Manufacturing Lab Project

Automated Yoyo Assembly Manual

ENGR 480

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Introduction

This manual provides a list of instructions, diagrams, descriptions and important information for the operation and maintenance of the yoyo assembly machine.

Loading Machine

These are the necessary steps in order to load parts into the machine properly.

1. Slide bearings into track, make sure lower stop is in place before hand.
2. Place yoyo halves on conveyor.
3. Load a roll of silicon rings into place above conveyor.
4. Load screws into track.

The location of different tracks and conveyors are shown in figures below.

Starting Machine

These are the necessary steps in order to safely start the yoyo assembly machine.

1. Remove any obstructions.
2. Ensure parts are loaded.
3. Turn on power.
4. Turn red emergency stop button clockwise to turn on air flow.
5. Set PLC to run.

Clearing Machine

If machine malfunctions and jams immediately press the large red emergency button. Then verify that each part of the station has not been damaged. If a part of the machine has been damaged replace it and recalibrate machine.

Description of Operation

Indexing Turret

This is the main component of our system. It is what all the stations are centered around. It has 8 positions and rotates counter clockwise. The turret has the tendency to operate very slowly most of the time, if this occurs gently help the turret to rotate while being careful that fingers or hands do not get hurt. At each of the 8 positions there is a holder for the yoyo halves. The yoyo halves fit snugly on the holders and the holders can be rotated by gears so that different screwing operations can be performed by the stations.

Station 0 – Yoyo half pick and place system/silicon ring placement

This station feeds the yoyo assembly line. First, a conveyer belt is loaded with pre-machined yoyo halves. These yoyo halves travel under a ring applicator. The ring applicator, initiated by a sensor on the conveyer, pulls a paper roll of rings over an edge causing the rings to detach from the roll and stick to

the yoyo half. The yoyo half then travels on to be positioned under a pick and place. An optical sensor senses the yoyo half is in place and moves the yoyo half from the conveyer to a rotating turret.

Station 0 setup:

1. Match the speed of the steeper motor with the conveyer by adjusting the speed in the conveyer.
2. Adjust the horizontal linear cylinder stops to pick and place the yoyo precisely.

