CPE 301 - 1001

DESIGN ASSIGNMENT 2

The goal of the assignment is use GPIO, delays, and Interrupts:

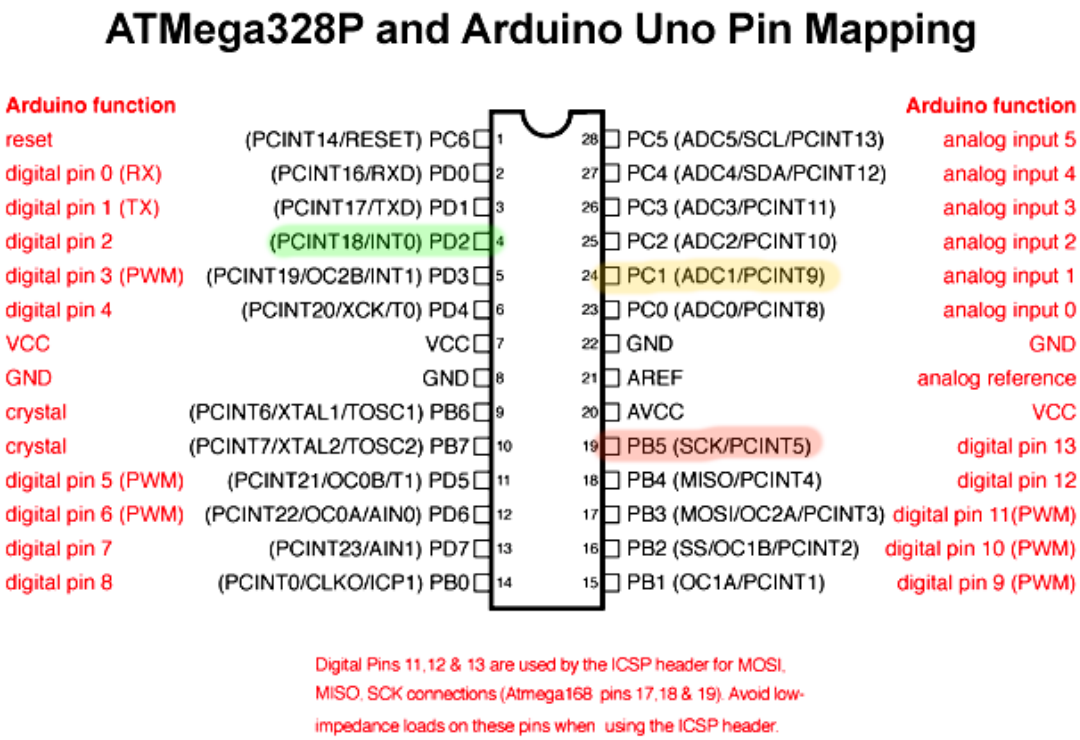
1. Design a delay subroutine to generate a delay of 0.15 sec.

2. Connect a switch to PORTC.1 to poll for an event to turn on the led at PORTB.5 for 1.5 sec after the event.

3. Continue with task 2, connect a switch to INT0 (PD2 pin) (active high - turn on the pull up transistor) and using an interrupt mechanism turn on the led at PORTB.5 for 3 sec after the event.

4. Submit codes and demos for three tasks, one for (2), another for (3), and another for (2 & 3) working together. Verify the delays using simulation and logic analyzer.

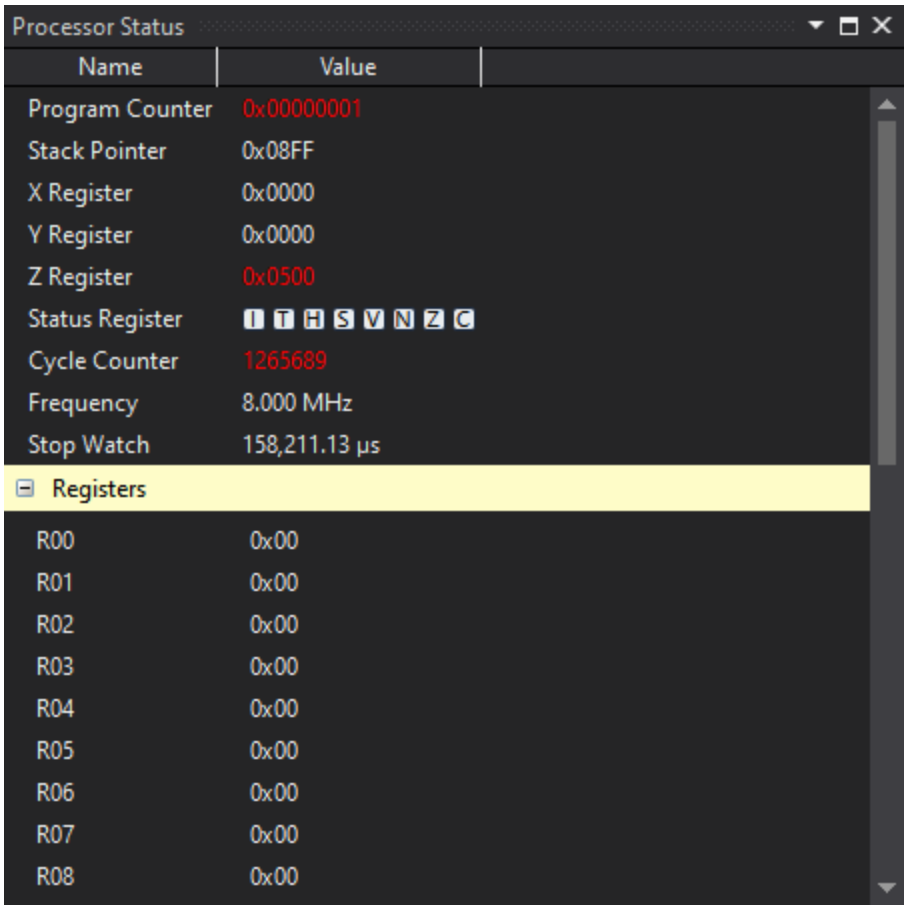
Components Used/Connected



Task 1

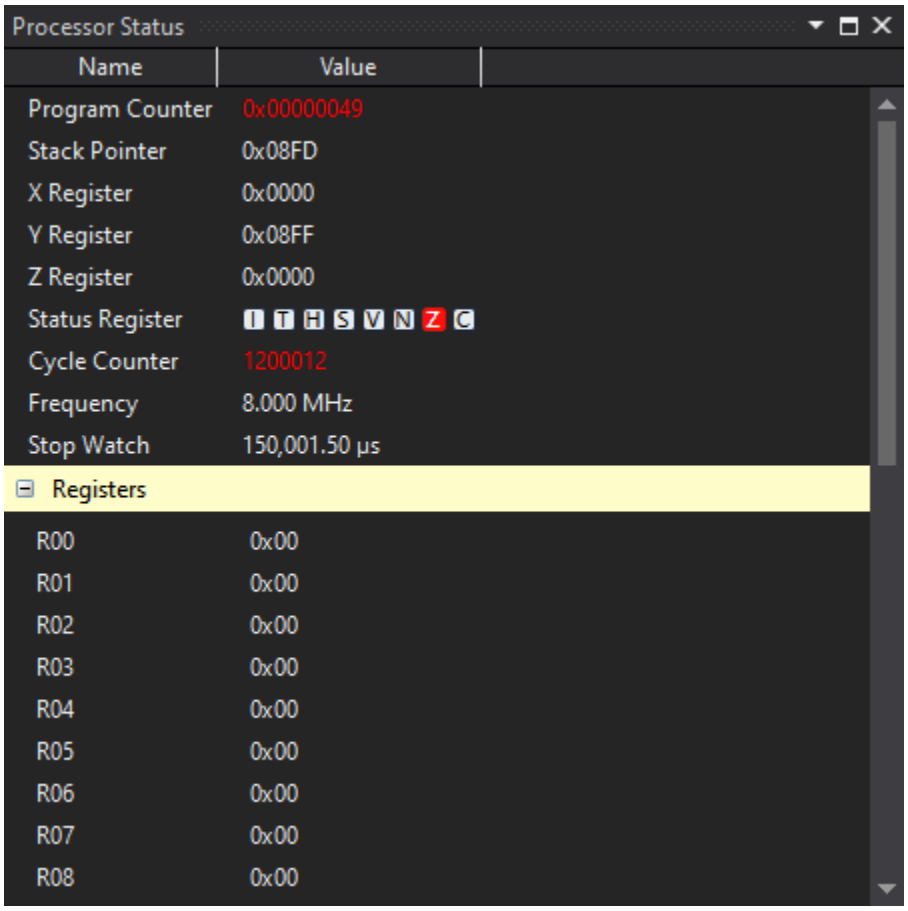
```
; AssemblerApp_DA2_1.asm
;
; Created: 3/9/2025 7:21:43 PM
; Author : enriq
;

.include "M328Pdef.inc"
.equ Value = 0xFB2C ;Timing value for 0.15 sec delay

Main:
    rcall Delay         ; Call the 0.15 second delay
      nop
Done:
    rjmp Done           ; Loop forever

Delay:                  ; ~0.15 second delay using Timer1
    ldi R30, high(Value)
    sts TCNT1H, R30
    ldi R30, low(Value)
    sts TCNT1L, R30     ; Load TCNT1 with starting value

    ldi R31, 0x00
    sts TCCR1A, R31     ; Normal mode

    ldi R31, 0x05       ; Prescaler 1024
    sts TCCR1B, R31     ; Start Timer1

Wait:
    sbis TIFR1, TOV1    ; Wait for overflow flag
    rjmp Wait

    sbi TIFR1, TOV1     ; Clear overflow flag
    ldi R30, 0x00
    sts TCCR1B, R30     ; Stop Timer1

    ret

```

DA2


Processor Status
Name
Value
Program Counter
0x00000001
Stack Pointer
0x08FF
X Register
0x0000
Y Register
0x0000
Z Register
0x0500
Status Register
I T H S V N Z C
Cycle Counter
1265689
Frequency
8.000 MHz
Stop Watch
158,211.13 µs
Registers
R00
0x00
R01
0x00
R02
0x00
R03
0x00
R04
0x00
R05
0x00
R06
0x00
R07
0x00
R08
0x00

DA2

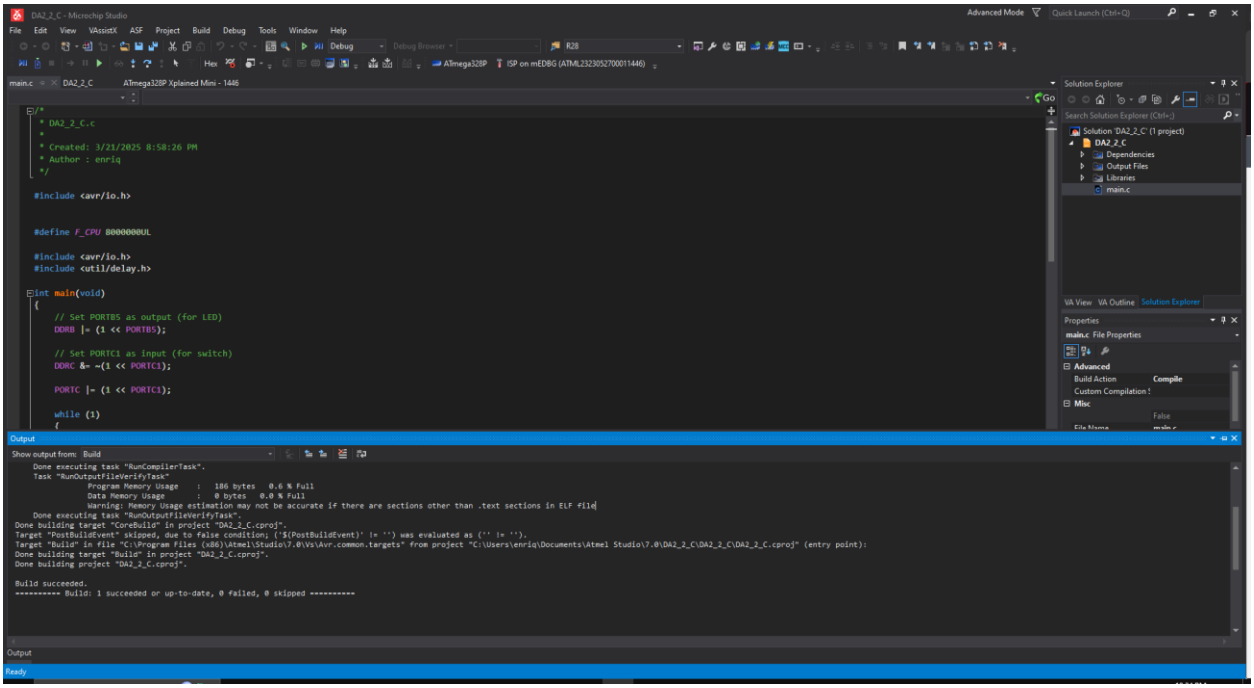
```c
/*
 * GccApp_DA2_1.c
 *
 * Created: 3/9/2025 7:55:28 PM
 * Author : enriq
 */

#define F_CPU 8000000UL

#include <avr/io.h>
#include <util/delay.h>

int main(void)
{
	_delay_ms(150);

	return 0;
}

```



Task 2

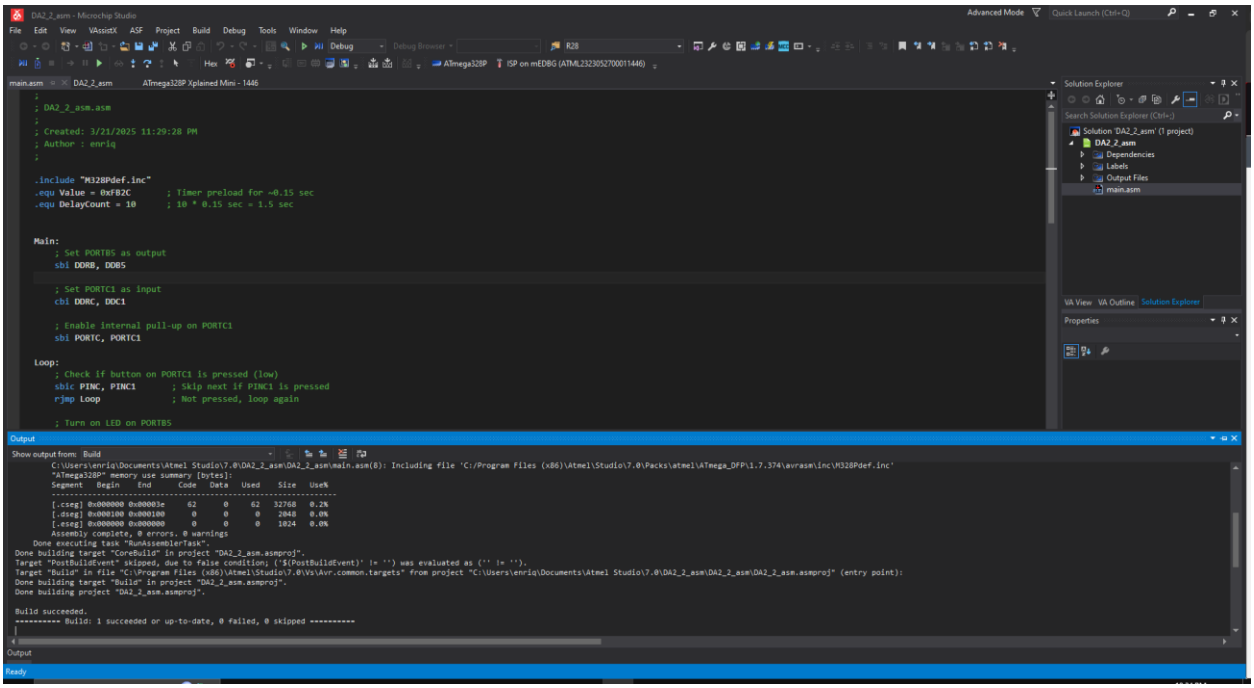
```c
/*
 * DA2_2_C.c
 *
 * Created: 3/21/2025 8:58:26 PM
 * Author : enriq
 */

#include <avr/io.h>


#define F_CPU 8000000UL

#include <avr/io.h>
#include <util/delay.h>

int main(void)
{
	// Set PORTB5 as output (for LED)
	DDRB |= (1 << PORTB5);

	// Set PORTC1 as input (for switch)
	DDRC &= ~(1 << PORTC1);

	PORTC |= (1 << PORTC1);

	while (1)
	{
		// check if pressed (low)
		if (!(PINC & (1 << PINC1)))
		{
			// Turn LED on
			PORTB |= (1 << PORTB5);

			// Delay for 1.5 seconds
			_delay_ms(1500);

			// Turn LED off
			PORTB &= ~(1 << PORTB5);
		}
	}

	return 0;
}

```

DA2

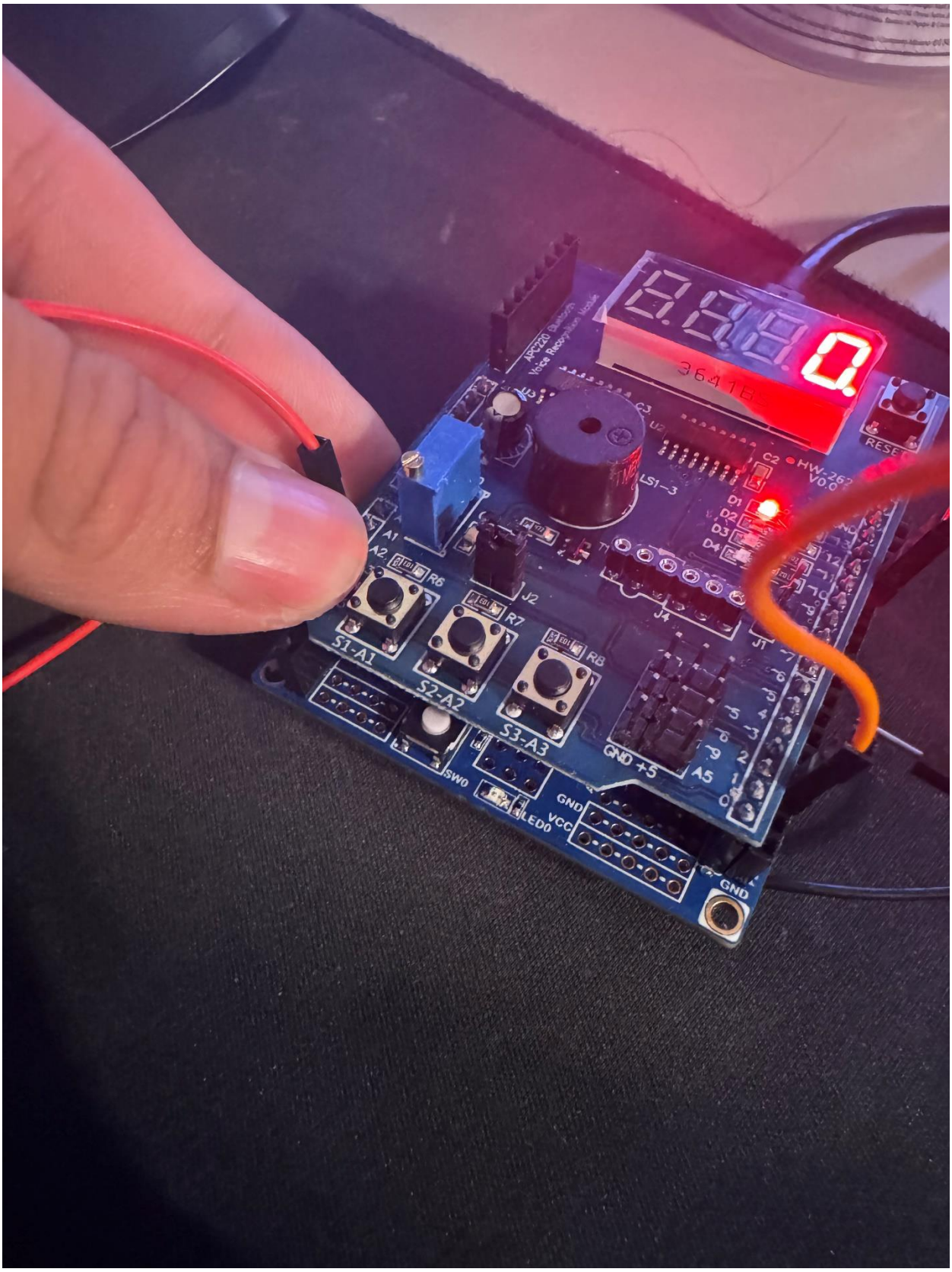

DA2_2_C - Microchip Studio
File Edit View VAssistX ASF Project Build Debug Tools Window Help
Debug
ATmega328P
ISP on mEDBG (ATML2323052700011446)
main.c
DA2_2_C
ATmega328P Xplained Mini - 1446
/*
* DA2_2_C.c
*
* Created: 3/21/2025 8:58:26 PM
* Author : enriq
*/
#include <avr/io.h>
#define F_CPU 8000000UL
#include <avr/io.h>
#include <util/delay.h>
int main(void)
{
// Set PORTB5 as output (for LED)
DDRB |= (1 << PORTB5);
// Set PORTC1 as input (for switch)
DDRC &= ~(1 << PORTC1);
PORTC |= (1 << PORTC1);
while (1)
{
Solution Explorer
Solution 'DA2_2_C' (1 project)
DA2_2_C
Dependencies
Output Files
Libraries
main.c
Properties
main.c File Properties
Advanced
Build Action
Compile
Misc
Output
Show output from: Build
Done executing task "RunCompilerTask".
Task "RunOutputFileVerifyTask"
Program Memory Usage : 186 bytes 0.6 % 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 "DA2_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\enriq\Documents\Atmel Studio\7.0\DA2_2_C\DA2_2_C\DA2_2_C.cproj" (entry point):
Done building target "Build" in project "DA2_2_C.cproj".
Done building project "DA2_2_C.cproj".
Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
Output
Ready

```
;
; DA2_2_asm.asm
;
; Created: 3/21/2025 11:29:28 PM
; Author : enriq
;

.include "M328Pdef.inc"
.equ Value = 0xFB2C       ; Timer preload for ~0.15 sec
.equ DelayCount = 10      ; 10 * 0.15 sec = 1.5 sec


Main:
    ; Set PORTB5 as output
    sbi DDRB, DDB5

    ; Set PORTC1 as input
    cbi DDRC, DDC1

    ; Enable internal pull-up on PORTC1
    sbi PORTC, PORTC1

Loop:
    ; Check if button on PORTC1 is pressed (low)
    sbic PINC, PINC1       ; Skip next if PINC1 is pressed
    rjmp Loop              ; Not pressed, loop again

    ; Turn on LED on PORTB5
    sbi PORTB, PORTB5

    ; Delay for 1.5 seconds using 10x 0.15 sec Delay
    ldi R20, DelayCount
DelayLoop:
    rcall Delay
    dec R20
    brne DelayLoop

    ; Turn off LED on PORTB5
    cbi PORTB, PORTB5

    rjmp Loop              ; Wait for next press

; 0.15 Second Delay

Delay:
    ldi R30, high(Value)
    sts TCNT1H, R30
    ldi R30, low(Value)
    sts TCNT1L, R30         ; Load TCNT1 with starting value

    ldi R31, 0x00
    sts TCCR1A, R31         ; Normal mode

    ldi R31, 0x05           ; Prescaler 1024
    sts TCCR1B, R31         ; Start Timer1

Wait:
    sbis TIFR1, TOV1        ; Wait for overflow flag
    rjmp Wait

    sbi TIFR1, TOV1         ; Clear overflow flag
    ldi R30, 0x00
    sts TCCR1B, R30         ; Stop Timer1

```

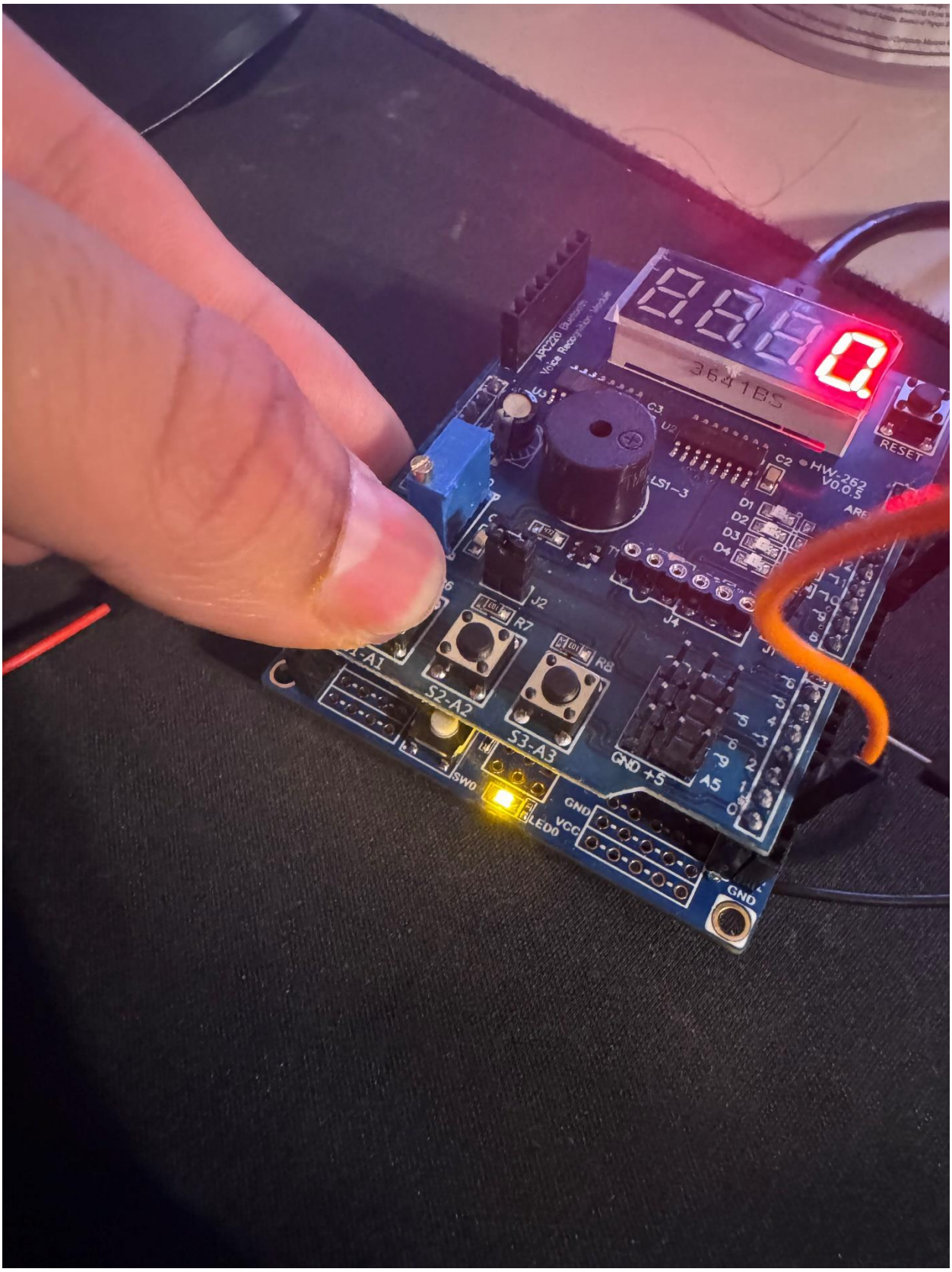
```
65.     ret
66.
```


DA2_2_asm - Microchip Studio
File Edit View VAssistX ASF Project Build Debug Tools Window Help
main.asm
DA2_2_asm
ATmega328P Xplained Mini - 1446
; DA2_2_asm.asm
; Created: 3/21/2025 11:29:28 PM
; Author : enriq
.include "M328Pdef.inc"
.equ Value = 0xFB2C ; Timer preload for ~0.15 sec
.equ DelayCount = 10 ; 10 * 0.15 sec = 1.5 sec
Main:
; Set PORTB5 as output
sbi DDRB, DDB5
; Set PORTC1 as input
cbi DDRC, DDC1
; Enable internal pull-up on PORTC1
sbi PORTC, PORTC1
Loop:
; Check if button on PORTC1 is pressed (low)
sbic PINC, PINC1 ; Skip next if PINC1 is pressed
rjmp Loop ; Not pressed, loop again
; Turn on LED on PORTB5
Solution Explorer
Solution 'DA2_2_asm' (1 project)
DA2_2_asm
Dependencies
Labels
Output Files
main.asm
Properties
Output
Show output from: Build
C:\Users\enriq\Documents\Atmel Studio\7.0\DA2_2_asm\DA2_2_asm\main.asm(8): Including file 'C:/Program Files (x86)\Atmel\Studio\7.0\Packs\atmel\ATmega_DFP\1.7.374\avrasm\inc\M328Pdef.inc'
"ATmega328P" memory use summary [bytes]:
Segment Begin End Code Data Used Size Use%
[.cseg] 0x000000 0x00003e 62 0 62 32768 0.2%
[.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 "DA2_2_asm.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\enriq\Documents\Atmel Studio\7.0\DA2_2_asm\DA2_2_asm.asmproj" (entry point):
Done building target "Build" in project "DA2_2_asm.asmproj".
Done building project "DA2_2_asm.asmproj".
Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
Output
Ready

DA2


S1-A1
S2-A2
S3-A3
GND +5
A5
SW0
LED0
VCC
GND
GND
LS1-3
J2
J4
R6
R7
R8
A1
A2

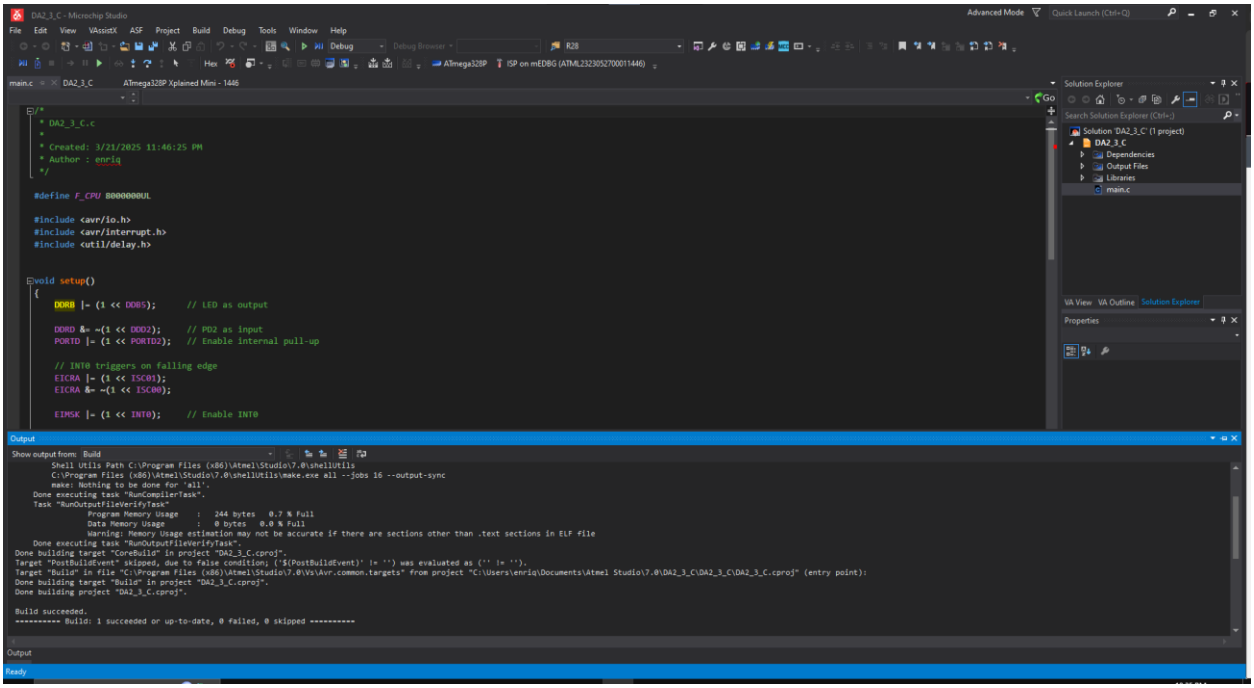
DA2



Task 3

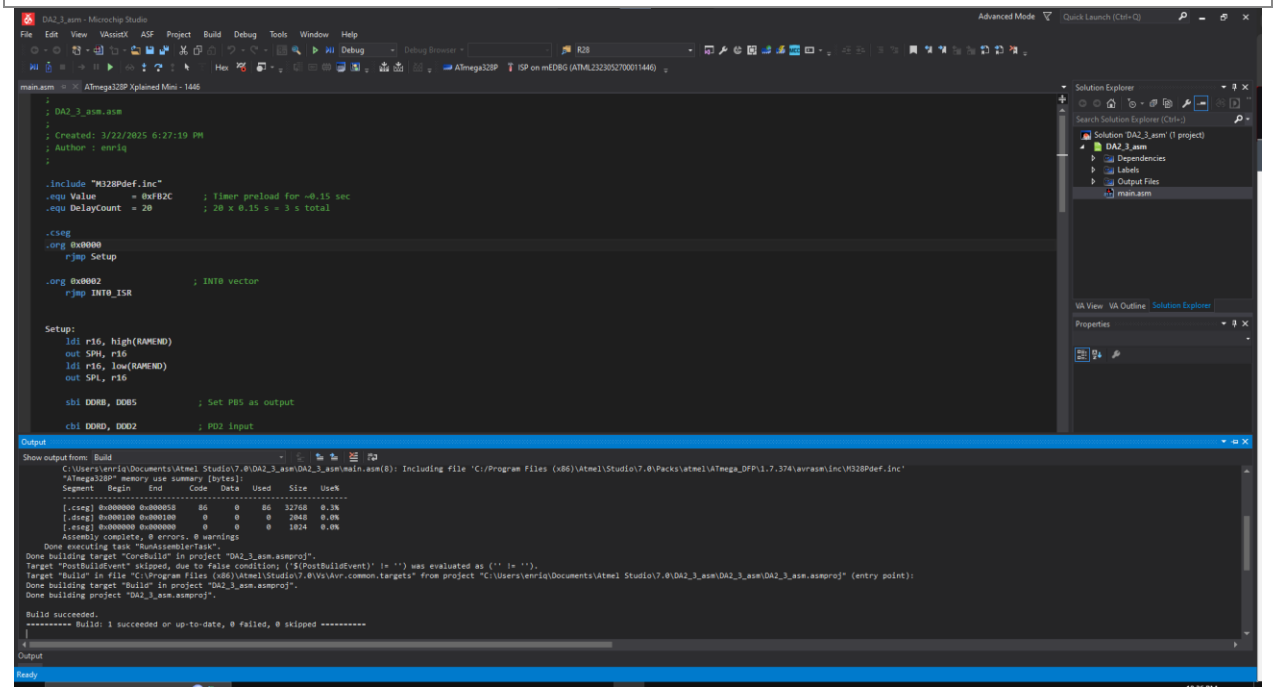
```c
/*
 * DA2_3_C.c
 *
 * Created: 3/21/2025 11:46:25 PM
 * Author : enriq
 */

#define F_CPU 8000000UL

#include <avr/io.h>
#include <avr/interrupt.h>
#include <util/delay.h>


void setup()
{
	DDRB |= (1 << DDB5);	// LED as output

	DDRD &= ~(1 << DDD2);	// PD2 as input
	PORTD |= (1 << PORTD2);	// Enable internal pull-up

	// INT0 triggers on falling edge
	EICRA |= (1 << ISC01);
	EICRA &= ~(1 << ISC00);

	EIMSK |= (1 << INT0);	// Enable INT0

	sei();			// Global interrupt enable
}

int main(void)
{
	setup();

	while (1)
	{

	}
}

ISR(INT0_vect)
{
	PORTB |= (1 << PORTB5);	// LED ON
	_delay_ms(3000);	// Wait 3 seconds
	PORTB &= ~(1 << PORTB5);	// LED OFF
}

```

DA2

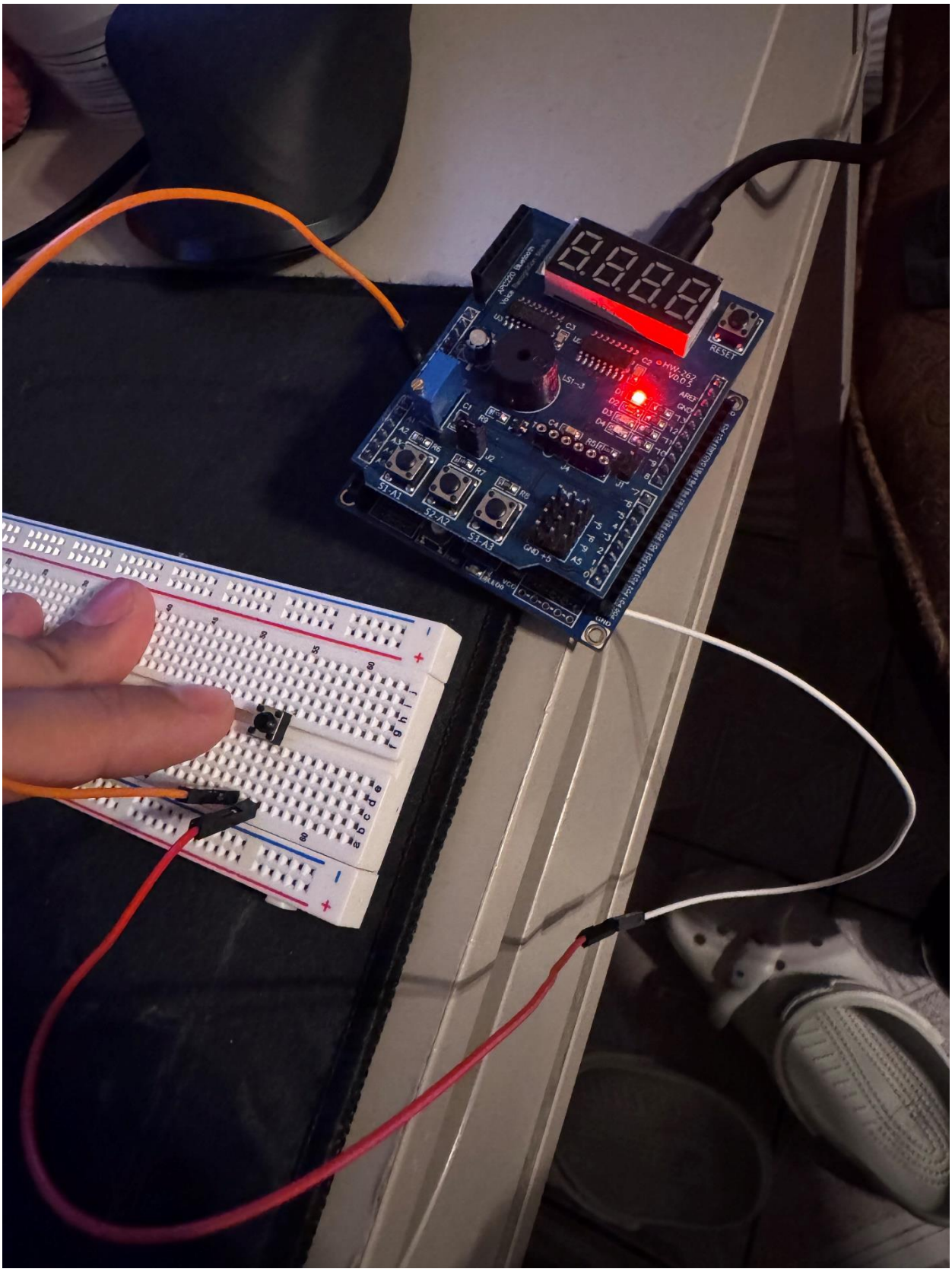

DA2_3_C - Microchip Studio
File Edit View VAssistX ASF Project Build Debug Tools Window Help
Debug
ATmega328P
ISP on mEDBG (ATML2323052700011446)
main.c
DA2_3_C
ATmega328P Xplained Mini - 1446
/*
* DA2_3_C.c
*
* Created: 3/21/2025 11:46:25 PM
* Author : enriq
*/
#define F_CPU 8000000UL
#include <avr/io.h>
#include <avr/interrupt.h>
#include <util/delay.h>
void setup()
{
DDRB |= (1 << DDB5); // LED as output
DDRD &= ~(1 << DDD2); // PD2 as input
PORTD |= (1 << PORTD2); // Enable internal pull-up
// INT0 triggers on falling edge
EICRA |= (1 << ISC01);
EICRA &= ~(1 << ISC00);
EIMSK |= (1 << INT0); // Enable INT0
Solution Explorer
Solution 'DA2_3_C' (1 project)
DA2_3_C
Dependencies
Output Files
Libraries
main.c
Properties
Output
Show output from: Build
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 16 --output-sync
make: Nothing to be done for 'all'.
Done executing task "RunCompilerTask".
Task "RunOutputFileVerifyTask"
Program Memory Usage : 244 bytes 0.7 % 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 "DA2_3_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\enriq\Documents\Atmel Studio\7.0\DA2_3_C\DA2_3_C\DA2_3_C.cproj" (entry point):
Done building target "Build" in project "DA2_3_C.cproj".
Done building project "DA2_3_C.cproj".
Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
Output
Ready

```
;
; DA2_3_asm.asm
;
; Created: 3/22/2025 6:27:19 PM
; Author : enriq
;

.include "M328Pdef.inc"
.equ Value       = 0xFB2C      ; Timer preload for ~0.15 sec
.equ DelayCount  = 20          ; 20 x 0.15 s = 3 s total

.cseg
.org 0x0000
    rjmp Setup

.org 0x0002                  ; INT0 vector
    rjmp INT0_ISR


Setup:
    ldi r16, high(RAMEND)
    out SPH, r16
    ldi r16, low(RAMEND)
    out SPL, r16

    sbi DDRB, DDB5            ; Set PB5 as output

    cbi DDRD, DDD2            ; PD2 input
    sbi PORTD, PORTD2         ; Enable pull-up on PD2


    ; set INT0
    ldi r16, (1 << ISC01)
    sts EICRA, r16

    ; Enable INT0 interrupt
    ldi r16, (1 << INT0)
    sts EIMSK, r16

    sei         ; Global interrupt enable

Main:
    rjmp Main

INT0_ISR:
    sbi PORTB, PORTB5     ; Turn on LED at PB5
    ldi r20, DelayCount

DelayLoop:
    rcall Delay
    dec r20
    brne DelayLoop

    ; Turn off LED at PB5
    cbi PORTB, PORTB5

    reti


Delay:                   ; ~0.15 second delay using Timer1
    ldi R30, high(Value)
    sts TCNT1H, R30
    ldi R30, low(Value)
    sts TCNT1L, R30     ; Load TCNT1 with starting value
```

```
65.
66.      ldi R31, 0x00
67.      sts TCCR1A, R31      ; Normal mode
68.
69.      ldi R31, 0x05        ; Prescaler 1024
70.      sts TCCR1B, R31      ; Start Timer1
71.
72. Wait:
73.      sbis TIFR1, TOV1     ; Wait for overflow flag
74.      rjmp Wait
75.
76.      sbi TIFR1, TOV1      ; Clear overflow flag
77.      ldi R30, 0x00
78.      sts TCCR1B, R30      ; Stop Timer1
79.
80.      ret
81.
```



DA2



DA2