Lab 5

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Section 75C9

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- Prelab Questions:

  1. List the XMEGA's USART registers used in your programs and briefly describe their functions.
  UsartD0_CTRLA: Is for interrupt level.
  UsartD0_CTRLB:Enables transmitter and receiver.
  UsartD0_CTRLC:Parity, stop bit, bit frame
  USARTC0_BAUDCTRLA & USARTC0_BAUDCTRLB: Baud rate configurations.
  USARTC0_STATUS:Check the status of the RX and TX, to see if we can receive or transmit.
  USARTC0_DATA:To actually send or receive the data from/to the USARTC system

  2. What is the difference between synchronous and asynchronous communication?
  Synchronous have a clock that was to wait in order to do something. While asynchronous doesn't have to wait and can be done at any time. In the lab we used asynchronous communication.

  3. What's the difference between serial and parallel communication?
  Serial communication transfers data one bit at a time, uses less wires, and can cover longer distances. Parallel communication sends data multiple bits at a time over multiple wires, and can do it much quicker.

  4. List the number of bounces from part A of this lab. How long (in ms) is your delay routine for debouncing?
  There are around 10 bounces on falling, and 2 bounces on rising. I used a 90ms delay for the debouncing.

  5. What is the maximum possible baud you can use **for asynchronous communication** if your board runs at 2Mhz? Support your answer with the values you would place in any special registers that are needed.
  he maximum baud rate is 124031 Hz, the bscale would be -7 and 1 for bsel.

  ```
  ldi R16, (BSel & 0xFF)
  sts USARTD0_BAUDCTRLA, R16
  ldi R16, ((BScale << 4) & 0xF0) | ((BSel >> 8) & 0x0F) sts USARTD0_BAUDCTRLB, R16
  ```

- Problems Encountered:
  Getting the menu to pop before taking in any characters into the console.
- Future Work/Applications:
  We now know how to interrupt a service which is useful for Operating Systems or other devices. We also learned serial communication which is used to receive and send data.

- Schematics:
  None for this lab

- Decoding Logic:
  None for this lab

- Pseudo code:

```
Part A:
Start a register with 0
Infinite loop
inside the interrupt:
increase register
output to led

PartC:
Fill in table with favorite stuff
Make an infinite loop where depending and the character it makes an rcall
when esc char is pressed end program

PartD:
Infinite loop turning LED on and off every .37s
Inside interrupt:
A get char
and spit it out in the console
```

- Program Code:
  Part A:

```
   (Note: The two include files are at the end)
/*
 * Lab5_A_RSR.asm
 *
 *  Created: 7/2/2015 1:26:06 PM
 *   Author: stefano92
 Lab 5 part A
 Name: Ricardo Stefano Reyna
 Section#: 75C9
 TA: Khaled Hassan
 Description: This program will count the number of interrupts and display them on the
LED
 */


.include "atxmega128a1udef.inc"
.include "EBI_STUFF.asm"
.include "Delay.asm"

.org 0x0000
	rjmp MAIN

.org PORTE_INT0_VECT		;place code at the interrupt vector for the PORTE_INT0
interrupt
	rjmp EXT_INT_ISR			;jump to our interrupt routine
```

```
.org 0x0200
MAIN:
       STACK_STUFF   ;Initialize stack

       EBI_INIT      ;Initialize EBI

       CS0_INIT      ;Initialize CS0

/////////////////////////START PROGRAM///////////////////

       ldi r17, 0x00
       rcall INIT_INTERRUPT ;call our subroutine to initialize our interrupt
       nop

LOOP:
       rjmp LOOP                          ;loop forver while our interrupt fires

INIT_INTERRUPT:
       ldi r16, 0x01               ;select PORTE_PIN0 as the interrupt source
       sts PORTE_INT0MASK, r16
       sts PORTE_DIRCLR, r16       ;PIN0 as input

       ldi r16, 0x01               ;select the external interrupt as a low level
       sts PORTE_INTCTRL, r16      ;  priority interrupt
;      Probably inappropriately cleared the INT1 interrupt level pins

       ldi    R16, 0x01                   ;select low level pin for external interrupt
       sts    PORTE_PIN0CTRL, r16  ;  (rising edge)
;      Probably inappropriately cleared pins 7, 5, 4, 3

       ldi r16, 0x01
       sts PMIC_CTRL, r16          ;turn on low level interrupts
;      Also effected pins 7-1
       sei                                       ;turn on the global interrupt flag LAST!
       ret

EXT_INT_ISR:
       call WASTE
       push r16
       in r16, CPU_SREG
       push r16
       nop                 ;dummy instruction to put a breakpoint on
       inc r17
       st X, r17                          ;Number of interrupts
       ldi    r16, 0x01
       sts PORTE_INTFLAGS, r16     ; Clear the PORTE_INTFLAGS
       pop r16
       out CPU_SREG, r16
       pop    r16
       reti          ;return from the interrupt routine
```

       PartC:

```
/*
 * Lab5_C_RSR.asm
 *
 *  Created: 7/6/2015 11:03:15 PM
 *   Author: stefano92
 Lab 5 part C
 Name: Ricardo Stefano Reyna
 Section#: 75C9
 TA: Khaled Hassan
 Description: This program will print strings of my favorite stuff
 */

.include "atxmega128a1udef.inc"
.include "EBI_STUFF.asm"


.equ BSel = 983
.equ BScale = -7     ;14400Hz

.equ CR = 0x0D
.equ LF = 0x0A
.equ ESC = 0x1B

.org 0x1000
MENU: .db "Stefano's favorite:", CR, LF, "1. Movie", CR, LF, "2. Book", CR, LF, "3.
Food", CR, LF, "4. Ice Cream/Yogurt flavor", CR, LF, "5. Pizza Topping", CR, LF, "6.
Redisplay Menu", CR, LF, "ESC: exit", CR, LF, 0x00
OP1: .db "Stefano's favorite movie is Fight Club", CR, LF, 0x00
OP2: .db "Stefano's favorite book is Chronicles of a Death Fortold", CR, LF, 0x00
OP3: .db "Stefano's favorite food is rice", CR, LF, 0x00
OP4: .db "Stefano's favorite ice cream/yogurt flavor is chocolate", CR, LF, 0x00
OP5: .db "Stefano's favorite pizza topping is pineapple", CR, LF, 0x00
OP6: .db "Done!", 0x00

.org 0x0000
       rjmp MAIN

.org 0x0200
MAIN:

       STACK_STUFF

       rcall INIT_USART
       rcall INIT_GPIO

LOOP:
       ldi ZL, low(MENU << 1)
       ldi ZH, high(MENU << 1)
       rcall OUT_STRING

GETCHAR:
       rcall IN_CHAR
       cpi R16, ESC  ;If ESC
       breq EXIT
       cpi R16, 0x31 ;If 1
       breq MOVIE
       cpi R16, 0x32 ;If 2
       breq BOOK
       cpi R16, 0x33 ;If 3
       breq FOOD
       cpi R16, 0x34 ;If 4
       breq ICEYO
       cpi R16, 0x35 ;If 5
       breq PIZZA
       cpi R16, 0x36 ;If 6
       breq LOOP
       rjmp GETCHAR

;OPTIONS
EXIT:
       ldi ZL, low(OP6 << 1)
       ldi ZH, high(OP6 << 1)
       call OUT_STRING
DONE:
       rjmp DONE

MOVIE:
       ldi ZL, low(OP1 << 1)
       ldi ZH, high(OP1 << 1)
       rcall OUT_STRING
       rjmp LOOP
BOOK:
       ldi ZL, low(OP2 << 1)
       ldi ZH, high(OP2 << 1)
       rcall OUT_STRING
       rjmp LOOP
FOOD:
       ldi ZL, low(OP3 << 1)
       ldi ZH, high(OP3 << 1)
       rcall OUT_STRING
       rjmp LOOP
ICEYO:
       ldi ZL, low(OP4 << 1)
       ldi ZH, high(OP4 << 1)
       rcall OUT_STRING
       rjmp LOOP
PIZZA:
       ldi ZL, low(OP5 << 1)
       ldi ZH, high(OP5 << 1)
       rcall OUT_STRING
       rjmp LOOP

;OUTSTR
OUT_STRING:
       push r16

WRITE:
       lpm r16, Z+         ;reads each char
       cpi r16, 0x00
       breq STOPW
       rcall OUT_CHAR
       rjmp WRITE          ;Write to console

STOPW:
       pop r16
       ret


;INCHAR
IN_CHAR:
       push r17
```

```
RX_POLL:
       lds r16, USARTD0_STATUS            ;load the status register
       sbrs r16, 7                               ;proceed to reading in a char if
                                                       ;  the receive flag is set
       rjmp RX_POLL                       ;else continue polling
       lds r16, USARTD0_DATA              ;read the character into R16

       pop r17
       ret

;OUTCHAR
OUT_CHAR:
       push R17

TX_POLL:
       lds R17, USARTD0_STATUS            ;load status register
       sbrs R17, 5                               ;proceed to writing out the char if
                                                       ;  the DREIF flag is set
       rjmp TX_POLL                       ;else go back to polling
       sts USARTD0_DATA, R16              ;send the character out over the USART
       pop R17

       ret

;INITUSART
INIT_USART:
       ldi R16, 0x18
       sts USARTD0_CTRLB, R16             ;turn on TXEN, RXEN lines

       ldi R16, 0x03
       sts USARTD0_CTRLC, R16             ;Set Parity to none, 8 bit frame, 1 stop bit

       ldi R16, (BSel & 0xFF)             ;select only the lower 8 bits of BSel
       sts USARTD0_BAUDCTRLA, R16  ;set baudctrla to lower 8 bites of BSel

       ldi R16, ((BScale << 4) & 0xF0) | ((BSel >> 8) & 0x0F)

       sts USARTD0_BAUDCTRLB, R16  ;set baudctrlb to BScale | BSel. Lower
                                                       ;  4 bits are upper 4 bits of BSel
                                                       ;  and upper 4 bits are the
BScale.
       ret

;INITGPIO
INIT_GPIO:
       ldi R16, 0x08
       sts PortD_DIRSET, R16       ;Must set PortD_PIN3 as output for TX pin
                                                 ;  of USARTD0
       sts PortD_OUTSET, R16       ;set the TX line to default to '1' as
                                                 ;  described in the documentation
       ldi R16, 0x04
       sts PortD_DIRCLR, R16       ;Set RX pin for input

       ldi R16, 0xA                ; PortQ bits 1 and 3 enable and select
       sts PORTQ_DIRSET, R16       ;   the PortD bits 2 and 3 serial pins
       sts PORTQ_OUTCLR, R16   ;   to be connected to the USB lines
       ret
       PartD:
/*
 * Lab5_D_RSR.asm
 *
 *  Created: 7/8/2015 1:21:39 PM
 *   Author: stefano92
 Lab 5 part D
 Name: Ricardo Stefano Reyna
 Section#: 75C9
 TA: Khaled Hassan
 Description: This program combines part A and C
 */

.include "atxmega128a1udef.inc"
.include "EBI_STUFF.asm"
.include "Delay.asm"

.equ BSel = 983
.equ BScale = -7     ;14400Hz

.org 0x0000
       rjmp MAIN

.org USARTD0_RXC_vect              ;place code at the interrupt vector for the PORTE_INT0
interrupt
       rjmp EXT_INT_ISR                   ;jump to our interrupt routine

.org 0x0200
MAIN:

       STACK_STUFF   ;Initialize stack

       EBI_INIT      ;Initialize EBI

       CS0_INIT      ;Initialize CS0

       rcall INIT_USART
       rcall INIT_GPIO

       ldi r16, 0x04
       ldi r18, 0x00


LOOP:
       ldi r19, 74
       st X, r16     ;ON
       call WASTE
       st X, r18     ;OFF
       call WASTE
       rjmp LOOP

;INCHAR
IN_CHAR:
       push r17
```

```
RX_POLL:
       lds r16, USARTD0_STATUS            ;load the status register
       sbrs r16, 7                               ;proceed to reading in a char if
                                                        ;  the receive flag is set
       rjmp RX_POLL                       ;else continue polling
       lds r16, USARTD0_DATA              ;read the character into R16

       pop r17
       ret

;OUTCHAR
OUT_CHAR:
       push R17

TX_POLL:
       lds R17, USARTD0_STATUS            ;load status register
       sbrs R17, 5                               ;proceed to writing out the char if
                                                        ;  the DREIF flag is set
       rjmp TX_POLL                       ;else go back to polling
       sts USARTD0_DATA, R16              ;send the character out over the USART
       pop R17

       ret

;INITUSART
INIT_USART:

       ldi r16, 0x10
       sts USARTD0_CTRLA, r16             ;turn on low level
       ldi r16, 0x18
       sts USARTD0_CTRLB, r16             ;turn on TXEN, RXEN lines

       ldi r16, 0x03
       sts USARTD0_CTRLC, r16             ;Set Parity to none, 8 bit frame, 1 stop bit

       ldi r16, (BSel & 0xFF)             ;select only the lower 8 bits of BSel
       sts USARTD0_BAUDCTRLA, r16  ;set baudctrla to lower 8 bites of BSel

       ldi r16, ((BScale << 4) & 0xF0) | ((BSel >> 8) & 0x0F)

       sts USARTD0_BAUDCTRLB, r16  ;set baudctrlb to BScale | BSel. Lower
                                                        ;  4 bits are upper 4 bits of BSel
                                                        ;  and upper 4 bits are the
BScale.

       ldi r16, 0x01
       sts PMIC_CTRL, r16   ;turn low level interrupts ON
       sei                                ;set the global interrupt flag to enable
interrupt
       ret

;INITGPIO
INIT_GPIO:
       ldi R16, 0x08
       sts PortD_DIRSET, R16       ;Must set PortD_PIN3 as output for TX pin
                                                 ;  of USARTD0
       sts PortD_OUTSET, R16       ;set the TX line to default to '1' as
                                                 ;  described in the documentation
```

```
        ldi R16, 0x04
        sts PortD_DIRCLR, R16       ;Set RX pin for input

        ldi R16, 0xA                ; PortQ bits 1 and 3 enable and select
        sts PORTQ_DIRSET, R16       ;   the PortD bits 2 and 3 serial pins
        sts PORTQ_OUTCLR, R16   ;   to be connected to the USB lines
        ret

EXT_INT_ISR:
        push r16
        in r16, CPU_SREG
        push r16
        nop                  ;dummy instruction to put a breakpoint on
        rcall IN_CHAR        ;Read char
        rcall OUT_CHAR              ;Output char
        pop r16
        out CPU_SREG, r16
        pop    r16
        reti          ;return from the interrupt routine

        Delay:
;This one takes r19 as an input
.LIST
.org 0xF00
WASTE:
        push r16
        push r17
        ldi r16, 0x00
        ldi r17, 0x00
EXTRA:
        inc r16
        cp r16, r19          ;change this number
        brne DELAY_10ms
        pop r17
        pop r16
        ret
DELAY_10ms:
        nop                  ; do nothing
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
        nop
```

```
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       nop
       inc r17              ;increase r18
       cpi r17, 0xFF ;check if r18 is 28
       brne DELAY_10ms      ;if not loop
       rjmp EXTRA

       EBI_STUFF:
;Simple program to initialize stuff
.set IOPORT = 0x4000
.set SRAMPORT = 0x1B0000

.macro STACK_STUFF
       ldi r16, 0xFF
       out CPU_SPL, r16                   ;initialize low byte of stack pointer
       ldi r16, 0x3F
       out CPU_SPH, r16                   ;initialize high byte of stack pointer
.endmacro

.macro EBI_INIT
       ldi r16, 0x17
       sts PORTH_DIR, r16 //set port pins as outputs for RE and ALE and WE

       ldi r16, 0x13
       sts PORTH_OUT, r16 //WE and RE is active low so it must be set

       ldi r16, 0xFF
       sts PORTJ_DIR, r16 //set datalines as outputs
       sts PORTK_DIR, r16 //set address lines as outputs

       ldi r16, 0x01
       sts EBI_CTRL, r16 //turn on 3 port SRAM ALE1 EBI
.endmacro

.macro CS0_INIT
       ldi ZH, HIGH(EBI_CS0_BASEADDR) //all the set up for CS0, since EBI won't work
without it
       ldi ZL, LOW(EBI_CS0_BASEADDR)
       ldi r16, ((IOPORT>>8) & 0xF0)
       st Z+, r16
       ldi r16, ((IOPORT>>16) & 0xFF)
       st Z, r16
       ldi r16, 0x11
       sts EBI_CS0_CTRLA, r16
       ldi XH, HIGH(IOPORT)
       ldi XL, LOW(IOPORT)
```

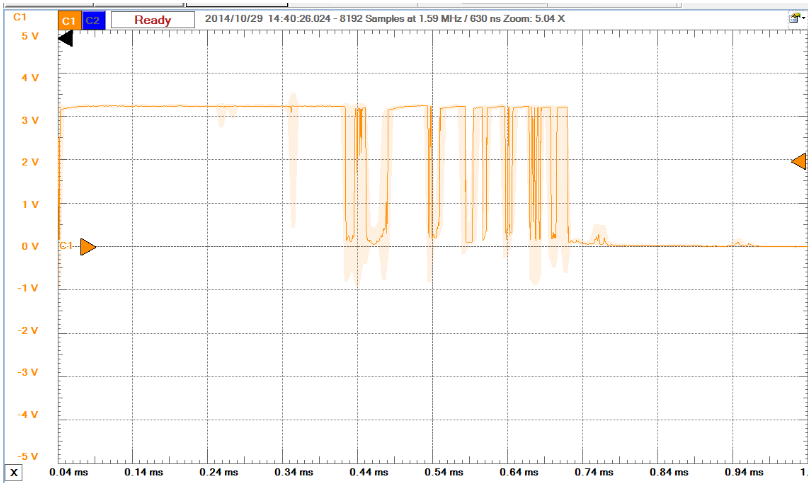
```
.endmacro

.macro CS1_INIT
       ldi ZH, HIGH(EBI_CS1_BASEADDR) //set up CS1 for the SRAM
       ldi ZL, LOW(EBI_CS1_BASEADDR)
       ldi r16, ((SRAMPORT>>8) & 0xF0)
       st Z+, r16
       ldi r16, ((SRAMPORT>>16) & 0xFF)
       st Z, r16

       ldi r16, 0b00011101
       sts EBI_CS1_CTRLA, r16
.endmacro
```

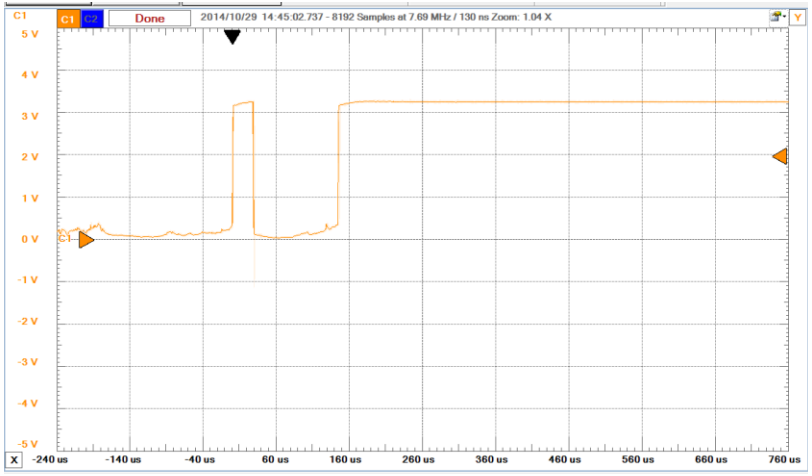
- <u>Appendix:</u>

Falling edge



2014/10/29 14:40:26.024 - 8192 Samples at 1.59 MHz / 630 ns Zoom: 5.04 X

Rising Edge



2014/10/29 14:45:02.737 - 8192 Samples at 7.69 MHz / 130 ns Zoom: 1.04 X