

Syringe Dispensing/Changing Machine Project

ENGR 480

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## Instructions

Once the machine has been set up by a licensed technician, operation follows simple procedures.

### Loading the machine

The syringe dispenser system is loaded with syringes at the top of a gravity-fed railing slide, with room for up to five syringes on the railing upstream of an air cylinder gating mechanism. Once the syringes have been loaded, move on to starting the machine.

### Starting the machine

To begin operating the machine,

1. first check that the machine is plugged in and receiving power. This shouldn't be an issue as there is no reason for it to be unplugged.
2. Once the power is on, check that the PLC is set to the off position so as to not start the program immediately on the following step.
3. release the E-stop switch to allow power to enter the stepper drives and the air cylinders
4. Once the user is ready to begin the program, switch the PLC control from *off* to *run* enabling the machine to begin homing. The homing process allows the machine to predictably start at the same location. The machine will stop moving when it finishes homing and will wait for user input
5. The user must press the *magic* button for the machine to continue.

For further instruction on operation, see the section titled operation.

### Clearing Jams

The syringes, being non uniformly shaped, get caught during certain processes in the operation. See the table below for diagnosing and potential solutions.

<i>Symptoms</i>	<i>Likely Problem</i>	<i>Potential Solution</i>
Syringe does not slide to orient	Aluminum extrusion is at too shallow of an angle	Try readjusting the angle, if too shallow, friction will overcome.
Syringe impacts the syringe orientating chute	The aluminum extrusion is at too steep of an angle	Try readjusting the angle, if too steep, the syringe will have too much speed as it impacts the chute.
Syringe does not drop in to the rotating plate	This is a distance issue, the syringe needs to be closer to the rotating plate so as to fall a shorter distance	Short term – manually place syringe into rotating plate, continue the operation. Long term – Redesign the chute system to be lower and closer to the rotating plate.
Lever arm is not moving	Leadscrew is caught between	Adjust the aluminum seesaw

	slot in aluminum seesaw	and the motor should continue rotating the seesaw.
Syringe is not ejecting	Syringe is caught between aluminum extrusion and rotating plate	Push the syringe out of the rotating plate to allow it to fall into the ejection rail.

## Operation

### *Loading Rail:*

Full syringes are placed into the top of the loading rail and rest aligned against the double air cylinder gating mechanism. To load a single syringe into the dispensing arm, the gating mechanism allows the syringes to slide forward by releasing its first air cylinder and isolates the lead cylinder by reactivating the air cylinder to block off the rest of the loaded syringes. A sensor placed in between the air cylinders determines that a syringe has been fed into the gated slot. Then the second air cylinder is released, allowing the isolated syringe to slide forward on its own. At the end of the load rail is a syringe orienting chute, which forces the syringe tabs to point perpendicular to the dispensing arm before dropping the syringe into a slot on the rotating syringe slot plate below.

### *Rotating Syringe Slot Plate:*

The rotating mechanism of the project is a rotating syringe slot plate made of 3-D printed plastic that is mounted on top of a hollow square aluminum extrusion tube and under the dispensing lever arm (see Figure 5). Its purpose is to catch the falling syringe from the loading rail and rotate to dispense the syringe a desired amount and to release the now empty syringe onto the ejection rail. Each rotation is done in 90 degree turns. It is controlled by a stepper motor which is placed inside the square tube. A hole is drilled into the center of the plate to allow it to fit onto the stepper motor. A pinning screw is also drilled through the side of the part, touching the lead screw of the motor to allow complete synchronization of the part and the motor. A proximity sensor is placed near the plate to sense its initial position for proper calibration of the syringe slots.

### *Dispensing Lever Arm - Seesaw:*

The lever arm is a aluminum plate that has been cut to size and fitted with a slot to allow the leadscrew of the motor to run through it. The mechanism works by powering the motors which cause the leadscrew to rotate, that rotation is translated to linear motion by way of a thread mounted nut that gets pushed up or down depending on the rotation of the leadscrew. This then translates to the seesaw rotating about its fixed axis and either pushing down on the syringe, or moving up to provide clearance.

### *Ejection:*

The rotating syringe slot plate rotates an empty syringe into a funnel that pushes it from the plate slot and drops it into the ejection railing below. The empty syringe drops through and slides to a stop at the end, where it can be removed and refilled to be used again.

## **Maintenance**

Make sure that all screws and bolts are properly tightened to their respective parts. Keep the software that runs the program up-to-date. Make sure that the air pistons are properly fastened. Check the tubes that are connecting to the pistons for wear.

## **Suggestions for Future Improvements**

Further design iterations are needed for both the syringe orienting chute and the rotating syringe slot plate; in order to guarantee a successful transition between the two of them.

Finish designing an ejection railing system such that another syringe-orienting chute is attached to the side of the metal block under the rotating syringe slot plate to catch the falling empty syringe, which will in turn direct this syringe to the ejection rails.

## **Performance Data**

The air cylinders were able to predictably singulate the syringes for the machine to use. As designed, the timing is automated and allows the syringes to move through as it should.

## **Mechanical Drawings/Annotated Photos**

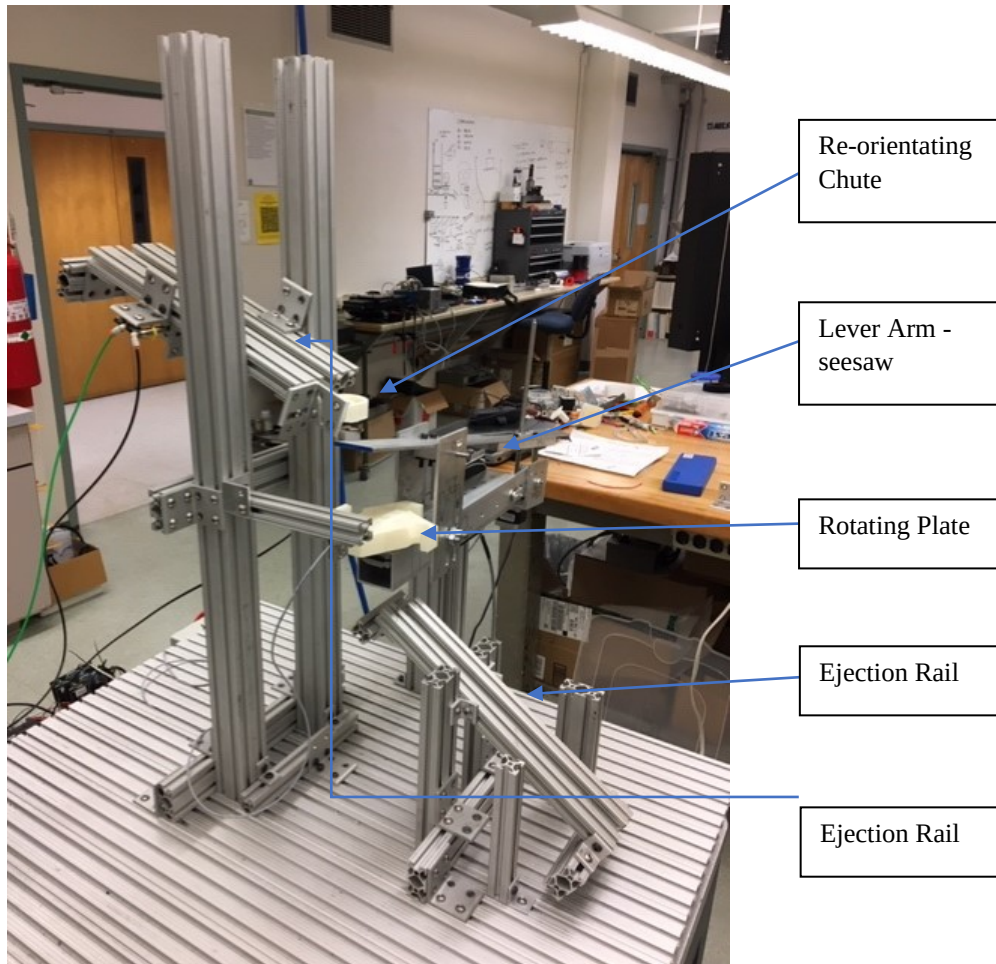


Figure 1: Entire assembly

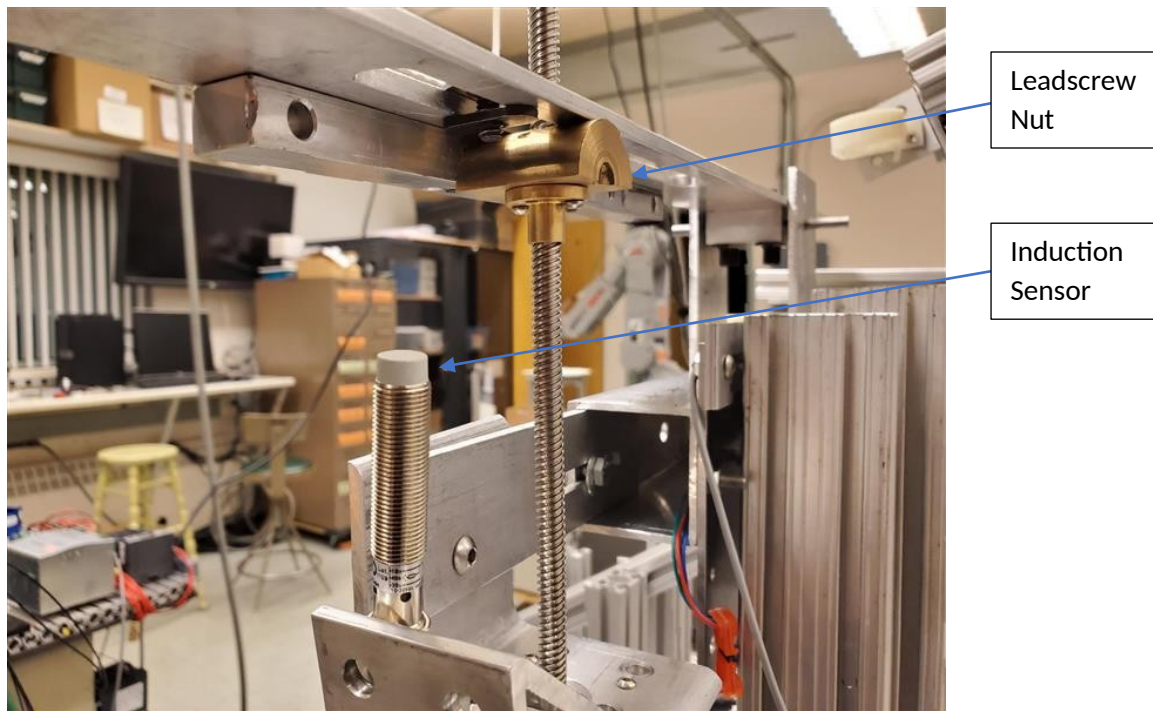


Figure 2: Dispensing mechanism



Figure 3: Syringe leaving the rotating mechanism



Figure 4: Syringe entering the syringe-orienting chute

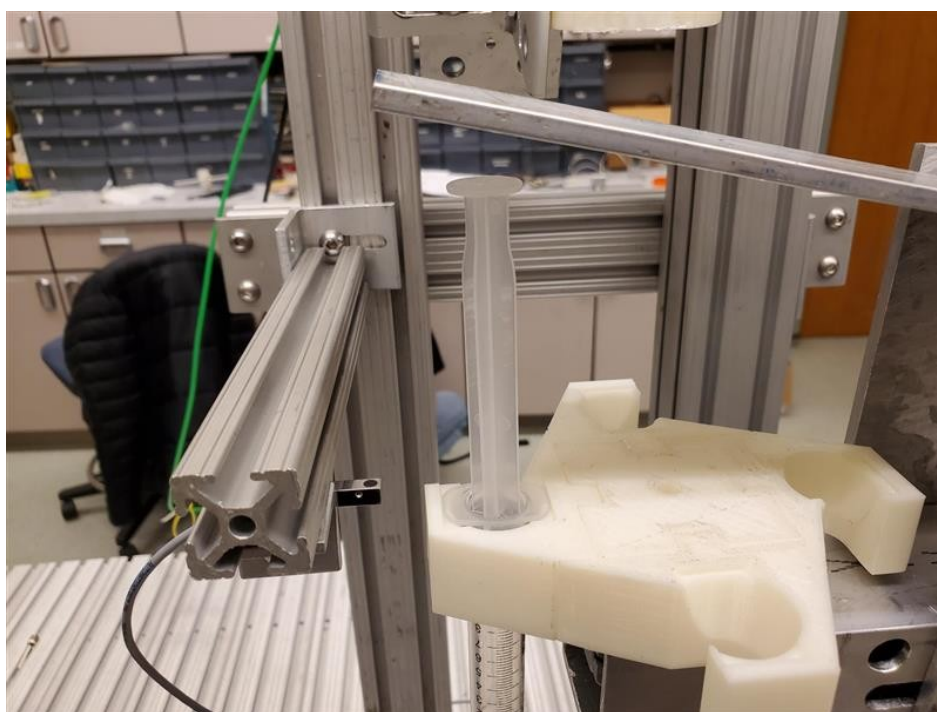


Figure 5: Dispensing of the fluid in the syringe





Figure 6: Syringe in the first position of the rotating mechanism

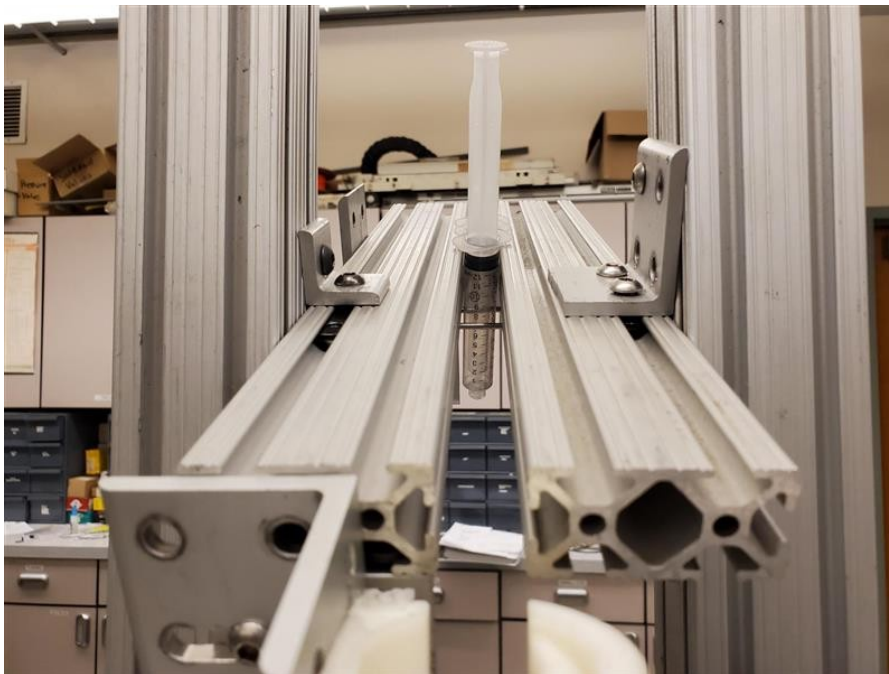


Figure 7: Initial position of the syringe at the loading stage



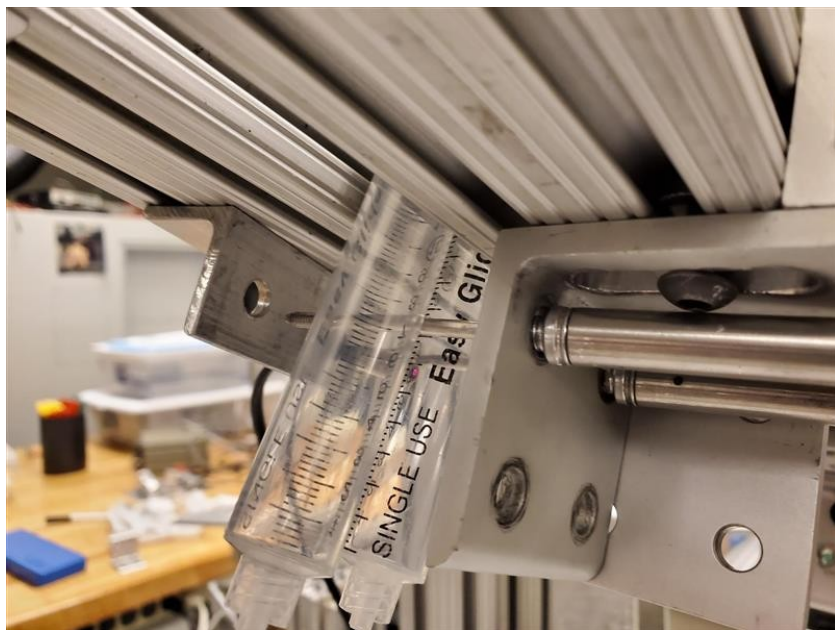


Figure 8: Pistons holding the syringes in place at the loading phase

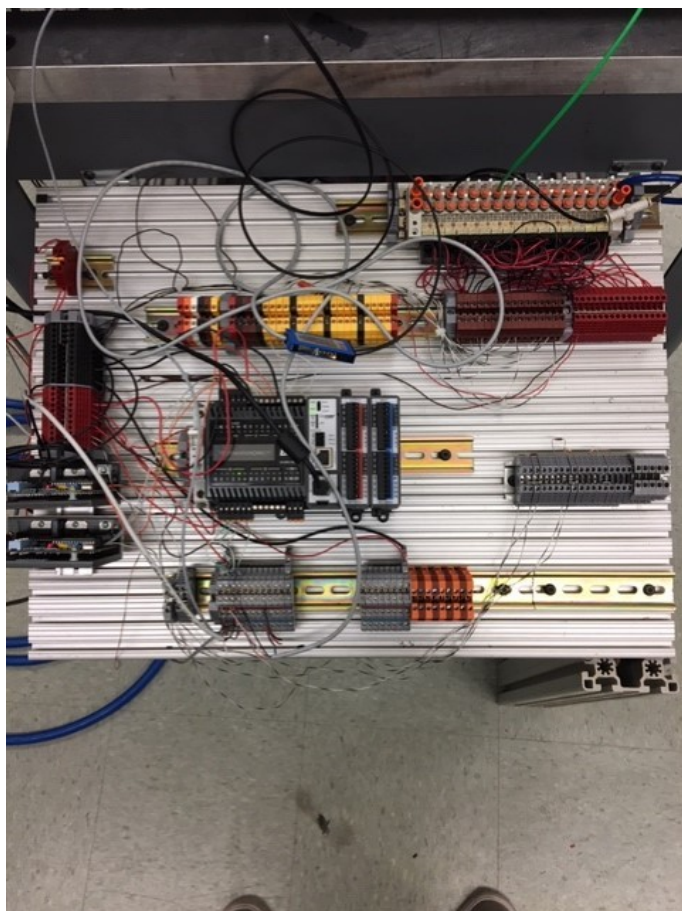
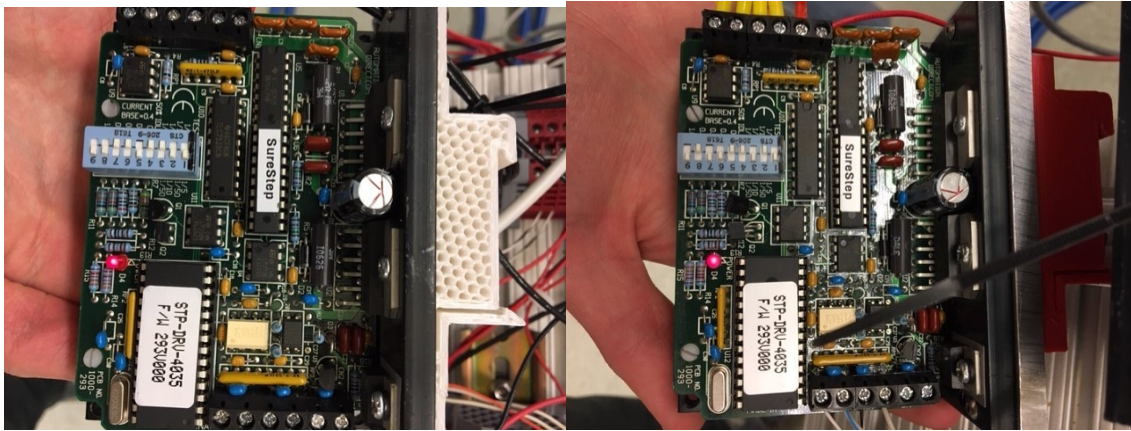


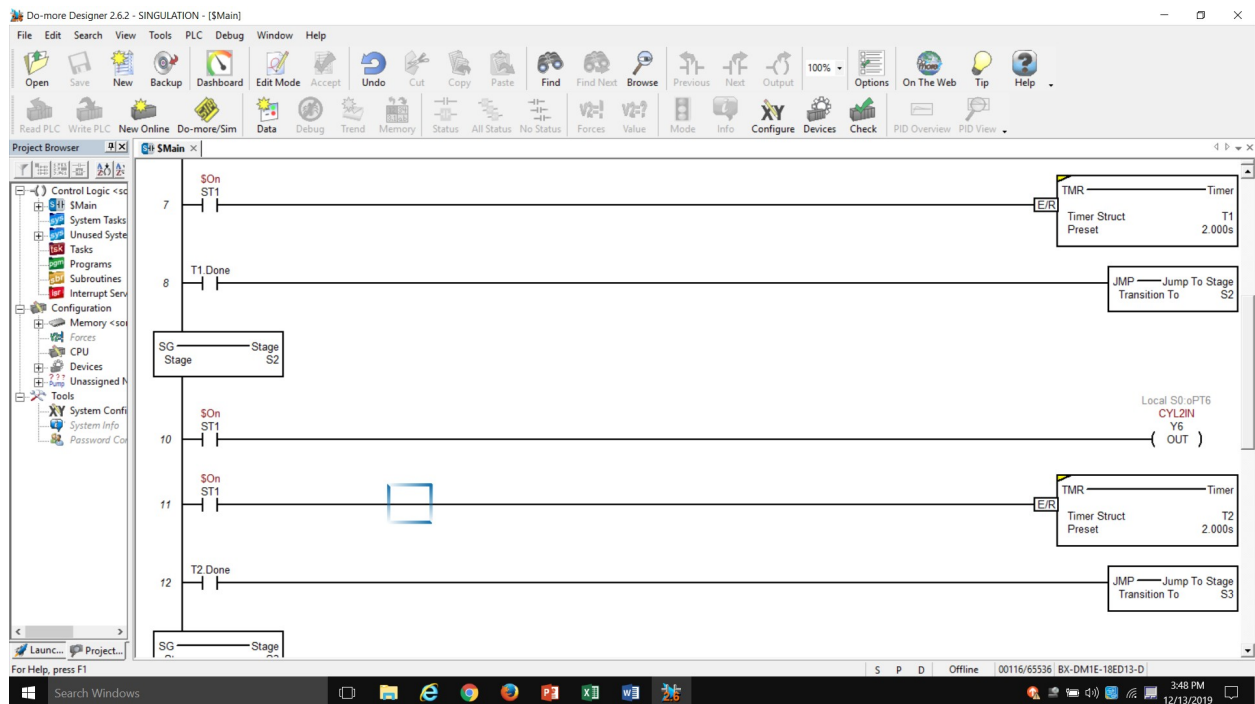
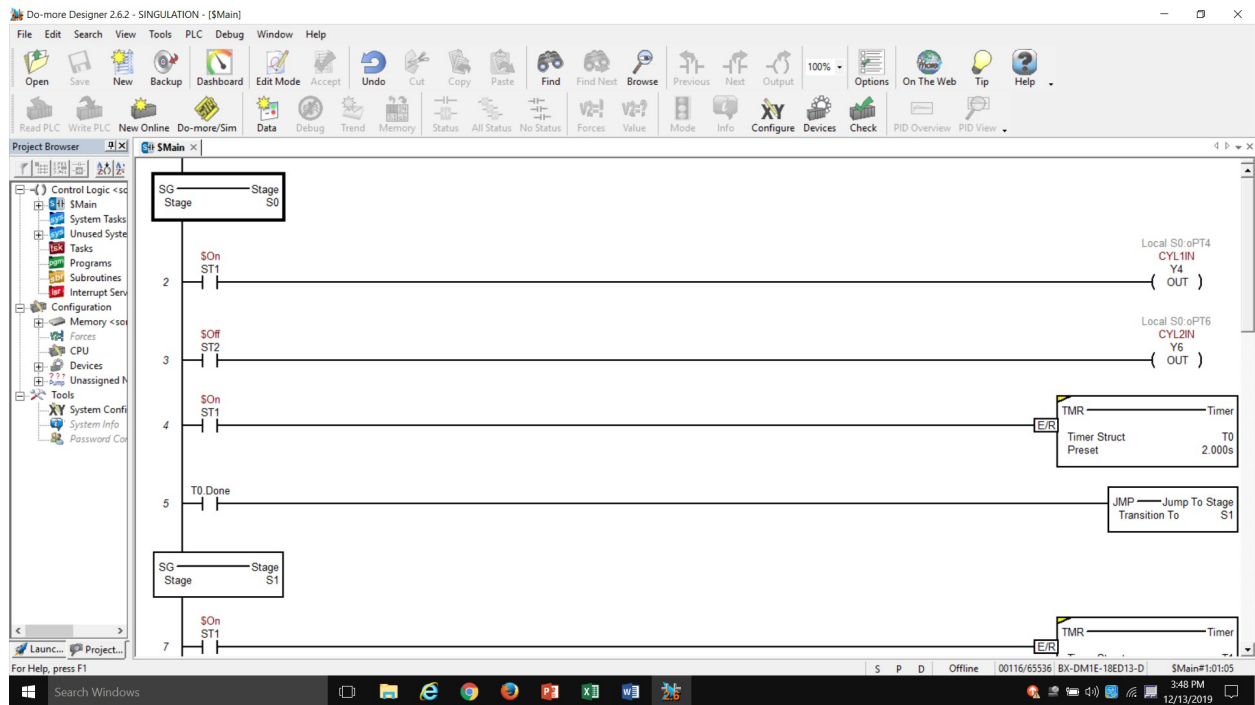
Figure 9: PLC and wiring setup

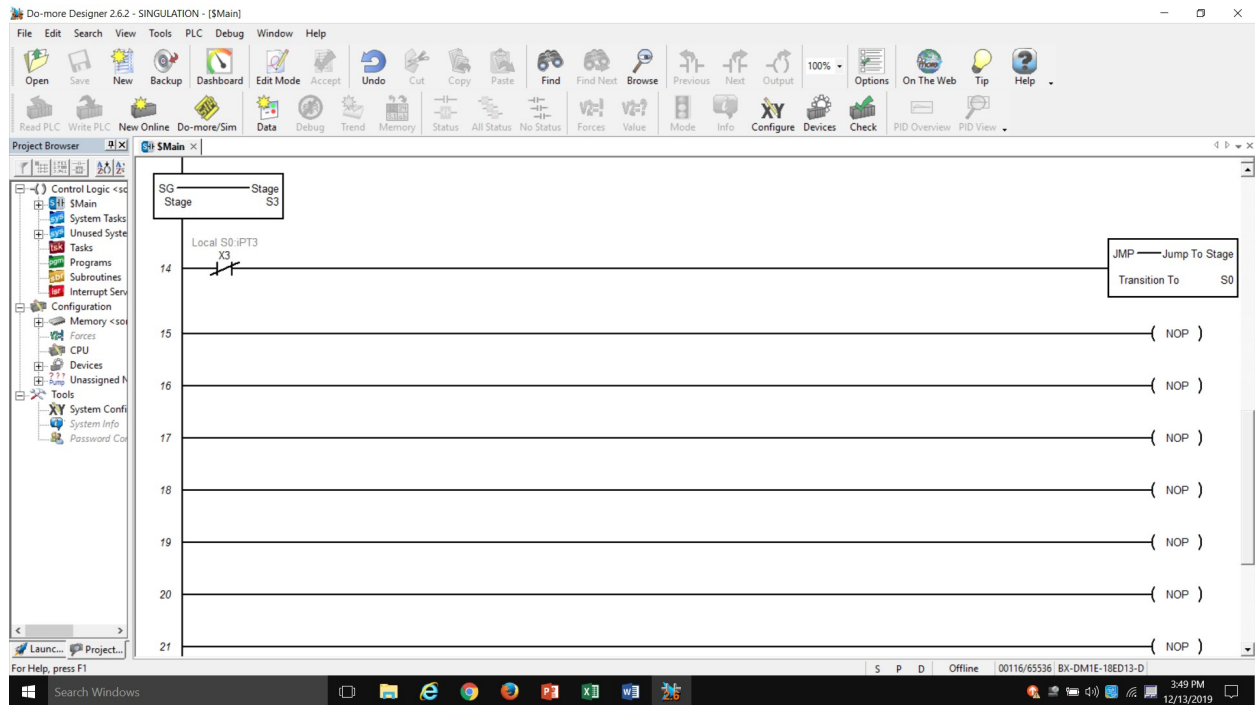


Figures 10 and 11: Stepper motor drives

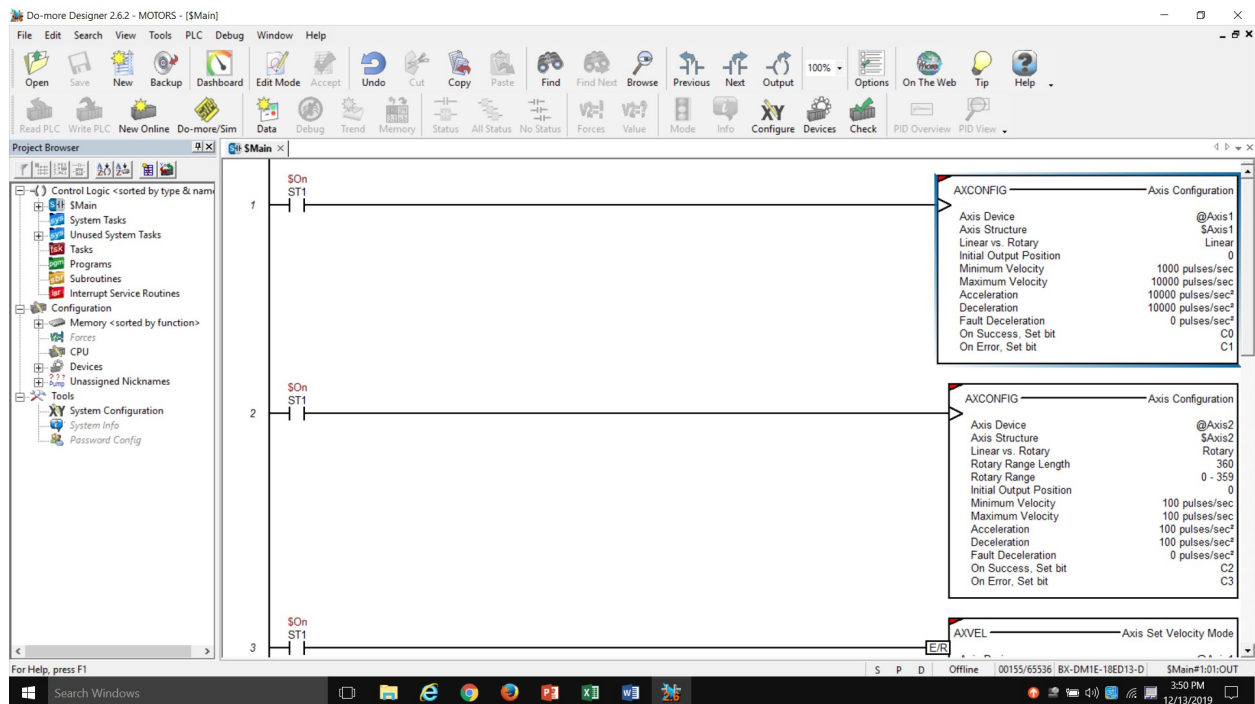
# PLC Ladder Logic (with element labels and rung comments)

Title: SINGULATION

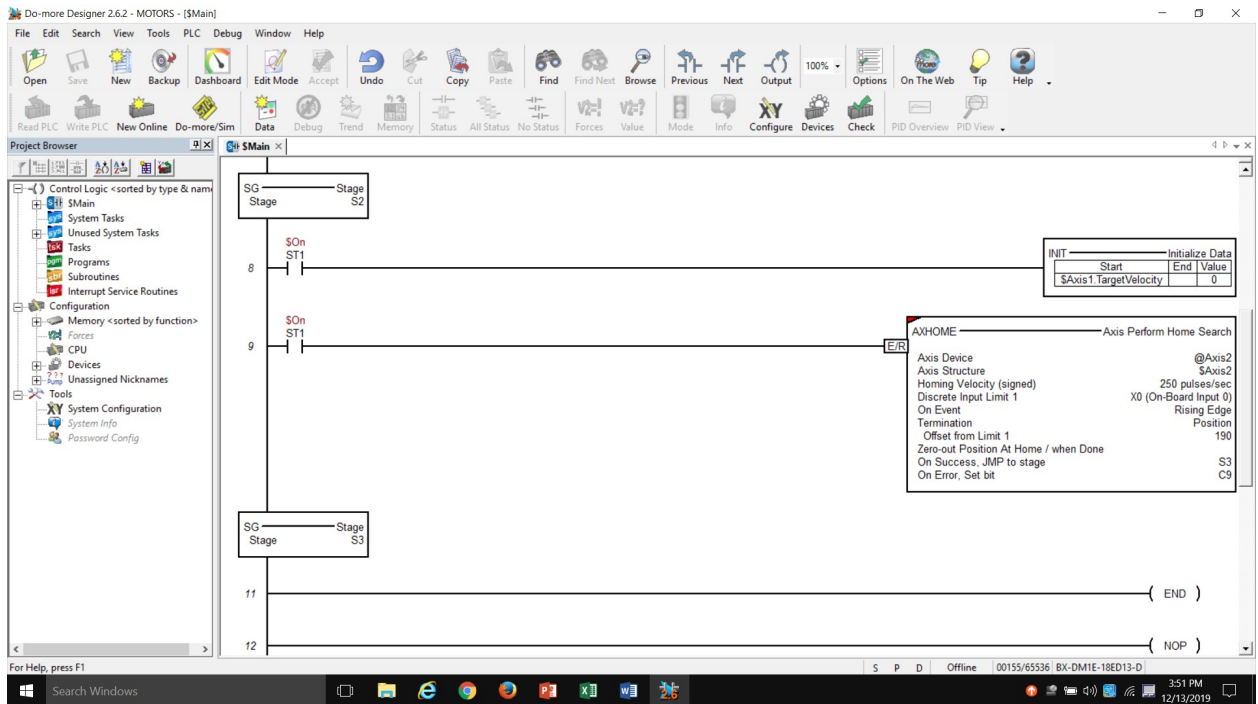
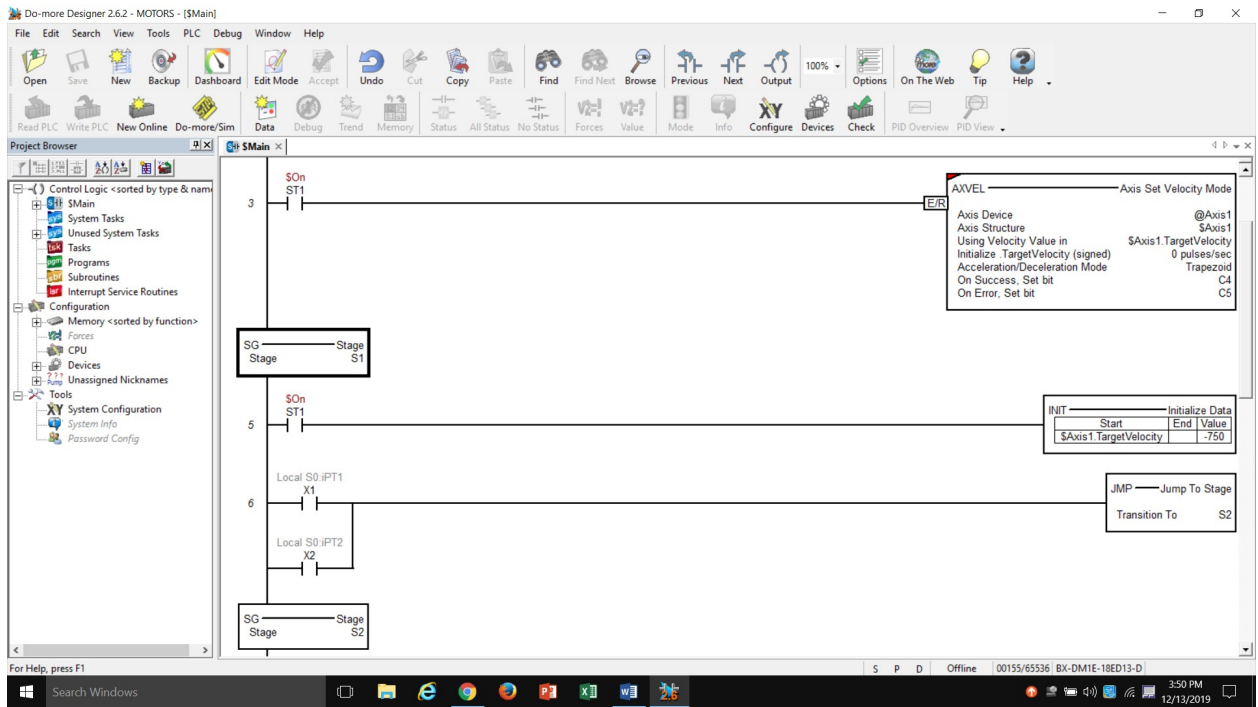




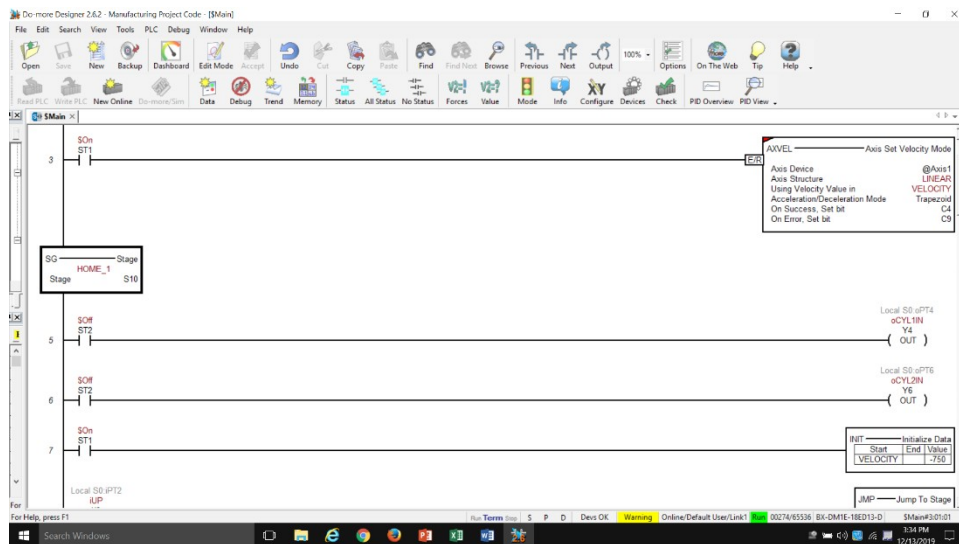
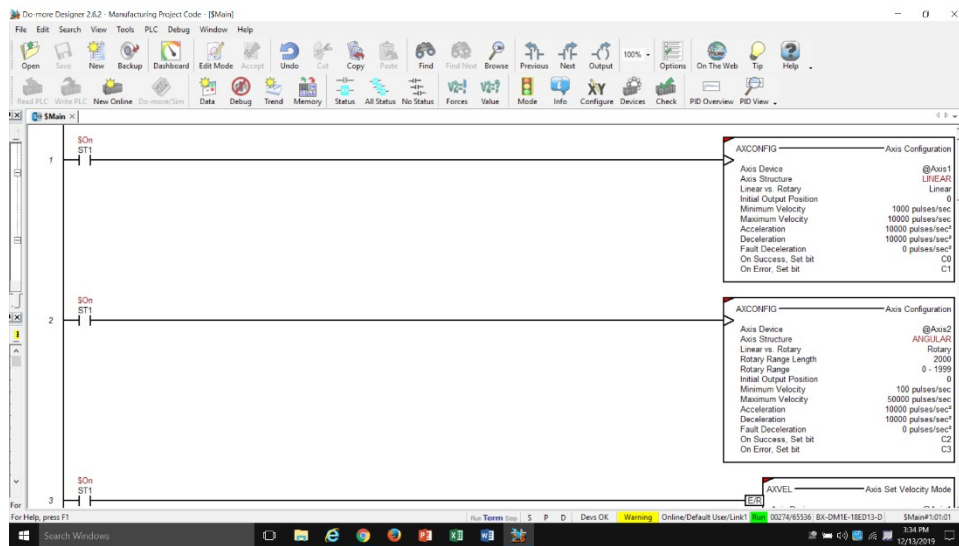
## Title: MOTORS



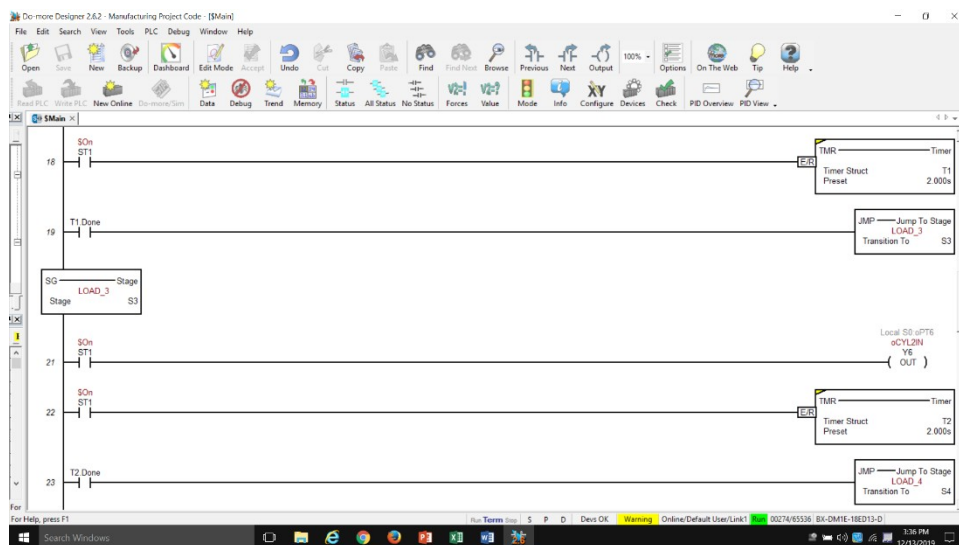
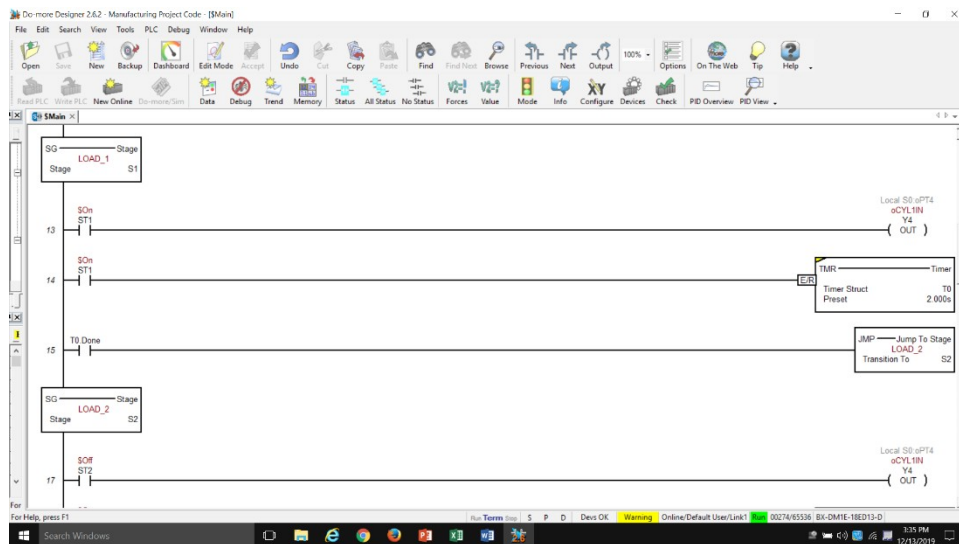
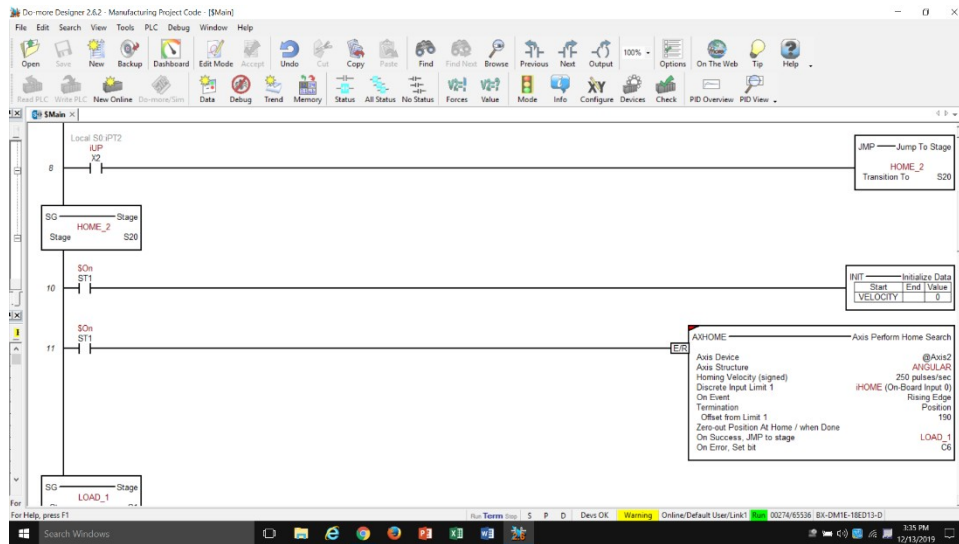


