Springfield Technical Community College

ELEC-485 Final Report

Gatorade Bottling System

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One Armory Square • Suite 1 • PO Box 9000 • Springfield, MA 01102-9000
p. 413-781-7822
f. Fax # 413-755-6344
pjchouinard@student.stcc.edu
https://www.youtube.com/watch?v=4WKfH-kh4ck&feature=youtu.be

Instructor

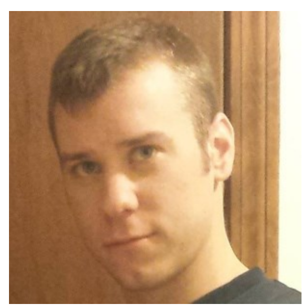
Richard Jagodowski

The Team:

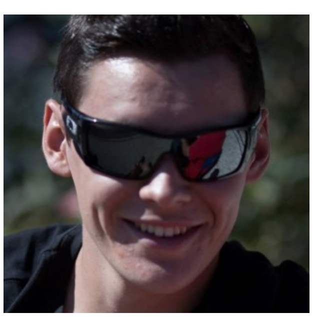
Wesley Kulig

Nate Sansoucy

Austin Holzhauerad



Adam Frederick Gay



Ryan Lombardini

Peter Chouinard

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Introduction

Gatorade bottling system

In the beginning of the semester our group brainstormed a few different ideas as to what our final project would be, in the end we decided to try and create a bottling system. The Bottling system would have to fill, cap and pack Gatorade bottles. The basic design started with a turn table with four stations the first being where the empty bottles would drop in. The second station was the filling station, third was the capping and then the four was were the bottles would slide through the table via a PVC pipe to the packing system.

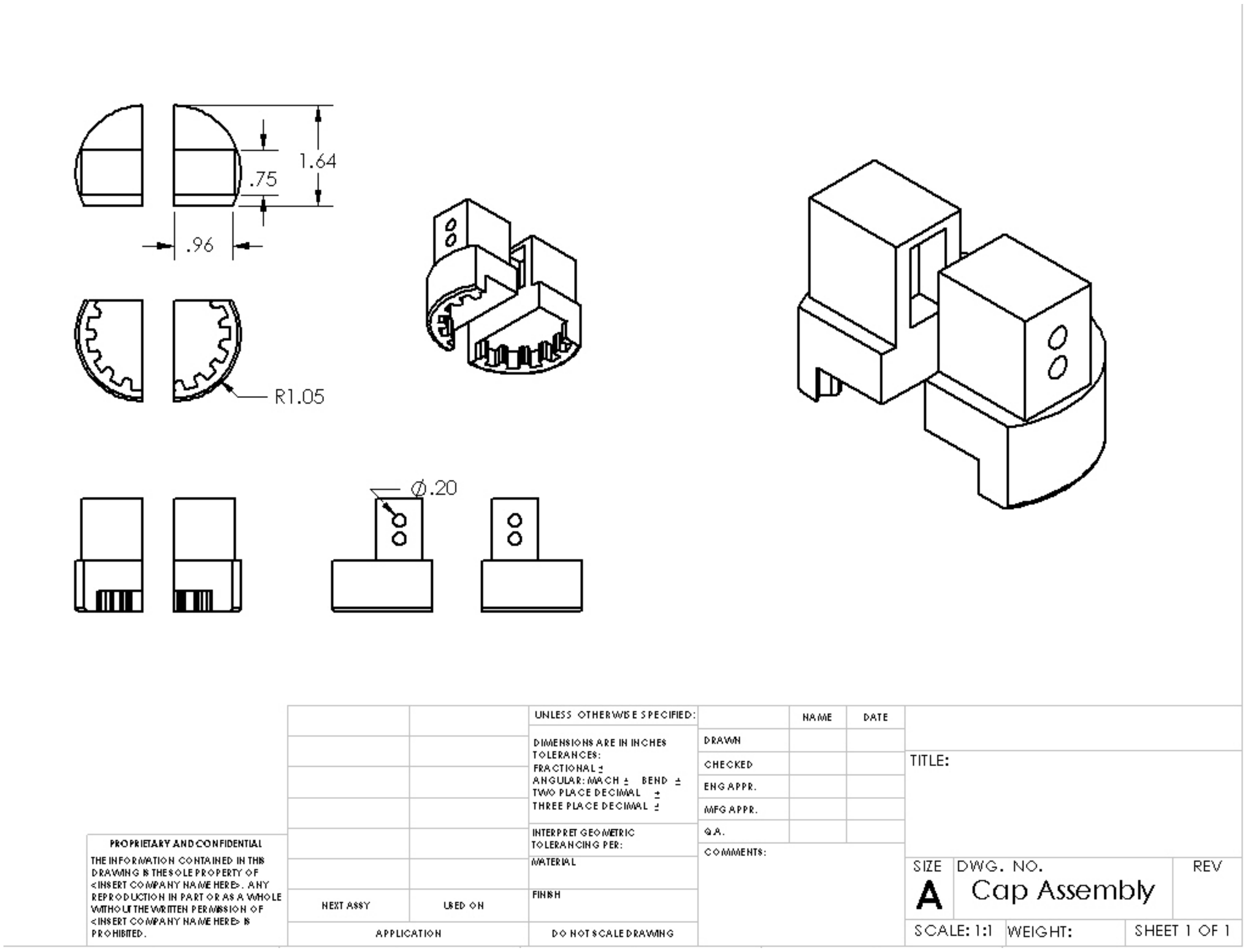
Objectives

- Program PLC/Robots
- Wire various components exp. Screw Drive, Pump, BS2 board, PLC and Relay Board
- Build: Bottling delivery system, Turn Table, Filling system, Capping System, and Packing system.
- Interface all components

Individual Tasks

End Effector (Peter Chouinard)

Before the semester even started it was decided that I would create the end effector for the robot. Creating the end effector seemed like an easy task I knew at the beginning I would be using SolidWorks and the 3D printers to make it. The end effector went through many stages before the final design shown below was created. This component was key in the success of this project and was anything but easy to create.


1.64
.75
.96
R1.05
Ø.20
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
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Bottle Delivery System (Ryan Lombardini)

Ryan built this system at his personal residence, on his own time, with his own resources which I'm sure contributed to its precise construction. He used a small motor attached to a very long screwdrive which pushed the bottles down a long troth like system to the end there a pneumatic piston would push them down a PVC pipe to the turntable.

Bottle Packing System (Nate Sansoucy)

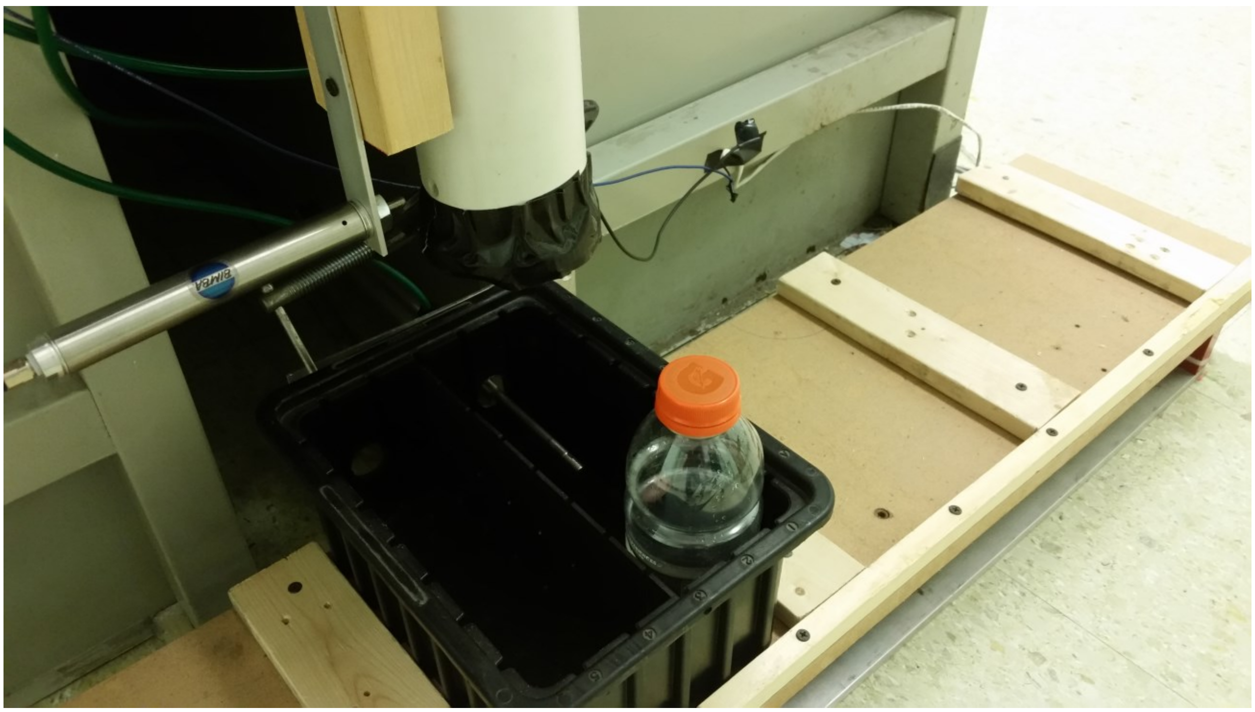
The Creation of the packing system began is Nate's decision to use the Pegasus Screw drive instead of a conventional conveyor belt. The Screwdrive could not be controlled through the Pegasus system without the accompaniment of the robot so in order to control the drive Nate used a BS2 program that ran through a relay board. Below is an explanation of what went into the building the packing system in Nate's own words as well as a materials list.

Building packaging process for bottles

I decided for this process to use the Pegasus Robot Screwdrive. At the beginning, issues unfolded as I realized I could not start the process until all the components in the project were set in place. Under testing, I found out that the screwdrive couldn't be controlled by the robot because of timing. Also, I couldn't add the steps needed into the robots process to be able to correctly control the screwdrive. I found difficulty controlling the screwdrive with a basic stamp board (external) and a relay board. I had to attach a board to the screwdrive so that the top would fit four six-pack holders (for the bottles.) I also used a pneumatic piston to center the bottles in the six-pack containers. Two pistons were used to drop the bottles down a tube for packaging. All of the materials for the packaging process were supplied. Overall, it took about a month for me to complete the process of building the packaging for the bottles. Here is a list of the materials I used for this part of the project.

Materials for building the packaging process

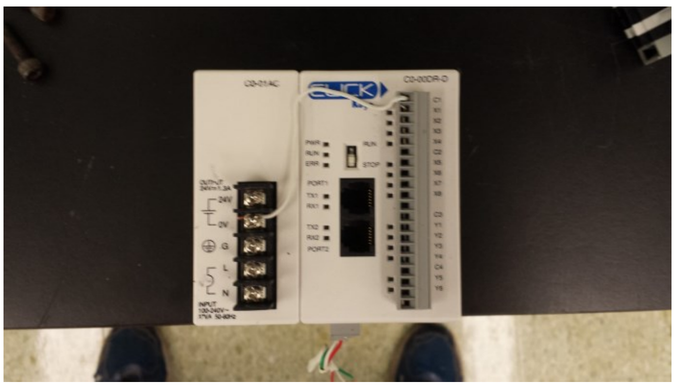
- Pegasus Screwdrive
- Containers that would hold six water bottles
- Parallax basic stamp board
- Parallax relay board
- Plywood 8 inch by 4 feet
- Screws
- Wire 18 gauge
- Computer for programming
- Piston for sliding bottles in the containers



Programming Stepper Motor, Programming Koyo Click PLC, Programming Pegasus II Robotic Arm, Interfaced all components (Adam Gay)

A vast majority of the programming was done by Adam our team leader. He put the time in to learn each program language in order to get the components to work together. Timing was the biggest issue when we got everything together all the different parts of the project worked great individually but getting them to work together took a lot of trial and error. Below is a list of Techniques use by Adam explained in his own words as well as a materials list.

Programming the Koyo Click PLC



Techniques used- The Koyo Click PLC was obtained through Professor Rutolo as well as the accompanying software. I loaded the software onto my computer. Everything worked well and was very easy to use and figure out. The inputs were 24 volts that was obtained from the PLC itself. At first I thought it would be possible to program the whole project from timing alone. Rick suggested that I use some kind of limit switch system and that programming the system on just timing alone would be difficult. I soon learned that he was right and added a limit switch and cut bottle cap toggles glued to each of the 4 bottle holding stations. After these were added I added to the parallax board and program a conditional statement saying that when the PLC was turned on it sent a high to the table turning it and timing the cycles to 45 seconds. This meant that every 45 seconds the table would turn on a closed loop program and every time the limit switch was deactivated and reactivated it would start a looped PLC program that would actuate the pneumatic piston lock system of Ryan's bottle delivery system dropping a bottle in an empty holder. It would also activate the solenoid valve attached to the submerged pump in the water tank, and activate the pneumatic piston system of Nate's bottle packaging tube.

Programming the Stepper Motor

Techniques used- The Stepper motor we used was an older model that we could not find a data sheet or instructions so I had to improvise. The main reason we used this stepper was that it was already attached to a turn table assembly we found and repurposed. The Stepper motor was a 4 wire type so I looked up some example circuits for the L293 Stepper motor driver chip. I then found a program and schematic for a stepper motor circuit and the accompanying parallax homework board. I then wired up the Motor and it did not function properly, by trial and error I figured out how to wire up the circuit and we got the motor turning. We then attached the turn table to the motor and set about calibrating how many steps and what direction to turn the motor in. The one thing we could find out about the stepper motor that was critical was that it required 6 volts to operate properly.

Programming the Pegasus II robotic arm

Techniques used- I choose this robot because I thought it would be the most modern and easy to program but found out later that this was not the case. We could not find any kind of manual but we did find a student lab activity manual online. I used this and example programs already saved on the computer we used to piece together a rudimentary program that used a Cartesian coordinates system and pauses to accomplish what we needed. We could not find out how to interface the robot and the PLC so I had to resort to starting both the robot program and the PLC program at the same time. One person had to start the Robot while another had to turn the PLC on. The robot paused for 55 seconds at the beginning because the table had to turn two cycles before a bottle was in place for capping. Then it went into a looped process based on pauses.

Materials used

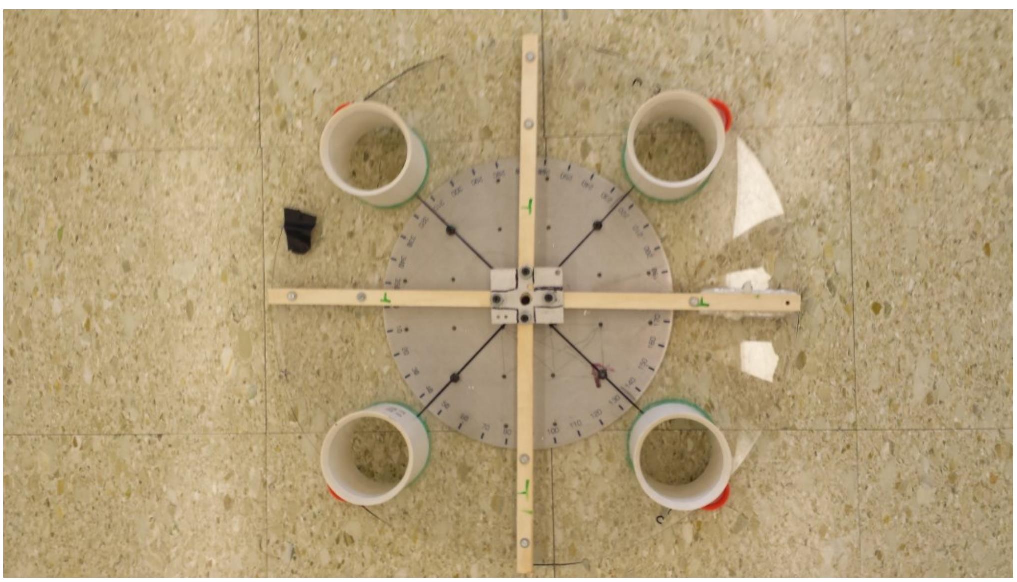
- Unknown Stepper Motor
- Turn table assembly with attached stepper motor and gearing system
- Bs2 Basic Stamp
- Parallax Homework Board
- L293d H Bridge Stepper Motor Driver
- Various Resistors
- Heat sink
- Thermal compound
- Cooling Fan

Mechanical Fabrications (Wesley Kulig)

Almost everything was build out of plexiglass glass or wood Wesley was instrumental in fabricating these materials to create the project. His biggest contribution to the project was the top of the turn table. Below is a picture of the turn table and a short description of the building process for the turn table in Wesley's words.

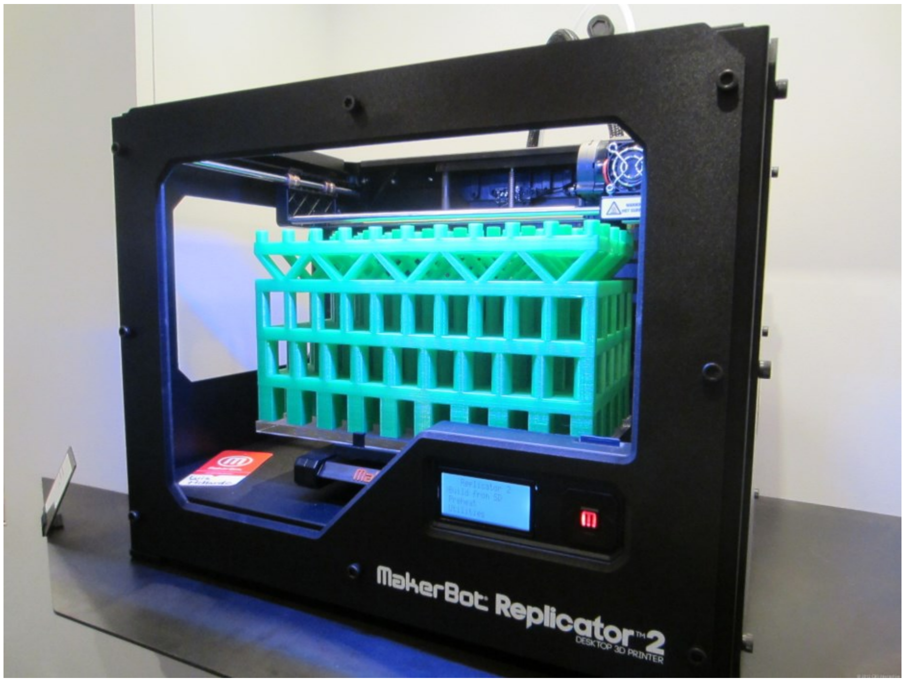
Turn Table

The most important component which I fabricated would be the turntable. This would be where the bottles would be dropped to but also how they would be transported. This meant the turntable had to be exact as the projects components moved on time intervals. The material that was chosen for this part of the project was plastic. Although the plastic was relatively strong it was also brittle and required a second set of hands to allow for perfect fabrication. Because of this Peter normally helped in shaping these pieces as I had helped him fabricate some of his components. Peter also assisted me in cutting some of the plastic tubes that the bottles would be enclosed by although the eventually were replaced by different sized tubes to make for a better design. In short mostly anything that was plastic or wood besides the bottle delivery system had been in some way fabricated by or adjusted by me.

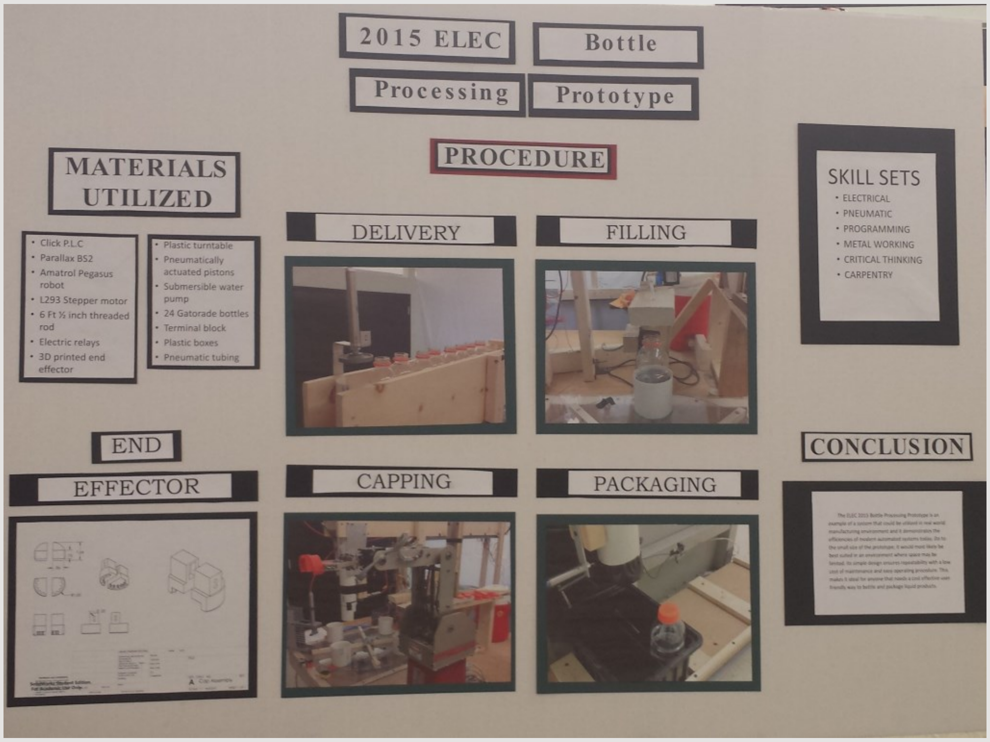


3D Printing (Austin Holzhauerad)

There was a few pieces of the project created using the 3D MakerBot printers the most important being the end effector for the robot. While I was the one that made the end effector file using the SolidWorks program Austin was put in charge of formatting the file to work with the MakerBot and overseeing the printing of it.



Project Overview



Obstacles

There were many obstacles to overcome during the making of our final project. Just working with people from various back rounds presents its own set of challenges but by the end of the semester we learned how to work together as a team to get the job done. The project itself gave us many technical problems as well from chips overheating to loose wiring. During the testing phase we found certain parts of the project would work one day and then because of some change in another part of the system it wouldn't work properly the next day. For instance the stepper motor had 298 steps and ran on 6 volts in order to move a quarter of the way around the table. The first time we tested it we didn't have full bottles on the table when we ran the test later with the full bottles on the table we realized we had to adjust the steps and voltage of the motor to compensate for the added weight. Getting each step of the process to happen as the correct time all in proper sequence was one of the major obstacles. The PLC controlled almost everything except the stepper motor so it was up to Adam and is PLC program to get the timing right.

Video of Project

This is the Link for a video Ryan made on YouTube of our project:

https://youtu.be/4WKfH-kh4ck

Appendix

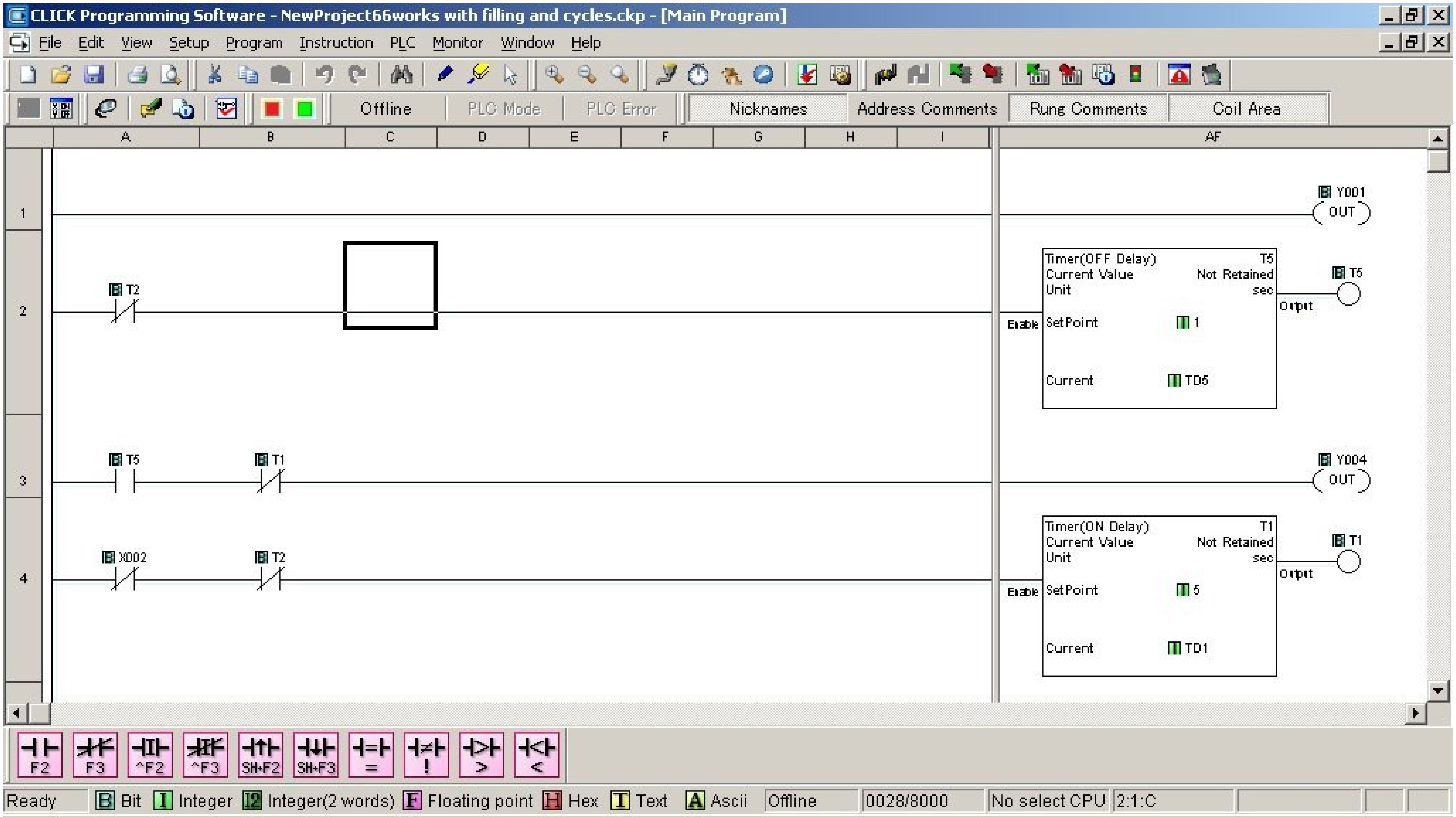
Stepper Motor Program

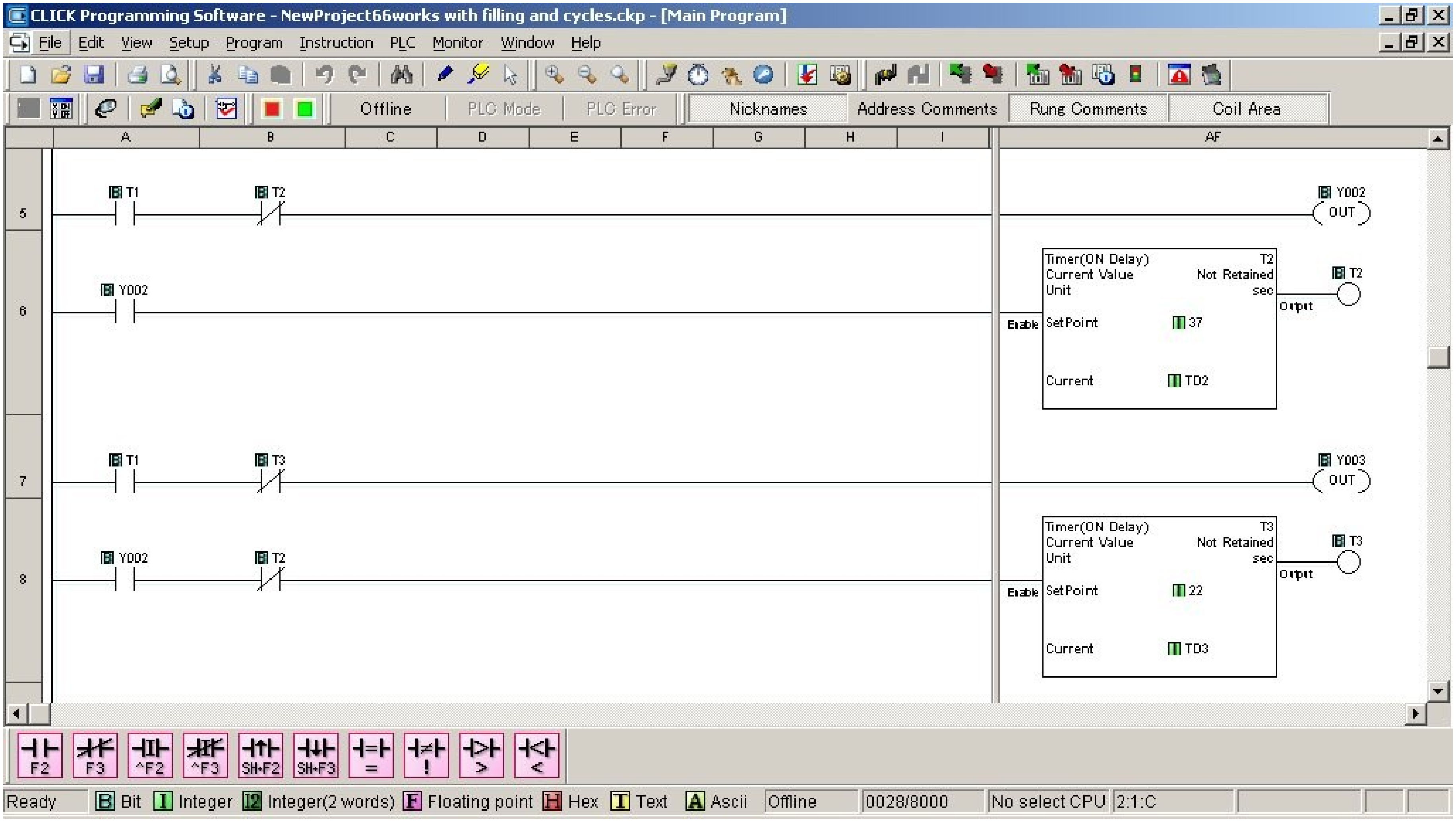
```
' {$STAMP BS2}

' {$PBASIC 2.5}

Coils VAR OUTB ' output to stepper coils

' -----[ Constants ]-------------------------------------------------------

Mitsumi CON 48 ' steps/rev by type

Howard CON 100

RevSteps CON Mitsumi ' steps per revolution

NumSteps CON 4 ' use 4-step sequence

LastStep CON NumSteps - 1 ' last step in sequence

#DEFINE Testing = 0 ' 1 for POT testing

' -----[ Variables ]-------------------------------------------------------

idx VAR Word ' loop counter

stpIdx VAR Nib ' step pointer

stpDelay VAR Byte ' delay for speed control

'rcRt VAR Word ' rc reading - right

'rcLf VAR Word ' rc reading - left

'diff VAR Word ' difference in readings

' -----[ EEPROM Data ]-----------------------------------------------------
```

