Computer Technology I

Lab. 2 : Subroutines

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Area: Computer Science
Course code: 1DT301

Contents

1 Task 1 - Switch – Ring counter / Johnson counter

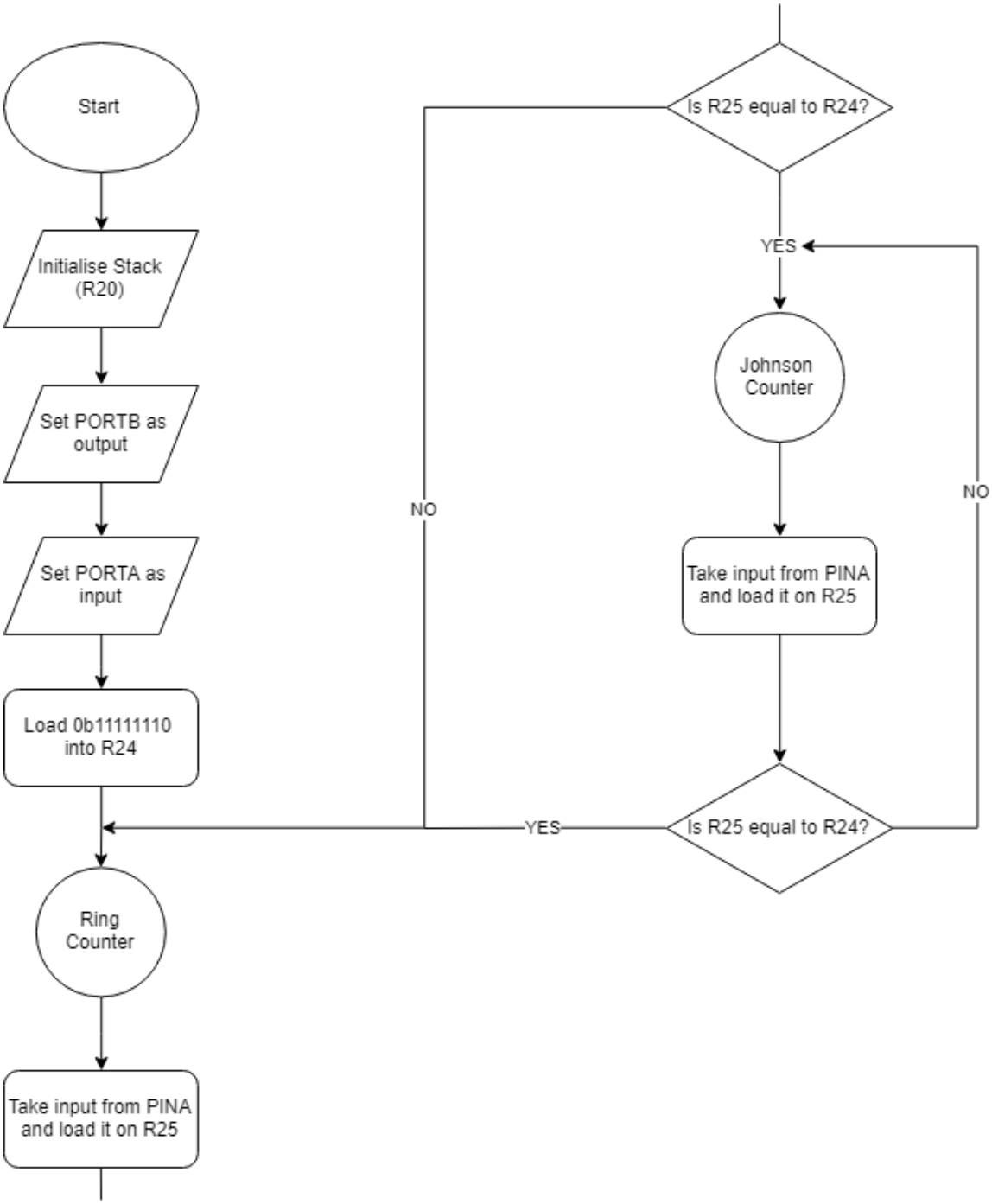
Write a program which switch between Ring counter and Johnson counter. You should not use Interrupt in this lab. The pushbutton must be checked frequently, so there is no delay between the button is pressed and the change between Ring/Johnson. Use SW0 (PA0) for the button. Each time you press the button, the program should change counter.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program that when the Switch number 0 is pressed, it will
   change between the Ring Counter and the Johnson Counter.
;
; Input ports: PORTA will be used as input to be able to get the
   information from the switches.
;
; Output ports: PORTB will be used as output to be able to light up the
    LEDs in the corresponding manner.
;
; Subroutines: To be able to do the delay
; Included files: m2560def.inc
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.includes "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 ; SPL = low part of RAMEND address

ldi r16, 0xFF ;setting up the data direction register port B
out DDRB, r16 ;Set port B as output
ldi r16, 0x00   ;Set the data direction register port A
out DDRA, r16   ;Set portA as input

ldi r24, 0b11111110     ;Desired switch

RC:     ;Ring Counter Code
        ldi r21, 0b11111111; inital LED state
        out portB, r21  ;Turn off all the lights
        mov r17, r21    ;Copy r21 into r17
        ldi r22, 0xFF   ;To compare to make it restart when all the
           lights turn off
        RC_loop:
                out portB, r17  ;Show the corresponding lights
                rol r17 ;rotate the bits to make them go left
                CALL Delay1     ;Delay of 0.5 seconds
                in r25, PINA    ;Read the input from the switch
                cp r25,r24      ;Compare the switches with the desired
```

```
                    switch
                breq JC ;If they are =, go to Johnson Counter
                cp r17, r22             ;Check if all the lights are
                    turned off
                breq RC_light   ;
        rjmp RC_loop
        RC_light:
                rol r17 ;do a rol here because we are not supposed to
                    see it appear.
                out portB, r17  ;light up the desired LEDs
                rjmp RC_loop    ;go back to the loop to make it
                    continue
rjmp RC

JC:     ;Johnson Counter Code
        ldi r21, 0b11111110     ;r21 = to light up the LEDs
        ldi r22, 0b11111111 ;Desired condituon
        ldi r23, 0b00000000     ;Desired condition

        my_loop1:       ;Loop to do the going left part of the Johnson
            Counter
                out portB, r21  ;Light up the corresponding LEDs
                LSL r21 ;Logical shift to the left of R21
                CALL Delay1     ;Delay of 0.5s
                in r25, PINA    ;Get the input from PINA
                cp r25,r24      ;Compare input and desired switch
                breq RC If equal go back to Ring Counter
                cp r21, r23 ;compare  info with desired one
                breq light      ;If equal go to "light" where it is
                    going right.
        rjmp my_loop1

        light:  ;initialisation process to be able to go right
                out portB, r23  ;Turn on all the lights
                CALL Delay1     ;Delay of 0.5s
                ldi r21, 0b10000000     ;Set up the first iteration to
                    make sure it goes right correctly
                out portB, r21  ;output to PortB
                Second_loop:    ;Action of going right here
                        in r25, PINA    ;check info from switches
                        cp r25,r24      ;Compare switches with desired
                            switch
                        breq RC ;If equal go back to Ring Counter
                        out portB, r21  ;Output it to r21
                        ASR r21 ;Arithmetic Shift right to be able to
                            shift the bits to the right.
                        CALL Delay1     ;Delay of 0.5s
                        cp r21, r22 ;compare  info with desired one
                        breq my_loop1   ;if equal go back my_loop1 and
                            go right again
                rjmp Second_loop
rjmp JC
Delay1:
; Generated by delay loop calculator
; at http://www.bretmulvey.com/avrdelay.html
; Delay 1 950 500 cycles
; 500ms at 3.901 MHz
    ldi  r18, 10
    ldi  r19, 230
```

```
    ldi  r20, 22
L1: dec  r20
    brne L1
    dec  r19
    brne L1
    dec  r18
    brne L1
RET
```

This is the flowchart of the task 1:



2 Task 2 - Electronic dice

You should create an electronic dice. Think of the LEDs placed as in the picture below. The number 1 to 6 should be generated randomly. You could use the fact that the time you press the button varies in length.

```
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; Author:
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;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function:Program that represent an electronic dice. The number 1 to 6
    will be choose randomly every time we click on the button
;
; Input ports: PORTA will be used as input to get the information from
   the switches.
; Output ports: PORTB will be used as output to light up the LEDs when
   needed.
;
; Subroutines: None needed here.
; Included files: m2560def.inc
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"

ldi r16, 0xFF ;setting up the data direction register PORTB
out DDRB, r16 ;Set PORTB as output

ldi r16,0x00    ;setting up the data direction register PORTA
out DDRA, r16   ;Set PORTA as input

ldi r19,1; Counter for the number of the dice
ldi r25, 0xFF   ;To turn off all the LEDs
out PortB,r25
ldi r24,0b11111110      ;Desired Switch Binary Code

Listening_For_Switch_Press:     ;Listening when the switch will be
   pressed.
        in r17,PINA     ;Get info from switches
        cp r17,r24      ;Compare the switches and the desired switch
           binary code.
        breq Listening_For_Switch_Release       ;If equal goes to the
           loop below.
rjmp Listening_For_Switch_Press