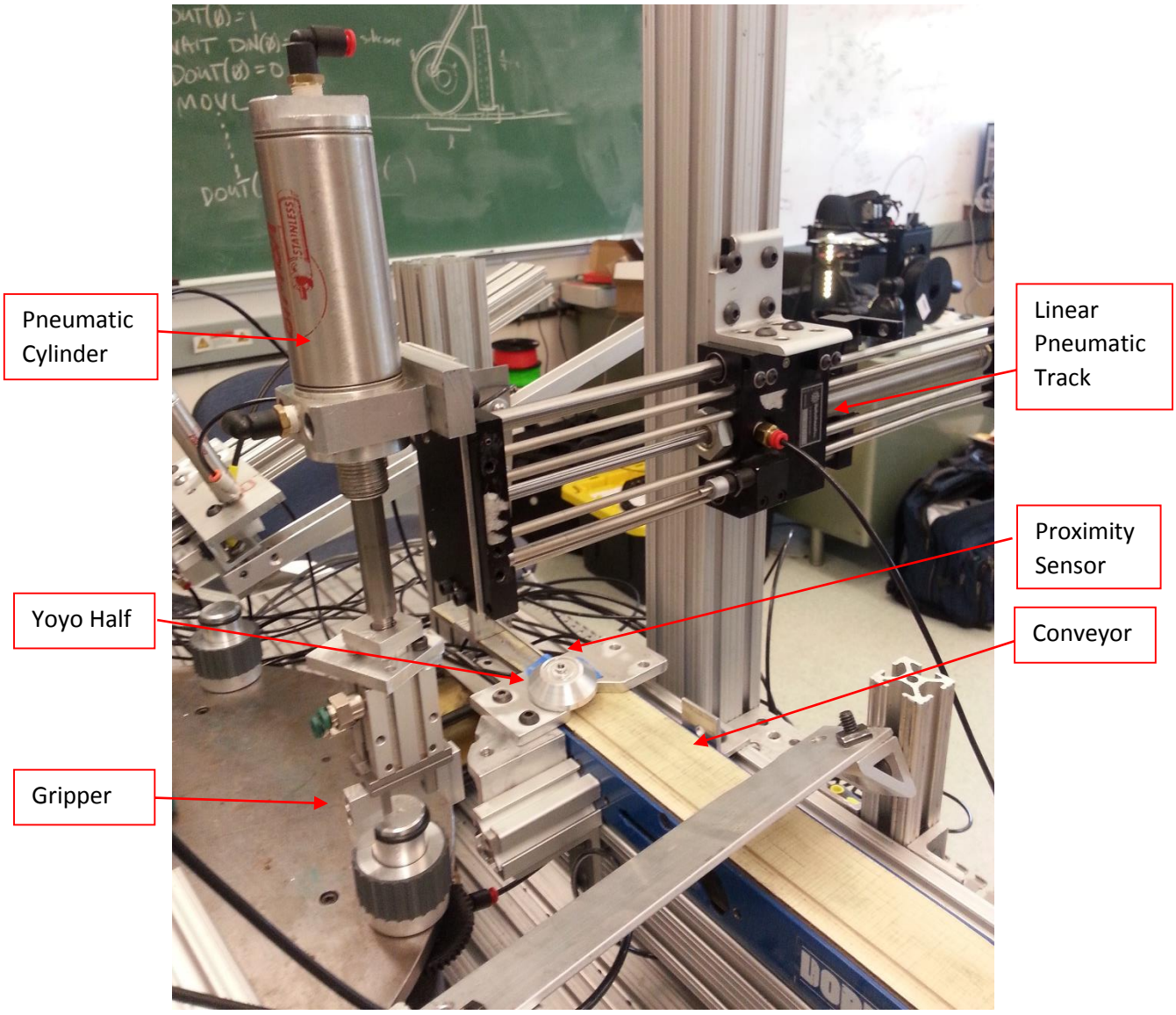


Figure 1. Yoyo Pick and Place Station

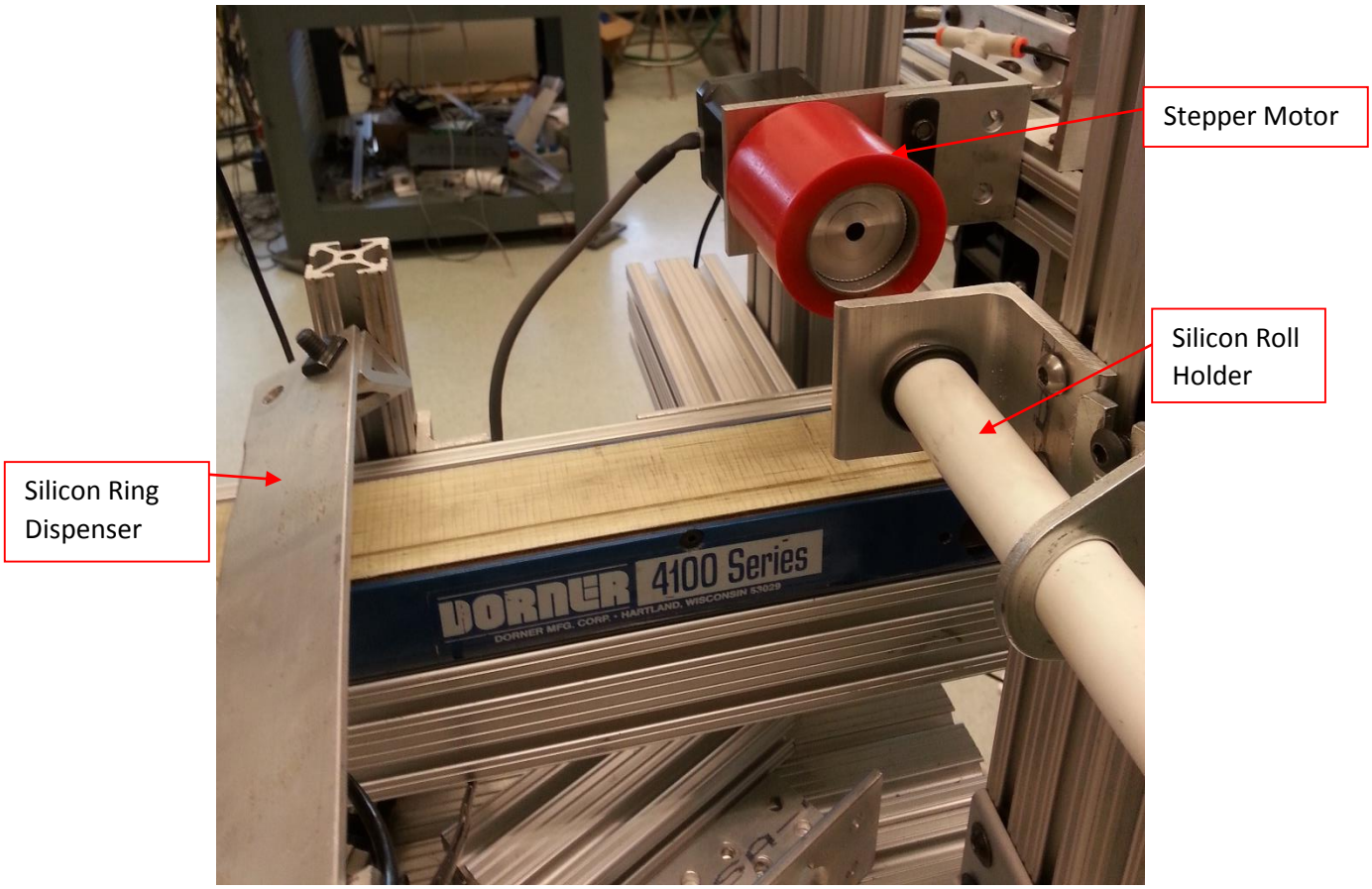


Figure 2. Silicon Ring Station

Station 1 – Bearing Feeder

The purpose of this station is to place a bearing onto a yoyo half. This stations operates on every other turret rotation because we only want a bearing on one half of the yoyo. Once the gravity feeder at the station is loaded there are two pneumatic cylinders, one above and one on the side of the gravity feeder that control the release of a bearing as well as a sensor to see if a bearing is in place. The pneumatic cylinder that is on the side of the gravity feeder is on initially and when the sensor is trigger the cylinder that is above the gravity feeder is released and stops the bearing that is second in the line. There is also a third pneumatic cylinder that's purpose is to make sure the bearing falls into the right position, this cylinder is released at the same time as the cylinder above the gravity feeder. The side cylinder is then released and the bearing falls down onto the yoyo half. The sensor is no longer sensing and this returns the cylinders to the original positions.

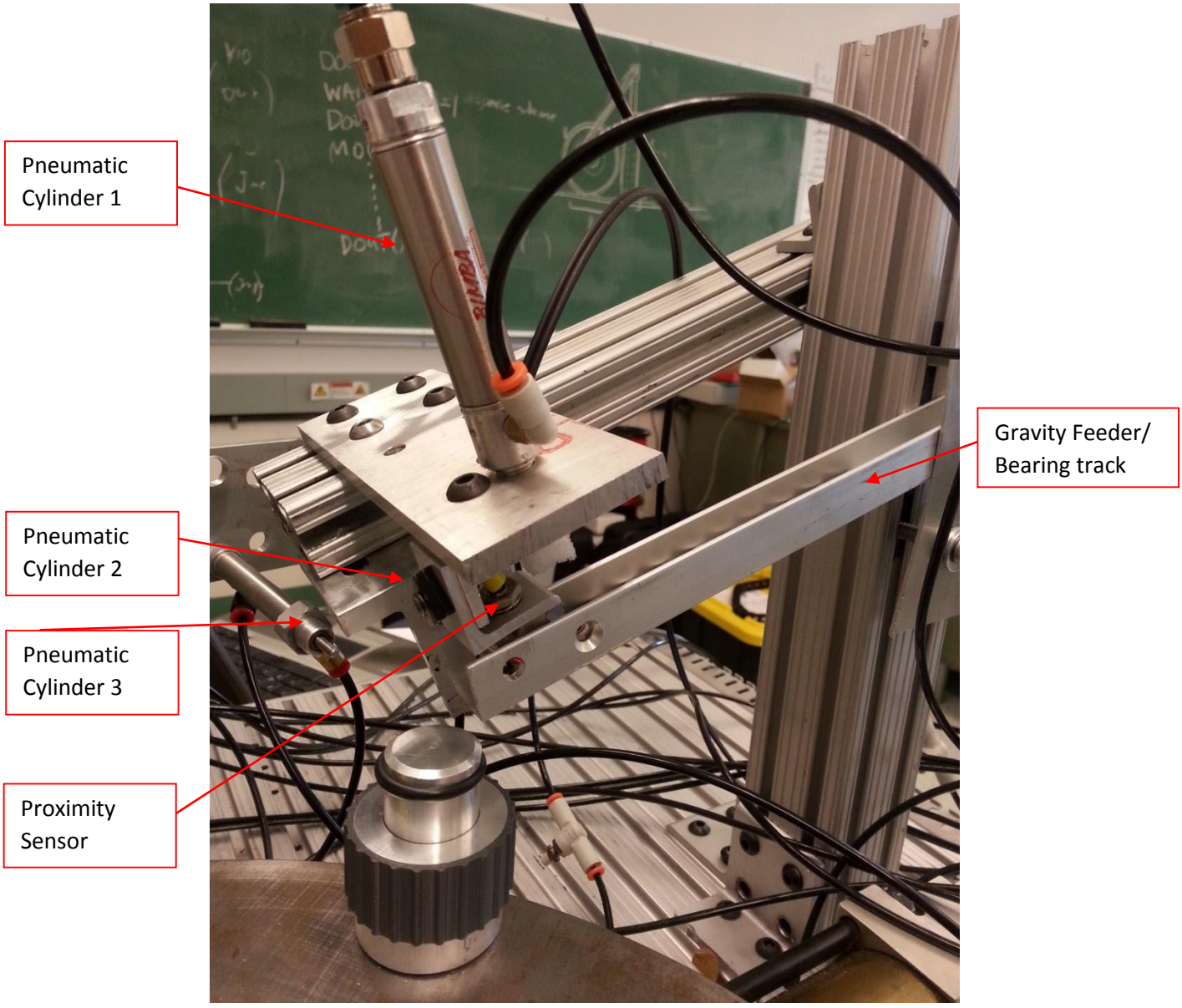


Figure 3. Bearing Feeder Station

Station 2 – Bearing Placement

The purpose of this station is to press fit the bearing on the yoyo. It operates on every other turret rotation but is the opposite rotation of station. There is a pneumatic cylinder with an aluminum block attached to the end. When the station goes the block presses down on the bearing press fitting the bearing onto the yoyo.

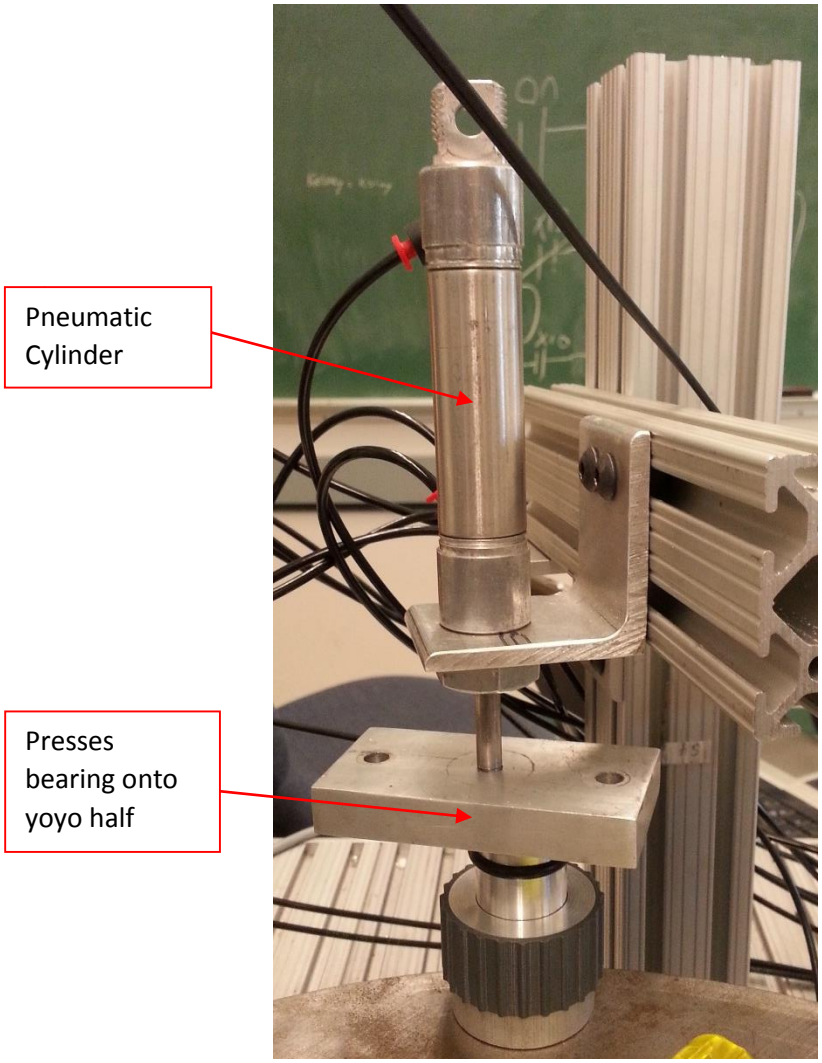


Figure 4.Bearing Placement Station

Station 3 – Screw Feeder/Placement

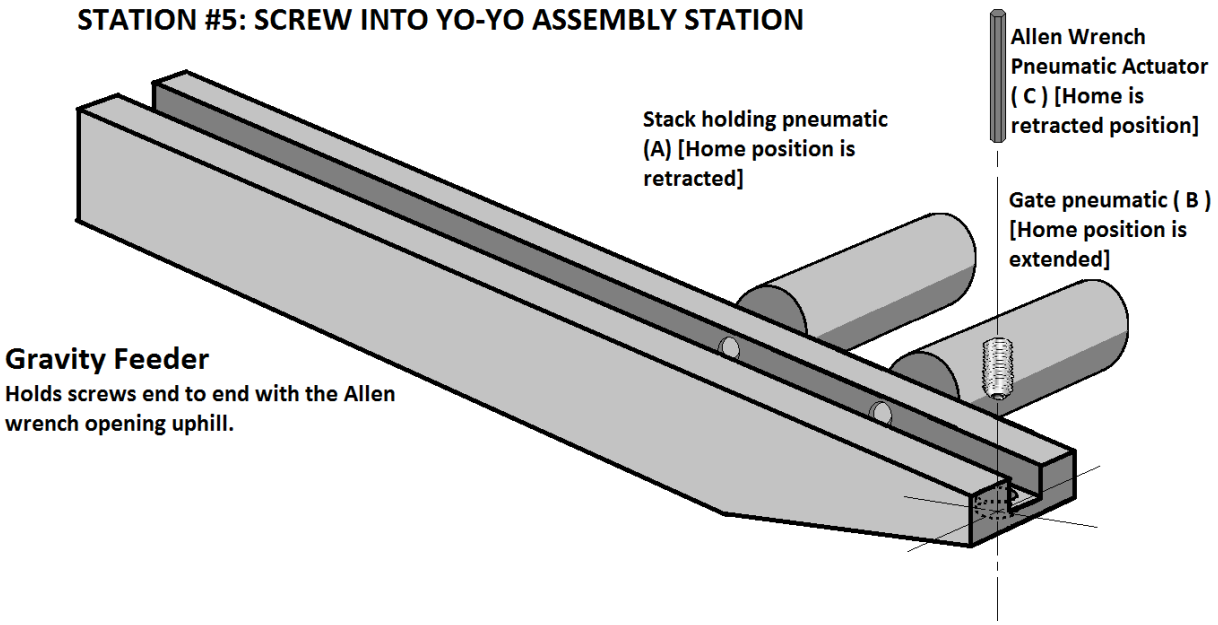


Figure 5.Screw Feeder/Placement Station

Description: The purpose of this station is to screw a ½ inch long, 1/8th inch diameter screw into an aluminum yo-yo half. In order to do that many sub-actions must take place. First a line of screws are placed in the gravity-feeder. This is a state that is only for loading and will not be used once the station gets going. This first state has all of the pneumatics retracted except for the gate pneumatic. In regards to how the gravity feeder works, screws are lined up end to end with their hex-bit ends facing uphill. The 2nd screw from the bottom end is pinned when the station reaches its 2nd state, holding the rest back. When this station receives its Station Go signal, the gate at the bottom of the gravity feeder opens and the 1st screw slides down slides down into an alignment hole. The screw stops when it runs into the yo-yo half, which will have had to been in place for the Station Go signal to be sent. Then, an Allen wrench is actuated on a pneumatic to push down where the aligned screw is such that the Allen wrench enters the screw and applies pressure. The yo-yo half is mounted on a rotating mount and when a stepper motor turns on, the yo-yo half begins to spin at a slow and steady rate. The screw, if it isn't already entered by the Allen wrench, it will now be. The spinning of the mount combined with the screw being held steady and having pressure applied on it results in the screw being driven at a steady rate into the yo-yo half. After a set amount of time for the motor and Allen wrench pneumatic, the motor deactivates (allows free spinning) and the pneumatic retracts. After a short time, the Allen wrench pneumatic is back in home position. The screw feeder then closes its gate and after a short time, opened the holding pin pneumatic and the screws increment down the gravity feeder by 1 position further. The pin pneumatic then "re-clamps" the 2nd screw. The Station Done signal and then sent to the PLC. The actions can now repeat from the 2nd state. Note that a screw is placed in every other yo-yo half.

Station 4 – Assembly of Two Yoyo Halves

This station is responsible for screwing two yoyo halves together. One yoyo half contains the bearing and the screw and the other contains neither. The yoyo half that contains neither will be picked up using a pneumatic gripper and a stepper motor and rotated up-side-down with a pneumatic actuator. Then this station waits for the turret to rotate so that another yoyo half is in place below the gripped yoyo half. The station then lowers the one yoyo half onto the other while turning the lower yoyo half with a stepper motor so that they screw together.

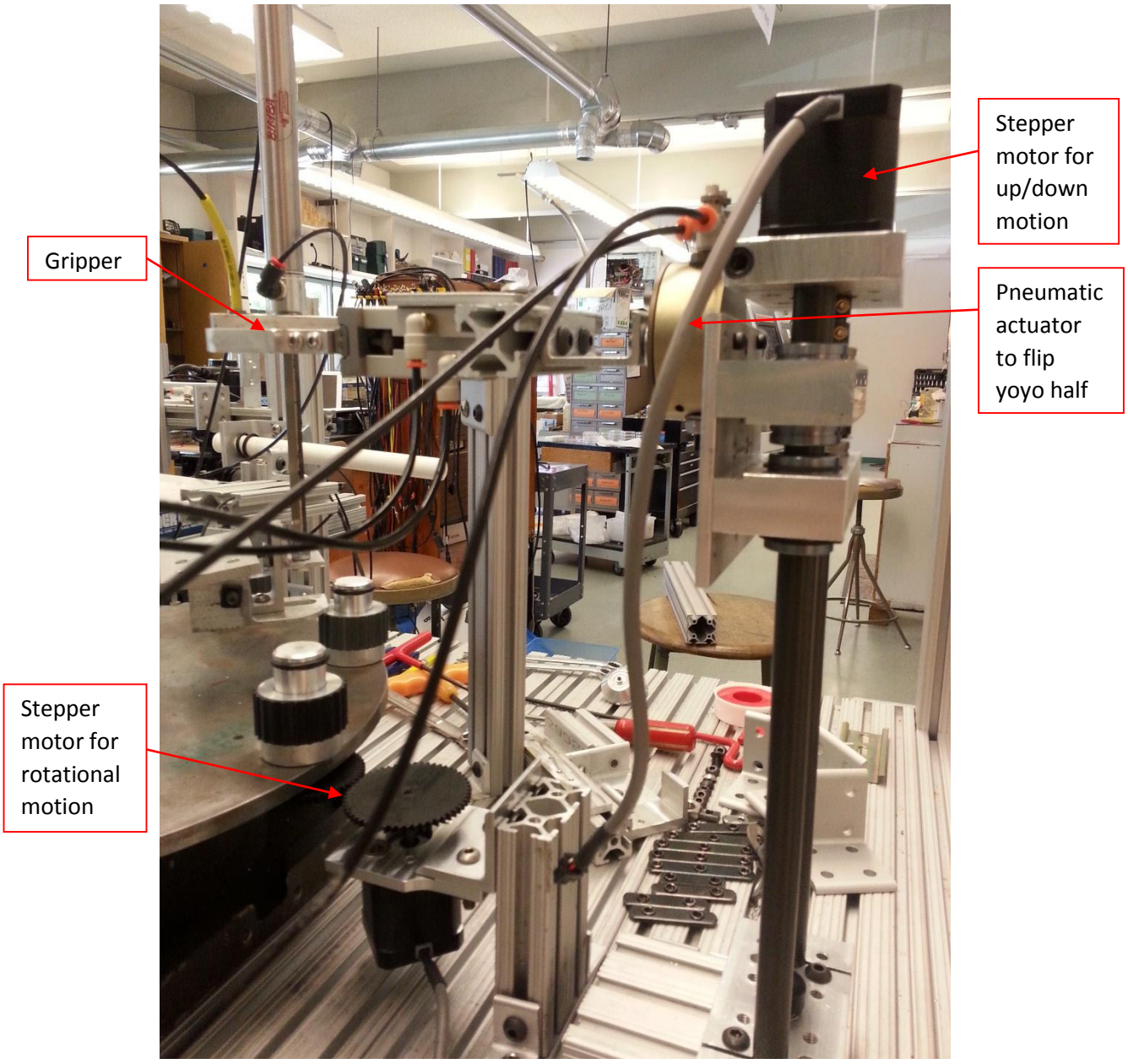


Figure 6. Assembly of Yoyo Halves Station

Station 5 – Eject Station

This station ejects a complete assembly of two yoyo halves. This is accomplished by one pneumatic cylinder which lifts the edge of the yoyo off that is on the turret causing it to fall off of the turret. This station contains a sensor to tell when the cylinder is in the upward position.

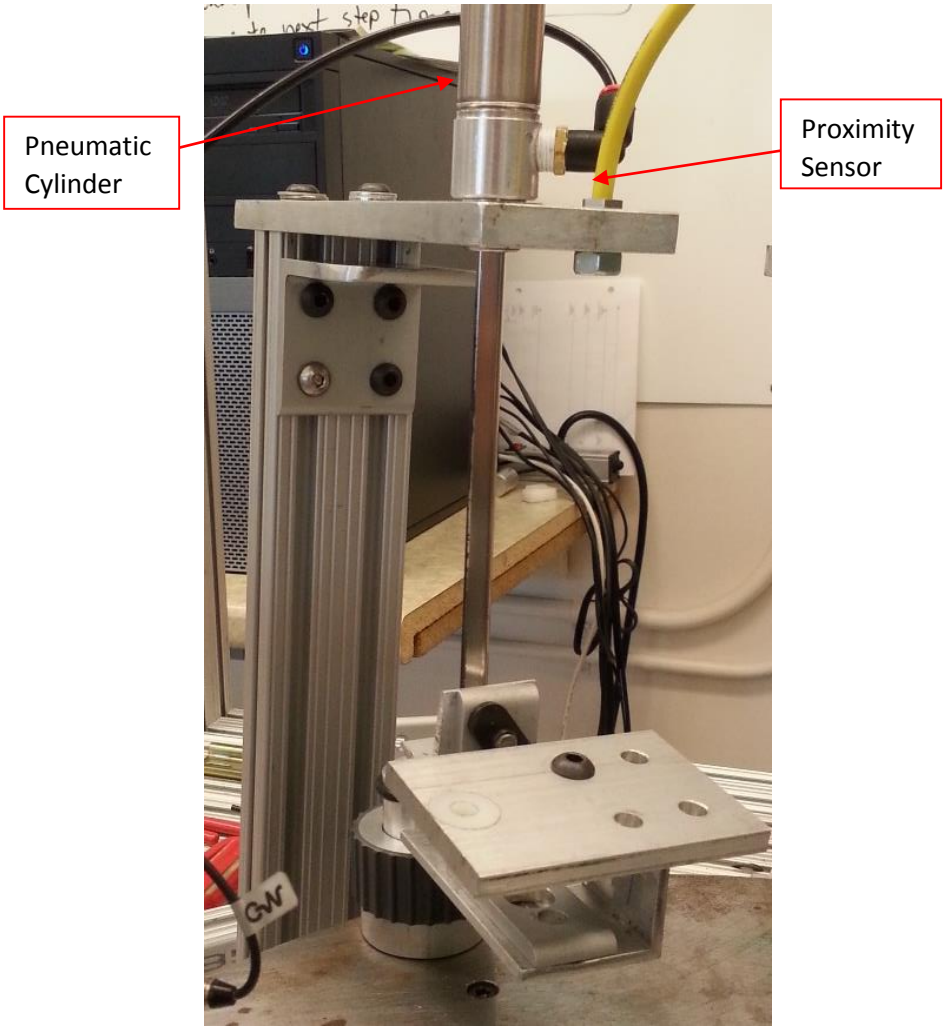


Figure 7. Eject Station

Station 6 – Turret Position sensor

This station contains only a sensor that senses if a yoyo holder on the turret is in position. We used a break-beam sensor for this station. This signal is used to tell the turret to index.

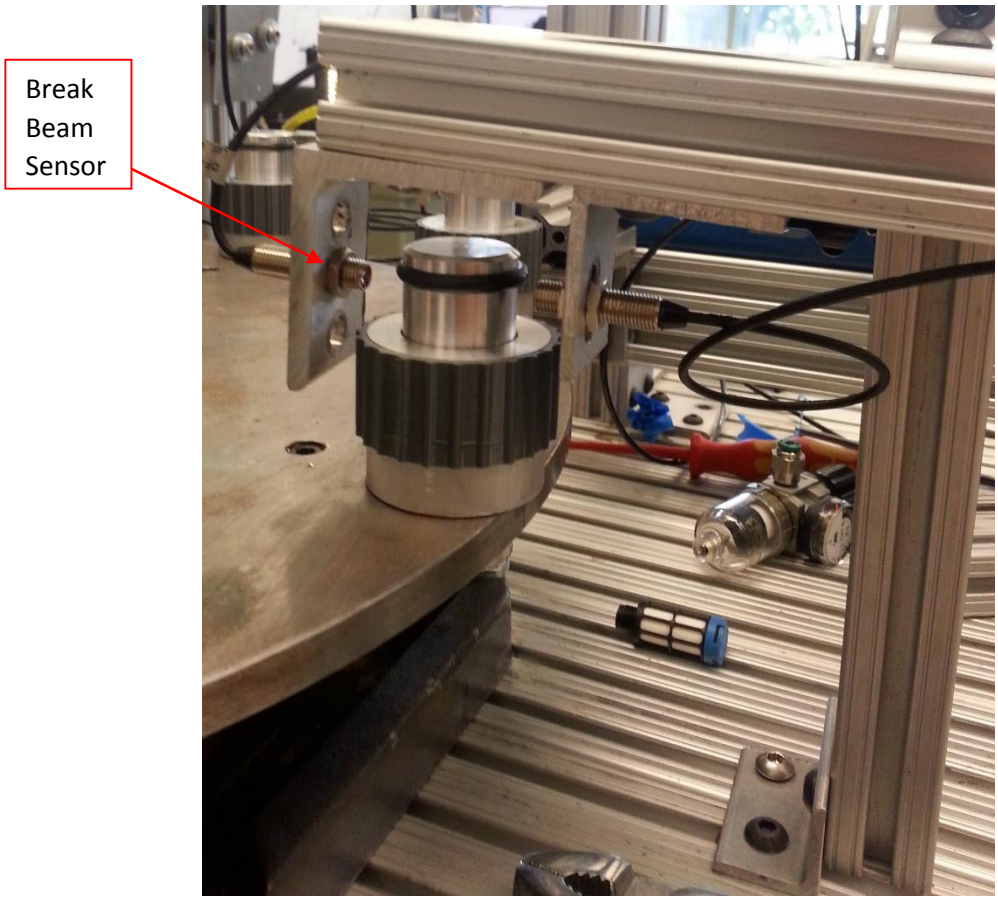


Figure 8. Turret Position Sensor Station

Maintenance

The indexing turret is the component that needs the most maintenance. It needs to be checked a minimum of every month to see if all parts are working. It also needs to be cleaned and re-lubricated every month as well.

Stepper Motor Configuration

The PLC and CITRO Workbench were used to operate our stepper motors. This seemed like the best way to control the stepper motors since we had multiple motors being operated at the same station but controlling different components. Different profiles were created for the different motions the motors would need to perform but when these profiles were loaded from PLC they would not run. An improvement that could be made for our system would be to figure out why the stepper motors will not run when controlled by the PLC or possibly switch and use Linux CNC to control the stepper motors in our system.

Wiring Table

Pnematic Clyinder	PLC OUTPUT	PLC INPUT
Turret	Y101	
Station 0		
Station 0 Clyinder 1	Y112	
Station 0 Clyinder 2	Y113	
Station 0 Clyinder 3	Y116	
Station 0 Sensor 1		X1
Station 1		
Station 1 Cylyinder 1	Y103	
Station 1 Cylyinder 2	Y104	
Station 1 Cylinder 3	Y105	
Station 1 Sensor 1		X3
Station 2		
Station 2 Clyinder 1	Y106	
Station 3		
Station 3 Cylinder 1	Y117	
Station 3 Cylinder 2	Y114	
Staiton 3 Cylinder 3	Y115	
Station 4		
Station 4 Cylinder 1	Y110	
Station 4 Cylinder 2	Y107	
Station 4 Stepper motor 1	Module 1	
Station 4 Stepper motor 2	Module 2	
Station 5		
Station 5 Clyinder 1	Y109	
Station 5 Sensor 1		X2
Station 6		
Station 6 sensor 1		X0

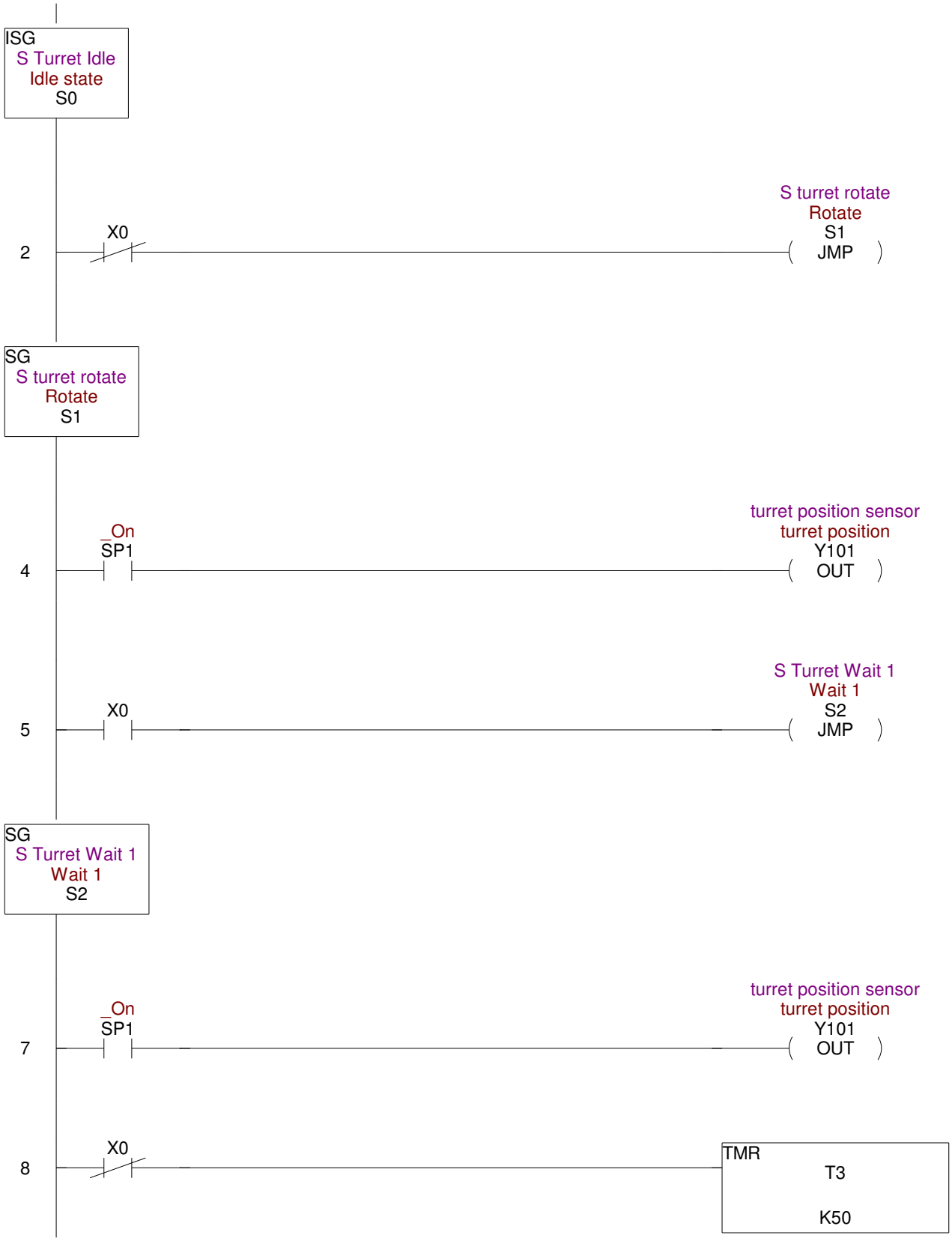
Future Improvements

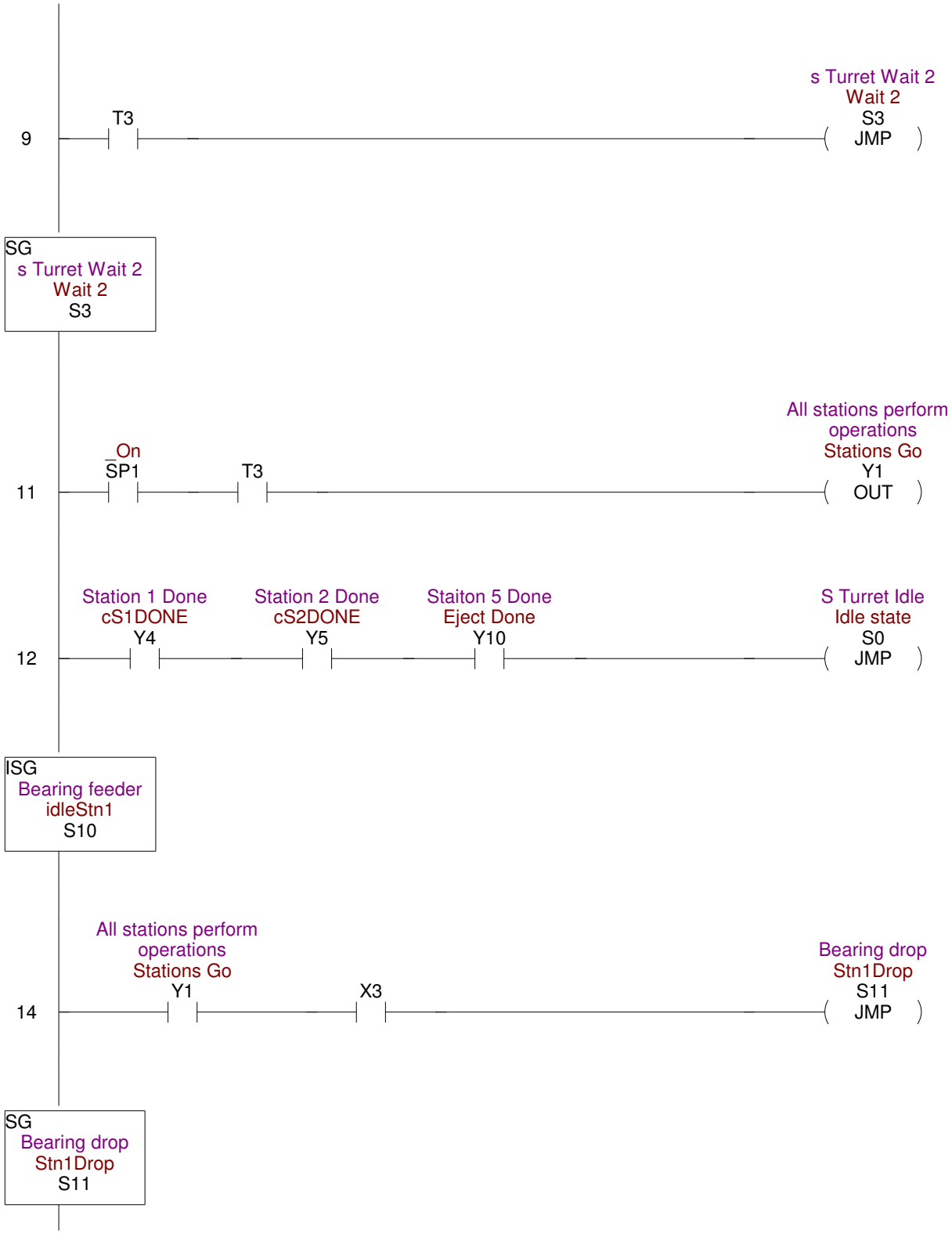
The major improvement that could be made would be to replace the indexing turret. The turret that has been used is very slow. We attempted to fix it by cleaning it and re-lubricating it and this seemed to work for a short amount of time but then started working poorly again. Another improvement that could be made would be to add an attachment to the third pneumatic cylinder in the bearing feeder station. We also need to improve the stepper motor control so that they work better.

