CPE301 – SPRING 2019

Design Assignment 2C

Student Name: Ron Joshua Recrio
Student #: 5003825419
Student Email: recrio@unlv.nevada.edu
Primary Github address: https://github.com/recrio
Directory: /DesignAssignments/DA2C

Submit the following for all Labs:

1. In the document, for each task submit the modified or included code (only) with highlights and justifications of the modifications. Also, include the comments.
2. Use the previously create a Github repository with a random name (no CPE/301, Lastname, Firstname). Place all labs under the root folder ESD301/DA, sub-folder named LABXX, with one document and one video link file for each lab, place modified asm/c files named as LabXX-TYY.asm/c.
3. If multiple asm/c files or other libraries are used, create a folder LabXX-TYY and place these files inside the folder.
4. The folder should have a) Word document (see template), b) source code file(s) and other include files, c) text file with youtube video links (see template).

1. COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS

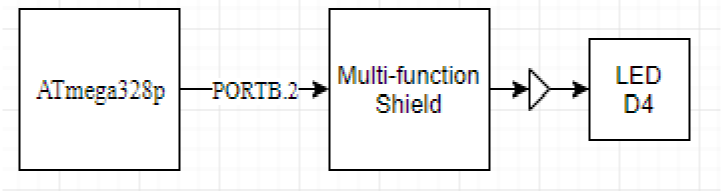
List of Components used

ATmega328p Xplained Mini

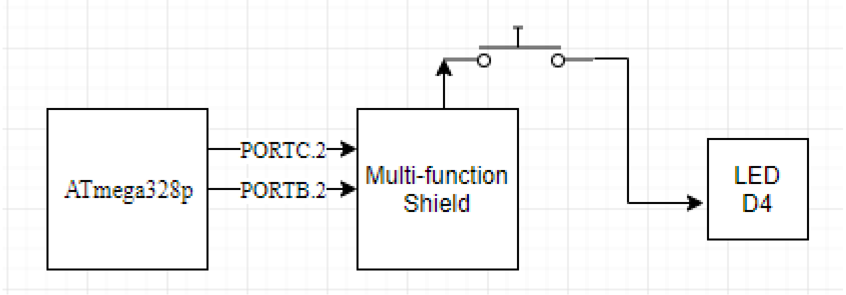
Multifunction Shield

Block diagram with pins used in the Atmega328P

Task 1-3 for Task 1:



Task 1-3 for Task 2:



2. INITIAL CODE OF DA2A

DA2A Task 1:

```
#include <stdio.h>
#include <avr/io.h>

int main(void)
{
    DDRB = (1<<2); //Make PB2 Output
       TCCR1B = 5;   // set prescaler to 1024

    while (1)
    {
              TCNT1 = 0; // set timer/counter to 0
              while (TCNT1 != 6796) {
              //do nothing
              }
              PORTB ^= (1<<2); // toggle PB2 using xor
              TCNT1 = 0; // reset again
              while (TCNT1 != 4531) {
              // do nothing
              }
              PORTB ^= (1<<2); // toggle PB2 using xor
    }
}
```

DA2A Task 2:

```
#define F_CPU 16000000UL //Change frequency to 16MHz
#include <avr/io.h>
#include <util/delay.h>

int main(void)
{
       DDRB |= (1<<2);      //PB2 is an output, XXXX X1XX
       PORTB |= (1<<2);     //PB2 set as high to turn off LED, XXXX X1XX
       DDRC &= (0<<2);      //PC2 is an input, XXXX X0XX
       PORTC |= (0<<2);     //PC2 set as low or unpressed, XXXX X0XX
       while (1) {
              if (!(PINC & (1 << PINC2))){ // If button is pressed
              PORTB &= ~(1<<2);    // turn on LED
              _delay_ms(1250);     // delay for 1250ms
              }
           else {                  // if button is not pressed
                  PORTB |= (1<<2); // set PB2 to high or LED off
              }
    }
}
```

3. DEVELOPED CODE OF TASK 1/C FROM DA2A

DA2C Task 1 for Task 1:

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>

int main(void)
{
       DDRB = (1<<DDB2); // Make PB2 Output
       PORTB = (0<<DDB2); // Turn on LED
       TCCR0A = 0; // Normal Mode
       TCCR0B = 5; // Set prescaler to 1024
       int ovrflow = 0; // overflow counter
    while (1)
    {
              TCNT0 = 0; // Reset counter
              ovrflow = 0; // Reset overflow counter

              // Delay for 6796
              while (ovrflow < 26) { // Gets to 6656
                     while ((TIFR0 & 0x01) == 0) {}
                     ovrflow++; // increment ovrflow
                     TCNT0 = 0; // reset counter
                     TIFR0 = 1; // reset ovf flag
              }
              while (TCNT0 < 140) {} // 6656+140 = 6796

              PORTB ^= (1<<DDB2); // Turn off LED
              TCNT0 = 0;    // reset counter
              ovrflow = 0; // reset ovrflow counter

              // Delay for 4531
              while (ovrflow < 17) { // 4352
                     while ((TIFR0 & 0x01) == 0) {}
                     ovrflow++; // increment ovrflow
                     TCNT0 = 0; // reset counter
                     TIFR0 = 1; // reset ovf flag
              }
              while (TCNT0 < 179) {} // 4352+179 = 4531
              PORTB ^= (1<<DDB2); // Turn on LED
    }
}
```

DA2C Task 1 for Task 2:

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>

int main(void)
{
       DDRB = (1<<DDB2); // Make PB2 Output
       DDRC = (0<<DDC2); // Make PC2 Input
       PORTB = (1<<DDB2); // Turn off LED
       PORTC = (1<<DDC2); // Turn on pull-up transistor
       TCCR0A = 0; // Normal Mode
       TCCR0B = 5; // Set prescaler to 1024
       int ovrflow = 0; // overflow counter
       while (1)
       {
              if (!(PINC & (1 << PINC2))) {      // if button pressed
              PORTB ^= (1<<DDB2); // Turn on LED
              TCNT0 = 0; // Reset counter
              ovrflow = 0; // Reset overflow counter


              // Delay for 1.25 sec (19531 TCNT)
              while (ovrflow < 76) { // Gets to 19456
                     while ((TIFR0 & 0x01) == 0) {}
                     ovrflow++; // increment ovrflow
                     TCNT0 = 0; // reset counter
                     TIFR0 = 1; // reset ovf flag
              }
              while (TCNT0 < 75) {} // 19456+75 = 19531

              PORTB ^= (1<<DDB2); // Turn off LED

              }
       }
}
```

4. DEVELOPED CODE OF TASK 2/C FROM DA2A

DA2C Task 2 for Task 1:

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>
#include <avr/interrupt.h>

int ovrflow = 0; // global ovrflow counter

int main(void)
{
       DDRB = (1<<DDB2); // Make PB2 Output
       PORTB = (0<<DDB2); // Turn on LED
       TIMSK0 |= (1<<TOIE0); // Set up interrupt
       TCCR0A = 0; // Normal Mode
       sei(); // interrupt enable
       TCCR0B = 5; // Set prescaler to 1024

       while (1)
       {

       }
}

ISR (TIMER0_OVF_vect) {
       ovrflow++; //increment ovrflow
       if (ovrflow == 26) { // delay for .435s
              TCNT0 = 0;
              while (TCNT0 < 140) {}
              PORTB ^= (1<<DDB2); // Turn OFF
              TCNT0 = 0; // reset counter
       }
       else if (ovrflow == 43) { // delay for .29s
              TCNT0 = 0;
              while (TCNT0 < 179) {}
              PORTB ^= (1<<DDB2); // Turn ON
              ovrflow = 0; // reset ovrflow
              TCNT0 = 0; // reset counter
       }
       TCNT0 = 0;
}
```

DA2C Task 2 for Task 2:

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>
#include <avr/interrupt.h>

int ovrflow = 0; // global ovrflow counter

int main(void)
{
        DDRB = (1<<DDB2); // Make PB2 Output
        DDRC = (0<<DDC2); // Make PC2 Input
        PORTB = (1<<DDB2); // Turn off LED
        PORTC = (1<<DDC2); // Turn on pull-up transistor
        TIMSK0 |= (1<<TOIE0); // Set up interrupt
        TCCR0A = 0; // Normal Mode
        sei();
        TCCR0B = 5; // Set prescaler to 1024
        while (1)
        {
                if (!(PINC & (1 << PINC2))) { // if button pressed
                        PORTB ^= (1 << DDB2); // Turn on LED
                        TCNT0 = 0;
                        ovrflow = 0;
                        while (!(PORTB & (1<<PORTB2))) {} // while on
                }
                ovrflow = 0;

        }
}

ISR (TIMER0_OVF_vect) {
        ovrflow++; //increment ovrflow
        if (ovrflow == 76) {
                TCNT0 = 0;
                while (TCNT0 < 75) {}
                PORTB ^= (1<<DDB2); // Turn off LED
        }
        TCNT0 = 0; //reset counter
}
```

5. DEVELOPED CODE OF TASK 3/C FROM DA2A

DA2C Task 3 for Task 1:

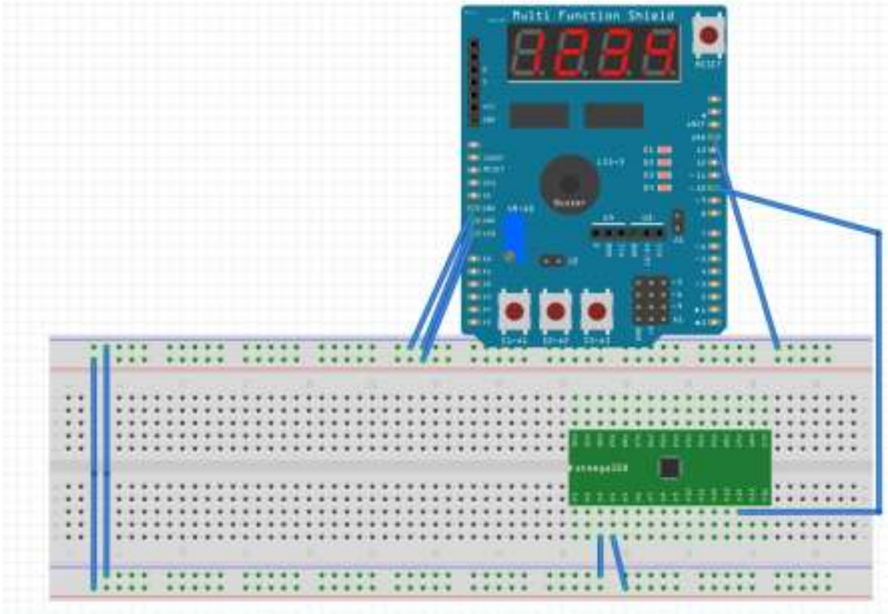
```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>
#include <avr/interrupt.h>

int ovrflow = 0; // global ovrflow counter

int main(void)
{
        DDRB |= (1<<DDB2); // Make PB2 Output
        PORTB &= (0<<DDB2); // Turn on LED
        TIMSK0 |= (1<<OCIE0A); // Set up interrupt
        TCCR0A |= (1<<WGM01); // Normal Mode
        OCR0A = 0xFF;
        TCNT0 = 0;
        sei(); // interrupt enable
        TCCR0B |= (1<<CS02) | (1<<CS00); // Set prescaler to 1024

        while (1)
        {

        }
}

ISR (TIMER0_COMPA_vect) {
        ovrflow++; //increment ovrflow
        if (ovrflow == 26) { // delay for .435s
                TCNT0 = 0;
                while (TCNT0 < 140) {}
                PORTB ^= (1<<DDB2); // Turn OFF
                TCNT0 = 0; // reset counter
        }
        else if (ovrflow == 43) { // delay for .29s
                TCNT0 = 0;
                while (TCNT0 < 179) {}
                PORTB ^= (1<<DDB2); // Turn ON
                ovrflow = 0; // reset ovrflow
                TCNT0 = 0; // reset counter
        }
}
```

DA2C Task 3 for Task 2:

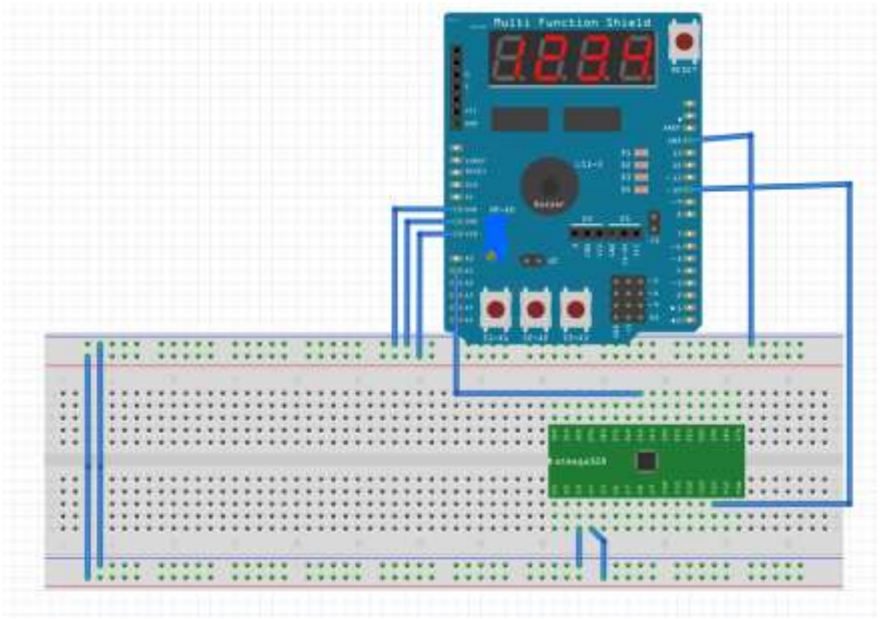
```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>
#include <avr/interrupt.h>

int ovrflow = 0; // global ovrflow counter

int main(void)
{
	DDRB |= (1<<DDB2); // Make PB2 Output
	DDRC &= (0<<DDC2); // Make PC2 Input
	PORTB |= (1<<DDB2); // Turn off LED
	PORTC |= (1<<DDC2); // Turn on pull-up transistor
	TIMSK0 |= (1<<OCIE0A); // Set up interrupt
	TCCR0A |= (1<<WGM01); // Normal Mode
	OCR0A = 0xFF;
	TCNT0 = 0;
	sei();
	TCCR0B |= (1<<CS02) | (1<<CS00); // Set prescaler to 1024
	while (1)
	{
		if (!(PINC & (1 << PINC2))) { // if button pressed
			PORTB ^= (1 << DDB2); // Turn on LED
			TCNT0 = 0;
			ovrflow = 0;
			while (!(PORTB & (1<<PORTB2))) {} // while on
		}
		ovrflow = 0;

	}
}

ISR (TIMER0_COMPA_vect) {
	ovrflow++; //increment ovrflow
	if (ovrflow == 76) {
		TCNT0 = 0;
		while (TCNT0 < 75) {}
		PORTB ^= (1<<DDB2); // Turn off LED
	}
	TCNT0 = 0; //reset counter
}
```

6. SCHEMATICS

Task 1-3 for Task 1:

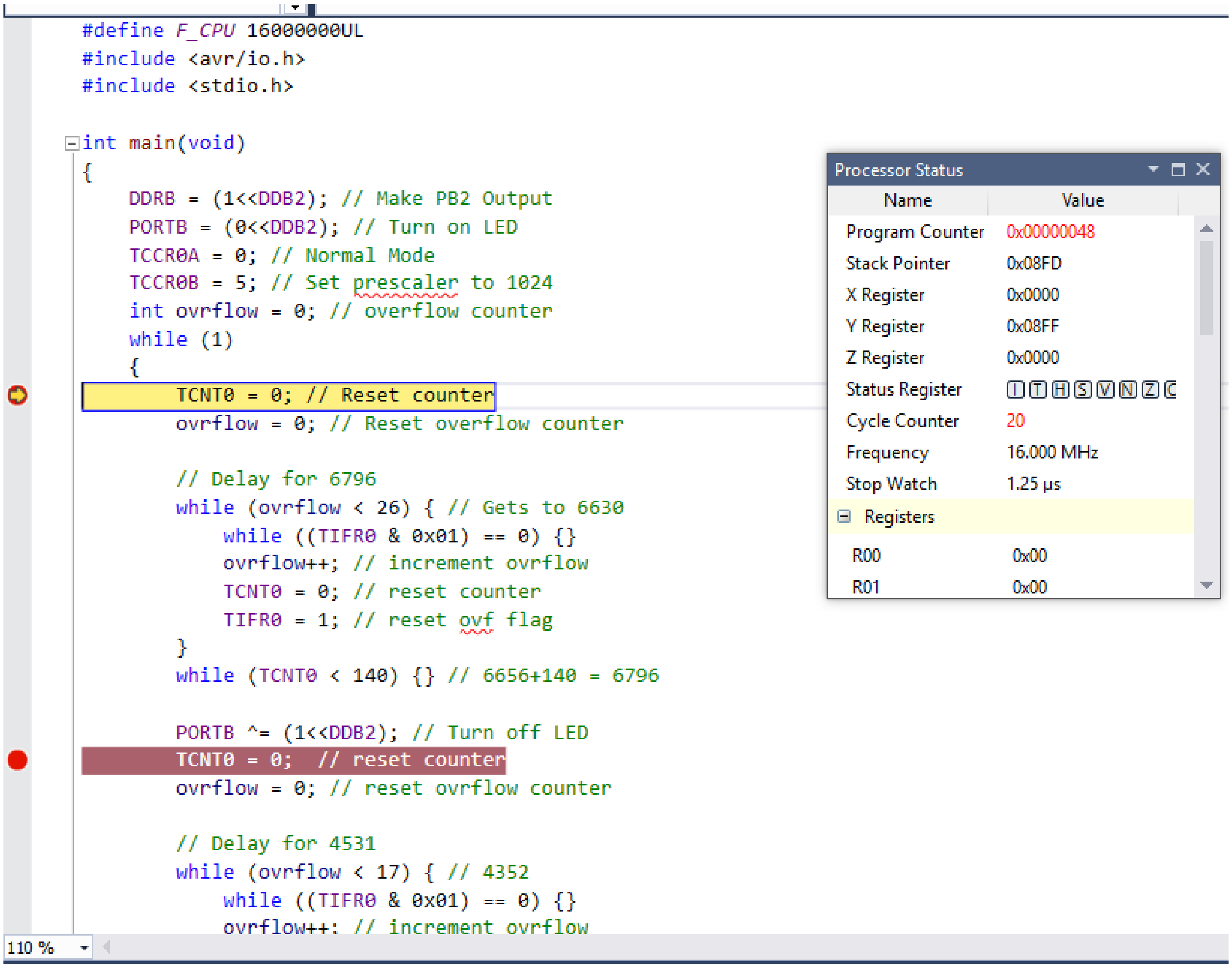


Task 1-3 for Task 2:



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

DA2C Task 1_1 (BEFORE):

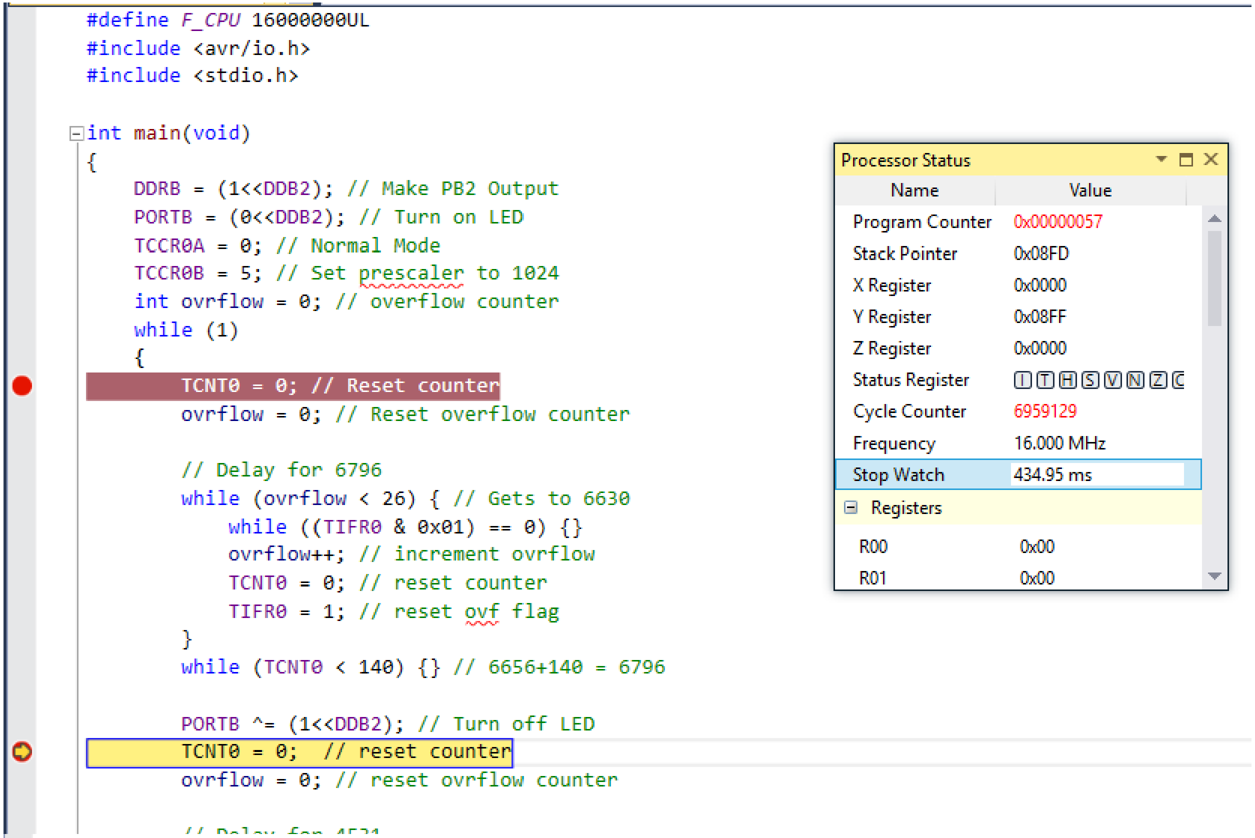


```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>

int main(void)
{
    DDRB = (1<<DDB2); // Make PB2 Output
    PORTB = (0<<DDB2); // Turn on LED
    TCCR0A = 0; // Normal Mode
    TCCR0B = 5; // Set prescaler to 1024
    int ovrflow = 0; // overflow counter
    while (1)
    {
        TCNT0 = 0; // Reset counter
        ovrflow = 0; // Reset overflow counter

        // Delay for 6796
        while (ovrflow < 26) { // Gets to 6630
            while ((TIFR0 & 0x01) == 0) {}
            ovrflow++; // increment ovrflow
            TCNT0 = 0; // reset counter
            TIFR0 = 1; // reset ovf flag
        }
        while (TCNT0 < 140) {} // 6656+140 = 6796

        PORTB ^= (1<<DDB2); // Turn off LED
        TCNT0 = 0;  // reset counter
        ovrflow = 0; // reset ovrflow counter

        // Delay for 4531
        while (ovrflow < 17) { // 4352
            while ((TIFR0 & 0x01) == 0) {}
            ovrflow++; // increment ovrflow
```

Processor Status

Name	Value
Program Counter	0x00000048
Stack Pointer	0x08FD
X Register	0x0000
Y Register	0x08FF
Z Register	0x0000
Status Register	I T H S V N Z C
Cycle Counter	20
Frequency	16.000 MHz
Stop Watch	1.25 µs
Registers	
R00	0x00
R01	0x00

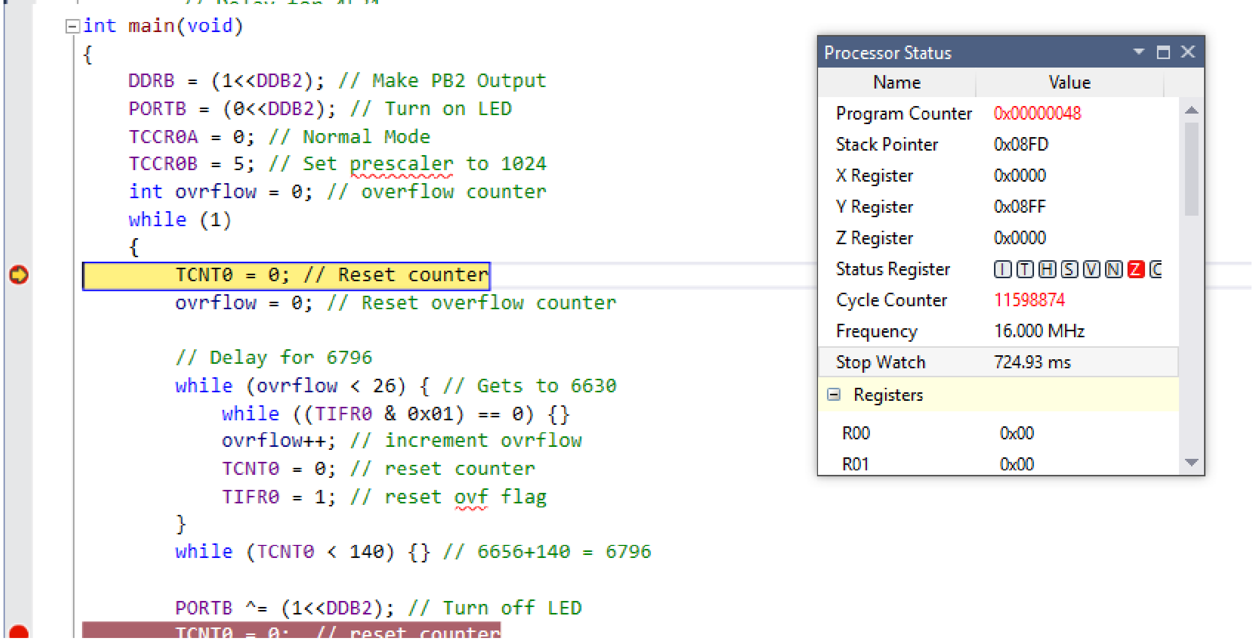
DA2C Task 1_1 (AFTER):



```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>

int main(void)
{
    DDRB = (1<<DDB2); // Make PB2 Output
    PORTB = (0<<DDB2); // Turn on LED
    TCCR0A = 0; // Normal Mode
    TCCR0B = 5; // Set prescaler to 1024
    int ovrflow = 0; // overflow counter
    while (1)
    {
        TCNT0 = 0; // Reset counter
        ovrflow = 0; // Reset overflow counter

        // Delay for 6796
        while (ovrflow < 26) { // Gets to 6630
            while ((TIFR0 & 0x01) == 0) {}
            ovrflow++; // increment ovrflow
            TCNT0 = 0; // reset counter
            TIFR0 = 1; // reset ovf flag
        }
        while (TCNT0 < 140) {} // 6656+140 = 6796

        PORTB ^= (1<<DDB2); // Turn off LED
        TCNT0 = 0;  // reset counter
        ovrflow = 0; // reset ovrflow counter

        // Delay for 4521
```

Processor Status

Name	Value
Program Counter	0x00000057
Stack Pointer	0x08FD
X Register	0x0000
Y Register	0x08FF
Z Register	0x0000
Status Register	I T H S V N Z C
Cycle Counter	6959129
Frequency	16.000 MHz
Stop Watch	434.95 ms
⊟ Registers	
R00	0x00
R01	0x00

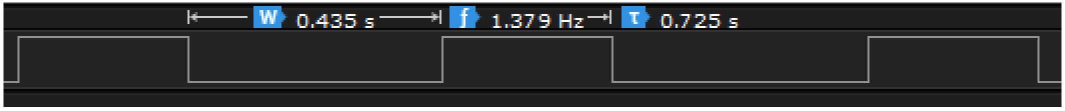


```
int main(void)
{
    DDRB = (1<<DDB2); // Make PB2 Output
    PORTB = (0<<DDB2); // Turn on LED
    TCCR0A = 0; // Normal Mode
    TCCR0B = 5; // Set prescaler to 1024
    int ovrflow = 0; // overflow counter
    while (1)
    {
        TCNT0 = 0; // Reset counter
        ovrflow = 0; // Reset overflow counter

        // Delay for 6796
        while (ovrflow < 26) { // Gets to 6630
            while ((TIFR0 & 0x01) == 0) {}
            ovrflow++; // increment ovrflow
            TCNT0 = 0; // reset counter
            TIFR0 = 1; // reset ovf flag
        }
        while (TCNT0 < 140) {} // 6656+140 = 6796

        PORTB ^= (1<<DDB2); // Turn off LED
        TCNT0 = 0;  // reset counter
```

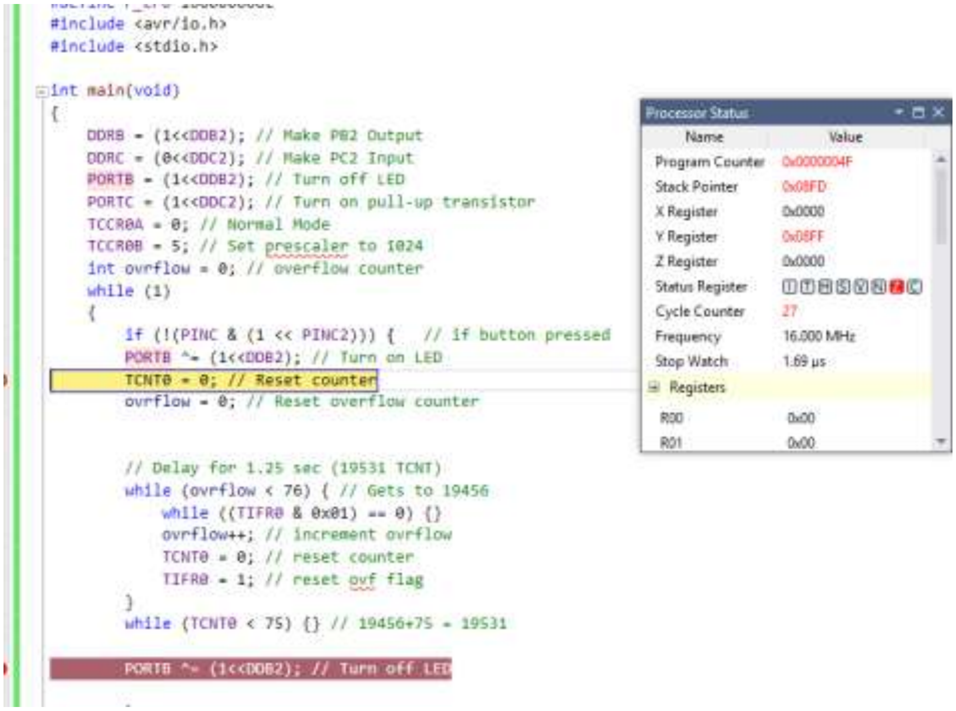
Processor Status

Name	Value
Program Counter	0x00000048
Stack Pointer	0x08FD
X Register	0x0000
Y Register	0x08FF
Z Register	0x0000
Status Register	I T H S V N Z C
Cycle Counter	11598874
Frequency	16.000 MHz
Stop Watch	724.93 ms
⊟ Registers	
R00	0x00
R01	0x00

DA2C Task 1_1 Waveform:



DA2C Task 1_2 (BEFORE):

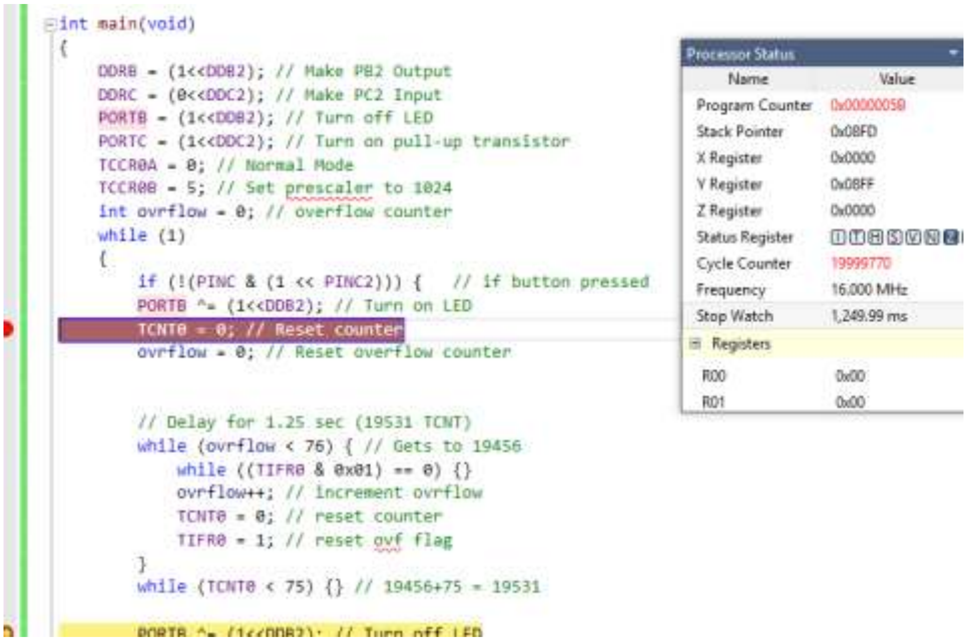


```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>

int main(void)
{
    DDRB = (1<<DDB2); // Make PB2 Output
    DDRC = (0<<DDC2); // Make PC2 Input
    PORTB = (1<<DDB2); // Turn off LED
    PORTC = (1<<DDC2); // Turn on pull-up transistor
    TCCR0A = 0; // Normal Mode
    TCCR0B = 5; // Set prescaler to 1024
    int ovrflow = 0; // overflow counter
    while (1)
    {
        if (!(PINC & (1 << PINC2))) {   // if button pressed
        PORTB ^= (1<<DDB2); // Turn on LED
        TCNT0 = 0; // Reset counter
        ovrflow = 0; // Reset overflow counter


        // Delay for 1.25 sec (19531 TCNT)
        while (ovrflow < 76) { // Gets to 19456
            while ((TIFR0 & 0x01) == 0) {}
            ovrflow++; // increment ovrflow
            TCNT0 = 0; // reset counter
            TIFR0 = 1; // reset ovf flag
        }
        while (TCNT0 < 75) {} // 19456+75 = 19531

        PORTB ^= (1<<DDB2); // Turn off LED
```

Processor Status

Name	Value
Program Counter	0x0000004F
Stack Pointer	0x08FD
X Register	0x0000
Y Register	0x08FF
Z Register	0x0000
Status Register	I T H S V N Z C
Cycle Counter	27
Frequency	16.000 MHz
Stop Watch	1.69 µs
⊟ Registers	
R00	0x00
R01	0x00

DA2C Task 1_2 (AFTER):

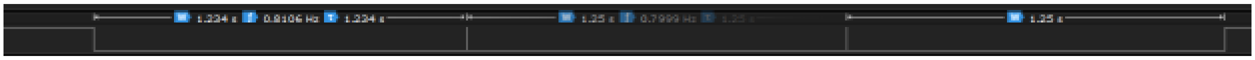


```
int main(void)
{
    DDRB = (1<<DDB2); // Make PB2 Output
    DDRC = (0<<DDC2); // Make PC2 Input
    PORTB = (1<<DDB2); // Turn off LED
    PORTC = (1<<DDC2); // Turn on pull-up transistor
    TCCR0A = 0; // Normal Mode
    TCCR0B = 5; // Set prescaler to 1024
    int ovrflow = 0; // overflow counter
    while (1)
    {
        if (!(PINC & (1 << PINC2))) {   // if button pressed
        PORTB ^= (1<<DDB2); // Turn on LED
        TCNT0 = 0; // Reset counter
        ovrflow = 0; // Reset overflow counter


        // Delay for 1.25 sec (19531 TCNT)
        while (ovrflow < 76) { // Gets to 19456
            while ((TIFR0 & 0x01) == 0) {}
            ovrflow++; // increment ovrflow
            TCNT0 = 0; // reset counter
            TIFR0 = 1; // reset ovf flag
        }
        while (TCNT0 < 75) {} // 19456+75 = 19531

        PORTB ^= (1<<DDB2); // Turn off LED
```

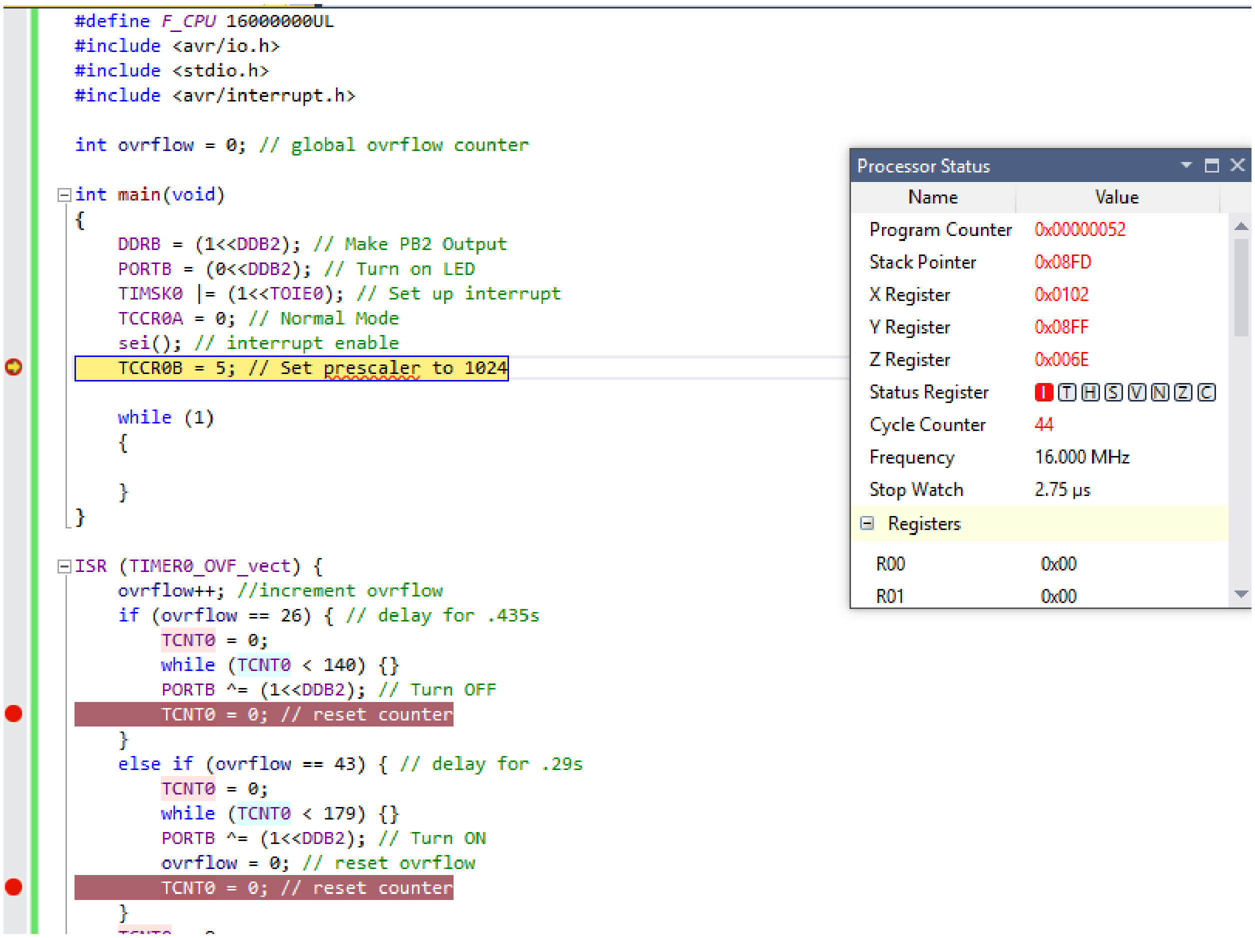
Processor Status

Name	Value
Program Counter	0x0000005B
Stack Pointer	0x08FD
X Register	0x0000
Y Register	0x08FF
Z Register	0x0000
Status Register	I T H S V N Z
Cycle Counter	19999770
Frequency	16.000 MHz
Stop Watch	1,249.99 ms
⊟ Registers	
R00	0x00
R01	0x00

DA2C Task 1_2 Waveform:



DA2C Task 2_1 (BEFORE):

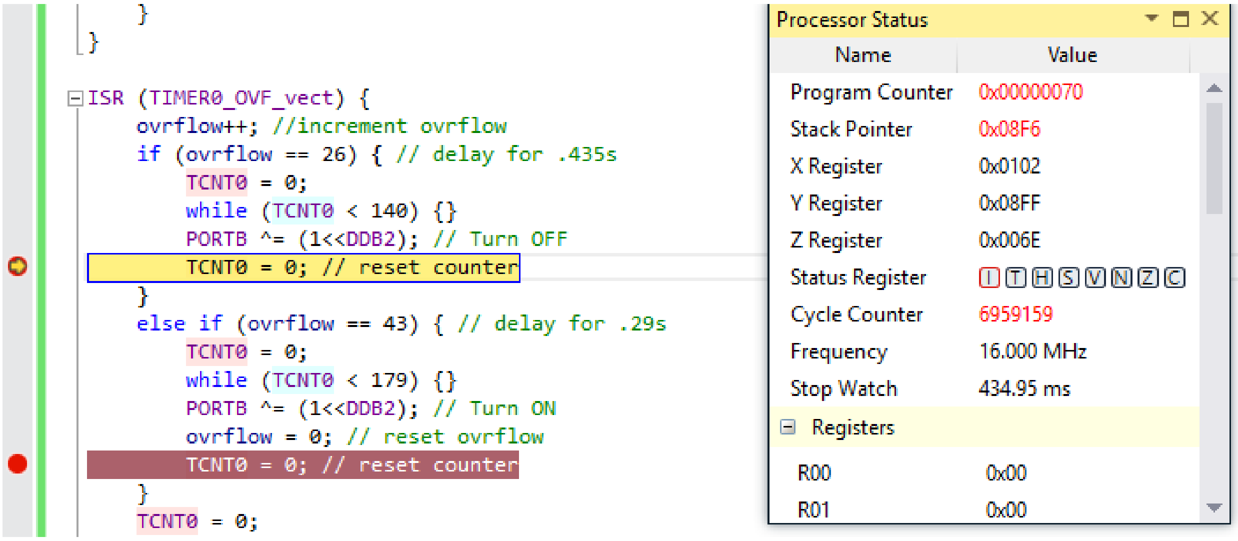


```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <stdio.h>
#include <avr/interrupt.h>

int ovrflow = 0; // global ovrflow counter

int main(void)
{
    DDRB = (1<<DDB2); // Make PB2 Output
    PORTB = (0<<DDB2); // Turn on LED
    TIMSK0 |= (1<<TOIE0); // Set up interrupt
    TCCR0A = 0; // Normal Mode
    sei(); // interrupt enable
    TCCR0B = 5; // Set prescaler to 1024

    while (1)
    {

    }
}

ISR (TIMER0_OVF_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 26) { // delay for .435s
        TCNT0 = 0;
        while (TCNT0 < 140) {}
        PORTB ^= (1<<DDB2); // Turn OFF
        TCNT0 = 0; // reset counter
    }
    else if (ovrflow == 43) { // delay for .29s
        TCNT0 = 0;
        while (TCNT0 < 179) {}
        PORTB ^= (1<<DDB2); // Turn ON
        ovrflow = 0; // reset ovrflow
        TCNT0 = 0; // reset counter
    }
```

Processor Status

Name	Value
Program Counter	0x00000052
Stack Pointer	0x08FD
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	44
Frequency	16.000 MHz
Stop Watch	2.75 µs
Registers	
R00	0x00
R01	0x00

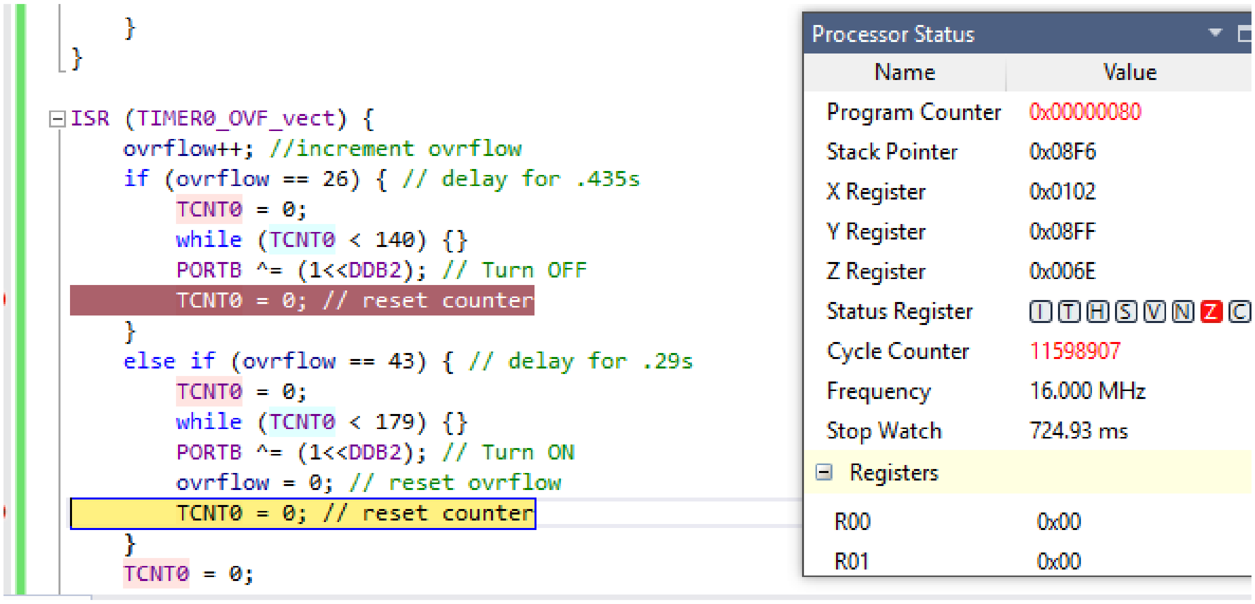
DA2C Task 2_1 (AFTER):



```
        }
    }

ISR (TIMER0_OVF_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 26) { // delay for .435s
        TCNT0 = 0;
        while (TCNT0 < 140) {}
        PORTB ^= (1<<DDB2); // Turn OFF
        TCNT0 = 0; // reset counter
    }
    else if (ovrflow == 43) { // delay for .29s
        TCNT0 = 0;
        while (TCNT0 < 179) {}
        PORTB ^= (1<<DDB2); // Turn ON
        ovrflow = 0; // reset ovrflow
        TCNT0 = 0; // reset counter
    }
    TCNT0 = 0;
```

Processor Status

Name	Value
Program Counter	0x00000070
Stack Pointer	0x08F6
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	6959159
Frequency	16.000 MHz
Stop Watch	434.95 ms
⊟ Registers	
R00	0x00
R01	0x00

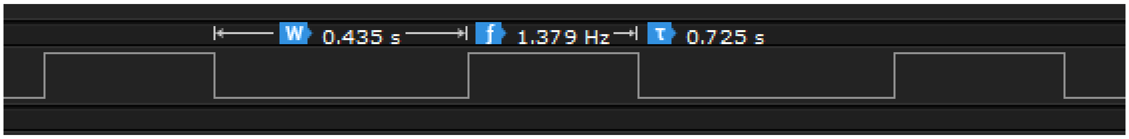


```
        }
    }

ISR (TIMER0_OVF_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 26) { // delay for .435s
        TCNT0 = 0;
        while (TCNT0 < 140) {}
        PORTB ^= (1<<DDB2); // Turn OFF
        TCNT0 = 0; // reset counter
    }
    else if (ovrflow == 43) { // delay for .29s
        TCNT0 = 0;
        while (TCNT0 < 179) {}
        PORTB ^= (1<<DDB2); // Turn ON
        ovrflow = 0; // reset ovrflow
        TCNT0 = 0; // reset counter
    }
    TCNT0 = 0;
```

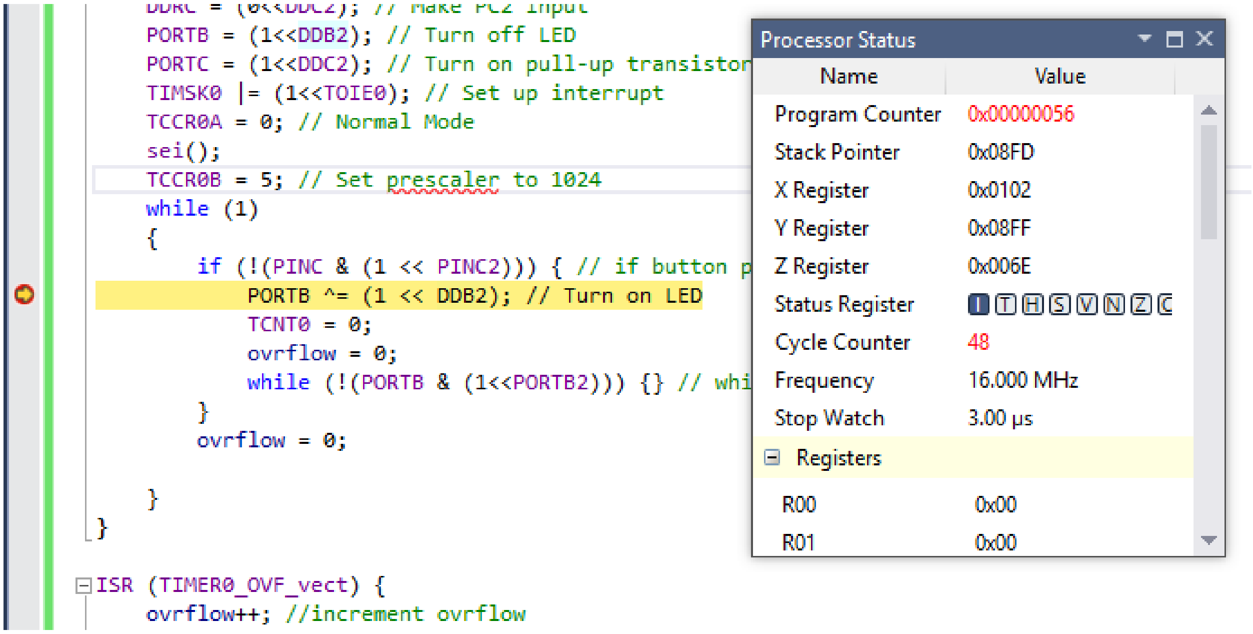
Processor Status

Name	Value
Program Counter	0x00000080
Stack Pointer	0x08F6
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	11598907
Frequency	16.000 MHz
Stop Watch	724.93 ms
⊟ Registers	
R00	0x00
R01	0x00

DA2C Task 2_1 Waveform:



DA2C Task 2_2 (BEFORE):

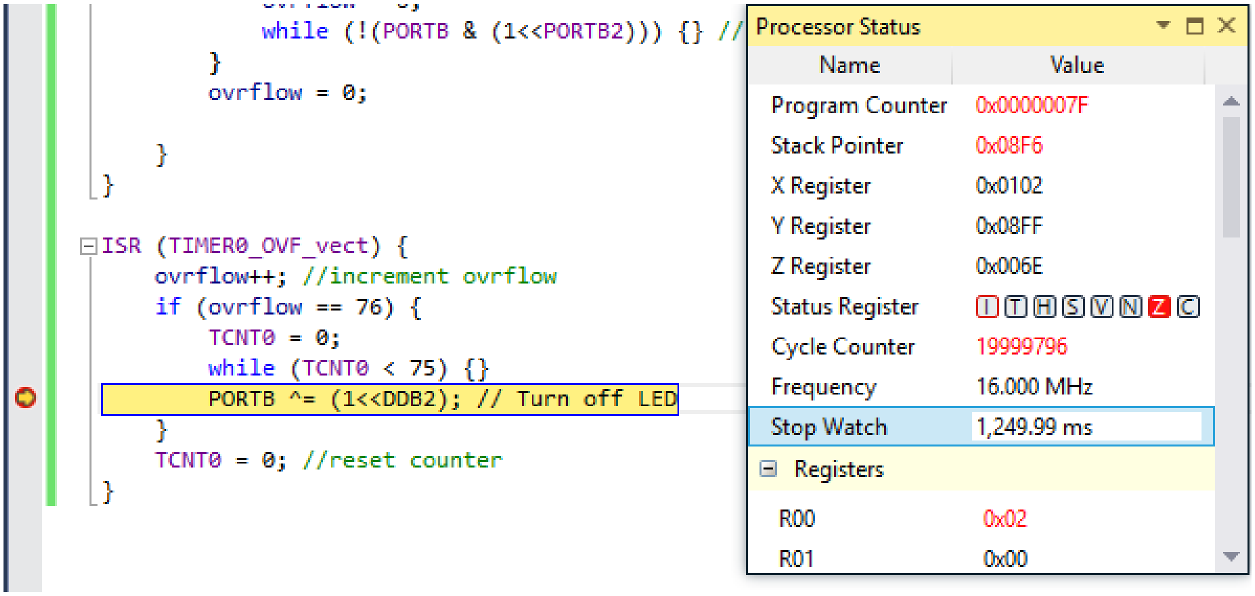


```
    DDRC = (0<<DDC2); // Make PC2 input
    PORTB = (1<<DDB2); // Turn off LED
    PORTC = (1<<DDC2); // Turn on pull-up transistor
    TIMSK0 |= (1<<TOIE0); // Set up interrupt
    TCCR0A = 0; // Normal Mode
    sei();
    TCCR0B = 5; // Set prescaler to 1024
    while (1)
    {
        if (!(PINC & (1 << PINC2))) { // if button p
            PORTB ^= (1 << DDB2); // Turn on LED
            TCNT0 = 0;
            ovrflow = 0;
            while (!(PORTB & (1<<PORTB2))) {} // whi
        }
        ovrflow = 0;

    }
}

ISR (TIMER0_OVF_vect) {
    ovrflow++; //increment ovrflow
```

Processor Status

Name	Value
Program Counter	0x00000056
Stack Pointer	0x08FD
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	48
Frequency	16.000 MHz
Stop Watch	3.00 µs
⊟ Registers	
R00	0x00
R01	0x00

DA2C Task 2_2 (AFTER):

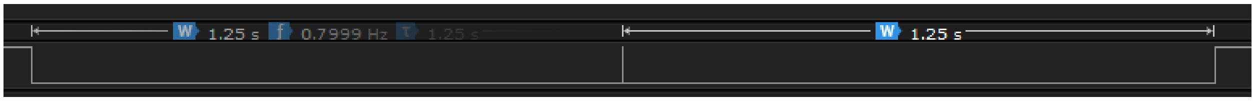


```
            ovrflow = 0;
            while (!(PORTB & (1<<PORTB2))) {} //
        }
        ovrflow = 0;

    }
}

ISR (TIMER0_OVF_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 76) {
        TCNT0 = 0;
        while (TCNT0 < 75) {}
        PORTB ^= (1<<DDB2); // Turn off LED
    }
    TCNT0 = 0; //reset counter
}
```

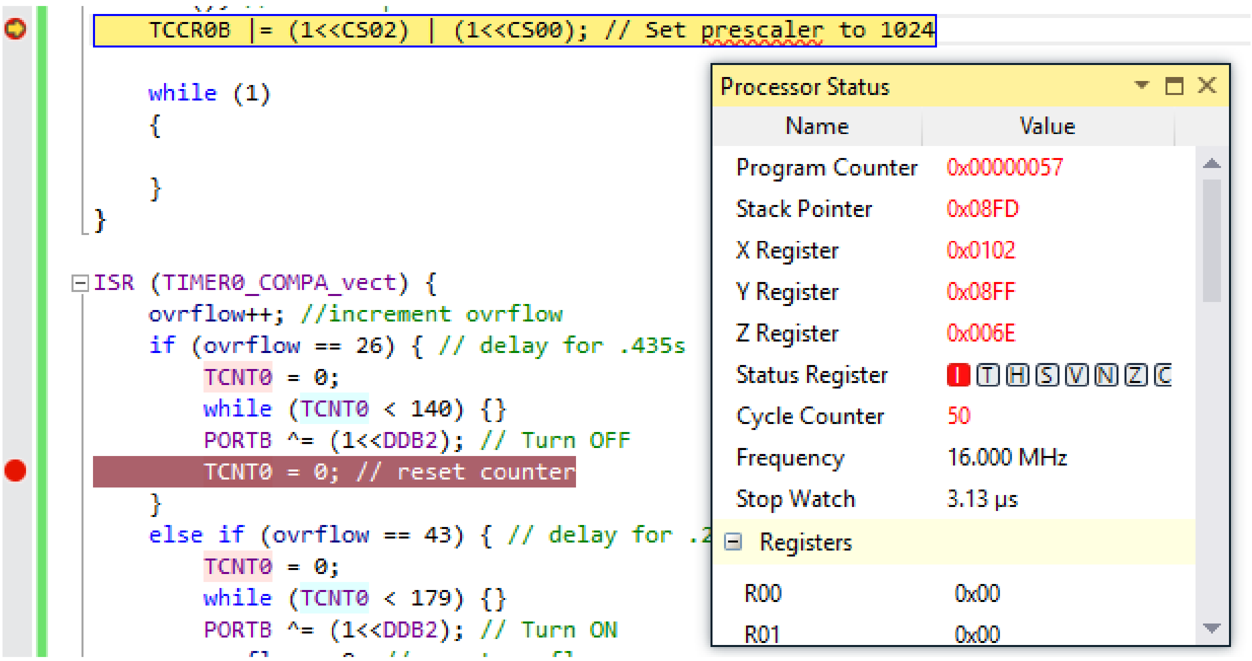
Processor Status

Name	Value
Program Counter	0x0000007F
Stack Pointer	0x08F6
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	19999796
Frequency	16.000 MHz
Stop Watch	1,249.99 ms
⊟ Registers	
R00	0x02
R01	0x00

DA2C Task 2_2 Waveform:



DA2C Task 3_1 (BEFORE):

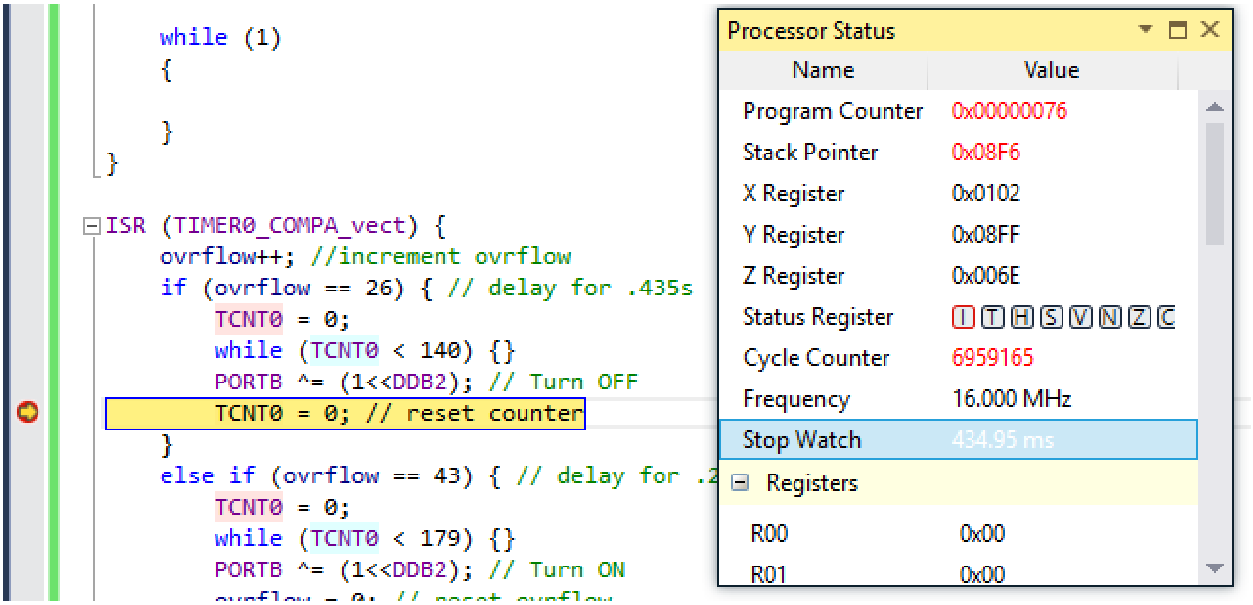


```
    TCCR0B |= (1<<CS02) | (1<<CS00); // Set prescaler to 1024

    while (1)
    {

    }
}

ISR (TIMER0_COMPA_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 26) { // delay for .435s
        TCNT0 = 0;
        while (TCNT0 < 140) {}
        PORTB ^= (1<<DDB2); // Turn OFF
        TCNT0 = 0; // reset counter
    }
    else if (ovrflow == 43) { // delay for .2
        TCNT0 = 0;
        while (TCNT0 < 179) {}
        PORTB ^= (1<<DDB2); // Turn ON
```

Processor Status

Name	Value
Program Counter	0x00000057
Stack Pointer	0x08FD
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	50
Frequency	16.000 MHz
Stop Watch	3.13 µs
Registers	
R00	0x00
R01	0x00

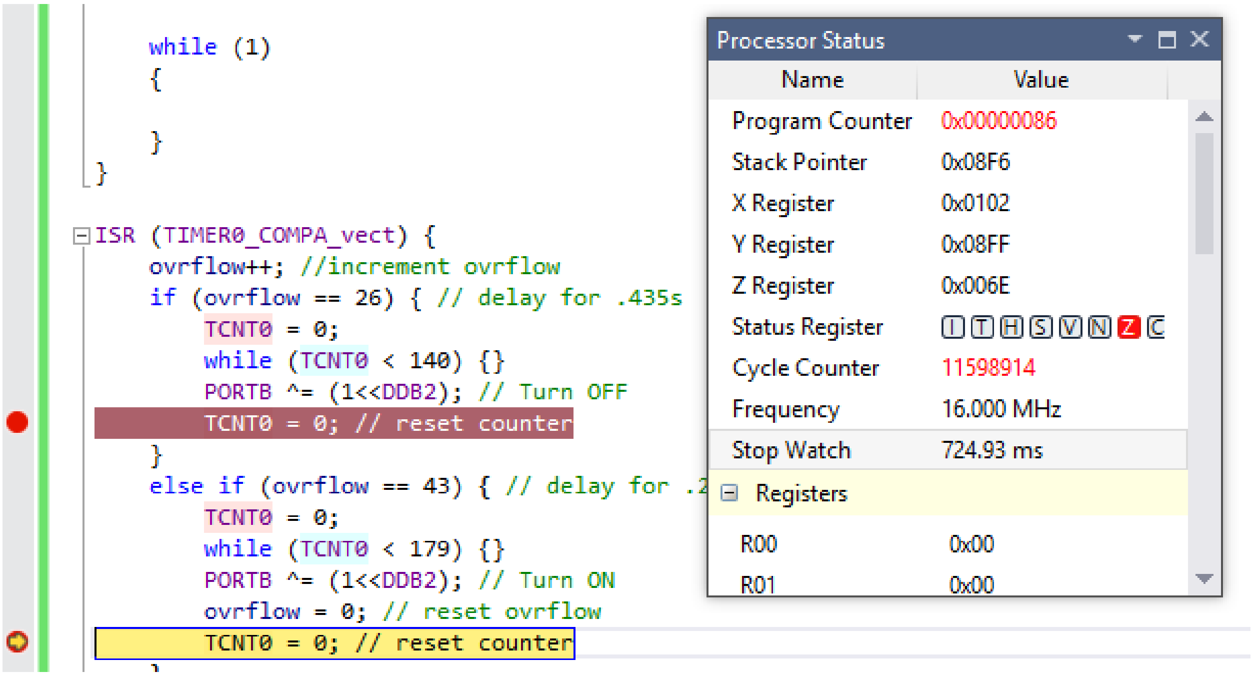
DA2C Task 3_1 (AFTER):



```
    while (1)
    {

    }
}

ISR (TIMER0_COMPA_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 26) { // delay for .435s
        TCNT0 = 0;
        while (TCNT0 < 140) {}
        PORTB ^= (1<<DDB2); // Turn OFF
        TCNT0 = 0; // reset counter
    }
    else if (ovrflow == 43) { // delay for .2
        TCNT0 = 0;
        while (TCNT0 < 179) {}
        PORTB ^= (1<<DDB2); // Turn ON
        ovrflow = 0; // reset ovrflow
```

Processor Status

Name	Value
Program Counter	0x00000076
Stack Pointer	0x08F6
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	6959165
Frequency	16.000 MHz
Stop Watch	434.95 ms
Registers	
R00	0x00
R01	0x00

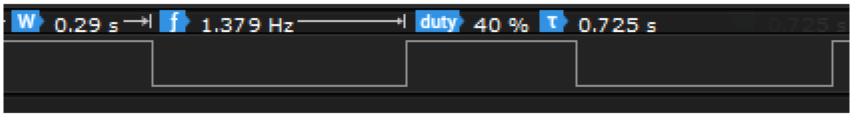


```
    while (1)
    {

    }
}

ISR (TIMER0_COMPA_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 26) { // delay for .435s
        TCNT0 = 0;
        while (TCNT0 < 140) {}
        PORTB ^= (1<<DDB2); // Turn OFF
        TCNT0 = 0; // reset counter
    }
    else if (ovrflow == 43) { // delay for .2
        TCNT0 = 0;
        while (TCNT0 < 179) {}
        PORTB ^= (1<<DDB2); // Turn ON
        ovrflow = 0; // reset ovrflow
        TCNT0 = 0; // reset counter
```

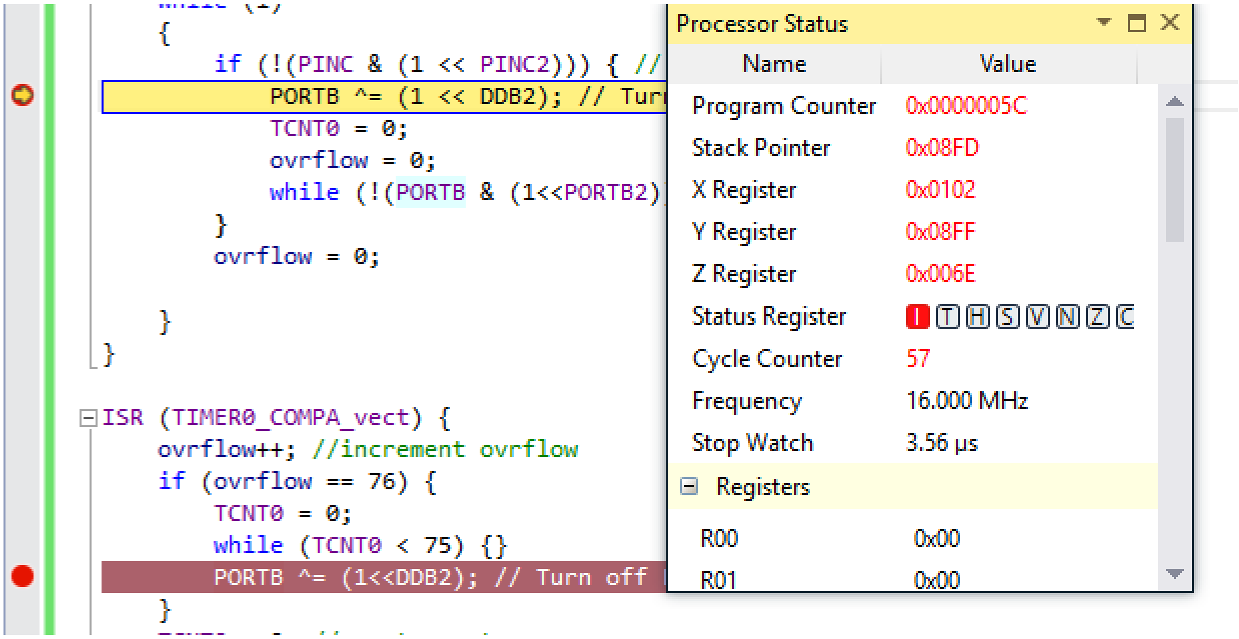
Processor Status

Name	Value
Program Counter	0x00000086
Stack Pointer	0x08F6
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	11598914
Frequency	16.000 MHz
Stop Watch	724.93 ms
Registers	
R00	0x00
R01	0x00

DA2C Task 3_1 Waveform:



DA2C Task 3_2 (BEFORE):

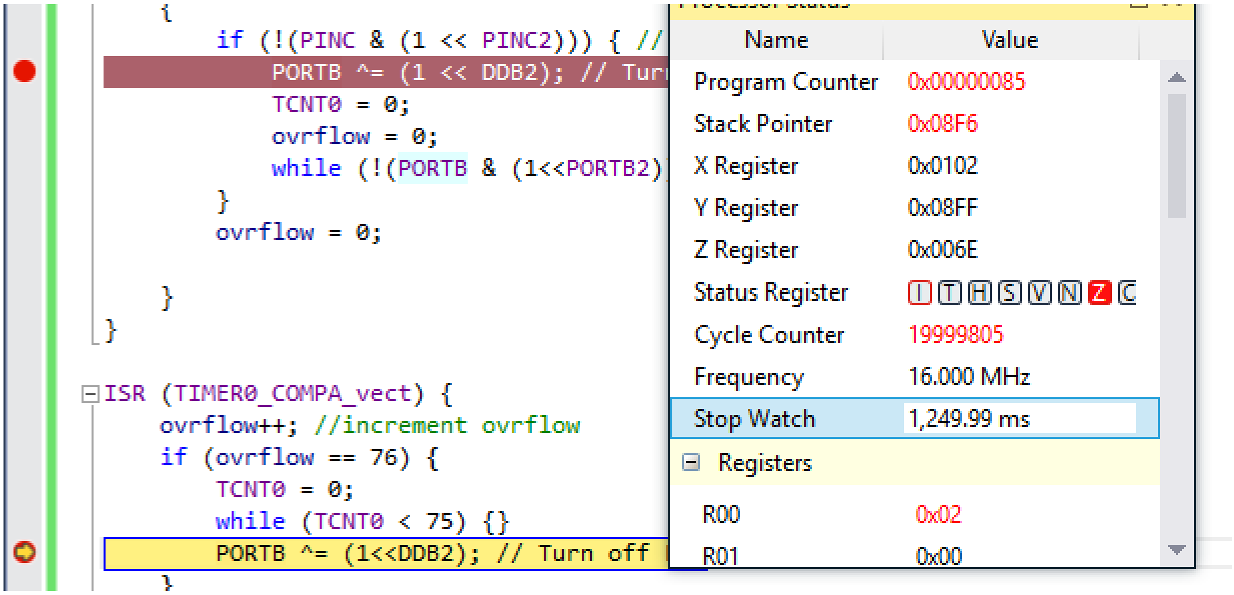


```
    while (1)
    {
        if (!(PINC & (1 << PINC2))) { //
            PORTB ^= (1 << DDB2); // Tur
            TCNT0 = 0;
            ovrflow = 0;
            while (!(PORTB & (1<<PORTB2)
        }
        ovrflow = 0;

    }
}

ISR (TIMER0_COMPA_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 76) {
        TCNT0 = 0;
        while (TCNT0 < 75) {}
        PORTB ^= (1<<DDB2); // Turn off
    }
```

Processor Status

Name	Value
Program Counter	0x0000005C
Stack Pointer	0x08FD
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	57
Frequency	16.000 MHz
Stop Watch	3.56 µs
Registers	
R00	0x00
R01	0x00

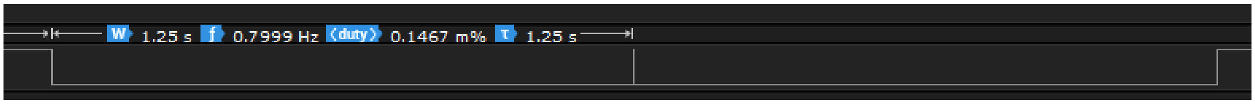
DA2C Task 3_2 (AFTER):



```
    {
        if (!(PINC & (1 << PINC2))) { //
            PORTB ^= (1 << DDB2); // Tur
            TCNT0 = 0;
            ovrflow = 0;
            while (!(PORTB & (1<<PORTB2)
        }
        ovrflow = 0;

    }
}

ISR (TIMER0_COMPA_vect) {
    ovrflow++; //increment ovrflow
    if (ovrflow == 76) {
        TCNT0 = 0;
        while (TCNT0 < 75) {}
        PORTB ^= (1<<DDB2); // Turn off
    }
```

Name	Value
Program Counter	0x00000085
Stack Pointer	0x08F6
X Register	0x0102
Y Register	0x08FF
Z Register	0x006E
Status Register	I T H S V N Z C
Cycle Counter	19999805
Frequency	16.000 MHz
Stop Watch	1,249.99 ms
Registers	
R00	0x02
R01	0x00

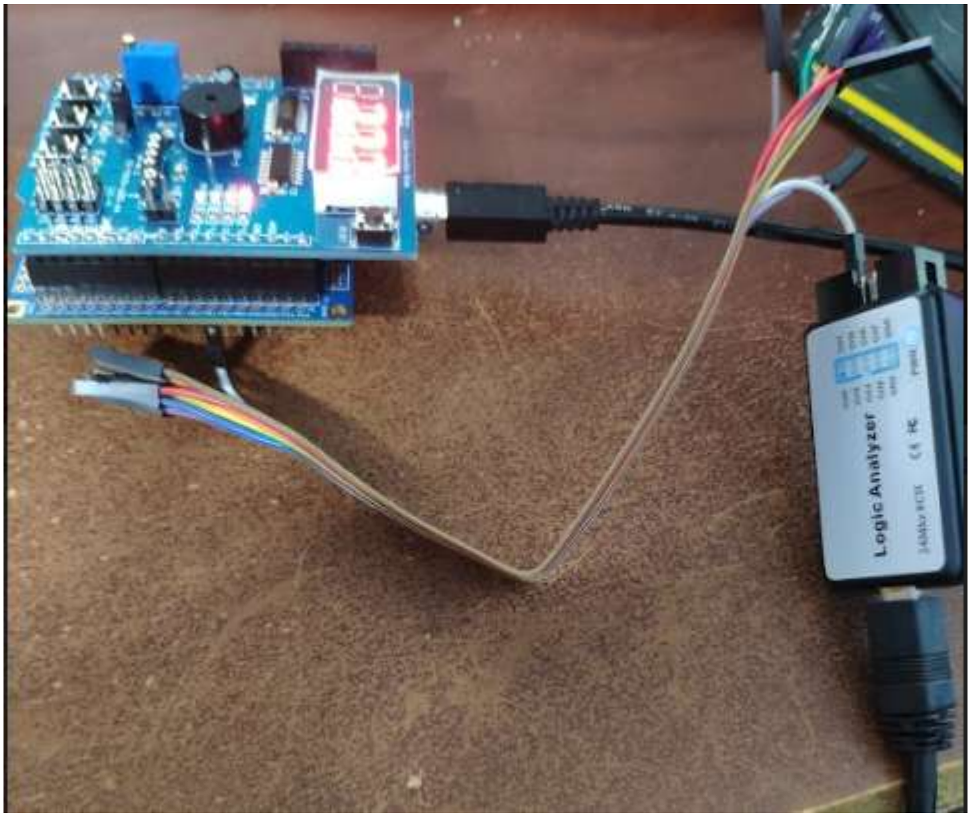
DA2C Task 3_2 Waveform:



W 1.25 s f 0.7999 Hz duty 0.1467 m% T 1.25 s

8. SCREENSHOT OF EACH DEMO (BOARD SETUP)

Task 1-3:



9. VIDEO LINKS OF EACH DEMO

https://youtu.be/hjMDncpwhuI

10. GITHUB LINK OF THIS DA

https://github.com/recrio/submissions/tree/master/DesignAssignments/DA2C

Student Academic Misconduct Policy
http://studentconduct.unlv.edu/misconduct/policy.html

"This assignment submission is my own, original work".
Ron Joshua Recrio