Computer Technology I

Lab. 1 : How to use the PORTs, Digital input/output, Subroutine call

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Area: Computer Science
Course code: 1DT301

Contents

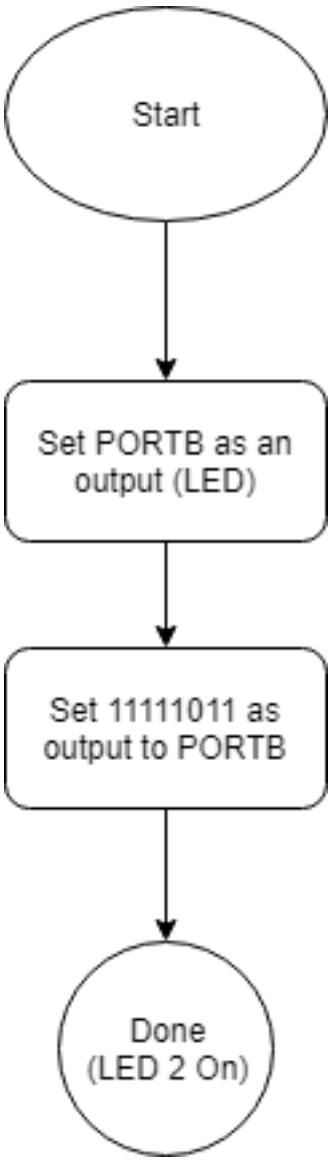
1 Task 1

Write a program in Assembly language to light LED 2. You can use any of the four ports, but start with PORTB. The program should be very short! How many instructions is minimum number?

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2019-09-09
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 1
; Title: How to use the PORTs. Digital input/output. Subroutine call.
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program to light up the LED number 2

; Input ports: NO inputs ports in this Task
;
; Output ports: The portB is used as an output port
;
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Other information:
;
; Changes in program: (Description and date)
;
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

.includes "m2560def.inc"
ldi r16, 0xFF
out DDRB, r16

ldi r16 , 0b11111011
out portB, r16
```

To be able to light up the LEDs we need 4 lines of code. The first line is to store into the register r16 the value 0xFF. In the second line the register r16 is loaded to DDRB (Data Direction Register of port B). In the third line the desired binary code is stored into register r16. The binary number will determine which LED will light up. In the last line the register r16 is loaded into the PortB (Data Register of Port B).

This is the flowchart of the task 1:

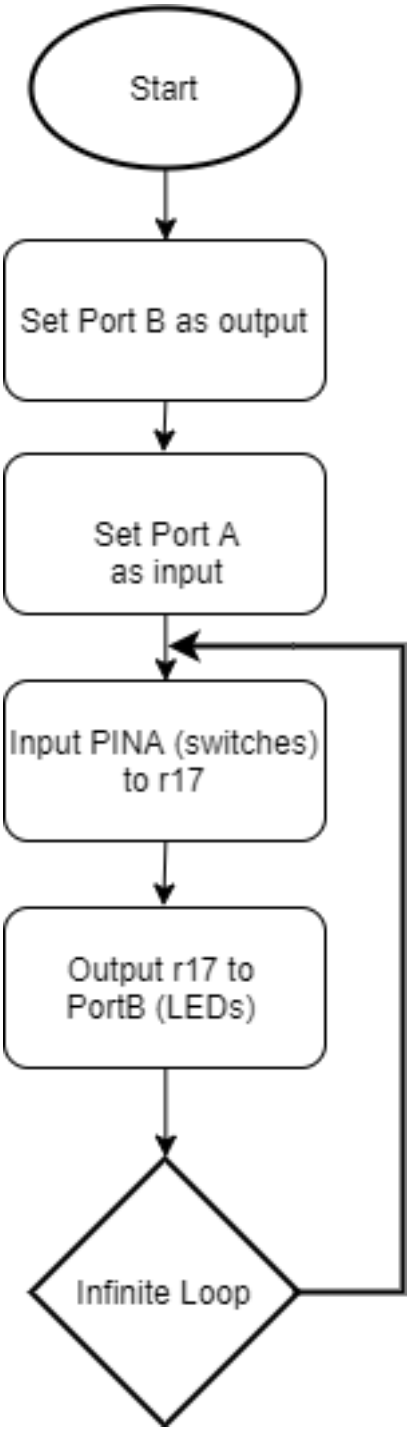


2 Task 2

Write a program in Assembly language to read the switches and light the corresponding LED. Example: When you press SW5, LED5 so should light. Make an initialization part of the program and after that an infinite loop.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2019-09-09
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 1
; Title: How to use the PORTs. Digital input/output. Subroutine call.
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program to light up the LED correponding to the switch. EX:
    (Switch number 1 will light up LED number 1)

; Input ports: PortA is used as input to get the information from the
   switches
;
; Output ports: The portB is used as an output ports to control the
   LEDs
;
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Other information:
;
; Changes in program: (Description and date)
;
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

.include "m2560def.inc"
ldi r16, 0xFF            ;Setting up the data direction for Port B
out DDRB, r16            ;Set port B as output

ldi r16, 0x00            ;Setting up the data direction for Port A
out DDRA, r16            ;Set Port A as output

my_loop:                 ;Loop to always check which switch is pressed
        in r17,PINA ;Getting the information of which switch is pressed
        out portB, R17   ;Lighting up the corresponding LED
rjmp my_loop
```