Listening_For_Switch_Release:   ;Listening when the switch will be
   released
        inc r19 ;increase r19 by 1 every time it comes into this loop
        cpi r19,7       ;compare to a constant (7) as we only want
           numbers from 1 to 6
        breq reset      ;if equal reset the counter
```

```
        in r17,PINA     ;Check the info from the switches
        cp r17,r25      ;Check if user has released the switches
        breq RD ;If yes go to RD loop
rjmp Listening_F        or_Switch_Release

reset:  ;to reset the counter
ldi r19,1
rjmp Main

RD:     ;This is where the random will happen
        cpi r19,1       ;When it will be sent to this loop
        breq ONE        ;It will stop on one of those numbers
        cpi r19,2       ;Depending on which number is
        breq TWO        ;r19 right now it will decide which
        cpi r19,3       ;number it will gets
        breq THREE
        cpi r19,4
        breq FOUR
        cpi r19,5
        breq FIVE
        cpi r19,6
        breq SIX
rjmp RD

ONE:                    ;If r19 was equal to 1 it will come here
ldi r18,0b11101111      ;Load to r18 the corresponding binary code to
   make it look like a 1
out PortB,r18           ;Output it to PORTB
rjmp Listening_For_Switch_Press ;and go back to the first loop
TWO:
ldi r18,0b10111011
out PortB,r18
rjmp Listening_For_Switch_Press
THREE:
ldi r18,0b10101011
out PortB,r18
rjmp Listening_For_Switch_Press
FOUR:
ldi r18,0b00111001
out PortB,r18
rjmp Listening_For_Switch_Press
FIVE:
ldi r18,0b00101001
out PortB,r18
rjmp Listening_For_Switch_Press
SIX:
ldi r18,0b00010001
out PortB,r18
rjmp Listening_For_Switch_Press
```

This is the flowchart of the task 1:

3 Task 3 - Change counter

Write a program that is able to count the number of changes on a switch. As a change we count when the switch SW0 goes from 0 to 1 and from 1 to 0, we expect therefore positive and negative edges. We calculate the changes in a byte variable and display its value on PORTB.

```
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; Author:
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;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Describe the function of the program, so that you can
   understand it,
; even if you're viewing this in a year from now!
;
; Input ports: Describe the function of used ports, for example on-
   board switches
; connected to PORTA.
;
; Output ports: Describe the function of used ports, for example on-
   board LEDs
; connected to PORTB.
;
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Changes in program: (Description and date)
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"

ldi r16, 0xFF ;setting up the data direction register port B
out DDRB, r16 ;Set port B as output

ldi r16,0x00
out DDRA, r16

ldi r25, 0
ldi r24,0

ldi r17, 0b11111111
out PORTB, r17

ldi r18, 0b11111110

my_loop:
```

```
        in r19, PINA
        cp r18,r19
        breq counter
rjmp my_loop

counter:
inc r25
mov r20,r25
com r20
out portB,r20
        loop:
                in r19,PINA
                cp r19,r17
                breq counter2
        rjmp loop

counter2:
inc r25
mov r20,r25
com r20
out portB,r20
rjmp my_loop
```

This is the flowchart of the task 3:

4 Task 4 - Delay subroutine with variable delay time

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
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;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Describe the function of the program, so that you can
   understand it,
; even if you're viewing this in a year from now!
;
; Input ports: Describe the function of used ports, for example on-
   board switches
; connected to PORTA.
;
; Output ports: Describe the function of used ports, for example on-
   board LEDs
; connected to PORTB.
;
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Changes in program: (Description and date)
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"
.equ INPUT= 1000

ldi r16, 0xFF ;setting up the data direction register port B
out DDRB, r16 ;Set port B as output

ldi r21, 0b11111111; inital LED state
out portB, r21
mov r17, r21
ldi r22, 0xFF
ldi r23, 0b11111110
RC_loop:
        out portB, r17
        rol r17
        CALL Delay
        cp r17, r22
        breq RC_light
rjmp RC_loop

RC_light:
        rol r17
        out portB, r17
        rjmp RC_loop
```

```
Delay:
        ldi r24, low(INPUT)
        ldi r25, high(INPUT)
        wait_milliseconds:
                call ms_delay
                sbiw r25:r24,1
                cpi r25, high(0)
                breq reset
        rjmp wait_milliseconds
reset:
RET

ms_delay:
        ; Generated by delay loop calculator
        ; at http://www.bretmulvey.com/avrdelay.html
        ;
        ; Delay 1 000 cycles
        ; 1ms at 1 MHz

        ldi  r18, 2
        ldi  r19, 75
L1: dec  r19
        brne L1
        dec  r18
        brne L1
        rjmp PC+1
RET
```

This is the flowchart of the task 1: