Lab1 Coursework Questions

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1.

The temperature sensors produce an analog voltage between 0-5 V. This means we have to use a reference voltage of 5 V. The ADC pin on the Arduino has a resolution of 10 bits so it reads a number in the range 0-1023.

Rearranging equation 1 from the data sheet:

$$n_{ADC} = \frac{V_{ADC}}{V_{ref}} * 1024$$

If V_{ref} is larger than V_{ADC} then not all values available on the pin are utilised. For example, with V_{ref} = 5 V, there is a maximum value of n_{ADC} of 675. We can improve the resolution by reducing the reference voltage.

2.

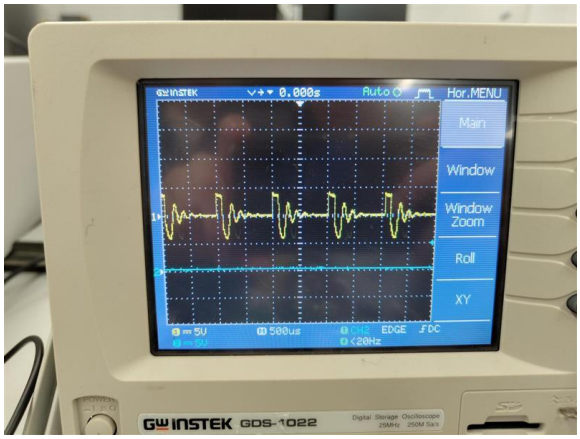


Figure 1 - 10% Duty cycle

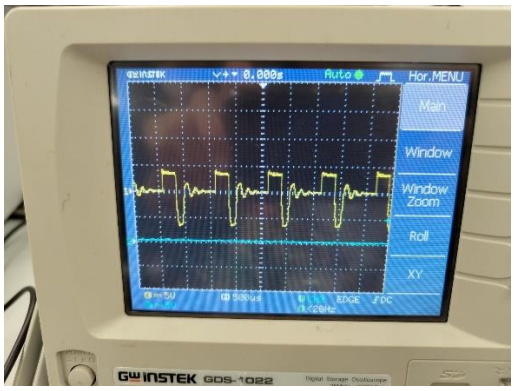


Figure 2 - 20% Duty cycle

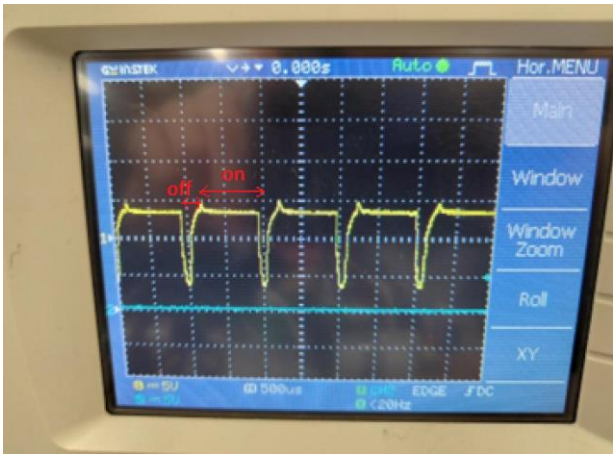


Figure 3 - 50% Duty cycle

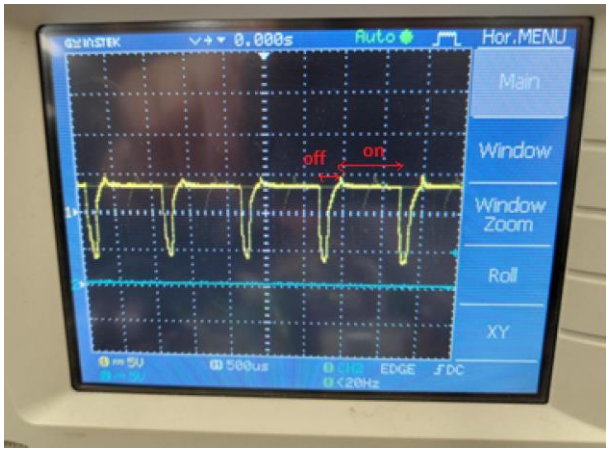


Figure 4 - 75% Duty cycle

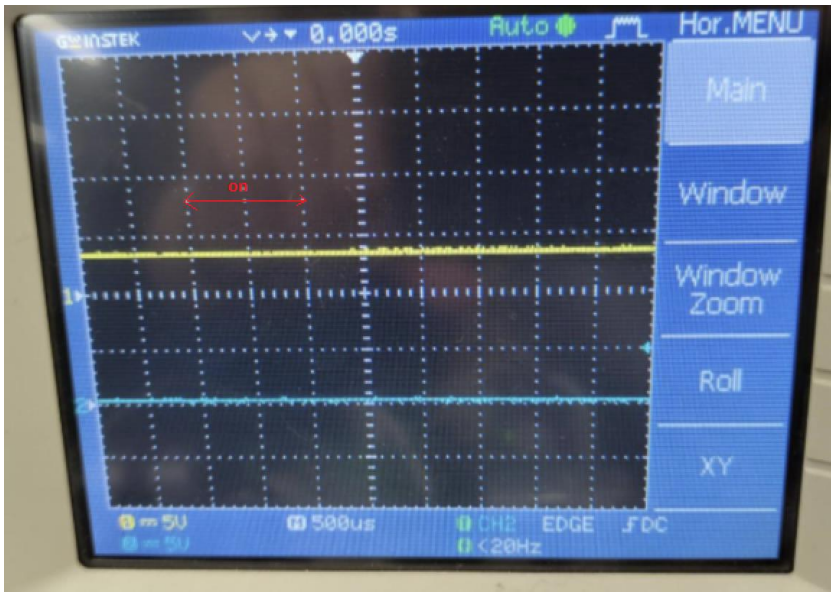


Figure 5 - 100% Duty cycle (Note that even though the whole graph is labelled on, it is still made of smaller pulses that are all on. The time period doesn't change)

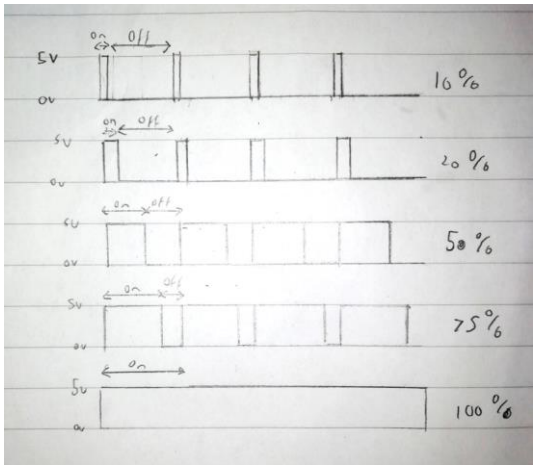
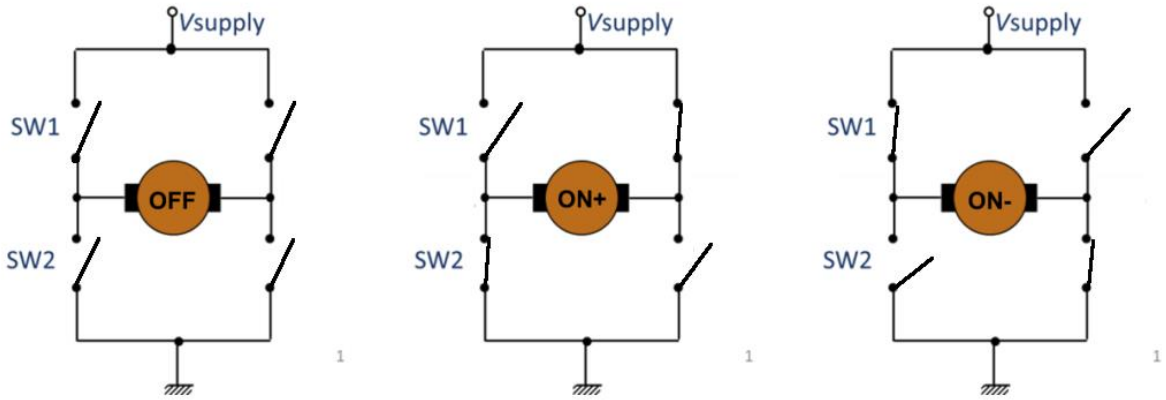


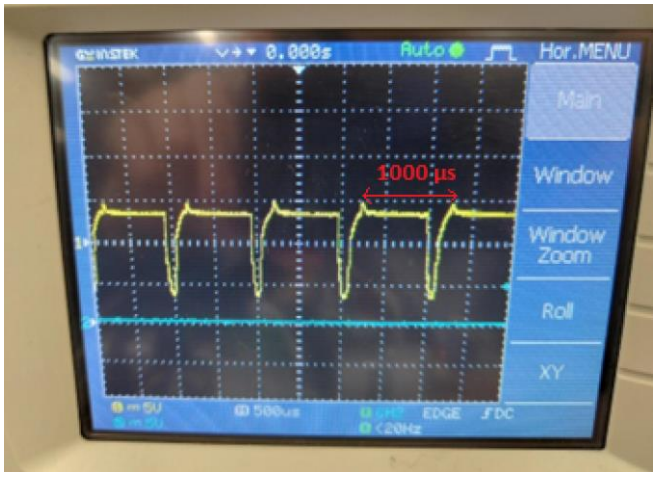
Figure 6 - Drawing of ideal duty cycles

It is expected that the frequency of the waves does not change at different duty cycles. As the percent duty cycle increases, the “on” region should become larger and the off region should decrease. At 100% duty cycle the signal is always on (at 5 V). There is no fluctuation from off to on, so the effective voltage is the same as the supply voltage. The voltage in the off region is not zero due to Transistor-Transistor Logic (TTL) signals. Voltage drops in circuitry and noise mean that the low signal will deviate from 0 V. The TTL gates have an acceptable input voltage of < 0.8 V and can guarantee an output of < 0.4 V.

3.



The default PWM frequency for an Arduino Mega 2560 for pins 2 to 12 (except 4) is 490 Hz. However, the default PWM frequency on pins 4 and 13 are 980 Hz. In this experiment pin 13 was used.



From the oscilloscopes there is an approximate time period of 1000 microseconds (1 ms), so the frequency (1/t) that can be heard is approximately 1000 Hz.

4.

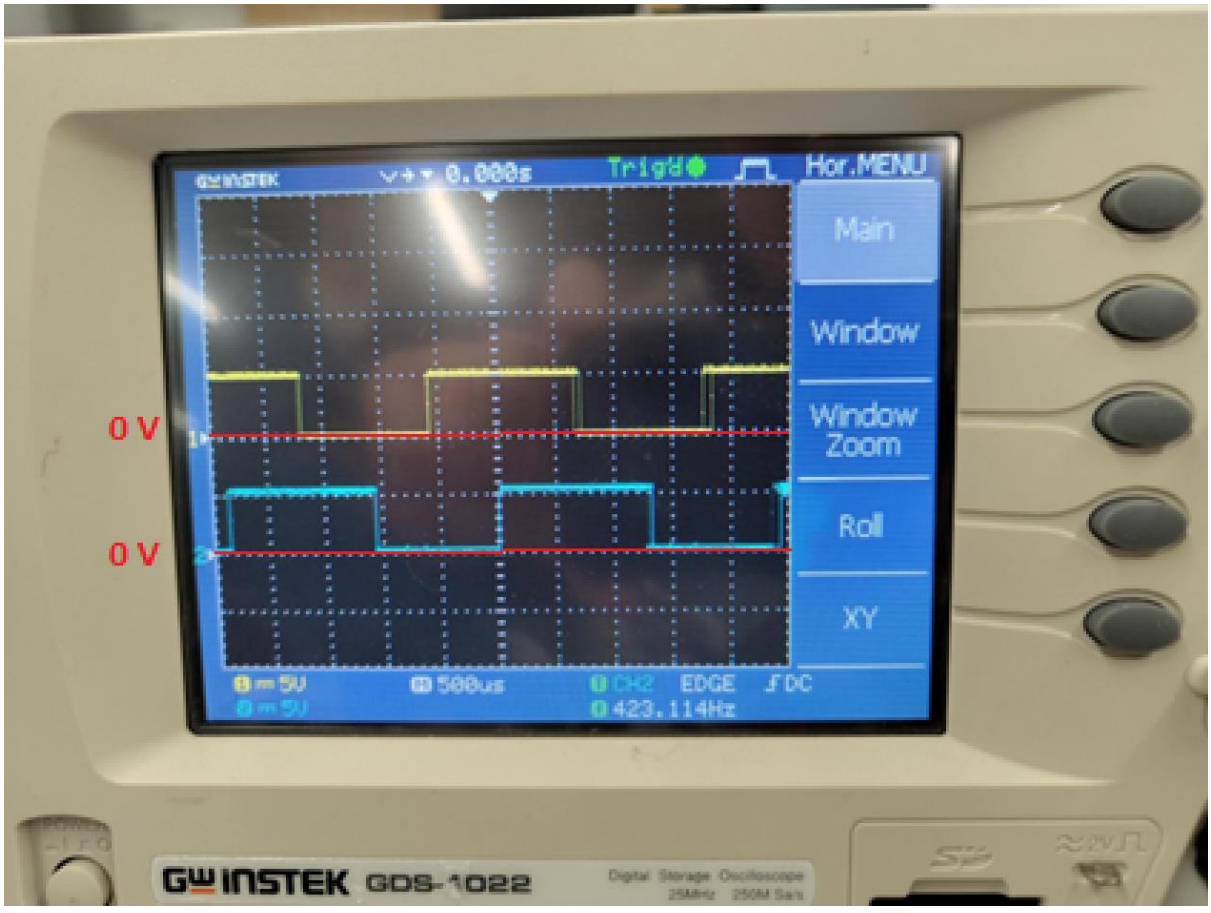


Figure 7 - Rotation in the positive direction. Channel A leads B.

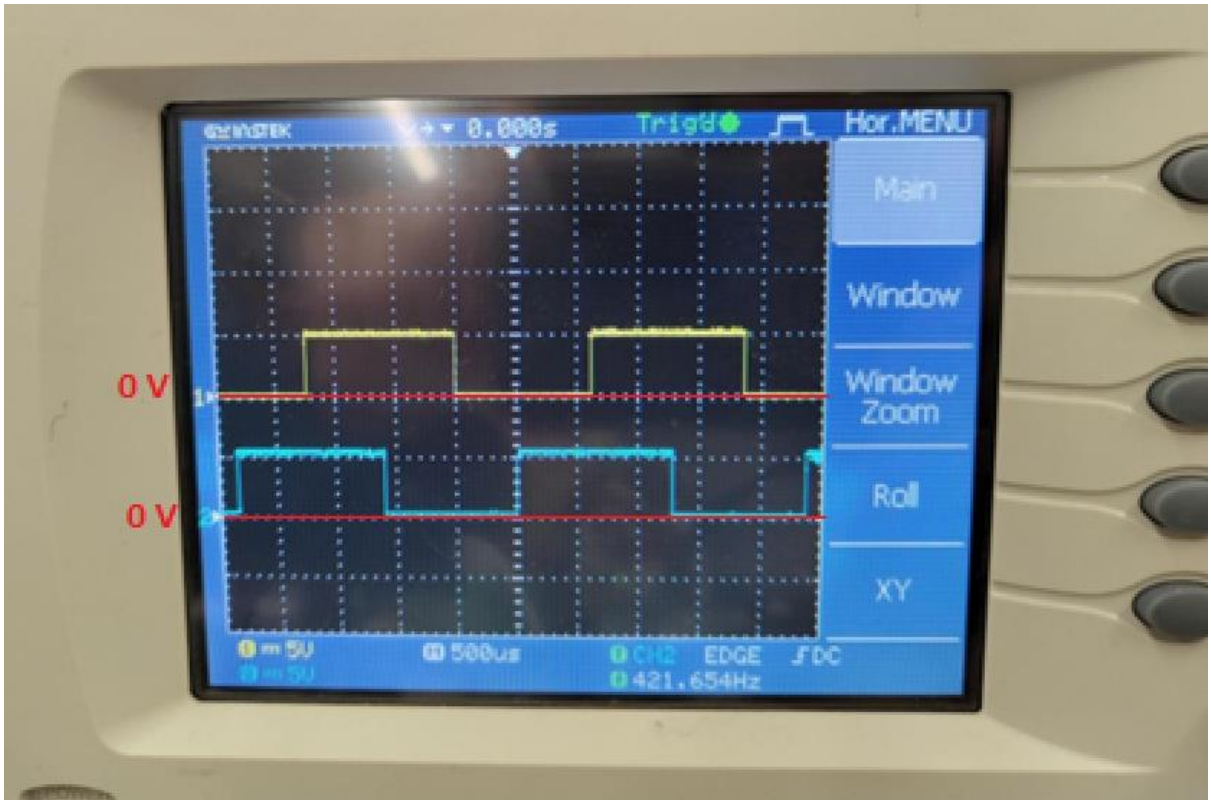


Figure 8 - Rotation in the negative direction. Channel B leads A.

5.

The timer/counter 5 only counts on the rising edge of 1 channel, compared to the LS7366R quadrature decoder which counts on the rising and falling edge of both channels. This means it will have a quarter of the resolution. Since it only uses 1 channel it can't detect the direction of rotation, so it cannot send a signal to rotate the servomotor the other way. In this lab the counter is set to the normal mode of operation.

6.

When running on large voltages on a high duty percent there was a significant number of errors recorded. As the voltage increases the frequency of the PWM waveform increases. The program takes time to run so sometimes a reading of the state may be skipped. This causes the error count to increase, and the state is set based on the current reading. At smaller time periods these errors will occur more often.