1DT301 lab2

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1 Introduction

This report provides the solutions for the second laboratory of the course 1DT301.

2 Task 1

Task 1 askes to write a programme which switches counter when SW0 is pressed. Code for the programme and corresponding diagram is presented below, but we will not present detailed mechanism for Johnson counter and ring counter on the diagram since it has already covered in the previous report.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
;     1DT301, Computer Technology I
;     Date: 2016-09-05
;     Author:
;     Songho Lee
;     Sarpreet Singh
;
;
;     Lab number: 2
;     Title: Task 1
;
;     Hardware: STK600, CPU ATmega2560
;
;     Function: It lights LED with Ring / Johnson
;
;     Input ports: On-board switches on portD
;
;     Output ports: On-board LEDs on PORTB.
;
;     Subroutines: If applicable.
;     Included files: m2560def.inc
;
;     Other information:
;     Changes in program: (Description and date)
;
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

;Load pre-configured files for the ports, and memory adresses.
.include "m2560def.inc"

;Initialize SP, Stack Pointer
ldi r20, HIGH(RAMEND)     ; R20 = high part of RAMEND address
out SPH,R20     ;SPH = high part of RAMEND address
ldi R20, low(RAMEND)      ; R20 = low part of RAMEND address
out SPL,R20

ldi r16, 0xFF  ;Set data direction registers.
```

```
out DDRB, r16  ;Set B port as output ports

ldi r16, 0x00  ;Set data direction registers.
out DDRD, r16  ;Set D port as input ports

;LED have 0 as on, 1 as off which is opposite to normal lamps
;Hereby we command second position of the lED to be on.

.def N = R18
.def K = R19


ldi r17,0b00000001
mov r21, r17   ;Registering 00000001 on both register 17, and 21.
ldi r25,0b11111111
ldi r22,0
.def DIRECTIONFLAG = R22
ldi r23,0
.def COUNTERFLAG = R23


mainloop:

firstloop:

rcall overalldelay

;Listening on the switch
in r16, PIND
ldi r26, 0b11111110
cp r26,r16

brne noreact
react:
com COUNTERFLAG
ldi R17, 0b00000001


noreact:
;Listening done

;COMPLEMNENT FOR LED
mov r16, r17
com r16
out portB, r16
;LED OPERATION DONE

cpi COUNTERFLAG, 0
brne johnson
ring:
LSL r17
cpi COUNTERFLAG, 0
breq johnsonend

johnson:

cpi DIRECTIONFLAG,0xFF ;RIGHT
breq shiftright

;COMPARISION
```

```
shiftleft:

LSL r17
add r17, r21

cpi DIRECTIONFLAG,0xFF
brne begincompare

shiftright:
LSR r17

begincompare:
cp r17, r25
breq equal

johnsonend:


cpi COUNTERFLAG,0
brne ringendconditiondone

cpi r17, 0
brne ringendconditiondone
ldi r17, 1

ringendconditiondone:

rjmp firstloop

equal:
com r25
com DIRECTIONFLAG

rjmp mainloop



;Now begin subroutines.

;;DELAY
overalldelay:
push N
push K
ldi N, 80;      r18 to be our N
ldi K, 0;       r19 to be our counter for all steps
superdelay1:
     push K
     ldi K, 0;
     outerdelay1:
     push K
     ldi K, 0;

     innerdelay1:
     inc K
     cp N, K
     brge innerdelay1
     pop K

     inc K
     cp N, K
```

```
        brge outerdelay1
        pop K
160
        inc K
        cp N, K
        brge superdelay1

165 pop K
    pop N

    ret
    ;;DELAY ENDS
```

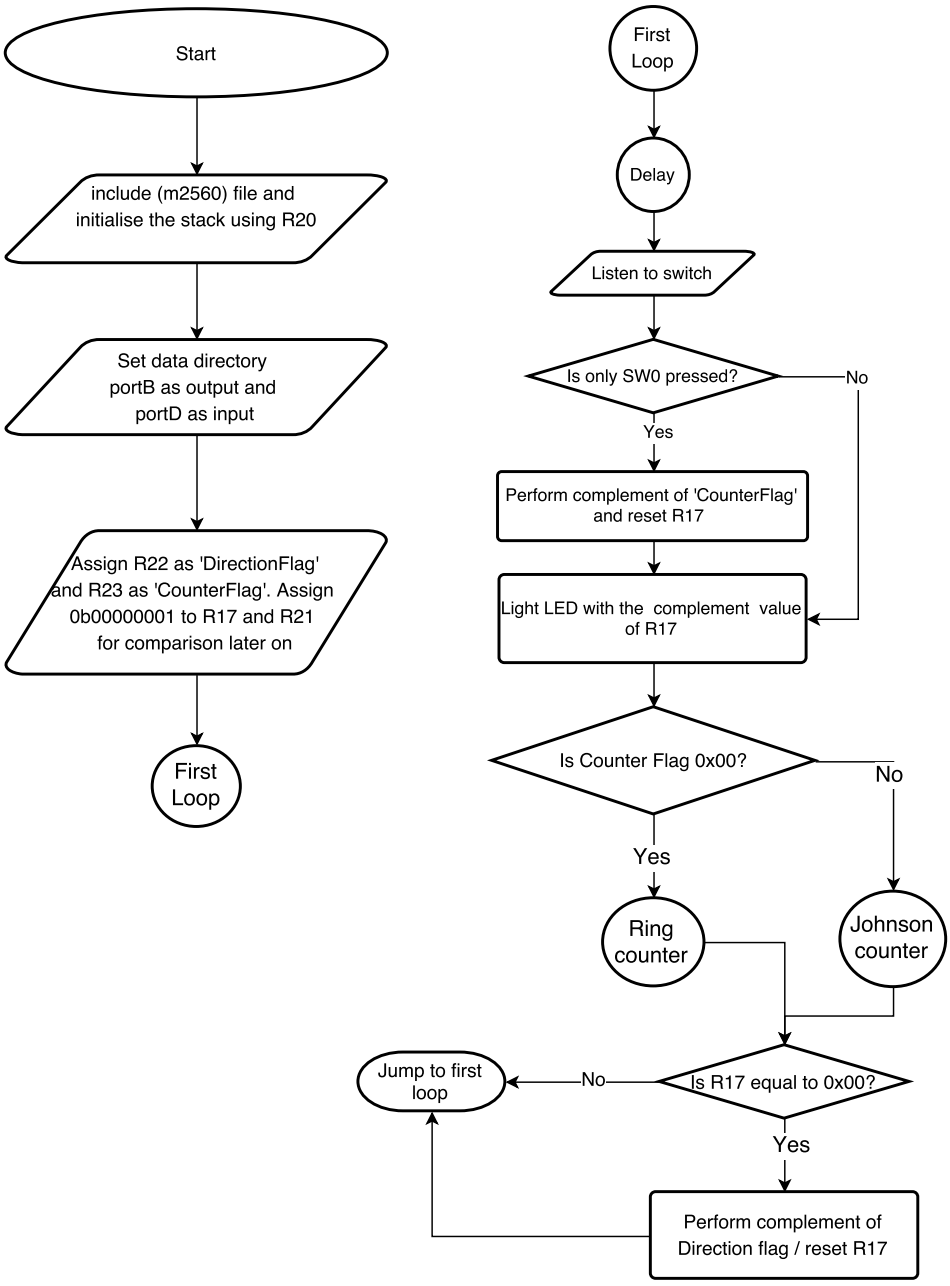

Figure 1: Flowchart of task 1

3 Task 2

Task two asks to create an electronic dice responding with random number. However, as current CPU - which is ATmega2560 - does not have a capability to create in terms of mathematics random number, hereby we listen on the length of switches that an arbitary user presses. We assume length of listening should vary in scope of $2.5 * 10^-7s$ interval, which is due to our configuration of the current CPU to perform on 4MHz.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
;    1DT301, Computer Technology I
;    Date: 2016-09-05
;    Author:
;    Songho Lee
;    Sarpreet Singh
;
;
;    Lab number: 2
;    Title: Task 2
;
;    Hardware: STK600, CPU ATmega2560
;
;    Function: Creating Electronic DICE
;
;    Input ports: On-board switches on portD
;
;    Output ports: On-board LEDs on PORTB.
;
;    Subroutines: If applicable.
;    Included files: m2560def.inc
;
;    Other information:
;    Changes in program: (Description and date)
;
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

;Load pre-configured files for the ports, and memory adresses.
.include "m2560def.inc"

ldi r16, 0xFF  ;Set data direction registers.
out DDRB, r16  ;Set B port as output ports
out portB, r16

ldi r16, 0x00  ;Set data direction registers.
out DDRD, r16  ;Set D port as input ports



;LED have 0 as on, 1 as off which is opposite to normal lamps
;Hereby we command second position of the lED to be on.


.def DICE = R17

;Initialise 9the DICE as 1 in the beginning.
ldi DICE, 1
mainloop:

listening:
in R18, PIND
```

```
cpi R18, 0xFF
breq stoplistening
inc DICE

cpi DICE,7

brne continue
ldi DICE, 1

continue:

rjmp listening


stoplistening:
cpi DICE, 1
breq one
cpi DICE, 2
breq two
cpi DICE, 3
breq three
cpi DICE, 4
breq four
cpi DICE, 5
breq five
cpi DICE, 6
breq six

one:
ldi R16, 0b11101111
out portB, R16
rjmp mainloop

two:
ldi R16, 0b10111011
out portB, R16
rjmp mainloop
three:
ldi R16, 0b10101011
out portB, R16
rjmp mainloop
four:
ldi R16, 0b00111001
out portB, R16
rjmp mainloop
five:
ldi R16, 0b00101001
out portB, R16
rjmp mainloop
six:
ldi R16, 0b00010001
out portB, R16
rjmp mainloop
```

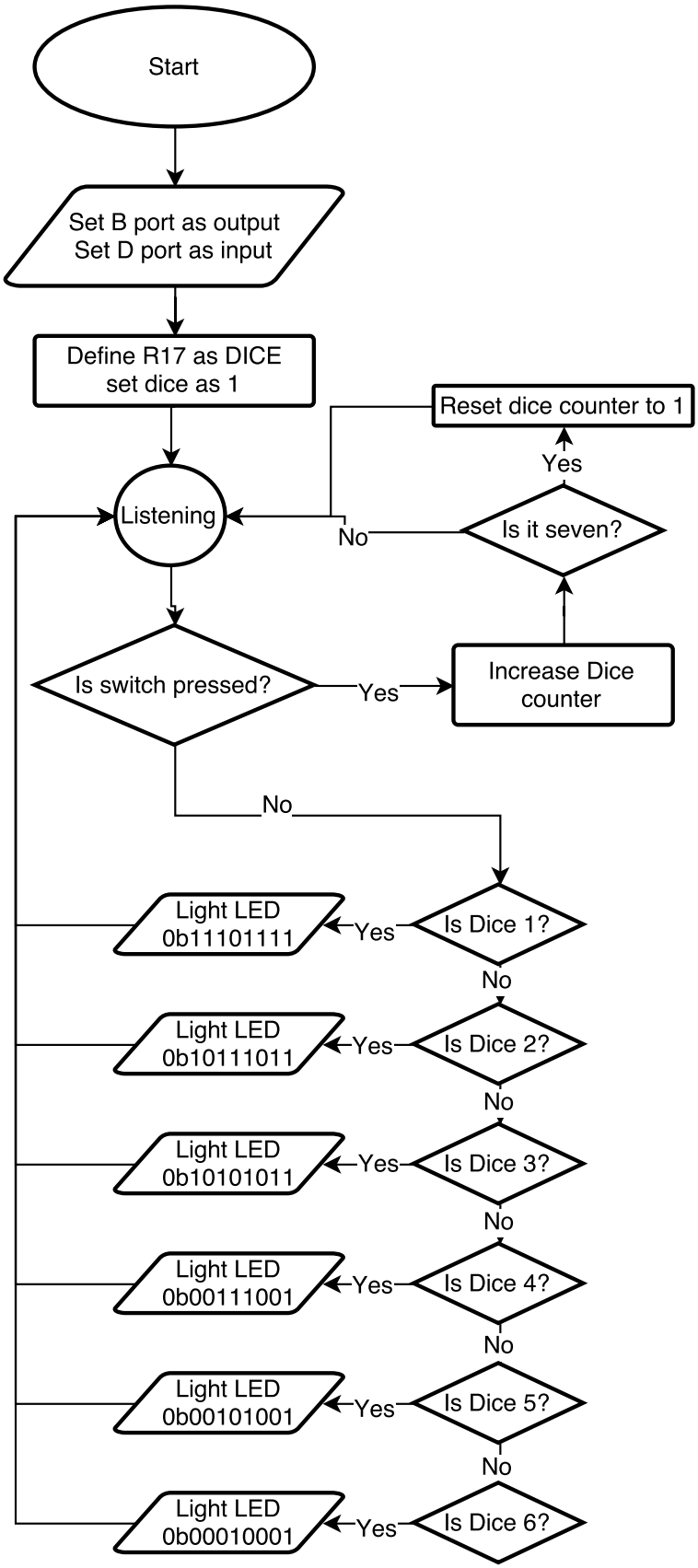

Figure 2: Flowchart of task 2

4 Task 3

The programme which listens on changes of SW0 and increases counter is presented below.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
;     1DT301, Computer Technology I
;     Date: 2016-09-05
;     Author:
;     Songho Lee
;     Sarpreet Singh
;
;
;     Lab number: 2
;     Title: Task 3
;
;     Hardware: STK600, CPU ATmega2560
;
;     Function: Creating Counter
;
;     Input ports: On-board switches on portD
;
;     Output ports: On-board LEDs on PORTB.
;
;     Subroutines: If applicable.
;     Included files: m2560def.inc
;
;     Other information:
;     Changes in program: (Description and date)
;
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

;Load pre-configured files for the ports, and memory adresses.
.include "m2560def.inc"

ldi r16, 0xFF  ;Set data direction registers.
out DDRB, r16  ;Set B port as output ports
out portB, r16

ldi r16, 0x00  ;Set data direction registers.
out DDRD, r16  ;Set D port as input ports



;LED have 0 as on, 1 as off which is opposite to normal lamps
;Hereby we command second position of the lED to be on.


.def COUNTER = R17

;Initialise 9the COUNTER as 1 in the beginning.
ldi COUNTER, 0
mainloop:

ldi R20,0

listening:
in R18, PIND

cpi R18, 0xFF
breq stoplistening
```

```
cpi R18, 0b11111110
brne continue

cpi R20,0
brne continue

rcall change
LDI R20, 0xFF

continue:
rjmp listening

stoplistening:
cpi R20, 0xFF
brne mainloop
rcall change

rjmp mainloop

change:
inc COUNTER

MOV R19, COUNTER
COM R19
out portB, R19
ret
```

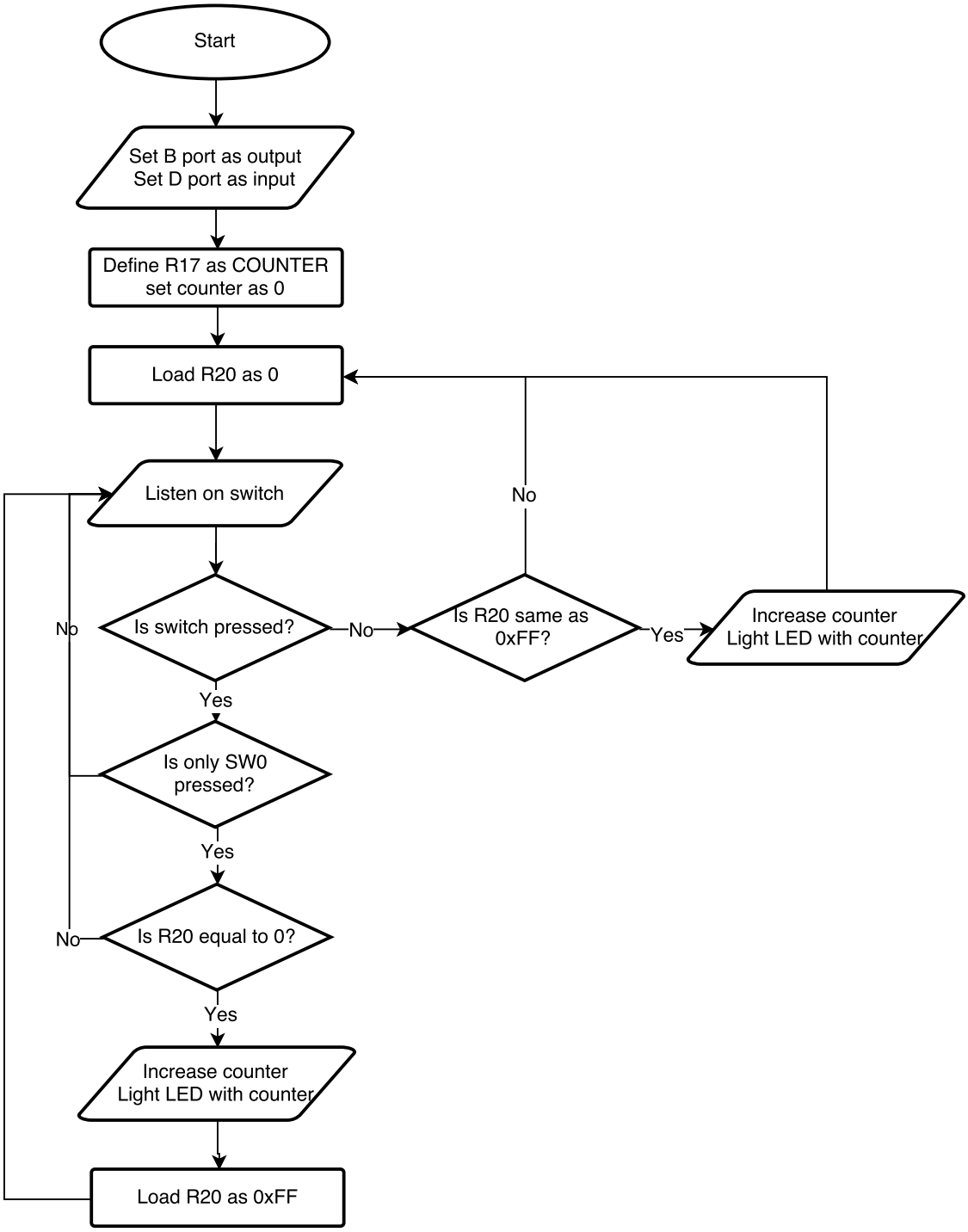

Figure 3: Flowchart of task 3

5 Task 4

Code and a flowchart for the fourth task is presented below. This programme would guarantee the timer only if it configured to run with 4MHz oscillation rate. As for diagram we have not mentioned detailed implementation of such as delay, which is already covered in the previous review about the mechanism behind the delay. The change of this task compared to the last one is that amount of repeating iteration has fine-tuned by introducing constant N, and M. Furthermore, the part in the diagram that we are comparing register pairs are done in two separate code in actually implementation, that is to compare the two later parts and two earlier parts of the register pair. However, in order to increase readability of the flow chart, hereby we decided to combine two decision making diagrams into one.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
;     1DT301, Computer Technology I
;     Date: 2016-09-05
;     Author:
;     Songho Lee
;     Sarpreet Singh
;
;
;     Lab number: 2
;     Title: Task 4
;
;     Hardware: STK600, CPU ATmega2560
;
;     Function: Ligntning LED corresponding with Ring counter
;     with interval of given milliseconds
;
;     Input ports: None. This is handled by the loop inside the programme.
;
;     Output ports: On-board LEDs are connected to PORTB.
;
;     Subroutines: If applicable.
;     Included files: m2560def.inc
;
;     Other information:
;     Changes in program: (Description and date)
;
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

;Load pre-configured files for the ports, and memory adresses.
.include "m2560def.inc"

ldi r16, 0xFF  ;Set data direction registers.
out DDRB, r16  ;Set B port as output ports

;Initialize SP, Stack Pointer
ldi r20, HIGH(RAMEND)     ; R20 = high part of RAMEND address
out SPH,R20     ;SPH = high part of RAMEND address
ldi R20, low(RAMEND)      ; R20 = low part of RAMEND address
out SPL,R20


.equ TIME = 60000
.def N = R18
.def M = R22
.def K = R19
ldi R24, LOW(TIME)
ldi R25, HIGH(TIME)
```

```
;LED have 0 as on, 1 as off which is opposite to normal lamps
;Hereby we command second position of the lED to be on.


ldi r17,0b00000001
ldi R21,0b00000000
firstloop:

mov r16, r17
com r16
out portB, r16

LSL r17
rcall specificdelay

cp r17, R21
brne firstloop
ldi r17,0b00000001
rjmp firstloop


;Now begin subroutines.

specificdelay:
ldi R26,0
ldi R27,0

loop:
rcall onemilliseconddelay

adiw R27:R26, 1

cp R24,R26
brne loop
cp R25,R27
brne loop
ret

rjmp loop

onemilliseconddelay:
push N
push K
ldi N, 8; r18 to be our N
ldi M, 9
ldi K, 0;      r19 to be our counter for all steps
superdelay1:
     push K
     ldi K, 0;
     outerdelay1:
     push K
     ldi K, 0;

     innerdelay1:
     inc K
     cp N, K
     brge innerdelay1
     pop K

     inc K
```

```
110         cp M, K
            brge outerdelay1
            pop K

            inc K
115         cp N, K
            brge superdelay1

    pop K
    pop N
120
    ret
```

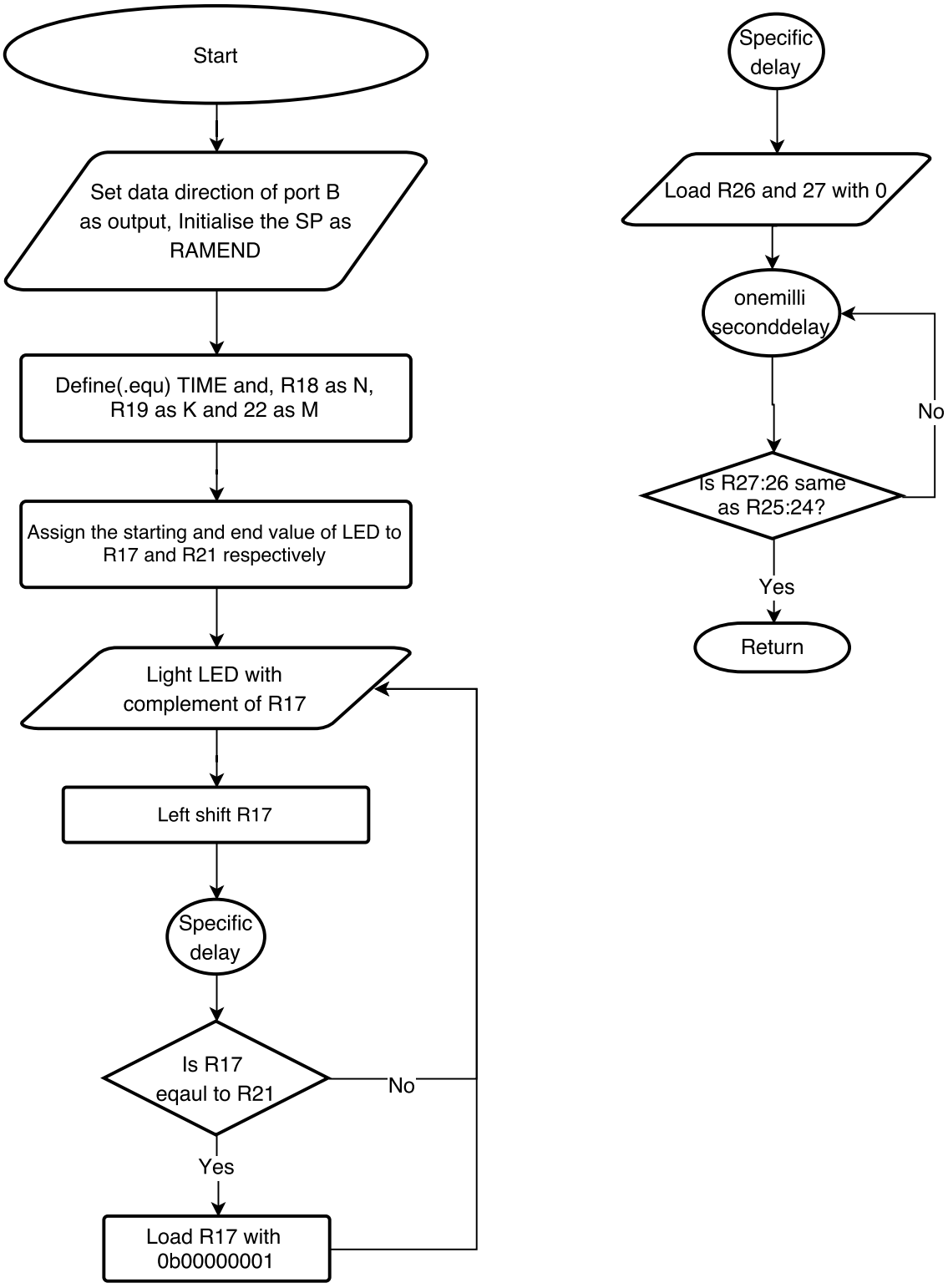

Figure 4: Flowchart of task 4