

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.

Digital Pins 11, 12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17, 18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

DA2

Task 1

```
1. ; AssemblerApp_DA2_1.asm
2. ;
3. ; Created: 3/9/2025 7:21:43 PM
4. ; Author : enriq
5. ;
6. ;
7. .include "M328Pdef.inc"
8. .equ Value = 0xFB2C ;Timing value for 0.15 sec delay
9. ;
10. Main:
11.     rcall Delay          ; Call the 0.15 second delay
12.     nop
13. Done:
14.     rjmp Done            ; Loop forever
15. ;
16. Delay:                  ; ~0.15 second delay using Timer1
17.     ldi R30, high(Value)
18.     sts TCNT1H, R30
19.     ldi R30, low(Value)
20.     sts TCNT1L, R30      ; Load TCNT1 with starting value
21. ;
22.     ldi R31, 0x00
23.     sts TCCR1A, R31      ; Normal mode
24. ;
25.     ldi R31, 0x05        ; Prescaler 1024
26.     sts TCCR1B, R31      ; Start Timer1
27. ;
28. Wait:
29.     sbis TIFR1, TOV1     ; Wait for overflow flag
30.     rjmp Wait
31. ;
32.     sbi TIFR1, TOV1      ; Clear overflow flag
33.     ldi R30, 0x00
34.     sts TCCR1B, R30      ; Stop Timer1
35. ;
36.     ret
37. ;
```

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 μ s
Registers	
R00	0x00
R01	0x00
R02	0x00
R03	0x00
R04	0x00
R05	0x00
R06	0x00
R07	0x00
R08	0x00

DA2

```
1. /*
2.  * GccApp_DA2_1.c
3.  *
4.  * Created: 3/9/2025 7:55:28 PM
5.  * Author : enriq
6.  */
7.
8. #define F_CPU 8000000UL
9.
10. #include <avr/io.h>
11. #include <util/delay.h>
12.
13. int main(void)
14. {
15.     _delay_ms(150);
16.
17.     return 0;
18. }
19.
```

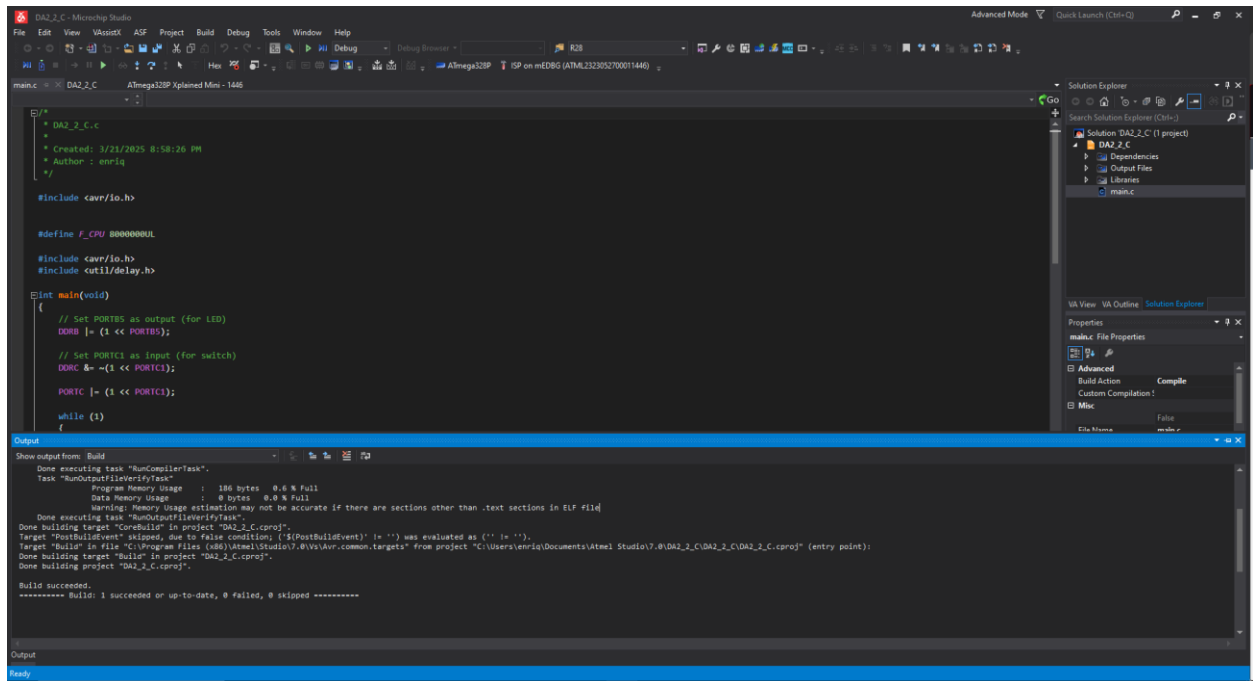
Processor Status	
Name	Value
Program Counter	0x00000049
Stack Pointer	0x08FD
X Register	0x0000
Y Register	0x08FF
Z Register	0x0000
Status Register	I T H S V N Z C
Cycle Counter	1200012
Frequency	8.000 MHz
Stop Watch	150,001.50 µs
Registers	
R00	0x00
R01	0x00
R02	0x00
R03	0x00
R04	0x00
R05	0x00
R06	0x00
R07	0x00
R08	0x00

DA2

Task 2

```
1. /*
2.  * DA2_2_C.c
3.  *
4.  * Created: 3/21/2025 8:58:26 PM
5.  * Author : enriq
6.  */
7.
8. #include <avr/io.h>
9.
10.
11. #define F_CPU 8000000UL
12.
13. #include <avr/io.h>
14. #include <util/delay.h>
15.
16. int main(void)
17. {
18.     // Set PORTB5 as output (for LED)
19.     DDRB |= (1 << PORTB5);
20.
21.     // Set PORTC1 as input (for switch)
22.     DDRC &= ~(1 << PORTC1);
23.
24.     PORTC |= (1 << PORTC1);
25.
26.     while (1)
27.     {
28.         // check if pressed (low)
29.         if (!(PINC & (1 << PINC1)))
30.         {
31.             // Turn LED on
32.             PORTB |= (1 << PORTB5);
33.
34.             // Delay for 1.5 seconds
35.             _delay_ms(1500);
36.
37.             // Turn LED off
38.             PORTB &= ~(1 << PORTB5);
39.         }
40.     }
41.
42.     return 0;
43. }
44.
```

DA2



```
/*
 * 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 PORTB as output (for LED)
    DDRB |= (1 << PORTB5);

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

    PORTC |= (1 << PORTC1);

    while (1)
    {

```

Output

Show output from: Build

Done executing task "RunCompilerTask".

Task "RunOutputFileVerifierTask".

Program Memory Usage : 186 bytes 0.0 % 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 "RunOutputFileVerifierTask".

Done building target "CoreBuild" in project "DA2_2_C.proj".

Target "PostBuildEvent" skipped, due to false condition: ('\$(PostBuildEvent)' != '') was evaluated as ('' != '').

Target "Build" in file "C:\Program Files (x86)\Atmel Studio\7.0\avr\common.targets" from project "C:\Users\enriq\Documents\Atmel Studio\7.0\DA2_2_C\DA2_2_C.proj" (entry point):

Done building target "Build" in project "DA2_2_C.proj".

Done building project "DA2_2_C.proj".

Build succeeded.

***** Build: 1 succeeded or up-to-date, 0 failed, 0 skipped *****

Output

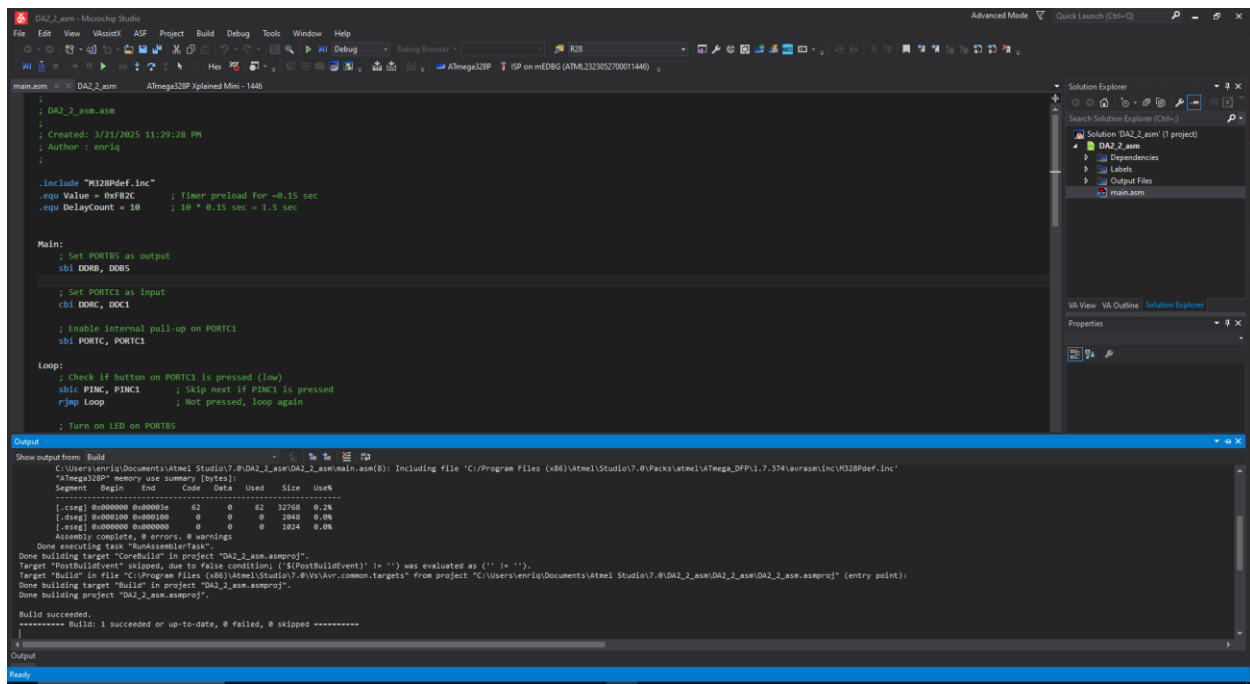
Ready

DA2

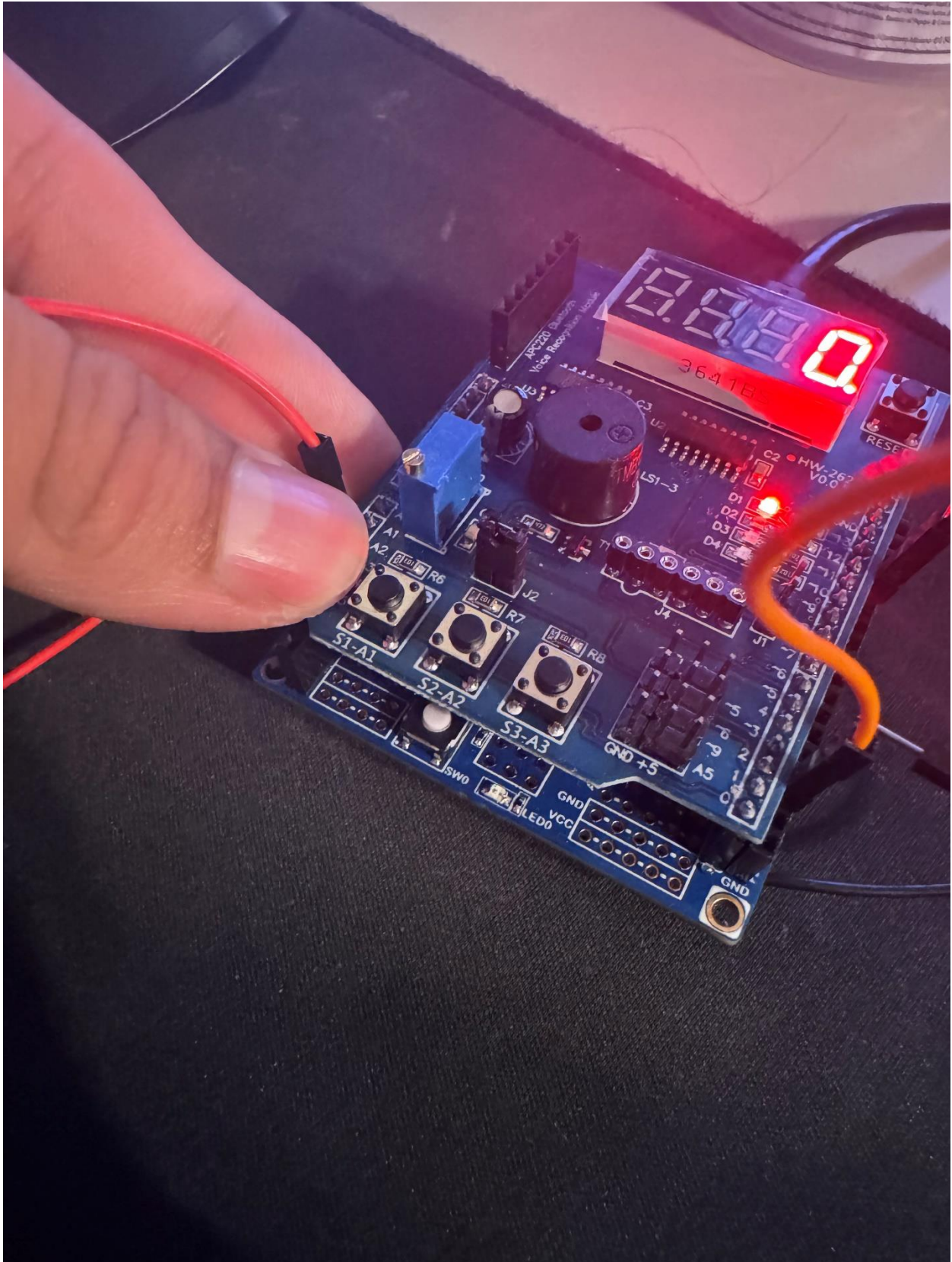
```
1. ;
2. ; DA2_2_asm.asm
3. ;
4. ; Created: 3/21/2025 11:29:28 PM
5. ; Author : enriq
6. ;
7. ;
8. .include "M328Pdef.inc"
9. .equ Value = 0xFB2C      ; Timer preload for ~0.15 sec
10. .equ DelayCount = 10    ; 10 * 0.15 sec = 1.5 sec
11.
12.
13. Main:
14.     ; Set PORTB5 as output
15.     sbi DDRB, DDB5
16.
17.     ; Set PORTC1 as input
18.     cbi DDRC, DDC1
19.
20.     ; Enable internal pull-up on PORTC1
21.     sbi PORTC, PORTC1
22.
23. Loop:
24.     ; Check if button on PORTC1 is pressed (low)
25.     sbic PINC, PINC1      ; Skip next if PINC1 is pressed
26.     rjmp Loop             ; Not pressed, loop again
27.
28.     ; Turn on LED on PORTB5
29.     sbi PORTB, PORTB5
30.
31.     ; Delay for 1.5 seconds using 10x 0.15 sec Delay
32.     ldi R20, DelayCount
33. DelayLoop:
34.     rcall Delay
35.     dec R20
36.     brne DelayLoop
37.
38.     ; Turn off LED on PORTB5
39.     cbi PORTB, PORTB5
40.
41.     rjmp Loop             ; Wait for next press
42.
43. ; 0.15 Second Delay
44.
45. Delay:
46.     ldi R30, high(Value)
47.     sts TCNT1H, R30
48.     ldi R30, low(Value)
49.     sts TCNT1L, R30      ; Load TCNT1 with starting value
50.
51.     ldi R31, 0x00
52.     sts TCCR1A, R31      ; Normal mode
53.
54.     ldi R31, 0x05        ; Prescaler 1024
55.     sts TCCR1B, R31      ; Start Timer1
56.
57. Wait:
58.     sbis TIFR1, TOV1     ; Wait for overflow flag
59.     rjmp Wait
60.
61.     sbi TIFR1, TOV1      ; Clear overflow flag
62.     ldi R30, 0x00
63.     sts TCCR1B, R30      ; Stop Timer1
64.
```


DA2

```
65.     ret
66.
```



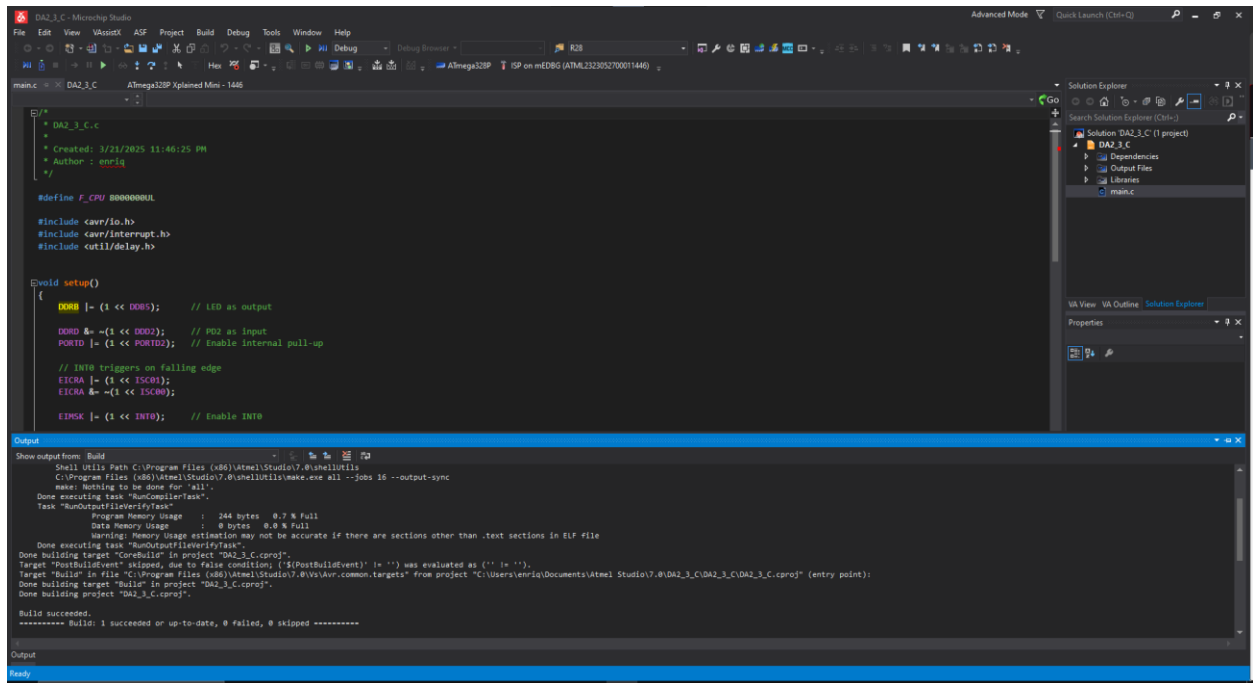
DA2



Task 3

```
1. /*
2.  * DA2_3_C.c
3.  *
4.  * Created: 3/21/2025 11:46:25 PM
5.  * Author : enriq
6.  */
7.
8. #define F_CPU 8000000UL
9.
10. #include <avr/io.h>
11. #include <avr/interrupt.h>
12. #include <util/delay.h>
13.
14.
15. void setup()
16. {
17.     DDRB |= (1 << DDB5);    // LED as output
18.
19.     DDRD &= ~(1 << DDD2);    // PD2 as input
20.     PORTD |= (1 << PORTD2);  // Enable internal pull-up
21.
22.     // INT0 triggers on falling edge
23.     EICRA |= (1 << ISC01);
24.     EICRA &= ~(1 << ISC00);
25.
26.     EIMSK |= (1 << INT0);    // Enable INT0
27.
28.     sei();                  // Global interrupt enable
29. }
30.
31. int main(void)
32. {
33.     setup();
34.
35.     while (1)
36.     {
37.
38.     }
39. }
40.
41. ISR(INT0_vect)
42. {
43.     PORTB |= (1 << PORTB5);  // LED ON
44.     _delay_ms(3000);         // Wait 3 seconds
45.     PORTB &= ~(1 << PORTB5); // LED OFF
46. }
47.
```

DA2



```
/*
 * 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()
{
    DDRC |= (1 << DD05); // LED as output

    DDRD |= ~(1 << DD02); // 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
}
```

Build

Shell Utils Path C:\Program Files (x86)\Atmel\Studio7.0\shellutils
C:\Program Files (x86)\Atmel\Studio7.0\shellutils\make.exe all --jobs 16 --output-sync
make: Nothing to be done for 'all'.
Done executing task "RunCompilerTask".
Task "RunOutputFileVerifierTask"
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 "RunOutputFileVerifierTask".
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\Studio7.0\VsAvr\common\targets" from project "C:\Users\enriq\Documents\Atmel Studio7.0\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

```
1. ;
2. ; DA2_3_asm.asm
3. ;
4. ; Created: 3/22/2025 6:27:19 PM
5. ; Author : enriq
6. ;
7. ;
8. .include "M328Pdef.inc"
9. .equ Value      = 0xFB2C      ; Timer preload for ~0.15 sec
10. .equ DelayCount = 20         ; 20 x 0.15 s = 3 s total
11. ;
12. .cseg
13. .org 0x0000
14.     rjmp Setup
15. ;
16. .org 0x0002                ; INT0 vector
17.     rjmp INT0_ISR
18. ;
19. ;
20. Setup:
21.     ldi r16, high(RAMEND)
22.     out SPH, r16
23.     ldi r16, low(RAMEND)
24.     out SPL, r16
25. ;
26.     sbi DDRB, DDB5          ; Set PB5 as output
27. ;
28.     cbi DDRD, DDD2          ; PD2 input
29.     sbi PORTD, PORTD2       ; Enable pull-up on PD2
30. ;
31. ;
32.     ; set INT0
33.     ldi r16, (1 << ISC01)
34.     sts EICRA, r16
35. ;
36.     ; Enable INT0 interrupt
37.     ldi r16, (1 << INT0)
38.     sts EIMSK, r16
39. ;
40.     sei                    ; Global interrupt enable
41. ;
42. Main:
43.     rjmp Main
44. ;
45. INT0_ISR:
46.     sbi PORTB, PORTB5       ; Turn on LED at PB5
47.     ldi r20, DelayCount
48. ;
49. DelayLoop:
50.     rcall Delay
51.     dec r20
52.     brne DelayLoop
53. ;
54.     ; Turn off LED at PB5
55.     cbi PORTB, PORTB5
56. ;
57.     reti
58. ;
59. ;
60. Delay:                ; ~0.15 second delay using Timer1
61.     ldi R30, high(Value)
62.     sts TCNT1H, R30
63.     ldi R30, low(Value)
64.     sts TCNT1L, R30       ; Load TCNT1 with starting value
```

DA2

```

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.

```

The screenshot shows the Microsoft Studio IDE with the assembly file `DA2_3.asm` open. The code is for an ATmega328P microcontroller. It includes a preprocessor directive for the ATmega328P, defines the timer preload and delay count, and sets up the timer. The code is then compiled and the build output is shown in the Output window.

Assembly Code:

```

; DA2_3.asm
;
; Created: 3/22/2025 6:27:19 PM
; Author: enriq
;
.include "M328Pdef.inc"
.equ Value = 0x02C        ; Timer preload for ~0.15 sec
.equ DelayCount = 20      ; 20 x 0.15 s = 3 s total

.cseg
.org 0x0000
rjmp Setup

.org 0x0002
rjmp INT0_vect

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

sbi DDOR, DD05           ; Set PB5 as output
cbi DDOR, DD02           ; PD2 input

```

Build Output:

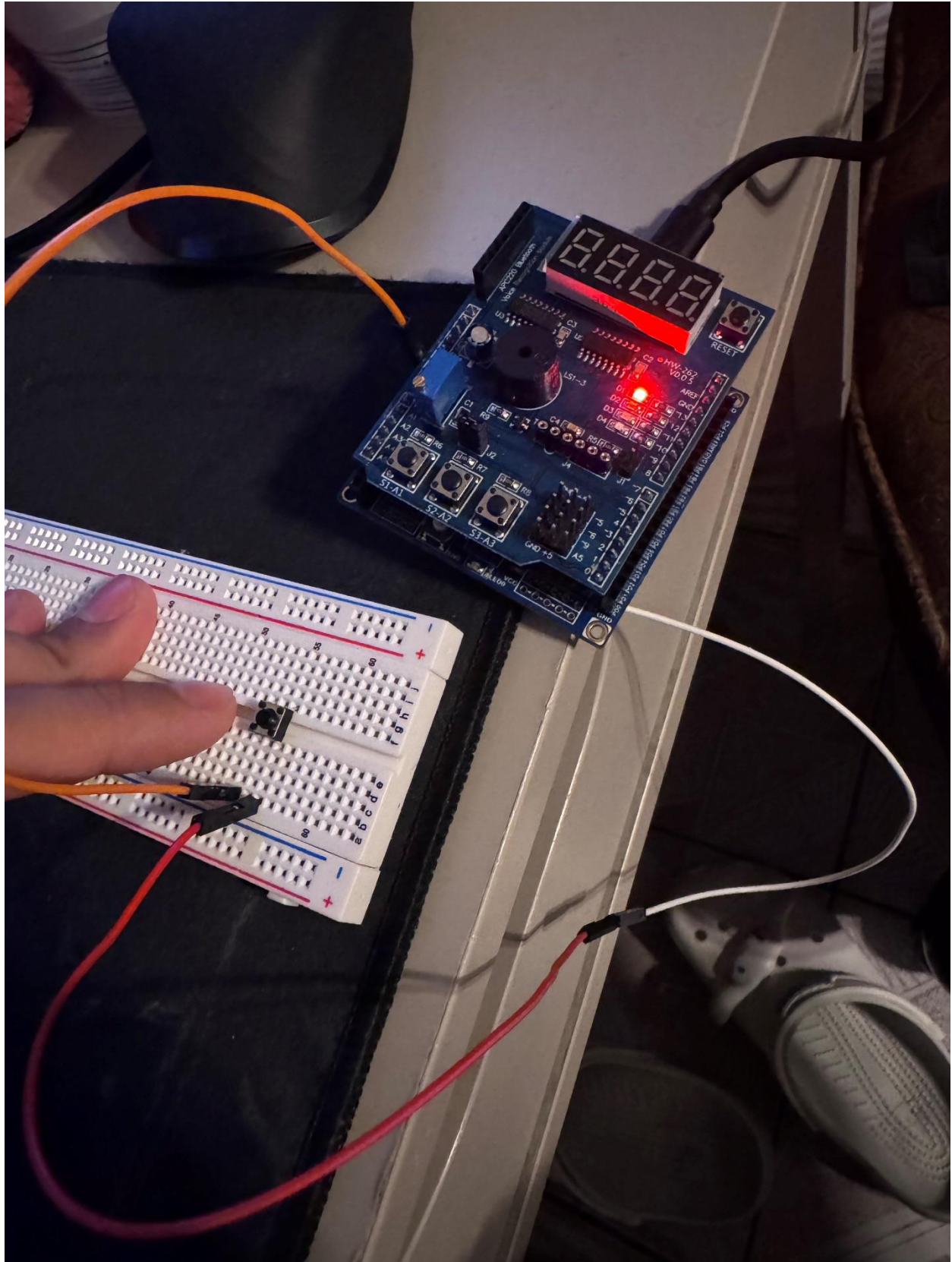
```

Show output from: Build
C:\Users\enriq\Documents\Atmel Studio\7.0\DA2_3\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 0x000010 86    0    86   32768  0.26
[.dseg] 0x0000100 0x0000100 0      0    0    2048  0.0%
[.sseg] 0x000000 0x000000 0      0    0    1824  0.0%
Assembly complete, 0 errors, 0 warnings
Done executing task "RunAssembleTask".
Done building target "CoreBuild" in project "DA2_3.asm.asmproj".
Target "PostBuildEvent" skipped, due to false condition; ('$(PostBuildEvent)' != '') was evaluated as ('' != '').
Target "Build" is file "C:\Program Files (x86)\Atmel\Studio\7.0\avr\common\targets" from project "C:\Users\enriq\Documents\Atmel Studio\7.0\DA2_3\asm\DA2_3.asm.asmproj" (entry point):
Done building target "Build" in project "DA2_3.asm.asmproj".
Done building project "DA2_3.asm.asmproj".

Build succeeded.
----- Build: 1 succeeded or up-to-date, 0 failed, 0 skipped -----
Output
Ready

```


DA2



DA2

