Computer Technology I

Lab. 2 : How to use the PORTs, Digital input/output, Subroutine call

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Area: Computer Science
Course code: 1DT301

Contents

1 Task 1

For the first task the goal was to get a light blinking. This was done by setting the data direction register to output, and after that setting the LED port low.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
;       Anas Kwefati
; Student name 2
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program that switches between Ring counter and Johnson
   counter.
;       No delay between the button is pressed and the change between
   Ring/Johnson.
;       Each time I press the button, the program should change
   counter.

; Input ports: PORTA checks if we pressed the switch 0 (SW0; PA0).
;
; Output ports: PORTB turns on/off the light (LEDs)
;
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Other information:
;
; Changes in program: (Description and date)
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

.include "m2560def.inc"

; Initialize SP, Stack Pointer
ldi r21, HIGH(RAMEND) ; R20 = high part of RAMEND address
out SPH,R21 ; SPH = high part of RAMEND address
ldi R21, low(RAMEND) ; R20 = low part of RAMEND address
out SPL,R21 ; SPL = low part of RAMEND address

;we initialize
ldi r16, 0xFF ;
out DDRB, r16 ; we set the DDRB as output

ldi r17, 0x00
out DDRA, r17 ; we set as output

ldi r16, 0xFF ; we load 0b1111 1111 to the register r16
out PORTA,r16 ; we set the PORTA to r16 SO it means that we put each
   light off

ldi r20, 0b11111110 ;check if we pressed SW0
ldi r19, 0b10111111 ;Turn on light at 0
ldi r22,0x00
```

```
loop:
        in r18, PINA ;we put the coming data received by the PIND(input
           ) to r18
        cp r20,r18 ; check if r20==r18
        breq ring_counter
        brne johnson_counter


ring_counter:
        ldi r18, 0b11111110
        call ring_loop

ring_loop:
        out PORTB, r18 ;we put the value of r18 to PORTB which should
           turn on the light
        call Delay
        com r18
        LSL r18
        com r18

        ;Check if everything is off if true then go to ring counter to
           make infinite loop
        ldi r24,0xFF
        cp r24, r18
        breq ring_counter

        in r19, PINA
        cp r20,r19
        breq johnson_counter

        rjmp ring_loop


rjmp loop ; we go back at the beginning of the infinite loop

johnson_counter :
        ldi r19, 0b11111110 ;Turn on light at 0
        ldi r22, 0x00

johnson_loop:
        out PORTB, r19
        LSL r19
        call Delay
        cp r19, r22
        breq johnson

;Check if PINA SW0 has been pressed if yes then it goes to ring counter
        in r18, PINA
        cp r20,r18
        breq ring_counter

        rjmp johnson_loop

rjmp loop ; we go back at the beginning of the infinite loop

johnson :
        out PORTB, r22
        ldi r22, 0b11111111
        call Delay
```

```
        ldi r19,0b10000000

        more_john :
                out PORTB, r19
                ASR r19
                call Delay
                cp r19, r22
                breq johnson_counter

;Check if PINA SW0 has been pressed if yes then it goes to ring counter
                in r18, PINA
                cp r20,r18
                breq ring_counter

        rjmp more_john



Delay :
; Generated by delay loop calculator
; at http://www.bretmulvey.com/avrdelay.html

        ldi  r21, 5
    ldi  r23, 20
    ldi  r24, 175
L1: dec  r24
    brne L1
    dec  r23
    brne L1
    dec  r21
    brne L1
        ret
```

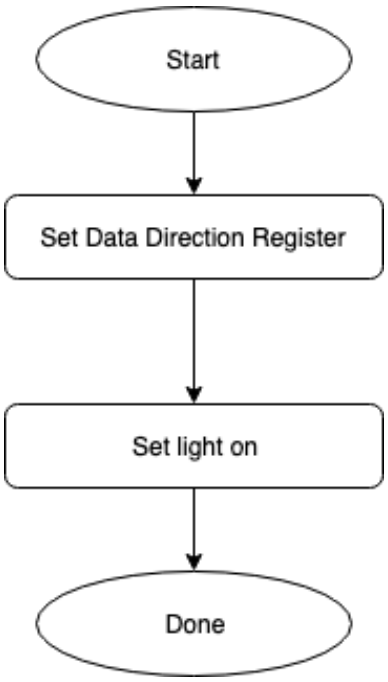

Figure 1: Task 1 flowchart

2 Task 2

For the second task the aim is to read switches and light to corresponding LED. This was done by using a data direction register

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
;       Anas Kwefati
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program that switches between Ring counter and Johnson
    counter.
;       No delay between the button is pressed and the change between
    Ring/Johnson.
;       Each time I press the button, the program should change
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; Input ports: PORTA checks if we pressed the switch 0 (SW0; PA0).
;
; Output ports: PORTB turns on/off the light (LEDs)
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;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
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out SPH,R21 ; SPH = high part of RAMEND address
ldi R21, low(RAMEND) ; R20 = low part of RAMEND address
out SPL,R21 ; SPL = low part of RAMEND address

;we initialize
ldi r16, 0xFF ;
out DDRB, r16 ; we set the DDRB as output

ldi r17, 0x00
out DDRA, r17 ; we set DDRA as input


out PORTB, r16
ldi r18, 0b11111110
ldi r20, 1

ldi r16, 0b11111111

loop :
        in r19,PINA
        cp r19, r18
        breq listening_loop

rjmp loop


listening_loop :
        inc r20
        cpi r20, 7
        breq reset
        in r19, PINA
        cp r16,r19
        breq random
rjmp listening_loop

reset :
        ldi r20, 1
        rjmp loop

random :
        cpi r20, 1
        breq number_one
        cpi r20, 2
        breq number_two
        cpi r20, 3
        breq number_three
        cpi r20, 4
        breq number_four
        cpi r20, 5
        breq number_five
        cpi r20, 6
        breq number_six
```

```
number_one:
        ldi r22, 0b11111101
        out PORTB, r22
        rjmp loop

number_two:
        ldi r22, 0b10111101
        out PORTB, r22
rjmp loop
number_three:
        ldi r22, 0b10101011
        out PORTB, r22
rjmp loop
number_four:
        ldi r22, 0b00111001
        out PORTB, r22
rjmp loop
number_five:
        ldi r22, 0b00101001
        out PORTB, r22
rjmp loop
number_six:
        ldi r22, 0b00010001
        out PORTB, r22
rjmp loop
```

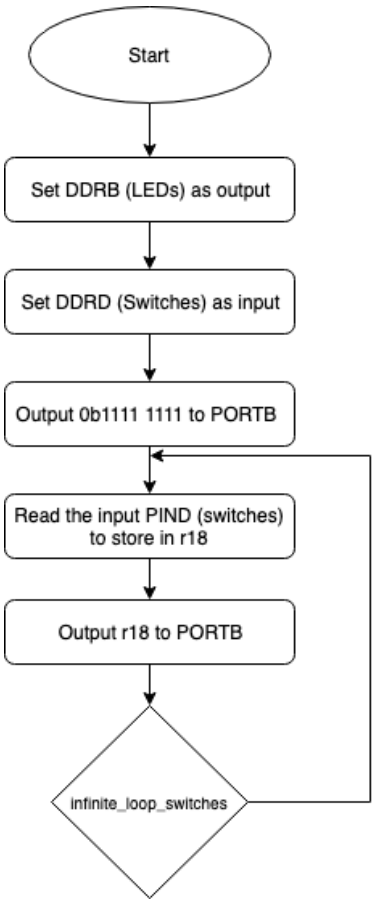


Figure 2: Task 2 flowchart

3 Task 3

In task 3 the goal was to turn on led 0, only if switch 5 was pressed. by checking if the bit for switch 5 is high we are able to turn the led on at the right moment

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
;       Anas Kwefati
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program that switches between Ring counter and Johnson
    counter.
;       No delay between the button is pressed and the change between
    Ring/Johnson.
;       Each time I press the button, the program should change
    counter.

; Input ports: PORTA checks if we pressed the switch 0 (SW0; PA0).
;
; Output ports: PORTB turns on/off the light (LEDs)
;
```

```
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Other information:
;
; Changes in program: (Description and date)
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"

; Initialize SP, Stack Pointer
ldi r21, HIGH(RAMEND) ; R20 = high part of RAMEND address
out SPH,R21 ; SPH = high part of RAMEND address
ldi R21, low(RAMEND) ; R20 = low part of RAMEND address
out SPL,R21 ; SPL = low part of RAMEND address

;we initialize
ldi r16, 0xFF ;
out DDRB, r16 ; we set the DDRB as output

ldi r17, 0x00
out DDRA, r17 ; we set DDRA as input

out PORTB, r16

ldi r18, 0b00000000 ; counter

ldi r19, 0b11111101 ; to check if button is pressed
ldi r23, 0xFF

loop :
        in r20, PINA
        cp r20,r19 ;compare r20 and r19
        breq counting ;if equal then go to counting
rjmp loop


counting :
        inc r18 ; we add +1

        mov r21, r18
        com r21

        out PORTB, r21

        counting_loop :

                in r20, PINA
                cp r20, r23

                breq whatever

                rjmp counting_loop

whatever :
        inc r18
        mov r21, r18
        com r21

        out PORTB, r21
```

```
        rjmp loop
```

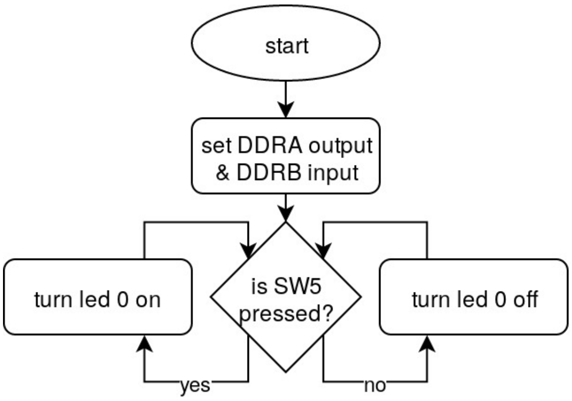


Figure 3: Task 3 flowchart

4 Task 4

For task 5 we needed to create a ring counter. This was done by creating a loop which constantly shifts the PORTB register one sideways with a delay.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
; Student name 1
; Student name 2
;
; Lab number: 1
; Title: How to use the PORTs. Digital input/output. Subroutine call.
;
; 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
;
; Other information:
;
; Changes in program: (Description and date)
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

.include "m2560def.inc"

; Initialize SP, Stack Pointer
ldi r21, HIGH(RAMEND) ; R20 = high part of RAMEND address
out SPH,R21 ; SPH = high part of RAMEND address
ldi R21, low(RAMEND) ; R20 = low part of RAMEND address
```

```
out SPL,R21 ; SPL = low part of RAMEND address

.equ nbrExecution = 2000 ; equ assigns a constant value to a label
   therefore this value cannot be changed later
; we define the number of loop executions as constant

;we initialize
ldi r16, 0xFF ;
out DDRB, r16 ; we set the DDRB as output

ring_counter:
        ldi r18, 0b11111110

ring_loop:
        out PORTB, r18 ;we put the value of r18 to PORTB which should
           turn on the light
        call Delay
        com r18
        LSL r18
        com r18

        ;Check if everything is off if true then go to ring counter to
           make infinite loop
        ldi r21,0xFF
        cp r21, r18
        breq ring_counter
        rjmp ring_loop

Delay :

        ; r25:r24 is a 16 bit register and so can have 65,536 different
            numbers, it can count 256 times longer than with an 8 bit
           register only.

        ;The lower byte of the 16-bit-adress is located in the lower
           register, the higher byte in the upper register. Both parts
            have their own names, e.g. the higher byte of Z is named
           ZH (=R31), the lower Byte is ZL (=R30).
        ;These names are defined in the standard header file for the
           chips. Dividing these 16-bit-pointer-names into two
           different bytes is done like follows:
        ldi r25, HIGH(nbrExecution) ; We set the Most Significant Bit
           at the address nbrExecution
        ldi r24, LOW(nbrExecution) ; We set the Least Significant Bit
           at the address nbrExecution

        wait_milliseconds :
                rcall sub_delay ;we call the sub_delay that contains 1
                   ms that is going to be repeated 1000 times to do 1s
                sbiw r24, 1 ; By doing that we substract 1 from the
                   register pair r25:r24
                ;The instruction "SBIW R24,1" decreases the register
                   pair word-wise. That means that whenever the LSB (
                   Least Significant Bit r24) underflows, the MSB(Most
                    Significant Bit r25) is also automatically reduced
                    by 1.
                brne wait_milliseconds ; if not zero start loop again,
                   if zero continue
```

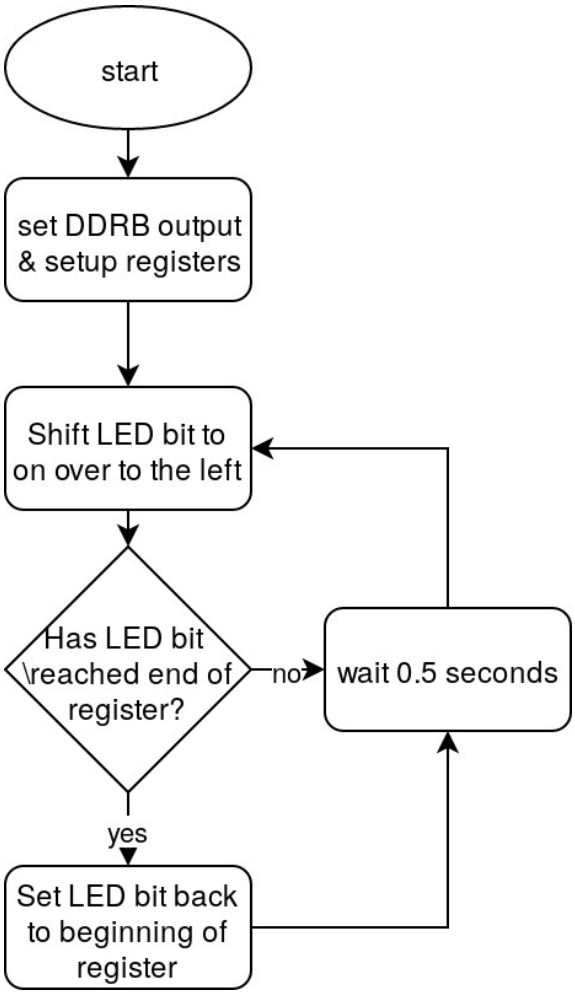
```
        ;rjmp wait_milliseconds ; as long as the pair value r25:r24 did
            not reach 0 it will stay in this wait_milliseconds loop



sub_delay :
        ; Generated by delay loop calculator
        ; at http://www.bretmulvey.com/avrdelay.html
        ;
        ; Delay 2 000 cycles
        ; 500us at 4.0 MHz

                ldi  r17, 3
                ldi  r19, 152
        L1: dec  r19
                brne L1
                dec  r17
                brne L1
                nop
                ret
```

Here is the flowchart for this task :



Task 5 flowchart