This is the flowchart for Task 2:

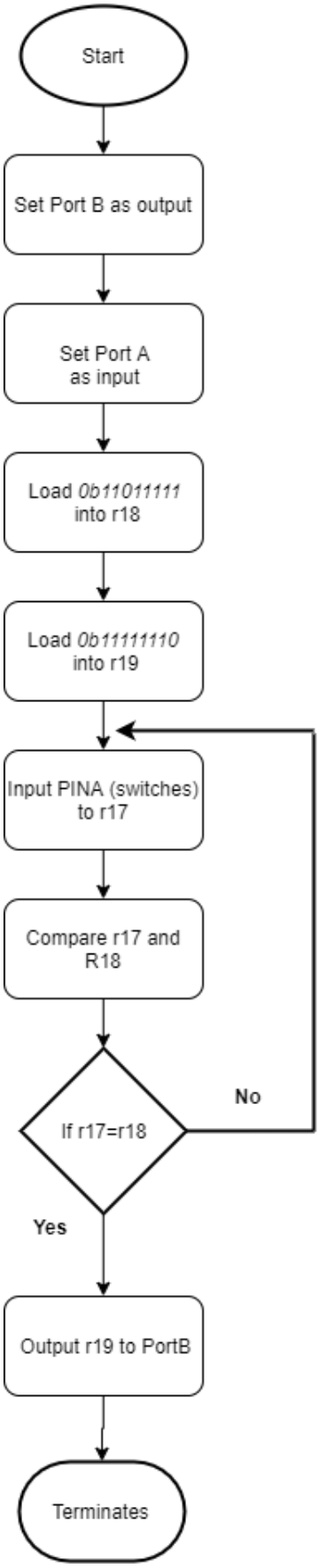


3 Task 3

Write a program in Assembly language to read the switches and light LED0 when you press SW5. For all other switches there should be no activity.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2019-09-09
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 1
; Title: How to use the PORTs. Digital input/output. Subroutine call.
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program to only light up LED number 0 if the switch number
   5 is pressed. If any other switch is pressed, nothing will happen

; Input ports: The Port A will be used as an input port in this Task
;
; Output ports: The portB is used as an output port
;
; Subroutines: If applicable.
; Included files: m2560def.inc
;
; Other information:
;
; Changes in program: (Description and date)
;
ldi r16, 0xFF           ;Setting up the data direction for Port B
out DDRB, r16           ;Set port B as output

ldi r16, 0x00           ;Setting up the data direction for Port A
out DDRA, r16           ;Set Port A as output

ldi r16, 0xFF           ;Turn off all the LEDs
out portB, r16

ldi r18, 0b11011111     ;Desired binary code for SWITCH number 5
ldi r19, 0b11111110     ;Binary code to light up LED0

