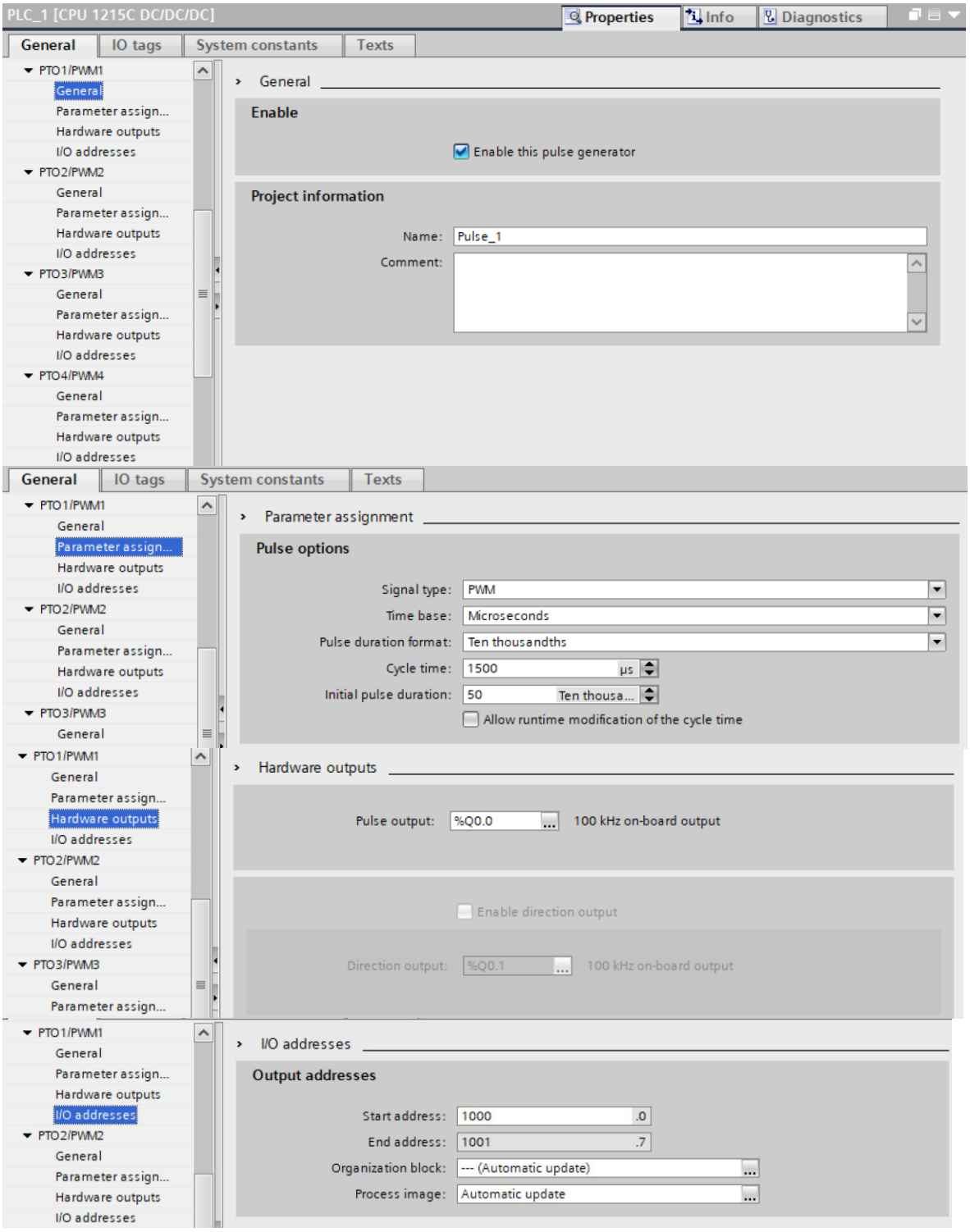
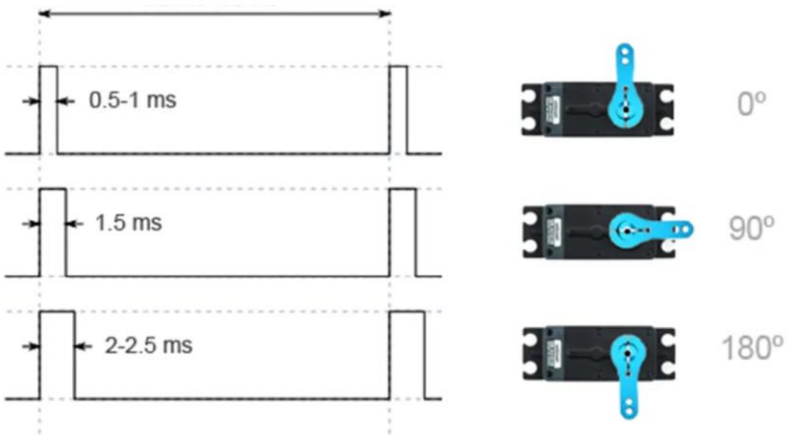
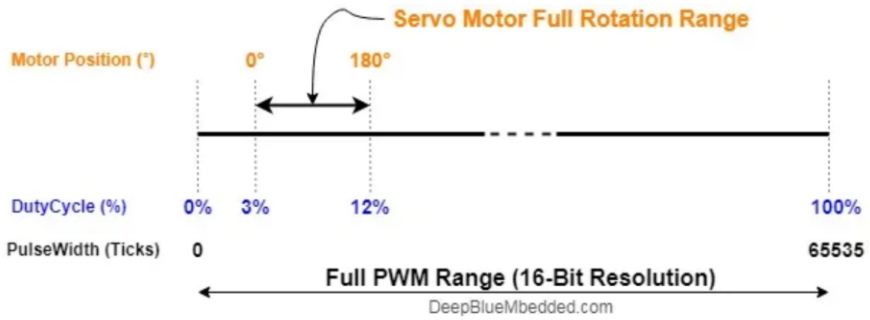
Chapter 8 PWM and RAMP

In this lab we are introduced to the PWM output of the Siemens 1200 PLC. Described below is the configuration of the PWM output channels of the first 4 outputs of the Siemens S7-1215 DCDCDC processor. The configuration shown is just part of the process to program a pwm output.