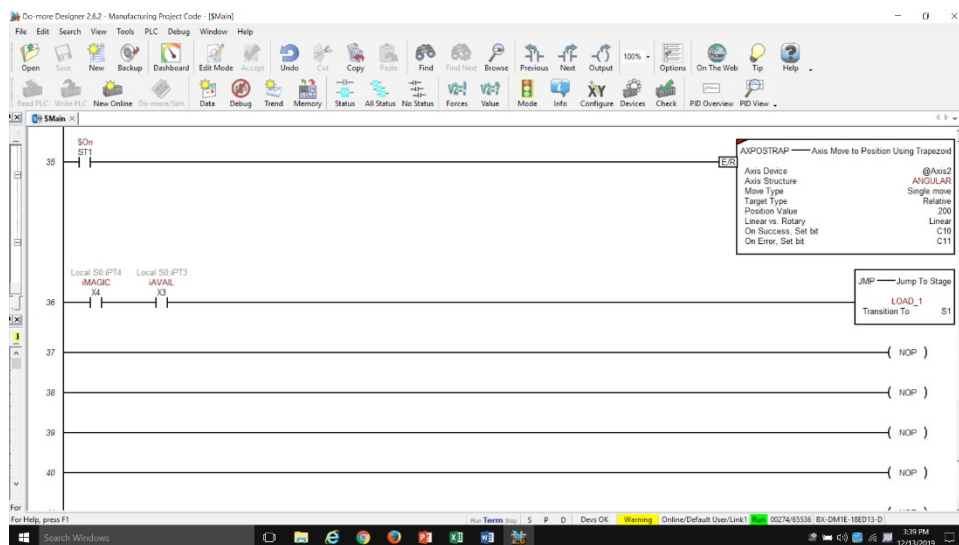
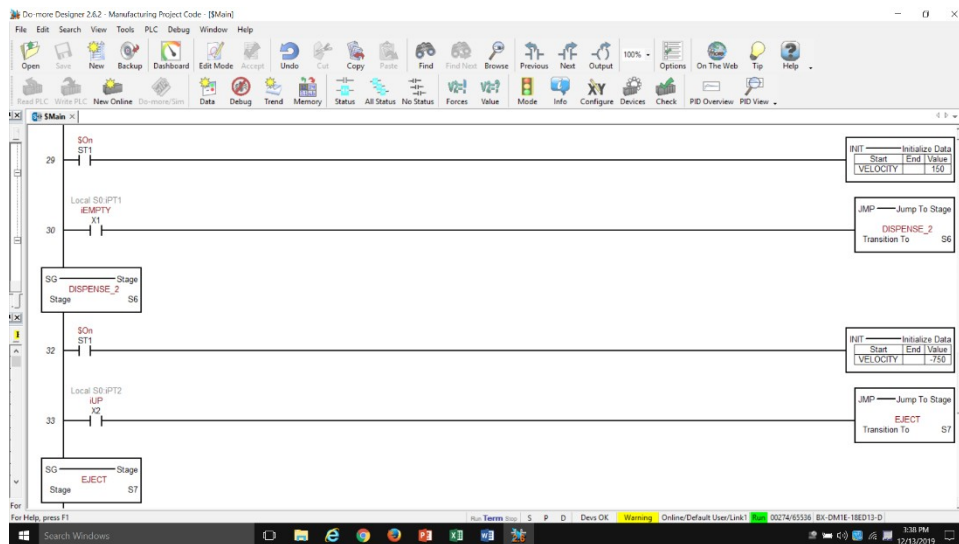
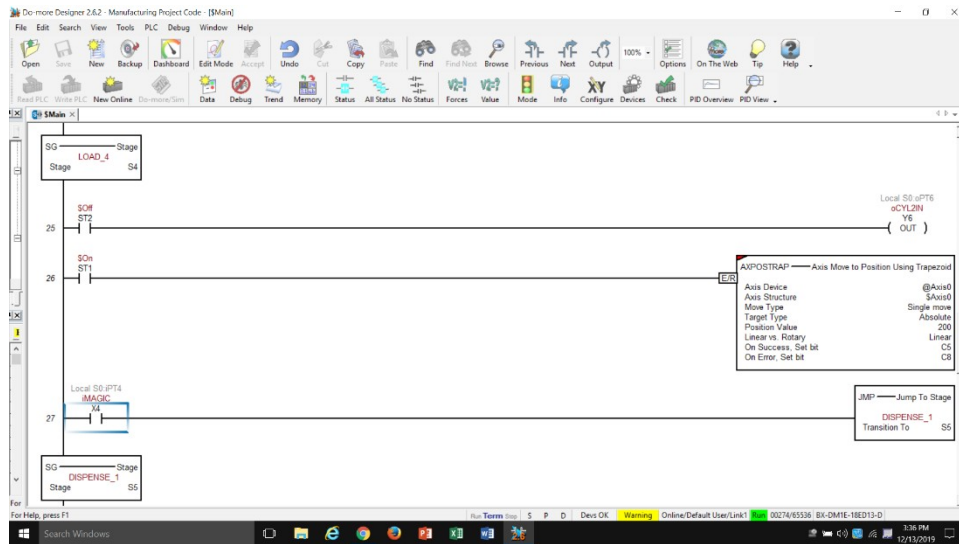


Title: Manufacturing Project Code (SINGULATION and MOTORS both included in this code)

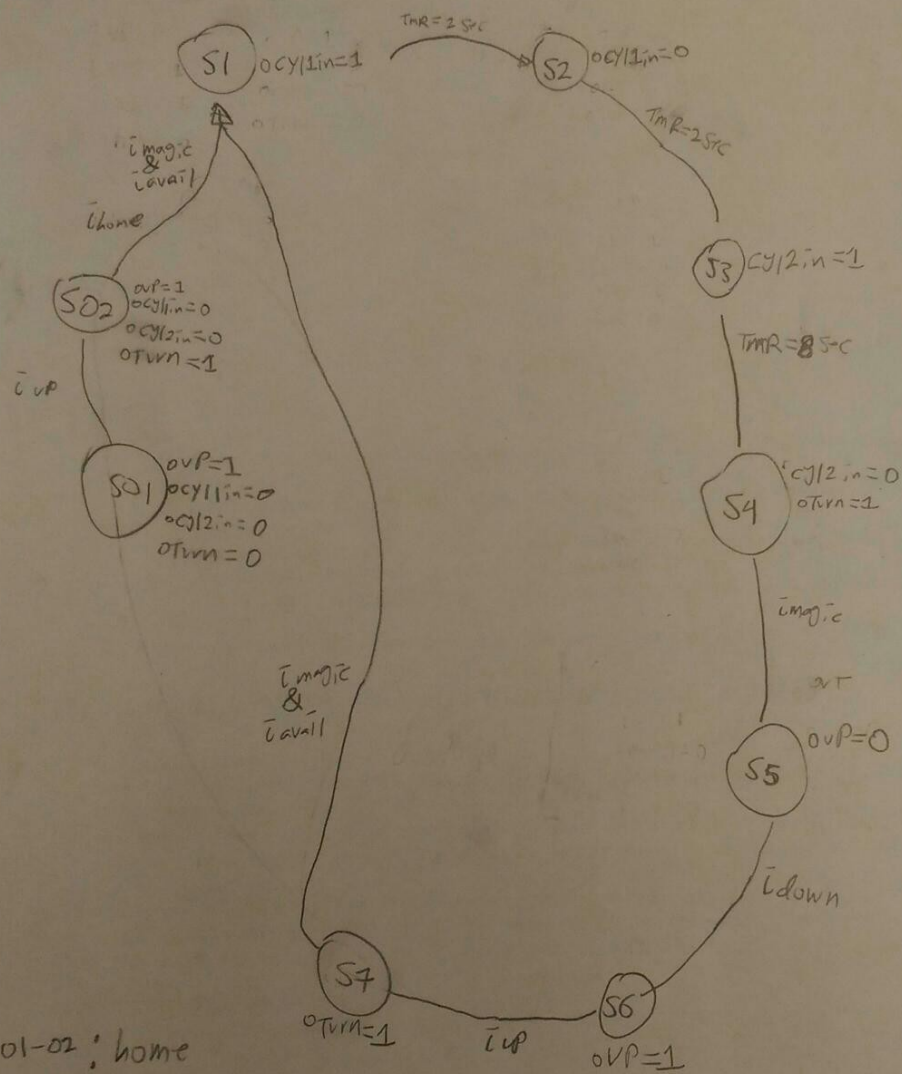








# State Machine Diagram(s)



01-02: home

1-4: load

5-6: Disperse

7: eject

Wiring Diagram with Stepper Motor Drive Configurations