my_loop:
        in r17, PINA    ;get the info from the switch
        cp r17, r18     ;compare switch info with desired one
        breq light      ;condition if r17=r18 go to the "light"
rjmp my_loop

light: out portB,r19    ;turns on the LED0
```

This is the flowchart for Task 3:



4 Task 5

Write a program in Assembly language that creates a Ring Counter. The values should be displayed with the LEDs. Use shift instructions, LSL or LSR. Make a delay of approximately 0.5 sec in between each count. Write the delay as a subroutine.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2019-09-09
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 1,  How to use the PORTs. Digital input/output.
   Subroutine call.
; Hardware: STK600, CPU ATmega2560
;
; Function: Create a program that creates a Ring Counter with a delay
   of 0.5 seconds.
;
; Output ports: The portB is used as an output port
;
; Subroutines: A subroutine will be used when creating the delay.
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.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 for Port B
out DDRB, r16            ;Set port B as output
ldi r17, 0b11111110      ;Initial LED state
out PortB, r17

my_loop:
        out portB, r17   ;Output the current binary to PortB
        CALL Delay       ;Delay of 0.5 second
        com r17          ;Shift the 0 to the left
        LSL r17          ;without adding
        com r17          ;more zeros to the right.
rjmp my_loop
Delay:
;Generated by delay loop calculator
:at http://www.bretmulvey.com/avrdelay.html
;Delay 4 050 000 cycles
;500ms at 8.1 MHz
        ldi r18, 21
        ldi r19, 140
        ldi 20, 174
L1:     dec r20
        brne L1
        dec r19
        brne L1
        dec r18
        brne L1
        rjmp PC+1
RET
```

This is the flowchart of the task 5:

5 Task 6

Write a program in Assembly language that creates a Johnson Counter in an infinite loop.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2019-09-09
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 1
; Title: How to use the PORTs. Digital input/output. Subroutine call.
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Creates a program that creates a Johnson Counter in an
   infinite loop

; Input ports: NO inputs ports in this Task
;
; Output ports: The portB is used as an output port
;
; Subroutines: To be able to use 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 date direction register for Port B
out DDRB, r16   ;Set port B as output

ldi r16, 0xFF   ;Turn off all the lights
out portB, r16  ;

ldi r21, 0b11111110      ;Initial LED state
ldi r22, 0xFF   ;When all the LEDs are turned off
ldi r23, 0x00   ;When all the LEDs are turned on

my_loop:
        out portB, r21   ;Output r21 to portB
        LSL r21          ;Shift all the bits to the left
        CALL Delay               ;Delay of 0.5 seconds
        ;Compare the current status of the LEDs to check if they are
           all turned on.
        cp r21, r23
        breq light       ;When r21=R23 go to method "light"
rjmp my_loop
```

```
light:
        out portB, r23  ;output r23 to portB
        CALL Delay              ;Delay of 0.5s
        ldi r21, 0b10000000     ;initialize the LED to make it go right
        out portB, r21
        Second_loop:
                out portB, r21  ;output r21 to portB
                ASR r21 ;Shift all the bits to the right so here it
                   would go from 0b1000 0000 to 0b1100 000 and so on
                CALL Delay ;we call the delay
                cp r21, r22             ;Compare the current status to
                   know if it needs to start going the other way
                                ;So for the first one we compare 0b1100
                                     0000 with 0b1111 1111
                breq my_loop ; if r21 == r22 which means all lights are
                    turned off we go back to my_loop
        rjmp Second_loop ;if breq is not true then we repeat the loop
           of Second_loop

Delay:
;Generated by delay loop calculator
:at http://www.bretmulvey.com/avrdelay.html
;
;Delay 4 050 000 cycles
;500ms at 8.1 MHz

        ldi r18, 21
        ldi r19, 140
        ldi 20, 174
L1:     dec r20
        brne L1
        dec r19
        brne L1
        dec r18
        brne L1
        rjmp PC+1
RET
```

This is the flowchart of the task 6: