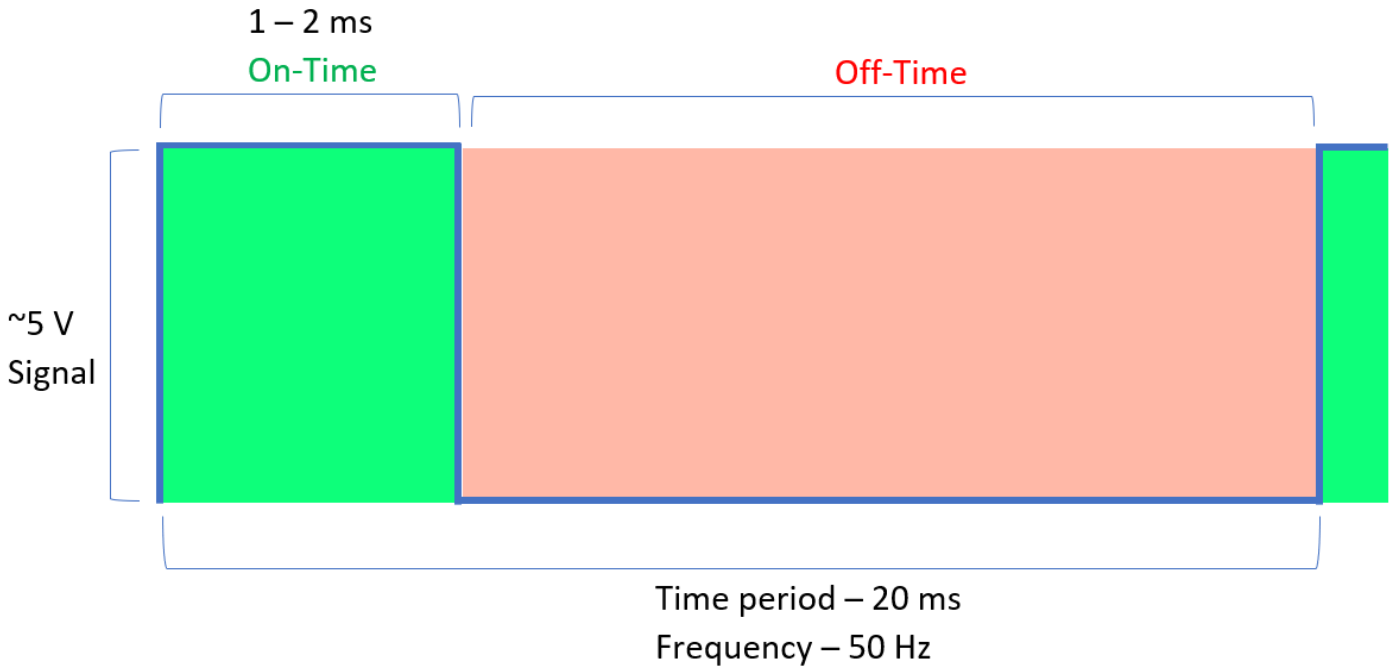
2. Servos

Servos are motors that adjusts to certain angles following certain PWM pulses.

Servo Signal Operation

Servo operates with 20 ms PWM periods.



Parameter	Typical Value
PWM Period	≈ 20 ms
Pulse Width	≈ 1 – 2 ms

Servo operates with 20 ms PWM periods. This can hardly be achieved with Timer0 since Timer0 is an **8-bit timer**.

This means its maximum counter value is:

```
2^8 - 1 = 255
```

20 ms period is hardly achievable with this which requires a **16-bit timer** is preferred.

$$2^{16} - 1 = 65535$$

This allows precise generation of long PWM periods.

Using a prescaler of 8:

$$f_{timer} = \frac{16\,MHz}{8} = 2\,MHz$$

Timer tick duration:

$$T_{tick} = \frac{1}{2\,MHz} = 0.5\,\mu s$$

Required servo period: 20 ms

Number of timer counts required:

$$TOP = \frac{T_{PWM}}{T_{tick}} = \frac{20\,ms}{0.5\,\mu s} = 40000$$

Servo Initialization Code Example

```
SBI DDRB, 1
```

Configure **OC1A pin** as output. Timer1 will control this pin automatically.

```
LDI R22, (1<<COM1A1) | (1<<WGM11)
STS TCCR1A, R22
```

TCCR1A configuration:

Bit	Purpose

COM1A1 = 1	Enable PWM output on OC1A
WGM11 = 1	Part of Fast PWM mode selection

This connects Timer1 to the output pin.

```
LDI R22, hi8(40000)
STS ICR1H, R22
LDI R22, lo8(40000)
STS ICR1L, R22
```

Set **ICR1 = 40000**.

This is to make the Timer 1 count to 40 000 following the previous calculations.

```
LDI R22, (1<<WGM13) | (1<<WGM12) | (1<<CS11)
STS TCCR1B, R22
```

TCCR1B configuration:

Bit	Purpose
WGM13 + WGM12	Complete Fast PWM Mode 14
CS11 = 1	Prescaler = 8

This starts Timer1 in Fast PWM mode.

Servo Initialization

```
; Sets Timer1 PWM in PB1 to use period of 20ms by using Fast PWM.
; Timer1 counts until ICR1
SERVO_init:
  SBI DDRB, 1

  LDI R22, (1<<COM1A1) | (1<<WGM11)
  STS TCCR1A, R22

  LDI R22, hi8(40000)
  STS ICR1H, R22
  LDI R22, lo8(40000)
  STS ICR1L, R22
```

```
LDI R22, (1<<WGM13) | (1<<WGM12) | (1<<CS11)
STS TCCR1B, R22

RET
```

Servo Usage

```
.EQU LEFT, 2400  ; Generates a 2400/40000 % duty cycle.

LDI R16, hi8(LEFT)
STS OCR1AH, R16
LDI R16, lo8(LEFT)
STS OCR1AL, R16
```

This code makes the PWM generate compare match at count `2400` this allows it to produce a 2400/40000 * 20 ms = ~1.2 ms pulse which is around 0 degrees.

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