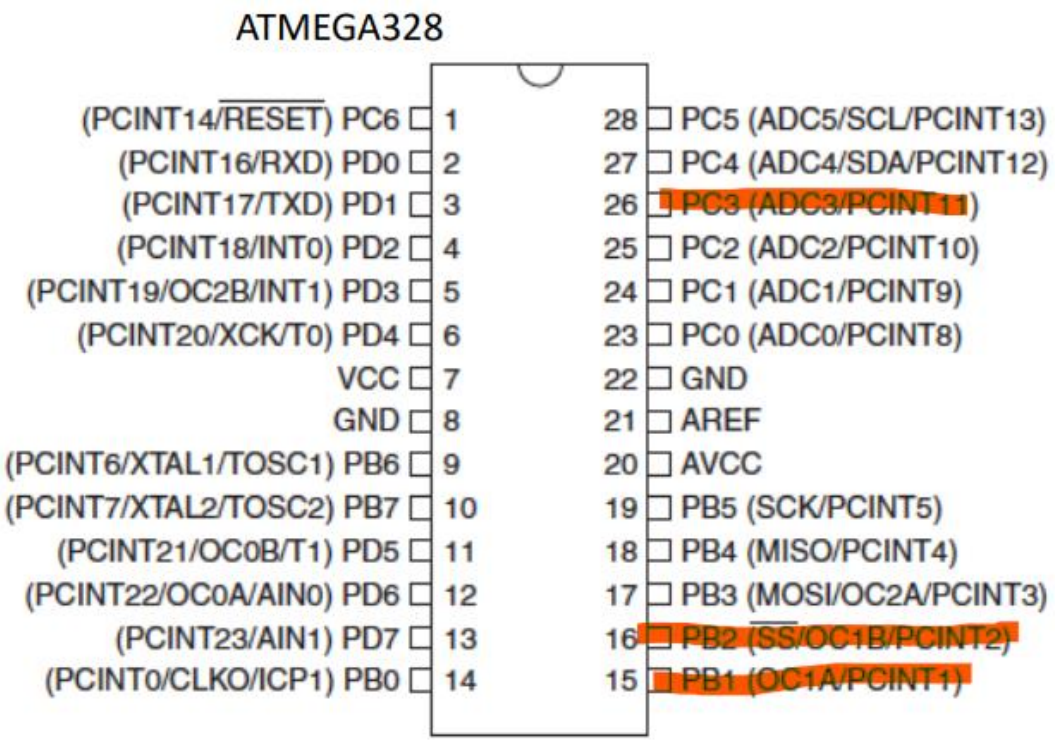
[redacted]

02 GPIO Delays and Interrupts

Student Name: [redacted]
Student #: [redacted]
Student Email: [redacted]
Primary Github address: https://github.com/DylanCaz/Submission_DA.git
Directory: https://github.com/DylanCaz/Submission_DA/tree/main/Design_Assignments_sub

1. COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS



2. INITIAL/MODIFIED/DEVELOPED CODE OF TASK 1/2

Task 2 C Code

```
/*
 * Design_Assignment_2_C.c
 *
 * Created: 2/19/2022 9:06:08 PM
```

```
 * Author : Dylan Cazares
 * Task 2
 */
#define F_CPU 16000000            // 16MHz
#include <avr/interrupt.h>
#include <avr/io.h>
#include <util/delay.h>                 // Delay Library

int main(void)
{
      DDRC &= (0 << 3);           // setting PORTC.3 as an input
      PORTC |= (1 << 3);                // enabling pull up


      DDRB |= (1 << 2);           // setting PORTB.2 as an output
      DDRB |= (1 << 3);           // setting PORTB.3 as an output
      PORTB |= (1 << 2);                // enabling pull up


    while (1)
    {
            if(!(PINC & (1 << PINC3)))
            {
                  PORTB &= ~(1 << 2);    // turn PORTB.2 LED on
                  _delay_ms(1250); // delay 1250 ms
                  PORTB |= (1 << 2);     // turn PORTB.2 LED off
            }
            else if
            {
                  PORTB |= (1 << 2);     // turn PORTB.2 LED off

            }
    }
}
```

Task 1/2 Assembly Code

```
;
; DA_2_Assembly.asm
; Created 2/19/2022 2:26:46 PM
; Author : Dylan Cazares
; Task 1/2
;

.include <m328pbdef.inc>

.ORG 0                  ; location for reset
JMP MAIN
.ORG 0x02         ; location for external interrupt 0

MAIN:
      CBI DDRC, 3`      ; setting PORTC.3 as an input
      SBI DDRB, 2       ; setting PORTB.2 as an output
```

```
      SBI DDRB, 3      ; setting PORTB.3 as an output


; stack initialization
LDI R20, HIGH(RAMEND)
OUT SPH, R20
LDI R20, LOW(RAMEND)
OUT SPL, R20

L1:
      SBIC PINC, 3           ; skip if PINC.3 is cleared
      RJMP L1                ; if PINC.3 cleared, check for input on
PINC.3
      CBI PORTB, 2           ; turn PORTB.2 LED on
      ; calling 250MS_Delay five times to generate a delay of 1.25 seconds
      CALL DELAY_250ms
      CALL DELAY_250ms
      CALL DELAY_250ms
      CALL DELAY_250ms
      CALL DELAY_250ms


      SBI PINB, 2            ; turn PINB.2 LED off

DELAY_250ms:                 ; delay subroutine to generate a delay of
0.25 seconds
      LDI R17, 16            ; R17 = 16
      L1_Delay:
            LDI R18, 200     ; R18 = 200
            L2_Delay:
                  LDI R19, 249     ; R19 = 249
                  NOP              ;  No Operation (do nothing)
                  NOP              ;  No Operation (do nothing)
                  L3_Delay:
                        NOP        ; No Operation (do nothing)
                        NOP        ; No Operation (do nothing)
                        DEC R19    ; decrement R19
                        BRNE L3_Delay    ; Branch to L3_Delay if R19 is not
equal to 0
                        DEC R18               ; Decrement R18
                        BRNE L2_Delay    ; Branch to L2_Delay if R18 is not
equal to 0
                        DEC R17               ; Decrement R17
                        BRNE L1_Delay    ; Branch to L1_Delay if R17 is not
equal to 0
                        RET                   ; return to caller
```

3. DEVELOPED MODIFIED CODE OF TASK 3

Task 3 C code

```
/*
 * Design_Assignment_2_C.c
 *
 * Created: 2/19/2022 9:06:08 PM
 * Author : Dylan Cazares
 * Task 3
 */
#define F_CPU 16000000            // 16MHz
#include <avr/interrupt.h>
#include <avr/io.h>
#include <util/delay.h>           // Delay Library



int main(void)
{
      DDRC &= (0 << 3);           // setting PORTC.3 as an input
      PORTC |= (1 << 3);          // enabling pull up


      DDRD &= (1 << 2);           // setting PORTD.2 as an input
      PORTD |= (1 << 2);          // enabling pull up


      DDRB |= (1 << 2);           // setting PORTB.2 as an output
      DDRB |= (1 << 1);           // setting PORTB.1 as an output
      PORTB |= (1 << 2);          // enabling pull up


    while (1)
    {
            if(!(PINC & (1 << PINC3)))
            {
                  PORTB &= ~(1 << 2);    // turn PORTB.2 LED on
                  _delay_ms(1250);       // delay 1250 ms
                  PORTB |= (1 << 2);     // turn PORTB.2 LED off
            }
            else if (!(PIND & (1 << PIND2)))
            {

                  EICRA = 0x02;               // make INT0 falling edge
triggered
                  EIMSK = (1 << INT0);        // enable external interrupt
0
                  sei();                      // enable interrupts
            }
    }
}
ISR(INT0_vect)                                // ISR for external
interrupt 0
```

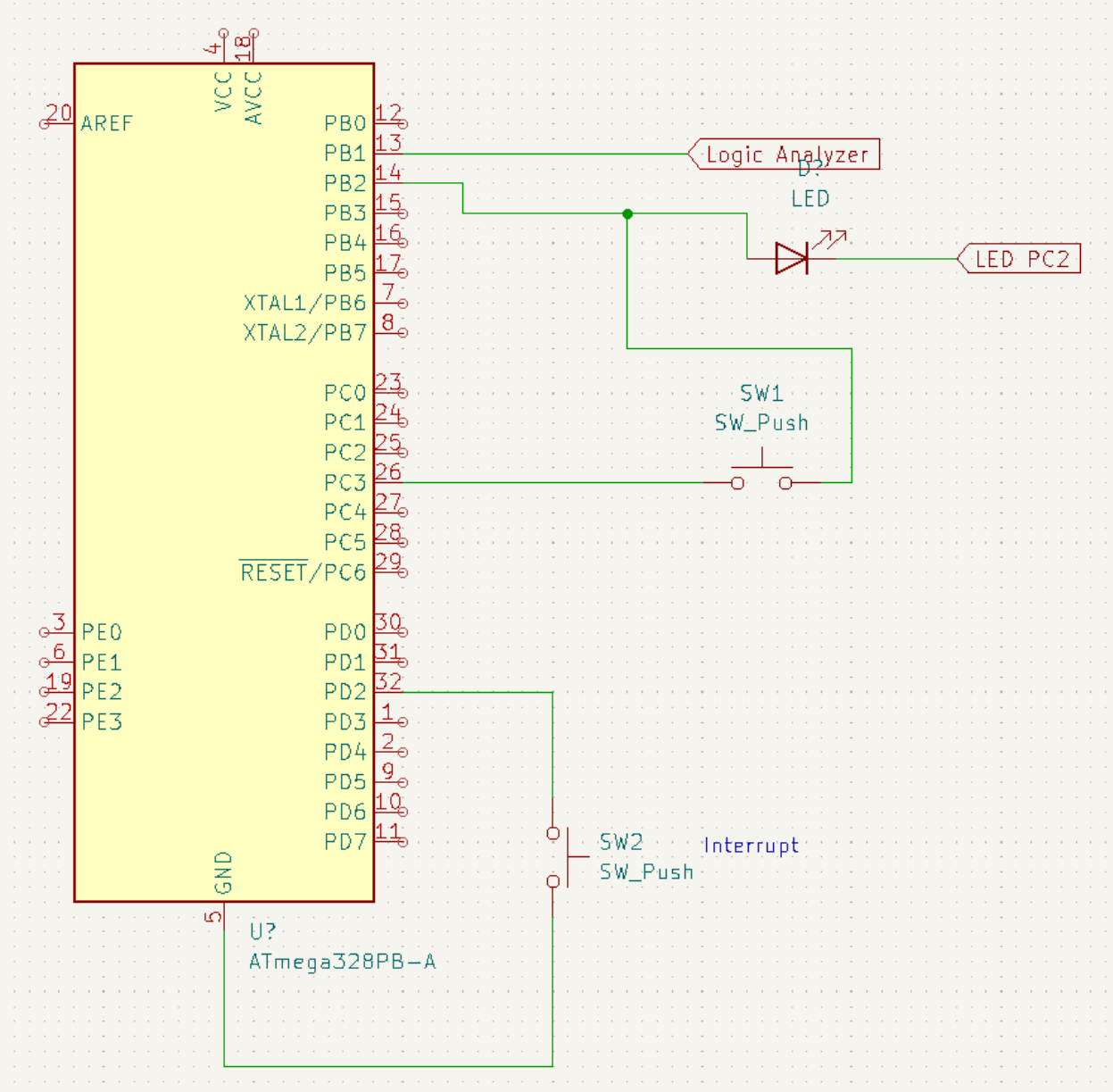
```
{
            PORTB ^= ~(1 << 3);                 // toggle PORTB.3 on
            _delay_ms(500);                     // delaying for 500ms
            PORTB |= (1 << 3);                  // toggle PORTB.3 off
}
```

Task 3 Assembly

```
;
; DA_2_Assembly.asm
; Created 2/19/2022 2:26:46 PM
; Author : Dylan Cazares
; Task 3
;

.include <m328pbdef.inc>

.ORG 0                  ; location for reset
JMP MAIN
.ORG 0x02         ; location for external interrupt 0
JMP EX0_ISR       ; jump to EX0_ISR

MAIN:
      CBI DDRC, 3`      ; setting PORTC.3 as an input
      SBI DDRB, 2       ; setting PORTB.2 as an output
      SBI DDRB, 3       ; setting PORTB.3 as an output
      CBI DDRD, 2       ; setting PORTD.2 as an input

; stack initialization
LDI R20, HIGH(RAMEND)
OUT SPH, R20
LDI R20, LOW(RAMEND)
OUT SPL, R20

L1:
      SBIC PINC, 3                        ; skip if PINC.3 is cleared
      RJMP L1                                   ; if PINC.3 cleared, check
for input on PINC.3
      CBI PORTB, 2                        ; turn PORTB.2 LED on
      ; calling 250MS_Delay five times to generate a delay of 1.25 seconds
      CALL DELAY_250ms
      CALL DELAY_250ms
      CALL DELAY_250ms
      CALL DELAY_250ms
      CALL DELAY_250ms


LDI R20, 0x02                             ; make INT0 falling edge triggered
STS EICRA, R20                            ; store falling edge in EICRA
SBI DDRD, 1                               ; activating pull up
LDI R20, 1 << INT0                        ; enable INT0
OUT EIMSK, R20                            ; storeing R20 in EIMSK location
SEI                                             ; enable interrupt

      SBI PINB, 2                         ; turn PINB.2 LED off
```

```
DELAY_250ms:                          ; delay subroutine to generate a
delay of 0.25 seconds
      LDI R17, 16                     ; R17 = 16
      L1_Delay:
            LDI R18, 200              ; R18 = 200
            L2_Delay:
                  LDI R19, 249        ; R19 = 249
                  NOP                       ;  No Operation (do nothing)
                  NOP                       ;  No Operation (do nothing)
                  L3_Delay:
                        NOP                 ; No Operation (do nothing)
                        NOP                 ; No Operation (do nothing)
                        DEC R19             ; decrement R19
                        BRNE L3_Delay   ; Branch to L3_Delay if R19 is not
equal to 0
                        DEC R18             ; Decrement R18
                        BRNE L2_Delay   ; Branch to L2_Delay if R18 is not
equal to 0
                        DEC R17             ; Decrement R17
                        BRNE L1_Delay   ; Branch to L1_Delay if R17 is not
equal to 0
                        RET                 ; return to caller
EX0_ISR:
      L2:
            SBIC PIND, 2              ; skip if PIND.2 is cleared
            RJMP L2                         ; if PIND.2 is 0 skip to
next
            CBI PORTB, 3              ; Turn PINB.3 LED on
            CALL DELAY_250ms      ; delay 250ms
            CALL DELAY_250ms      ; delay 250ms
            SBI PINB, 2                     ; Turn PINB.3 LED off
            RETI                    ; return from Interrupt
```

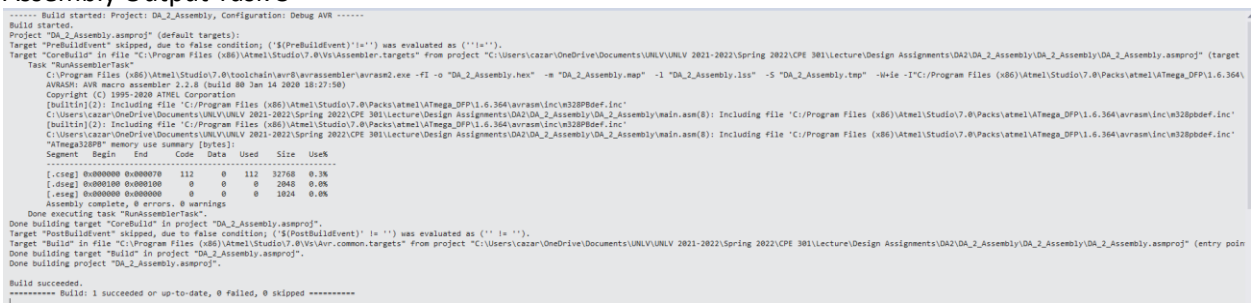
4. SCHEMATICS



5. SCREENSHOTS OF EACH TASK OUTPUT (ATMEL STUDIO OUTPUT)

Assembly Output Task 1/2

Assembly Output Task 3

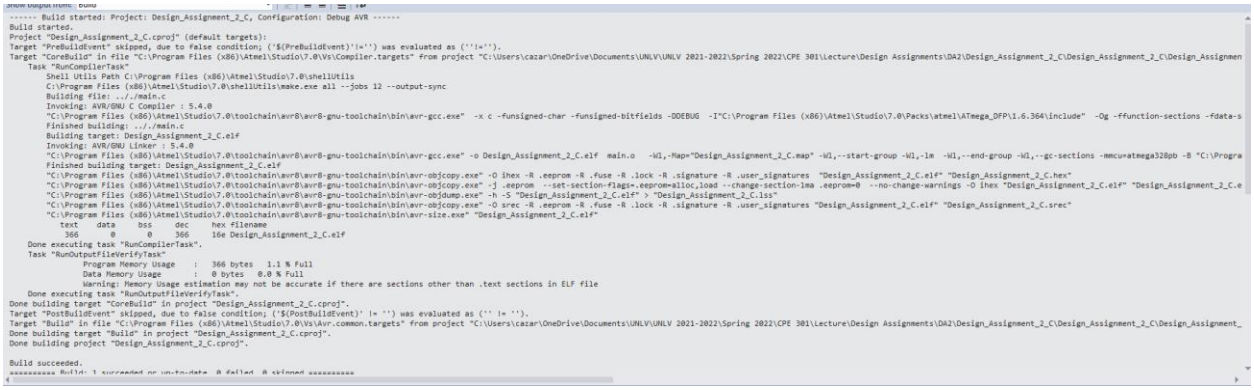


```
------ Build started: Project: DA_2_Assembly, Configuration: Debug AVR ------
Build started.
Project "DA_2_Assembly.asmproj" (default targets):
Target "PreBuildEvent" skipped, due to false condition; ('$(PreBuildEvent)'!='') was evaluated as (''!='').
Target "CoreBuild" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Assembler.targets" from project "C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\DA_2_Assembly\DA_2_Assembly\DA_2_Assembly.asmproj" (target
    Task "RunAssemblerTask"
        C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avrassembler\avrasm2.exe -fI -o "DA_2_Assembly.hex"  -m "DA_2_Assembly.map"  -l "DA_2_Assembly.lss"  -S "DA_2_Assembly.tmp"  -W+ie -I"C:/Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\
        AVRASM: AVR macro assembler 2.2.8 (build 80 Jan 14 2020 18:27:50)
        Copyright (C) 1995-2020 ATMEL Corporation
        [builtin](2): Including file 'C:/Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\avrasm\inc\m328PBdef.inc'
        C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\DA_2_Assembly\DA_2_Assembly\main.asm(8): Including file 'C:/Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\avrasm\inc\m328pbdef.inc'
        [builtin](2): Including file 'C:/Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\avrasm\inc\m328PBdef.inc'
        C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\DA_2_Assembly\DA_2_Assembly\main.asm(8): Including file 'C:/Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\avrasm\inc\m328pbdef.inc'
        "ATmega328PB" memory use summary [bytes]:
        Segment   Begin    End      Code   Data   Used    Size   Use%
        ----------------------------------------------------------------
        [.cseg] 0x000000 0x000070    112      0    112   32768   0.3%
        [.dseg] 0x000100 0x000100      0      0      0    2048   0.0%
        [.eseg] 0x000000 0x000000      0      0      0    1024   0.0%
        Assembly complete, 0 errors. 0 warnings
    Done executing task "RunAssemblerTask".
Done building target "CoreBuild" in project "DA_2_Assembly.asmproj".
Target "PostBuildEvent" skipped, due to false condition; ('$(PostBuildEvent)' != '') was evaluated as ('' != '').
Target "Build" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Avr.common.targets" from project "C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\DA_2_Assembly\DA_2_Assembly\DA_2_Assembly.asmproj" (entry poin
Done building target "Build" in project "DA_2_Assembly.asmproj".
Done building project "DA_2_Assembly.asmproj".

Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
```

C Code Task 2

```
------ Build started: Project: Design_Assignment_2_C, Configuration: Debug AVR ------
Build started.
Project "Design_Assignment_2_C.cproj" (default targets):
Target "PreBuildEvent" skipped, due to false condition; ('$(PreBuildEvent)'!='') was evaluated as (''!='').
Target "CoreBuild" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Compiler.targets" from project "C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\Design_Assignment_2_C\Design_Assignment_2_C\Design_Assignmen
    Using "RunCompilerTask" task from assembly "C:\Program Files (x86)\Atmel\Studio\7.0\Extensions\Application\AvrGCC.dll".
    Task "RunCompilerTask"
        Shell Utils Path C:\Program Files (x86)\Atmel\Studio\7.0\shellUtils
        C:\Program Files (x86)\Atmel\Studio\7.0\shellUtils\make.exe all --jobs 12 --output-sync
        ../../main.c: In function 'main':
C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\Design_Assignment_2_C\Design_Assignment_2_C\main.c(33,3): error: expected '(' before '{' token
          {
          ^
        make: *** [main.o] Error 1
        Building file: ../../main.c
        Invoking: AVR/GNU C Compiler : 5.4.0
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-gcc.exe"  -x c -funsigned-char -funsigned-bitfields -DDEBUG  -I"C:\Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\include"  -Og -ffunction-sections -fdata-s
C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\Design_Assignment_2_C\Design_Assignment_2_C\Debug\Makefile(76,1): error: recipe for target 'main.o' failed
    Done executing task "RunCompilerTask" -- FAILED.
Done building target "CoreBuild" in project "Design_Assignment_2_C.cproj" -- FAILED.
Done building project "Design_Assignment_2_C.cproj" -- FAILED.

Build FAILED.
========== Build: 0 succeeded or up-to-date, 1 failed, 0 skipped ==========
```

C Code Task 3

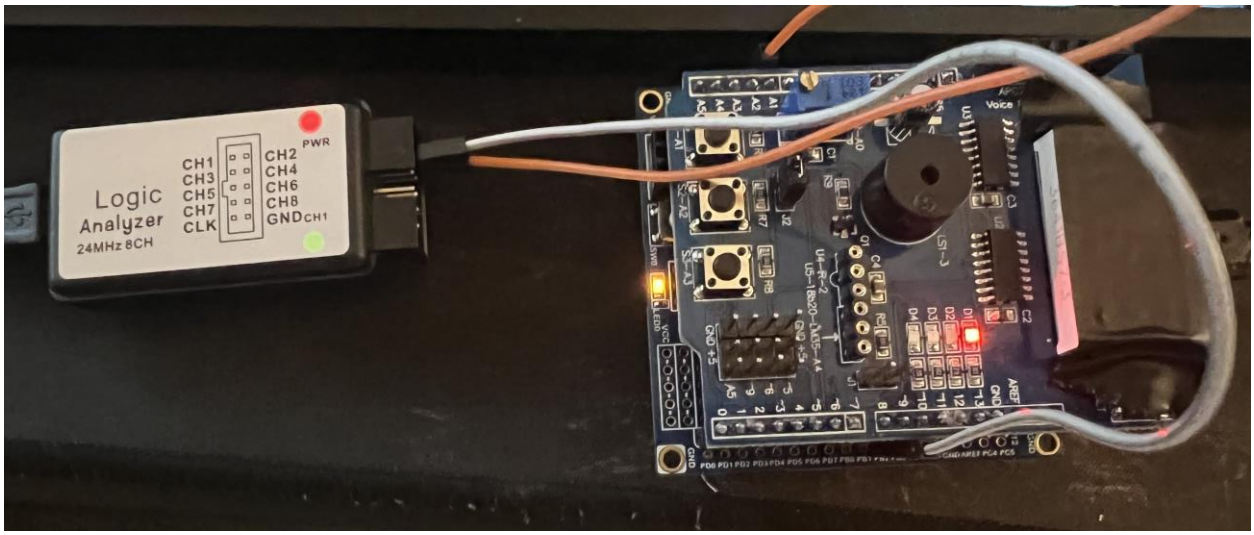


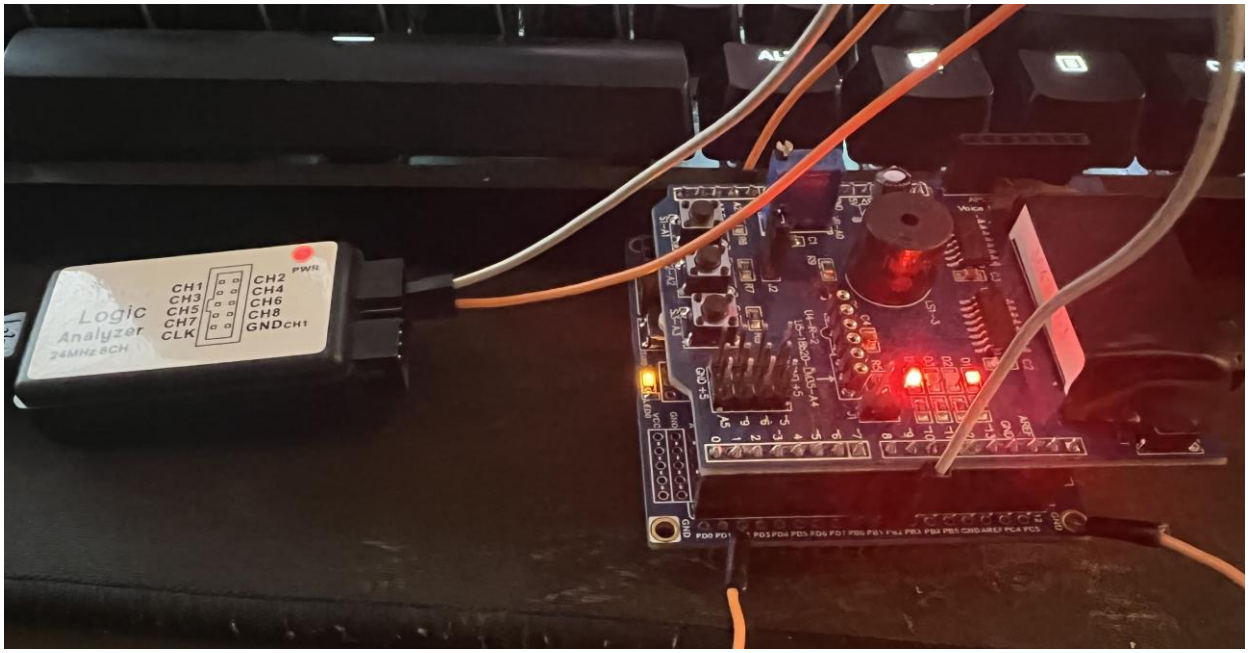
```
------ Build started: Project: Design_Assignment_2_C, Configuration: Debug AVR ------
Build started.
Project "Design_Assignment_2_C.cproj" (default targets):
Target "PreBuildEvent" skipped, due to false condition; ('$(PreBuildEvent)'!='') was evaluated as (''!='').
Target "CoreBuild" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Compiler.targets" from project "C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\Design_Assignment_2_C\Design_Assignment_2_C\Design_Assignmen
    Task "RunCompilerTask"
        Shell Utils Path C:\Program Files (x86)\Atmel\Studio\7.0\shellUtils
        C:\Program Files (x86)\Atmel\Studio\7.0\shellUtils\make.exe all --jobs 12 --output-sync
        Building file: ../../main.c
        Invoking: AVR/GNU C Compiler : 5.4.0
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-gcc.exe"  -x c -funsigned-char -funsigned-bitfields -DDEBUG  -I"C:\Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.6.364\include"  -Og -ffunction-sections -fdata-s
        Finished building: ../../main.c
        Building target: Design_Assignment_2_C.elf
        Invoking: AVR/GNU Linker : 5.4.0
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-gcc.exe" -o Design_Assignment_2_C.elf  main.o   -Wl,-Map="Design_Assignment_2_C.map" -Wl,--start-group -Wl,-lm  -Wl,--end-group -Wl,--gc-sections -mmcu=atmega328pb -B "C:\Progra
        Finished building target: Design_Assignment_2_C.elf
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-objcopy.exe" -O ihex -R .eeprom -R .fuse -R .lock -R .signature -R .user_signatures  "Design_Assignment_2_C.elf" "Design_Assignment_2_C.hex"
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-objcopy.exe" -j .eeprom  --set-section-flags=.eeprom=alloc,load --change-section-lma .eeprom=0  --no-change-warnings -O ihex "Design_Assignment_2_C.elf" "Design_Assignment_2_C.e
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-objdump.exe" -h -S "Design_Assignment_2_C.elf" > "Design_Assignment_2_C.lss"
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-objcopy.exe" -O srec -R .eeprom -R .fuse -R .lock -R .signature -R .user_signatures "Design_Assignment_2_C.elf" "Design_Assignment_2_C.srec"
        "C:\Program Files (x86)\Atmel\Studio\7.0\toolchain\avr8\avr8-gnu-toolchain\bin\avr-size.exe" "Design_Assignment_2_C.elf"
           text    data     bss     dec     hex filename
            366       0       0     366     16e Design_Assignment_2_C.elf
    Done executing task "RunCompilerTask".
    Task "RunOutputFileVerifyTask"
                Program Memory Usage     :   366 bytes   1.1 % Full
                Data Memory Usage        :   0 bytes   0.0 % Full
                Warning: Memory Usage estimation may not be accurate if there are sections other than .text sections in ELF file
    Done executing task "RunOutputFileVerifyTask".
Done building target "CoreBuild" in project "Design_Assignment_2_C.cproj".
Target "PostBuildEvent" skipped, due to false condition; ('$(PostBuildEvent)' != '') was evaluated as ('' != '').
Target "Build" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Avr.common.targets" from project "C:\Users\cazar\OneDrive\Documents\UNLV\UNLV 2021-2022\Spring 2022\CPE 301\Lecture\Design Assignments\DA2\Design_Assignment_2_C\Design_Assignment_2_C\Design_Assignment_
Done building target "Build" in project "Design_Assignment_2_C.cproj".
Done building project "Design_Assignment_2_C.cproj".

Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
```

Push Button Being Activated and 1.25s the LED being on

Interrupt of 500ms

6. SCREENSHOT OF EACH DEMO (BOARD SETUP)





7. VIDEO LINKS OF EACH DEMO

https://www.youtube.com/watch?v=j-aoKB34RRU

8. GITHUB LINK OF THIS DA

https://github.com/DylanCaz/Submission_DA/tree/main/Design_Assignments_sub/DA_2_sub

Student Academic Misconduct Policy

http://studentconduct.unlv.edu/misconduct/policy.html

"*This assignment submission is my own, original work*".

Dylan Cazares