The picture below is a hobby servo controller. The movement and control is based on a number in the output word associated with the output. With a configuration as above, the pulse width is determined by the servo specification. The specification below shows 1500 micro seconds or 1.5 msec duration. Both servo applications below use the HS-422 servo motor.





ANNOUNCED SPECIFICATION OF HS-422 STANDARD DELUXE SERVO

1.TECHNICAL VALUES

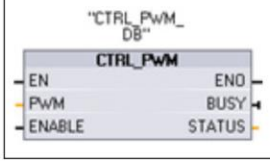
CONTROL SYSTEM	: +PULSE WIDTH CONTROL 1500usec NEUTRAL	
OPERATING VOLTAGE RANGE	: 4.8V TO 6.0V	
OPERATING TEMPERATURE RANGE	: -20 T0 +60°C	
TEST VOLTAGE	: AT 4.8V	AT 6.0V
OPERATING SPEED	: 0.21sec/60° AT NO LOAD	0.16sec/60° AT NO LOAD
STALL TORQUE	: 3.3kg.cm(45.82oz.in)	4.1kg.cm(56.93oz.in)
OPERATING ANGLE	: 45°/ONE SIDE PULSE TRAVELING 400usec	
DIRECTION	: CLOCK WISE/PULSE TRAVELING 1500 TO 1900usec	
CURRENT DRAIN	: 8mA/IDLE AND 150mA/NO LOAD RUNNING	
DEAD BAND WIDTH	: 8usec	
CONNECTOR WIRE LENGTH	: 300mm(11.81in)	
DIMENSIONS	: 40.6x19.8x36.6mm(1.59x0.77x1.44in)	
WEIGHT	: 45.5g(1.6oz)	

The instruction for driving the PWM output is the CTRL_PWM instruction. This instruction is explained in the Easy Manual and copied below:

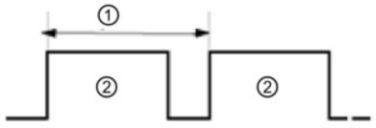
6.3.7 Pulse-width modulation (PWM)

The CTRL_PWM instruction is available in the Pulse group of the Extended instructions.

Table 6- 20 CTRL_PWM instruction

LAD / FBD	SCL	Desciption
	`"ctrl_pwm_db"( PWM:=W#16#0, ENABLE:=False, BUSY=>_bool_out_, STATUS=>_word_out_);`	The CTRL_PWM instruction provides a fixed cycle time output with a variable duty cycle. The PWM output runs continuously after being started at the specified frequency (cycle time). The pulse width is varied as required to affect the desired control.

When you insert the CTRL_PWM instruction in your code block, you create the DB for the instruction from the "Call options" dialog. The CTRL_PWM instruction stores the parameter information in the DB and controls the data block parameters.



Duty cycle can be expressed, for example, as a percentage of the cycle time or as a relative quantity (such as 0 to 1000 or 0 to 10000). The pulse width can vary from 0 (no pulse, always off) to full scale (no pulse, always on).

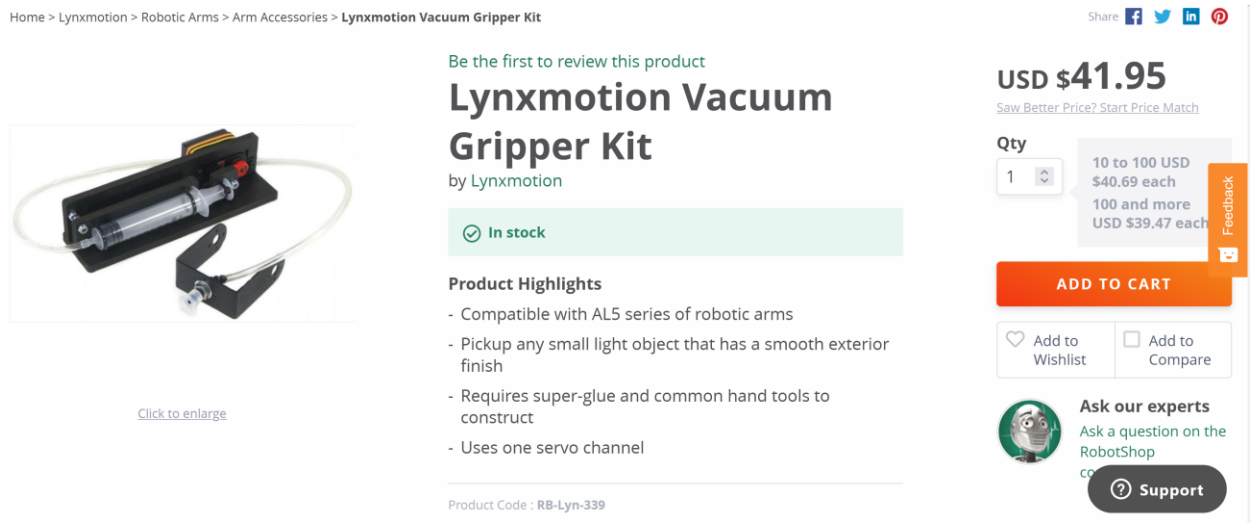
① Cycle time

② Pulse width time

The PWM output can be varied from 0 to full scale, providing a digital output that in many ways is the same as an analog output. For example, the PWM output can be used to control the speed of a motor from stop to full speed, or it can be used to control position of a valve from closed to fully opened.

Lab 8A

This lab requires the number in QW1000 to be modulated between two numbers to engage the vacuum and disengage the vacuum. The numbers and command to turn the vacuum on and off must be determined by trial and error.



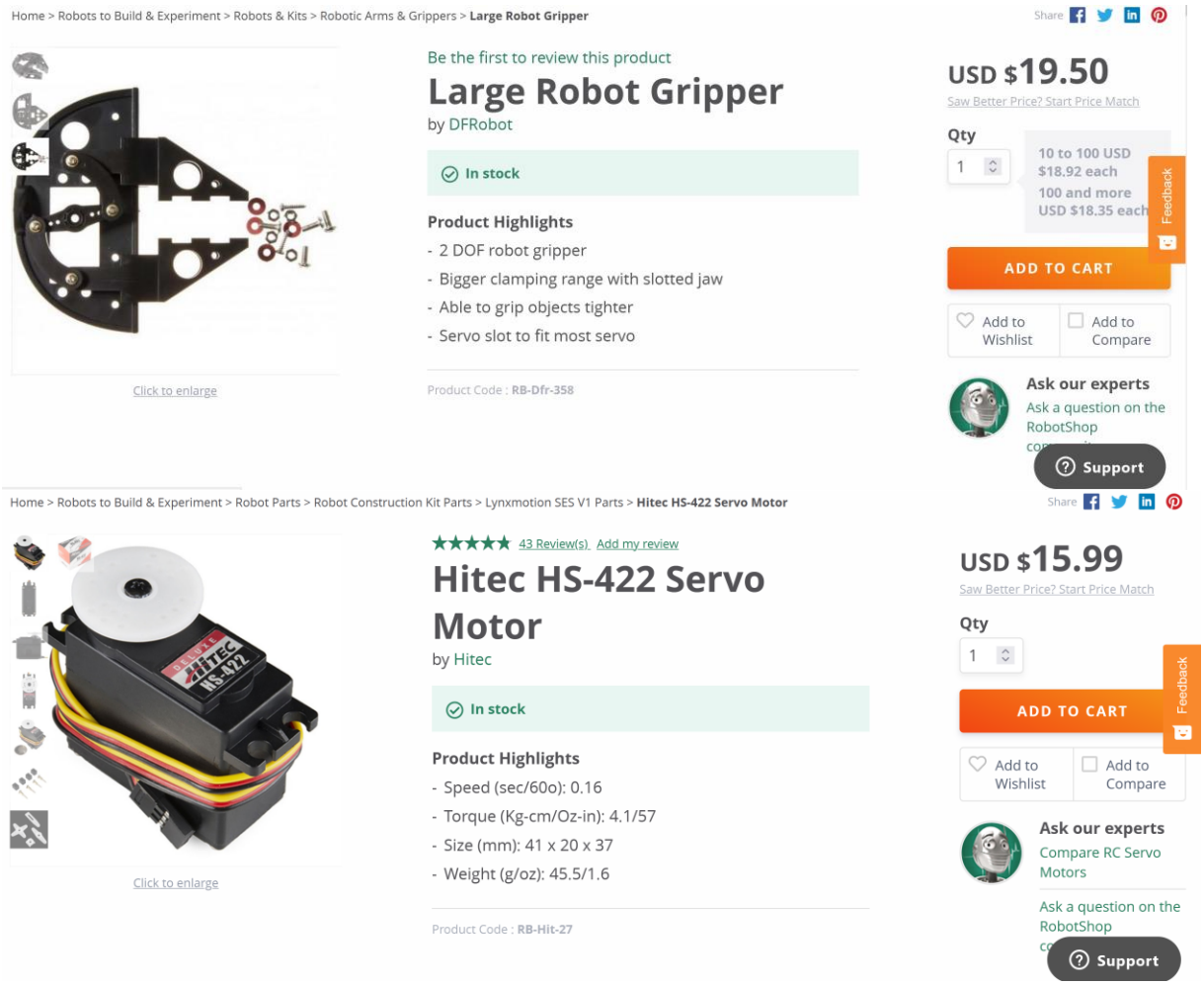
Description

- Compatible with AL5 series of robotic arms
- Pickup any small light object that has a smooth exterior finish
- Requires super-glue and common hand tools to construct
- Uses one servo channel

The **Lynxmotion Vacuum Gripper Kit** is a fun accessory to the AL5 series of robotic arms. This unique gripper uses an inexpensive syringe as the vacuum source. In the testing manufacturer was able to hold 3.5 ounces for over 30 minutes. The gripper will pickup any small light object that has a smooth exterior finish. The Vacuum Gripper uses one servo channel which removes/adds air to the vacuum tube.

Lab 8B

This lab requires the number in QW1000 to be modulated between two numbers to open and close the gripper. The numbers and command to open and close must be determined by trial and error. There must be a ramping of the numbers between the open and close values in order to move the gripper gradually instead of in a jerking manner. The speed of the move should be a variable controlled by the program.



The time to close and time to open should be programmable and controlled. The speed at which these grippers close should be a variable in the program. The signal is wired as shown below.

From the Hitec Manual:

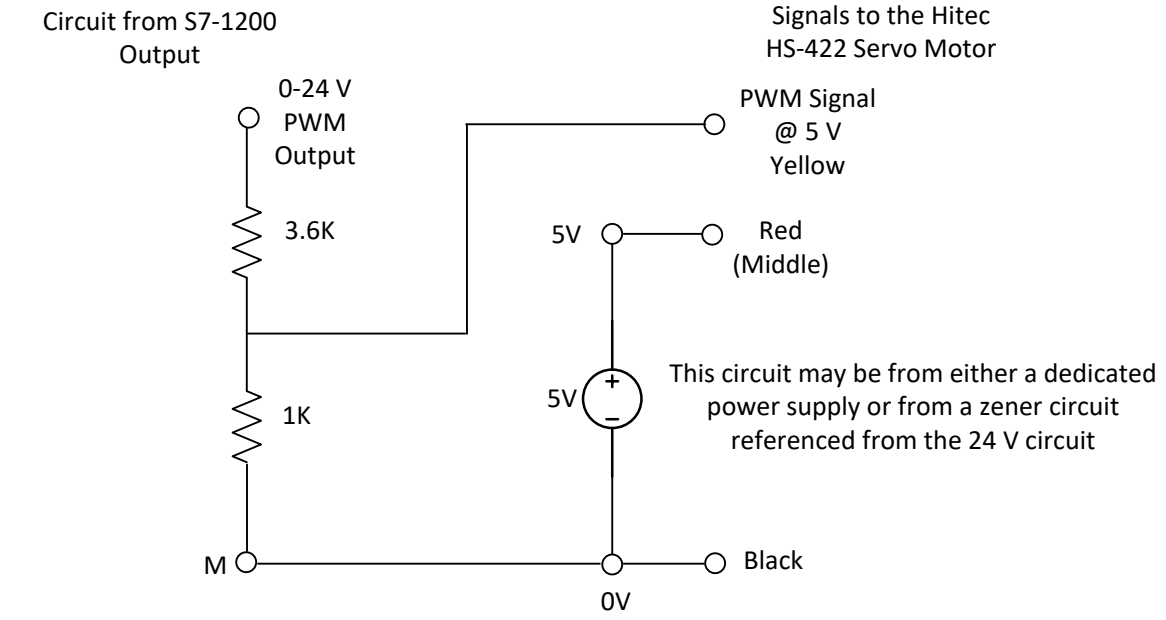
Pulse Data
All Hitec servos require 3-5V peak to peak square wave pulse. Pulse duration is from 0.9mS to 2.1mS with 1.5mS as center. The pulse refreshes at 50Hz (20mS).

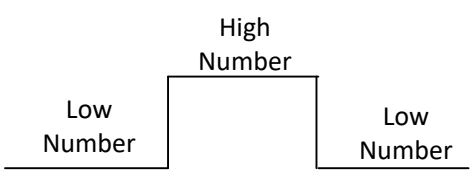
Voltage Range
All Hitec Servos can be operated within a 4.8V-6V. range.
Only the HS-50 operates exclusively with 4 Nicad cells (4.8 volt).

Wire Color Meanings
On all Hitec servos the Black wire is 'ground', the Red wire (center) is 'power' and the third wire is 'signal'.

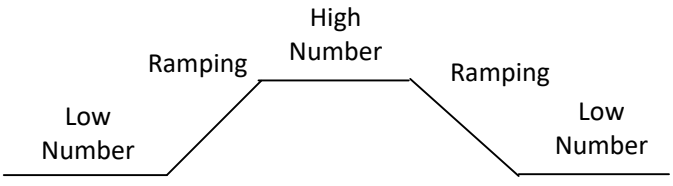
Direction of Rotation
All Hitec servos turn Clockwise direction (CW)

The circuit below shows the electrical connection and design to be used in the program for controlling the two grippers:



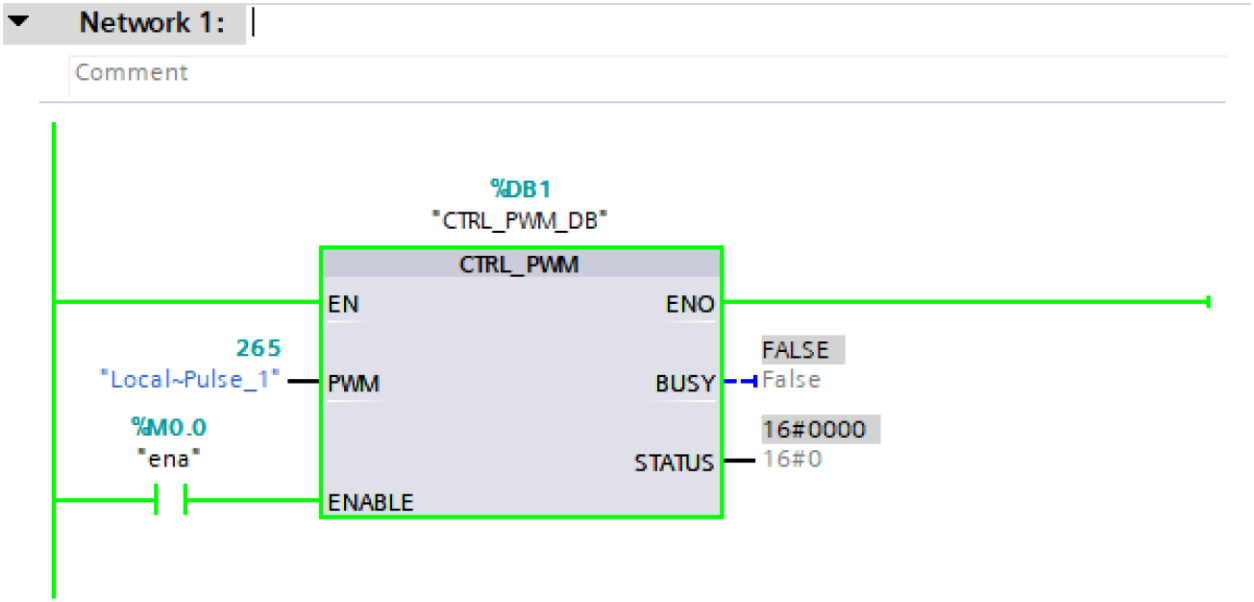


Circuit for Vacuum Gripper

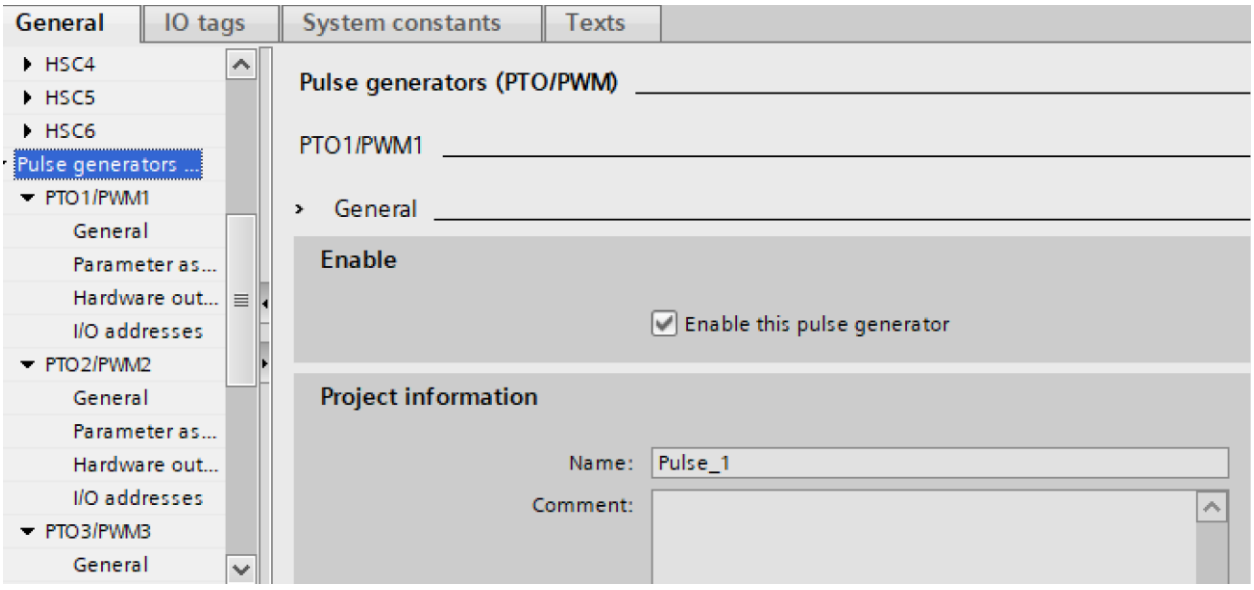


Circuit for Hand Gripper

The following figures outline the method of setting up the PWM output for the PLC and servo. The next figure shows the PWM instruction which must be added to the program. It may be inserted in any OB that is active. This instruction is inserted in OB1.

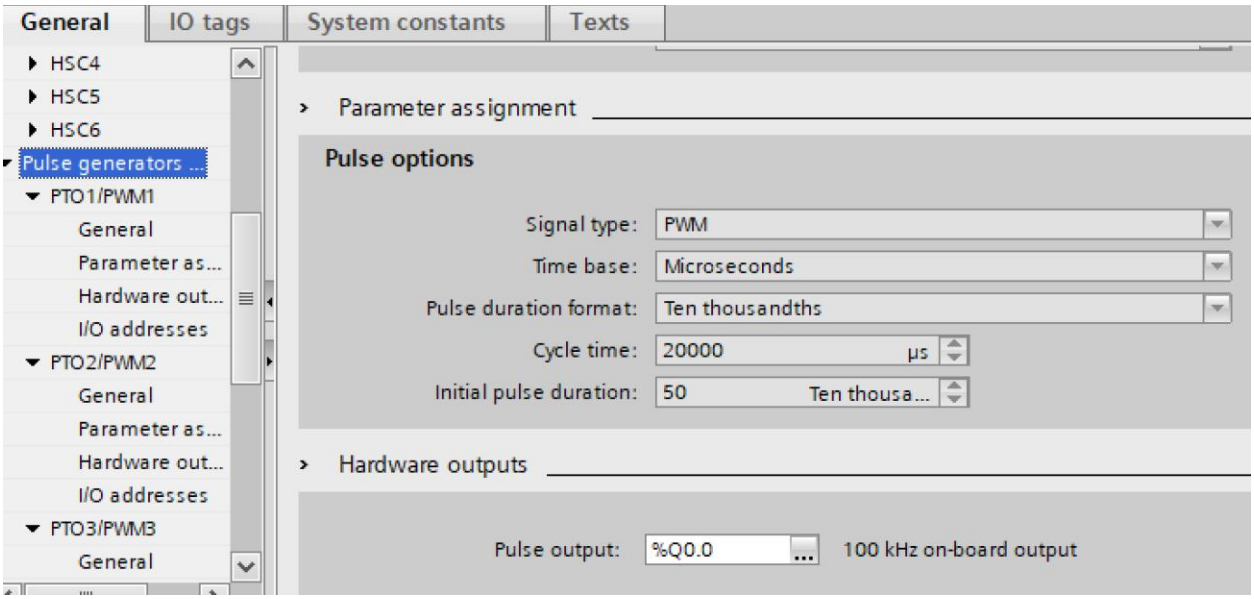


The configuration of the PWM for output on output 0.0 for the above servo is as follows:

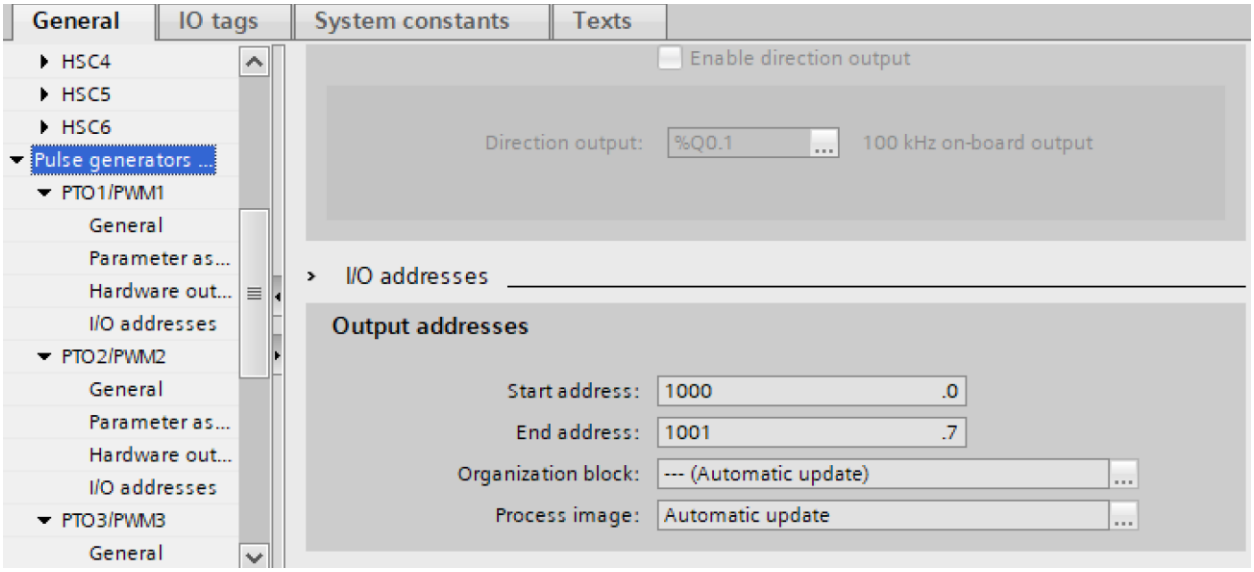


This must be done before the program is loaded and run. It should also be saved before running.

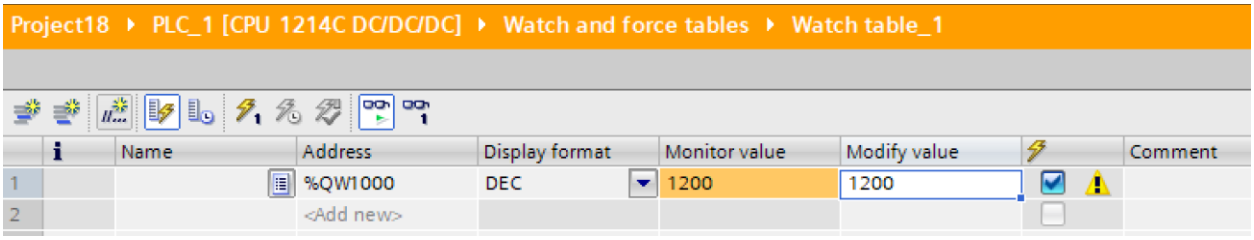
The following sets up the pulse duration for the servo above that requires a pulse duration of 20 msec.



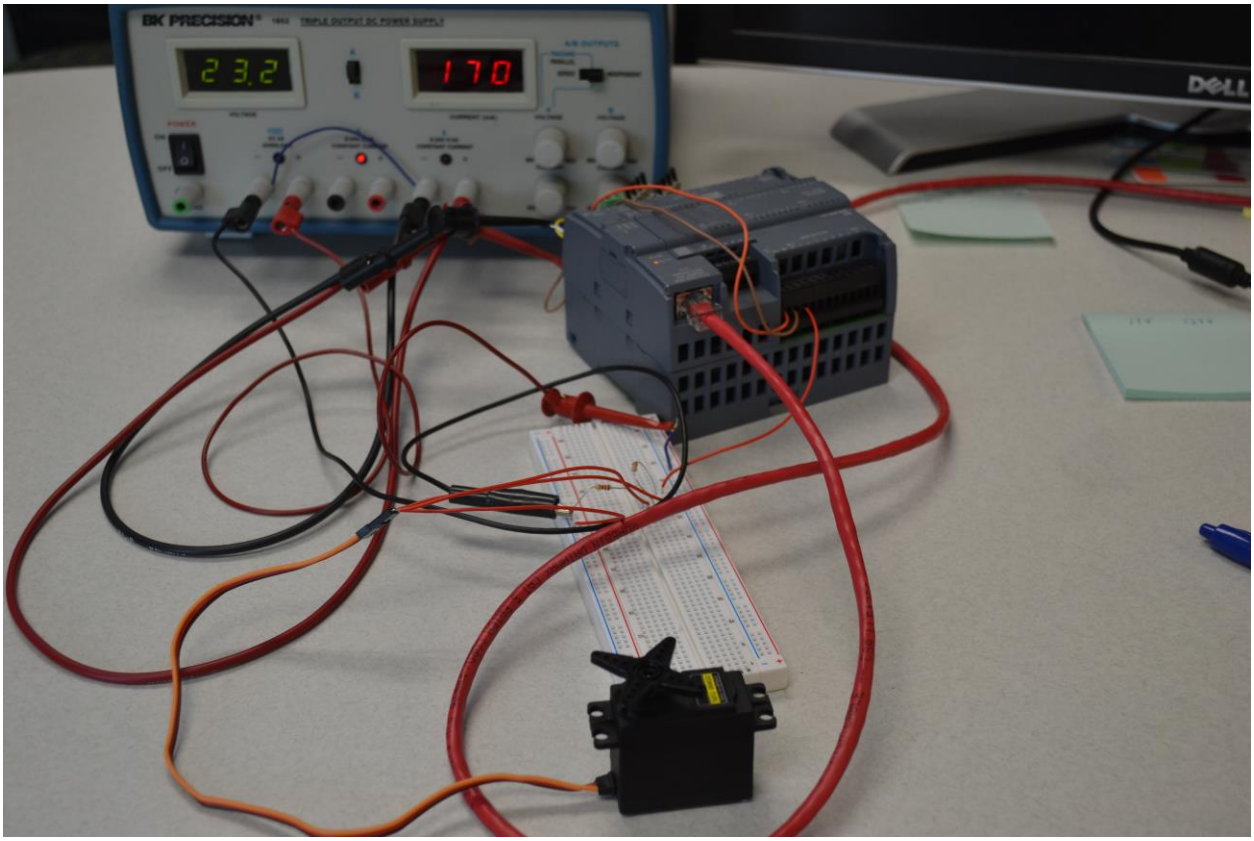
The following sets up the output word for entry of the pulse length in QW1000 (includes 1001):



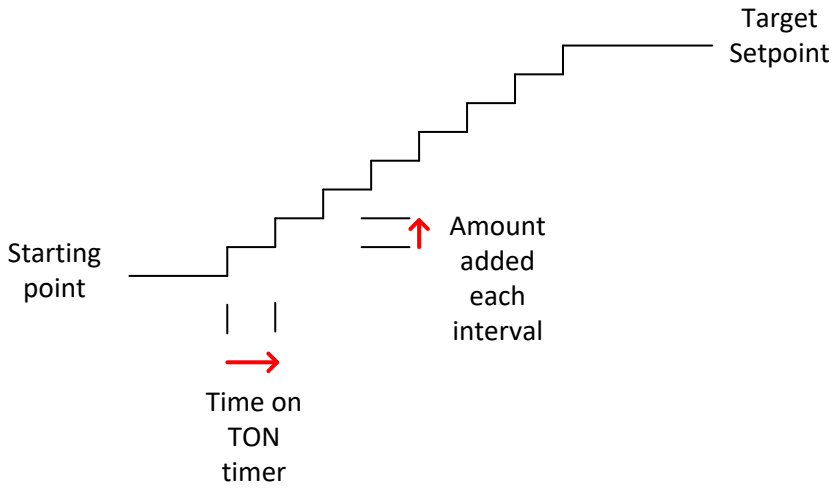
The above initialization allows the user (program) to input values in the QW1000 location to test the servo using the Watch Table:



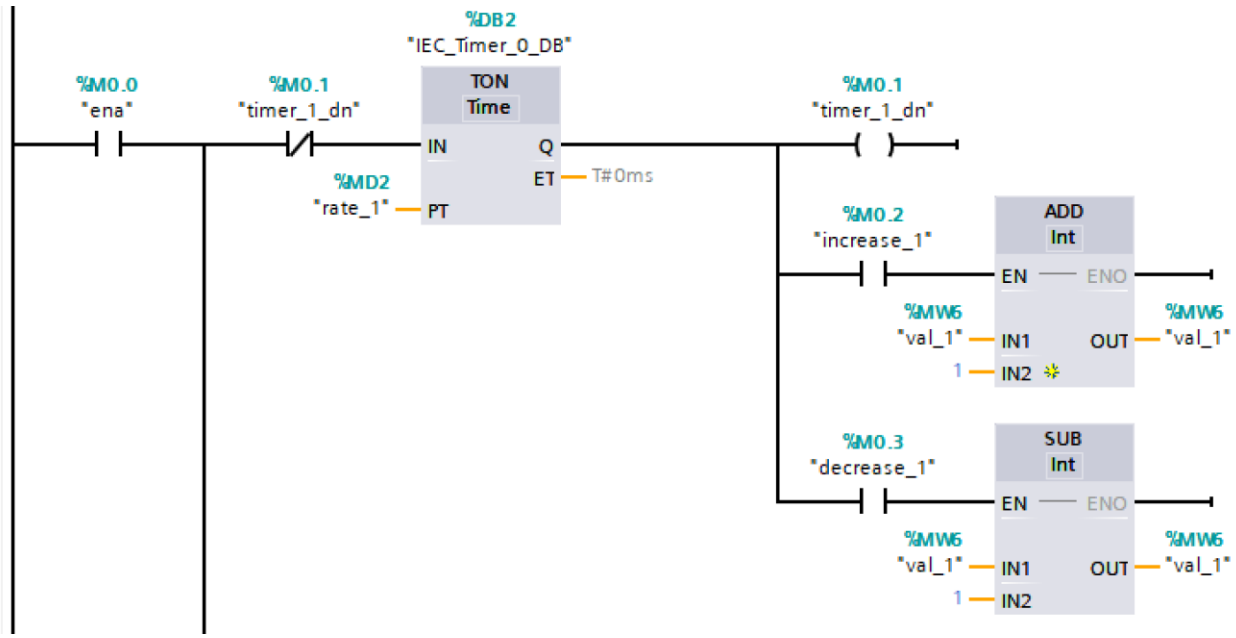
The experiment concludes with the values for the limits of QW1000 found. Completely clockwise is 175 and completely counter-clockwise is 1275. The servo ranges from 0 to 180^{o} in the process. The power supply shown is a good way to provide the +5V and +24 V to the process. This power supply has a variable supply A and B that can be set to close to +24 V.



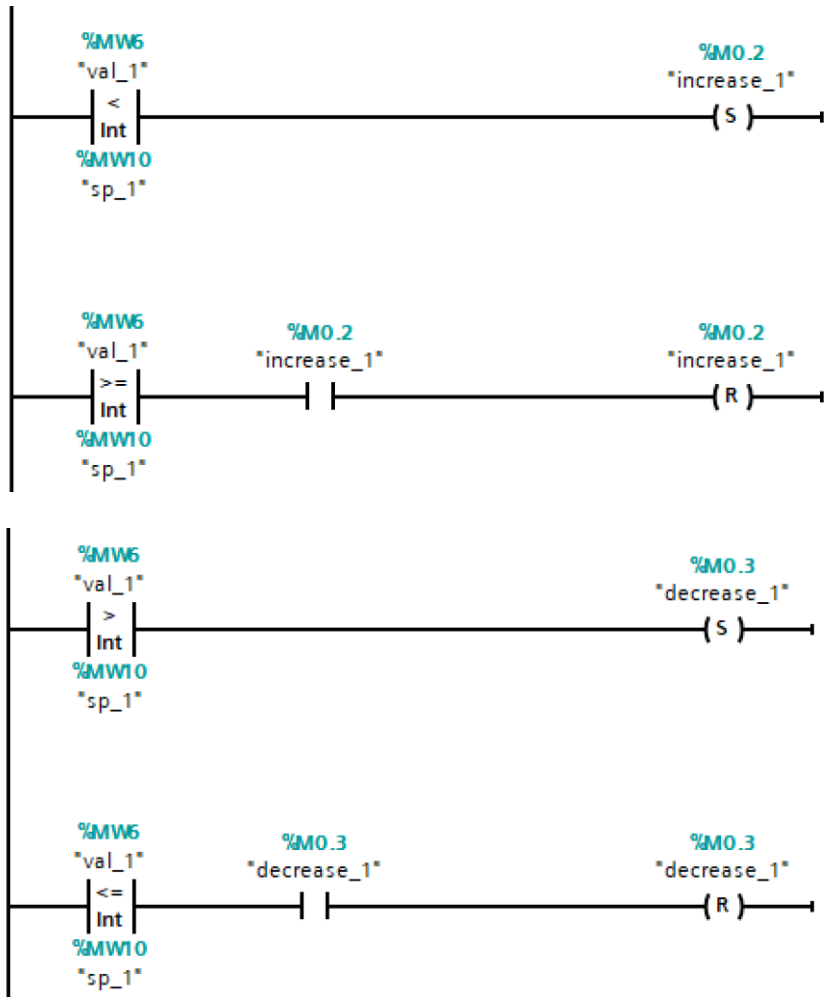
To add the ramp function, consider the program following. It ramps the value up or down from a present value to a target setpoint.



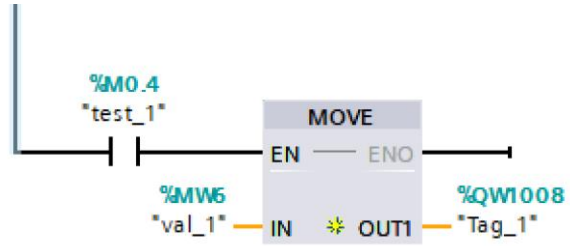
The 'ena' bit must be set on for the ramp function to operate. When the setpoint 'sp_1' is less than the present value, the 'decrease_1' bit is set. When the setpoint 'sp_1 is greater than the present value, the 'decrease_1' is set. The value added per this program per interval is 1. This may be 2, 3, or another step value. You need to try various time intervals and step values to find a combination that works best in your application. The ramp will move up or down based on the combination of the two values.



These rungs set the ramp to either increase or decrease:



The following rung moves the value out to the PWM word. In this example, the output is QW1008. You need to verify what word is appropriate for your application.



The next lab will be discussed in Ch. 13 of the text and Ch. 31 of the Lab Text. The servos discussed here are used in a robotic application to move the axes of a robot to automate an operation.