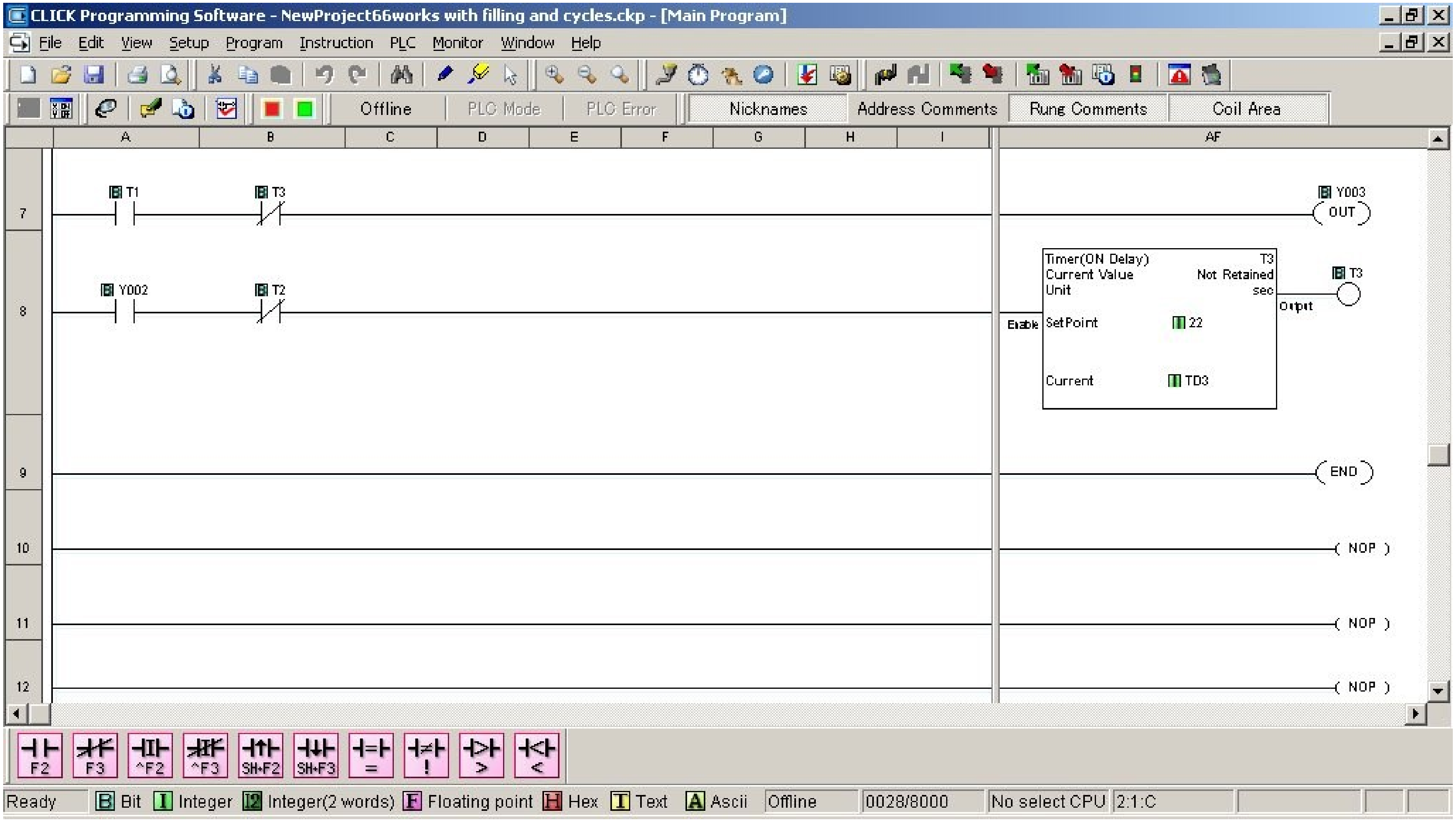
```
' —
' BAB
' -----
Step1 DATA %1001
Step2 DATA %0011
Step3 DATA %0110
Step4 DATA %1100
' -----[ Initialization ]---------------------------------------------------
Setup:
DIRB = %1111 ' make P4..P7 outputs
stpDelay = 15 ' set step delay  ,speed lower=faster
' -----[ Program Code ]-----------------------------------------------------
DO
IF IN15=1 THEN
PAUSE 1000
GOTO Demo
ENDIF
LOOP
Demo:
FOR idx = 0 TO 299 ' 1 rev forward  )distance of step( 200)
GOSUB Step_Fwd
```

```
NEXT

PAUSE 45000

GOTO Demo

' -----[ Subroutines ]-----------------------------------------------------

' Turn stepper clockwise one full step

Step_Fwd:

stpIdx = stpIdx + 1 // NumSteps ' point to next step

GOTO Do_Step

' Turn stepper counter-clockwise one full step

'Step_Rev:

'stpIdx = stpIdx + LastStep // NumSteps ' point to previous step

'GOTO Do_Step

' Read new step data and output to pins

Do_Step:

READ (Step1 + stpIdx), Coils ' output new coil data

PAUSE stpDelay ' pause between steps

RETURN
```

PLC Program


CLICK Programming Software - NewProject66works with filling and cycles.ckp - [Main Program]
File Edit View Setup Program Instruction PLC Monitor Window Help
Offline
PLC Mode
PLC Error
Nicknames
Address Comments
Rung Comments
Coil Area
A B C D E F G H I AF
1
Y001
OUT
2
T2
Timer(OFF Delay) T5
Current Value Not Retained
Unit sec
Enable SetPoint 1
Current TD5
Output
T5
3
T5
T1
Y004
OUT
4
X002
T2
Timer(ON Delay) T1
Current Value Not Retained
Unit sec
Enable SetPoint 5
Current TD1
Output
T1
F2 F3 ^F2 ^F3 SH+F2 SH+F3
Ready
Bit
Integer
Integer(2 words)
Floating point
Hex
Text
Ascii
Offline
0028/8000
No select CPU
2:1:C


CLICK Programming Software - NewProject66works with filling and cycles.ckp - [Main Program]
File Edit View Setup Program Instruction PLC Monitor Window Help
Offline
PLC Mode
PLC Error
Nicknames
Address Comments
Rung Comments
Coil Area
T1
T2
Y002
OUT
Timer(ON Delay) T2
Current Value Not Retained
Unit sec
SetPoint 37
Current TD2
T3
Y003
Timer(ON Delay) T3
SetPoint 22
Current TD3
Enable
Output
Ready Bit Integer Integer(2 words) Floating point Hex Text Ascii Offline 0028/8000 No select CPU 2:1:C


CLICK Programming Software - NewProject66works with filling and cycles.ckp - [Main Program]
File Edit View Setup Program Instruction PLC Monitor Window Help
Offline PLC Mode PLC Error Nicknames Address Comments Rung Comments Coil Area
T1 T3 Y003 OUT
Y002 T2
Timer(ON Delay) T3
Current Value Not Retained
Unit sec
Enable SetPoint 22
Current TD3
Output T3
END
NOP
NOP
NOP
Ready Bit Integer Integer(2 words) Floating point Hex Text Ascii Offline 0028/8000 No select CPU 2:1:C

Screwdrive Program for Packaging System

```
' {$STAMP BS2}

' {$PBASIC 2.5}

FWD_W VAR Word

FWD_B VAR Word

REV_W VAR Word

REV_B VAR Word

PIS VAR Word

COUNTER VAR Byte

FWD_W = 0  'RL1'

FWD_B = 1  'RL2'

REV_W = 8  'RL8'

REV_B = 7  'RL7'

PIS = 5  'RL5'
```

```
PAUSE 2000

'---------- first row ----------

'PIS1'

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

'step1'

HIGH FWD_W

HIGH FWD_B
```

```
PAUSE 1320

LOW FWD_W

LOW FWD_B

PAUSE 48680

'---------- second row ----------

'PIS2'

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500
```

```
'step2'

HIGH FWD_W

HIGH FWD_B

PAUSE 2092

LOW FWD_W

LOW FWD_B

PAUSE 47908

'---------- third row ----------

'PIS3'

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

HIGH PIS
```

```
PAUSE 500

LOW PIS

PAUSE 49500

'step3'

HIGH FWD_W

HIGH FWD_B

PAUSE 1360

LOW FWD_W

LOW FWD_B

PAUSE 48640

'---------- forth row ----------

'PIS4'

HIGH PIS

PAUSE 500
```

LOW PIS

PAUSE 49500

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

'step4'

HIGH FWD_W

HIGH FWD_B

PAUSE 2110

LOW FWD_W

LOW FWD_B

PAUSE 47890

```
'---------- fith row ----------

'PIS5'

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

'step5'

HIGH FWD_W

HIGH FWD_B

PAUSE 1380
```

LOW FWD_W

LOW FWD_B

PAUSE 48620

'---------- sixth row ----------

'PIS6'

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

HIGH PIS

PAUSE 500

LOW PIS

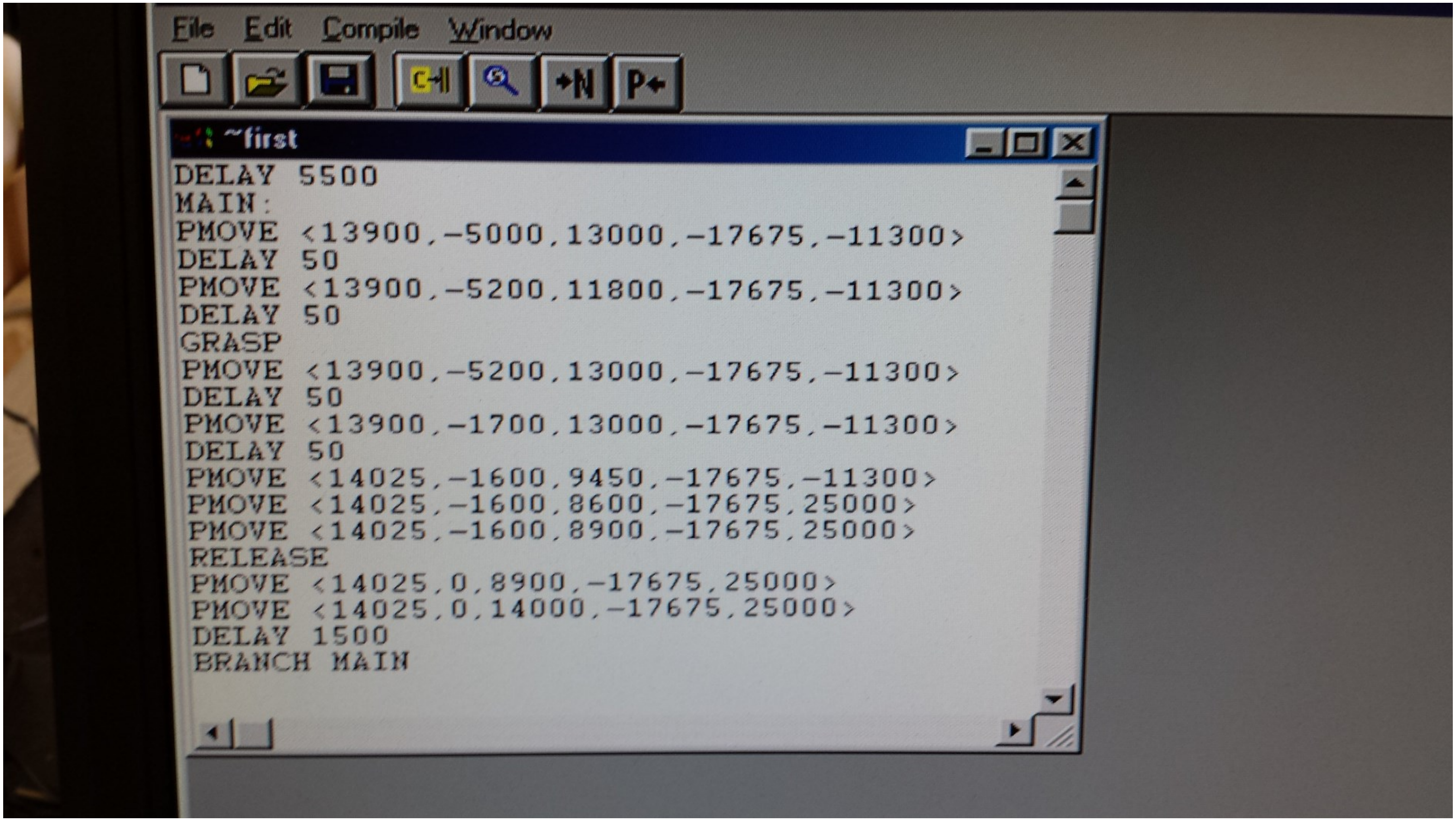
PAUSE 49500

```
'step6'

HIGH FWD_W

HIGH FWD_B

PAUSE 2200

LOW FWD_W

LOW FWD_B

PAUSE 47800

'---------- seventh row ----------

'PIS7'

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

HIGH PIS
```

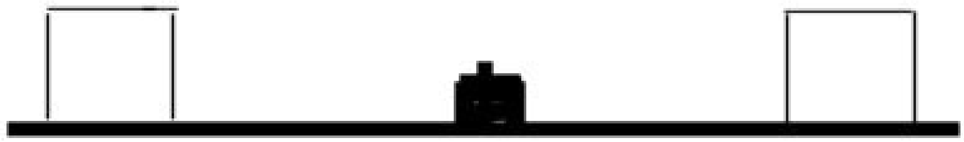
```
PAUSE 500

LOW PIS

PAUSE 49500

'STEP7'

HIGH FWD_W

HIGH FWD_B

PAUSE 1480

LOW FWD_W

LOW FWD_B

PAUSE 48520

'---------- eigth row ----------

'PISEND'

HIGH PIS

PAUSE 500
```

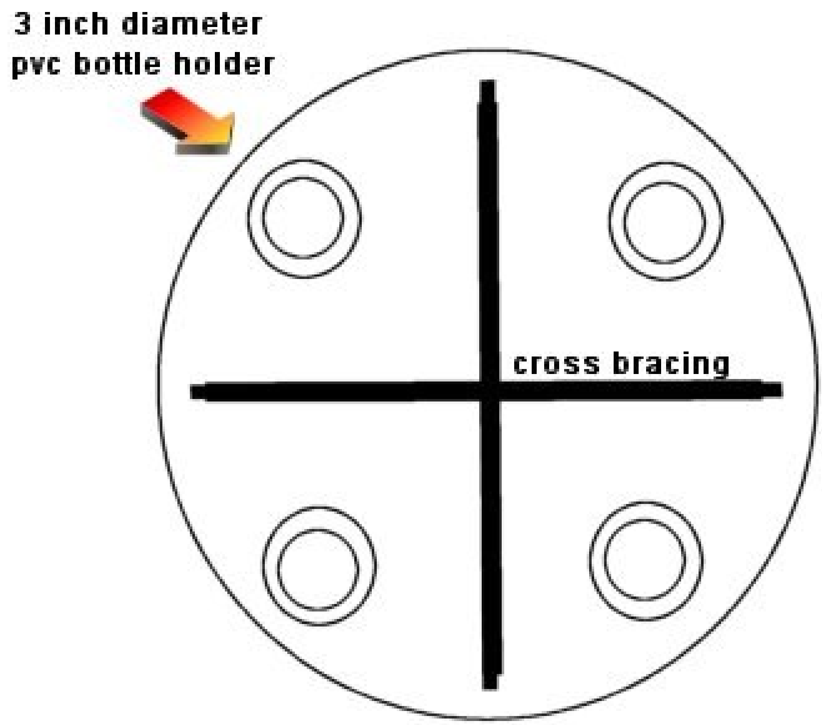
```
LOW PIS

PAUSE 49500

HIGH PIS

PAUSE 500

LOW PIS

PAUSE 49500

'stepREV'        "11942"

HIGH REV_W

HIGH REV_B

PAUSE 12500

LOW REV_W

LOW REV_B

PAUSE 50000
```

Robot Program

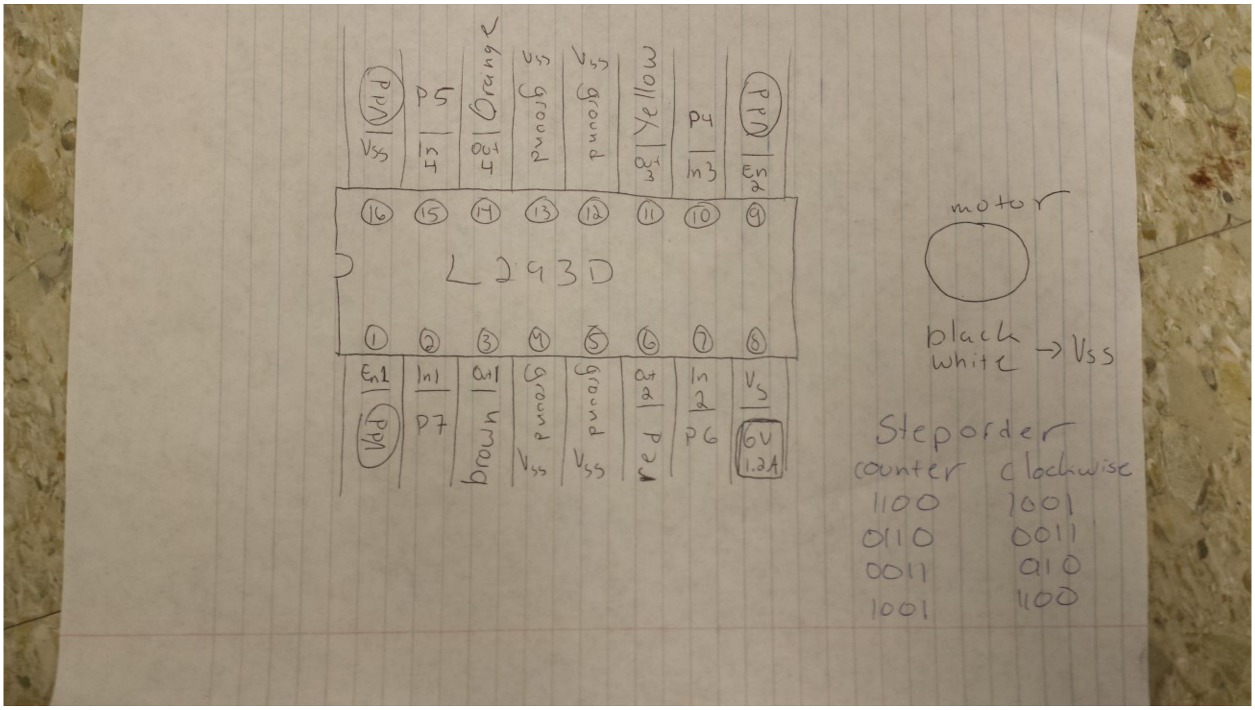


Diagrams





TURN TABLE ASSEMBLY


L293D
motor
black
white
→ Vss
Steporder
counter
clockwise
1100
0110
0011
1001
1001
0011
0110
1100
6V
1.2A