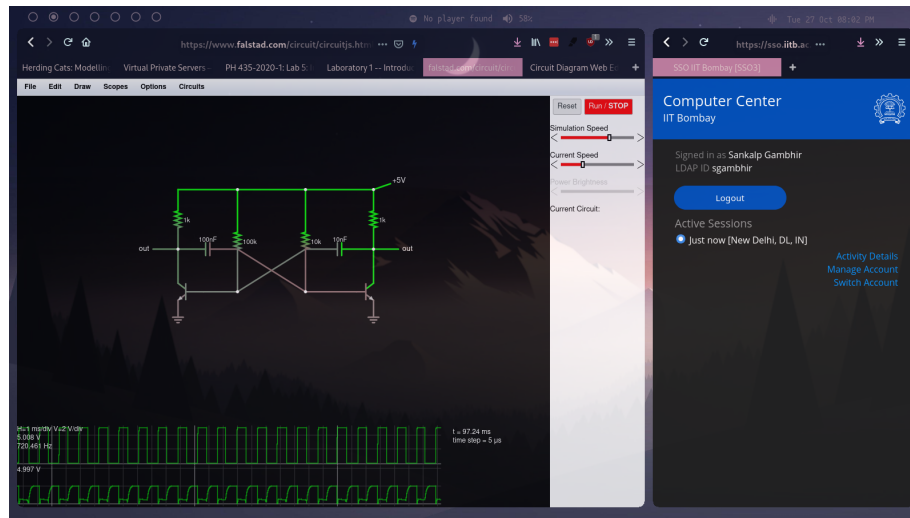


Figure 3: Circuit Simulation

3. Double speedmeter that also measures phase

Code uploaded is in the appendix. I measured the time difference between the two outputs from the square wave generator, flipped version of each other. The time difference observed, $740\mu\text{s}$ is in agreement with the expected value of $757\mu\text{s}$ as per the observed frequency in Part 2.

The state diagram is as follows

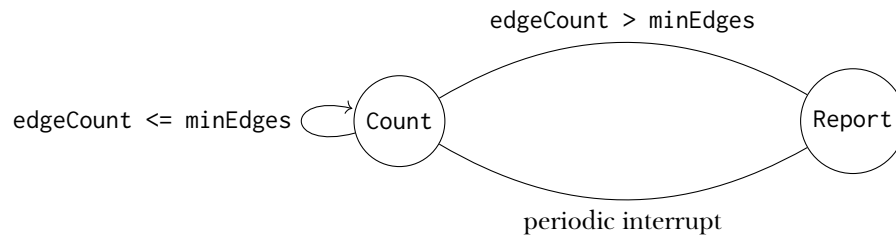


Figure 4: State Diagram for Frequency Measuring

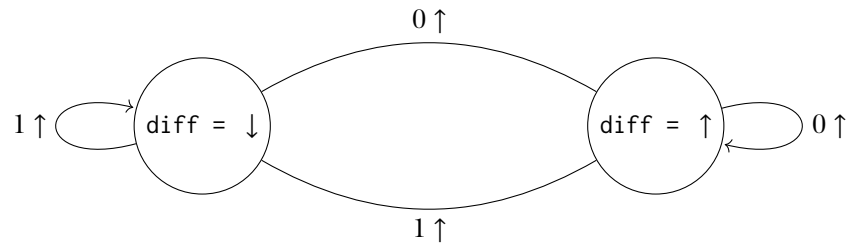


Figure 5: State Diagram for Phase Measuring

Appendix

I log in, therefore I am See [Figure 6](#). Measuring frequency

The code uploaded to the arduino for measuring the frequency of an input square pulse train.

```

1  /*
2  Lab 5
3  Interrupt based DSO
4  */
5
6  #include "TimerOne.h"
7
8  #define InPin(x) 3-x
9
10 // Declaring global variables
11 volatile float freq;
12 volatile int edgeCount;
13 long long int dt;
14 const int measureTime = 5000;
15 const int minEdges = 5000;
16 const int outTime = 500;
17
18 // functions
19 void checkFreq();
20
21 void setup() {
22
23   Serial.begin(9600); // why not
24
25   Timer1.initialize(measureTime);
26   Timer1.attachInterrupt(checkFreq);

```

```

27
28 pinMode(InPin(0), INPUT);
29 pinMode(InPin(1), INPUT);
30
31 attachInterrupt(digitalPinToInterrupt(InPin(0)),
32                [](void){edgeCount++;},
33                FALLING);
34
35 freq = dt = edgeCount = 0;
36 }
37
38 void loop() {
39     Serial.println(edgeCount);
40     delay(outTime);
41 }
42
43 void checkFreq(){
44     dt += measureTime/1000.0;
45     if(edgeCount >= minEdges){
46         freq = (edgeCount*1000.0)/(double)dt;
47         edgeCount = 0;
48         dt = 0;
49     }
50 }

```

Measuring time difference

The code uploaded to the arduino for measuring the time difference between two edges.

```

1  /*
2  Lab 5.420
3  Delay measuring with interrupts
4  */
5
6  #include "TimerOne.h"
7
8  #define InPin(x) 3-x
9
10 // Declaring global variables
11 long long dt;
12 long long diffMax;
13 const int measureTime = 10;
14
15 // functions
16 void phaseCheck();
17
18 void setup() {
19
20     Serial.begin(9600); // why not
21
22     Timer1.initialize(measureTime);
23     Timer1.attachInterrupt(phaseCheck);
24
25     pinMode(InPin(0), INPUT);
26     pinMode(InPin(1), INPUT);
27
28     attachInterrupt(digitalPinToInterrupt(InPin(0)),
29                    [](void){edgeCount++;},
30                    FALLING);

```

```
31
32   attachInterrupt(digitalPinToInterrupt(InPin(0)),
33                   [](void){diff = 1;},
34                   FALLING); // edge counting
35   attachInterrupt(digitalPinToInterrupt(InPin(1)),
36                   [](void){diff = 0;},
37                   FALLING);
38
39   dt = diff = diffMax = 0;
40 }
41
42 void loop() {
43   Serial.print("Max delay measured");
44   Serial.print(diffMax);
45   Serial.print(" uS\n");
46 }
47
48 void setup() { // put your setup code here, to run once:
49   Serial.begin(9600);
50   Timer1.initialize(t_period);
51   Timer1.attachInterrupt(phase_detect);
52   attachInterrupt(digitalPinToInterrupt(input_pin_1), [](){diff = 1;}, FALLING); //
53   interrupt
54   attachInterrupt(digitalPinToInterrupt(input_pin_2), [](){diff = 0;}, FALLING); //
55   interrupt
56   pinMode(input_pin_1, INPUT);
57   pinMode(input_pin_2, INPUT);
58   diff_count = 0;
59   del_t = 0;
60 }
61
62 void loop() {
63   Serial.print(diffMax);
64   Serial.println(" uS");
65   delay(output_period);
66 }
67
68 void checkPhase(){
69   if( diff == 1 ){
70     dt += measureTime;
71   }
72   if ( (diff == 0) && (del_t != 0) ){
73     diffMax = diffMax > dt ? diffMax : dt;
74     dt = 0;
75   }
76 }
77 }
```



Figure 6: Me logged in, with results