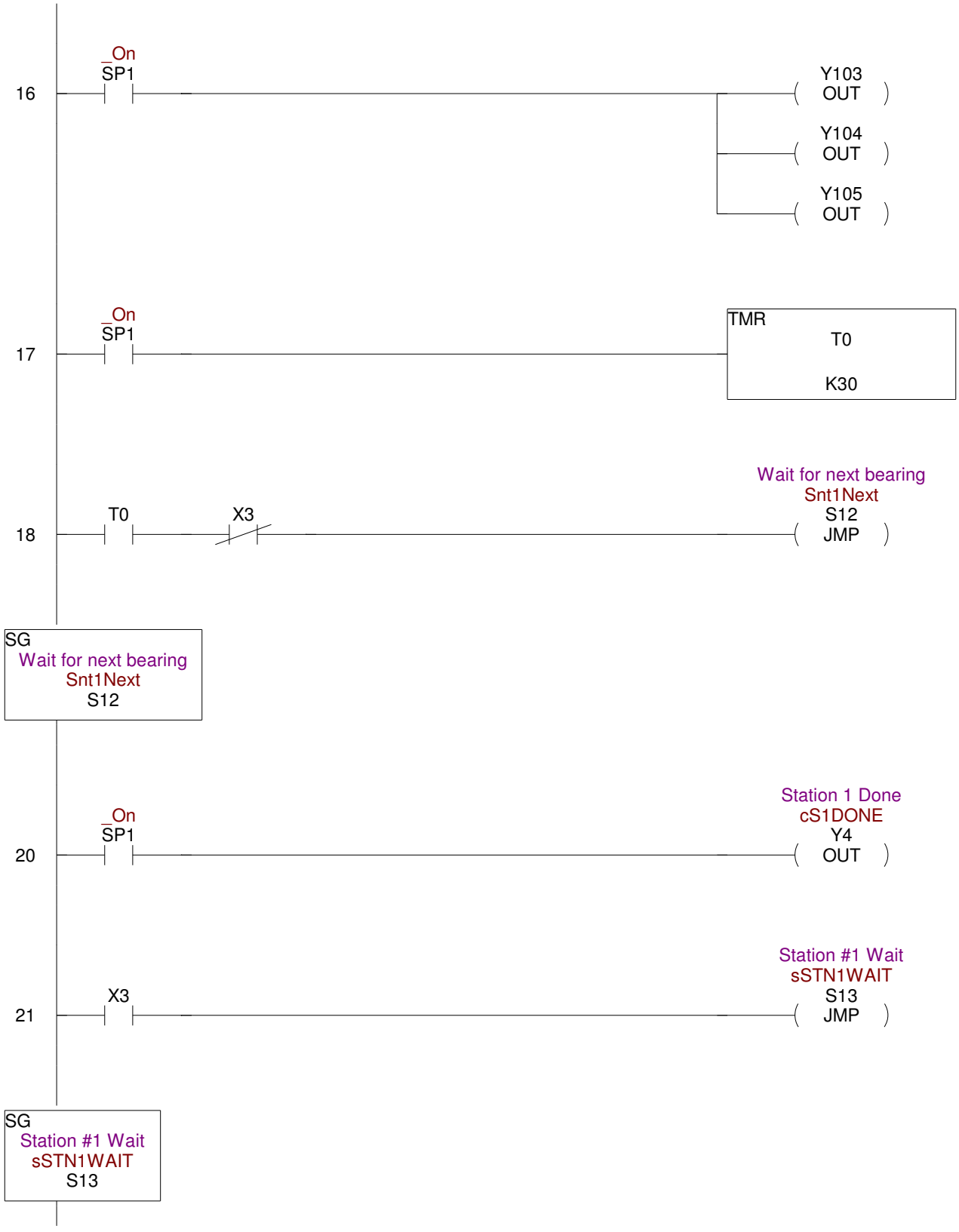
PLC Ladder Logic

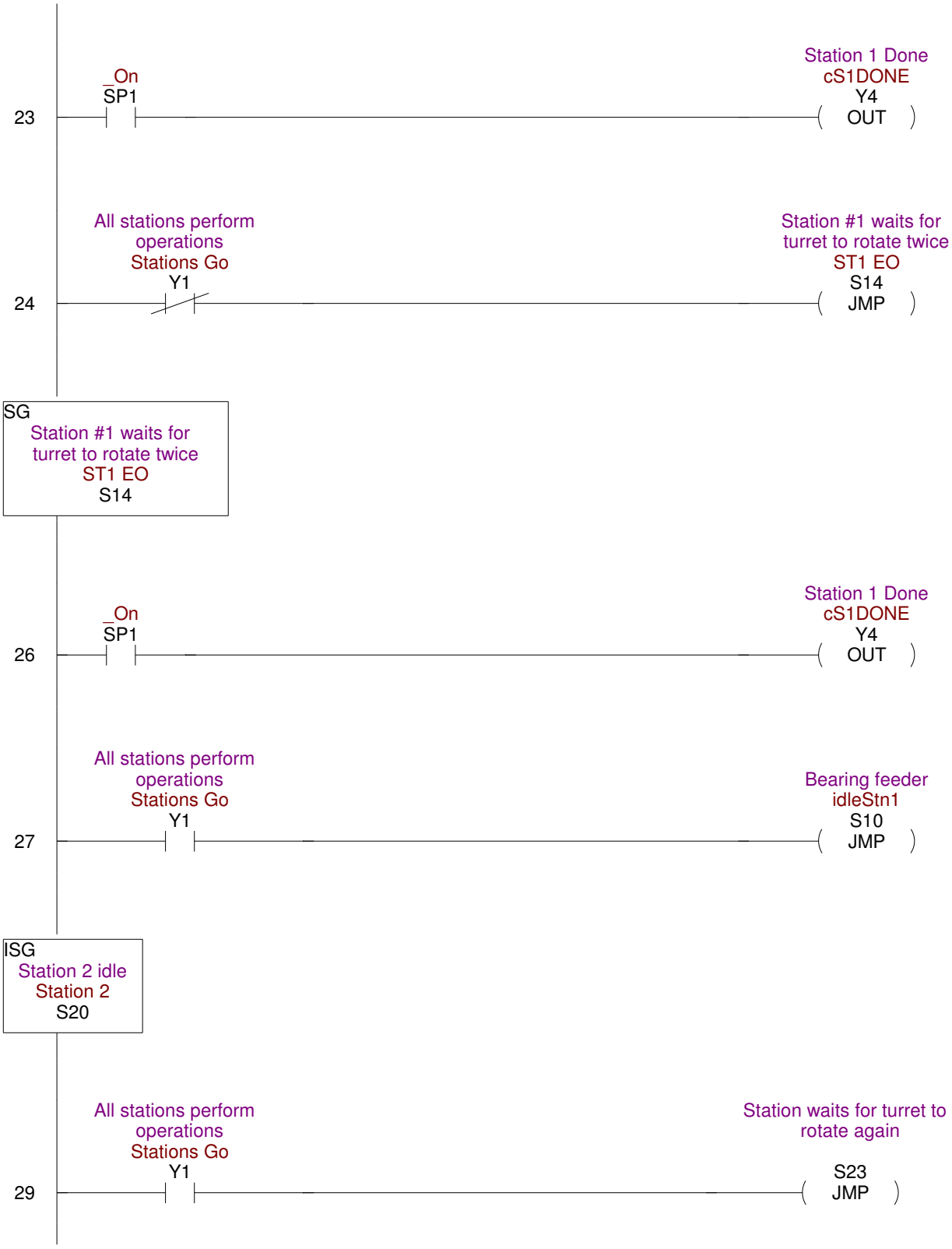
See attached

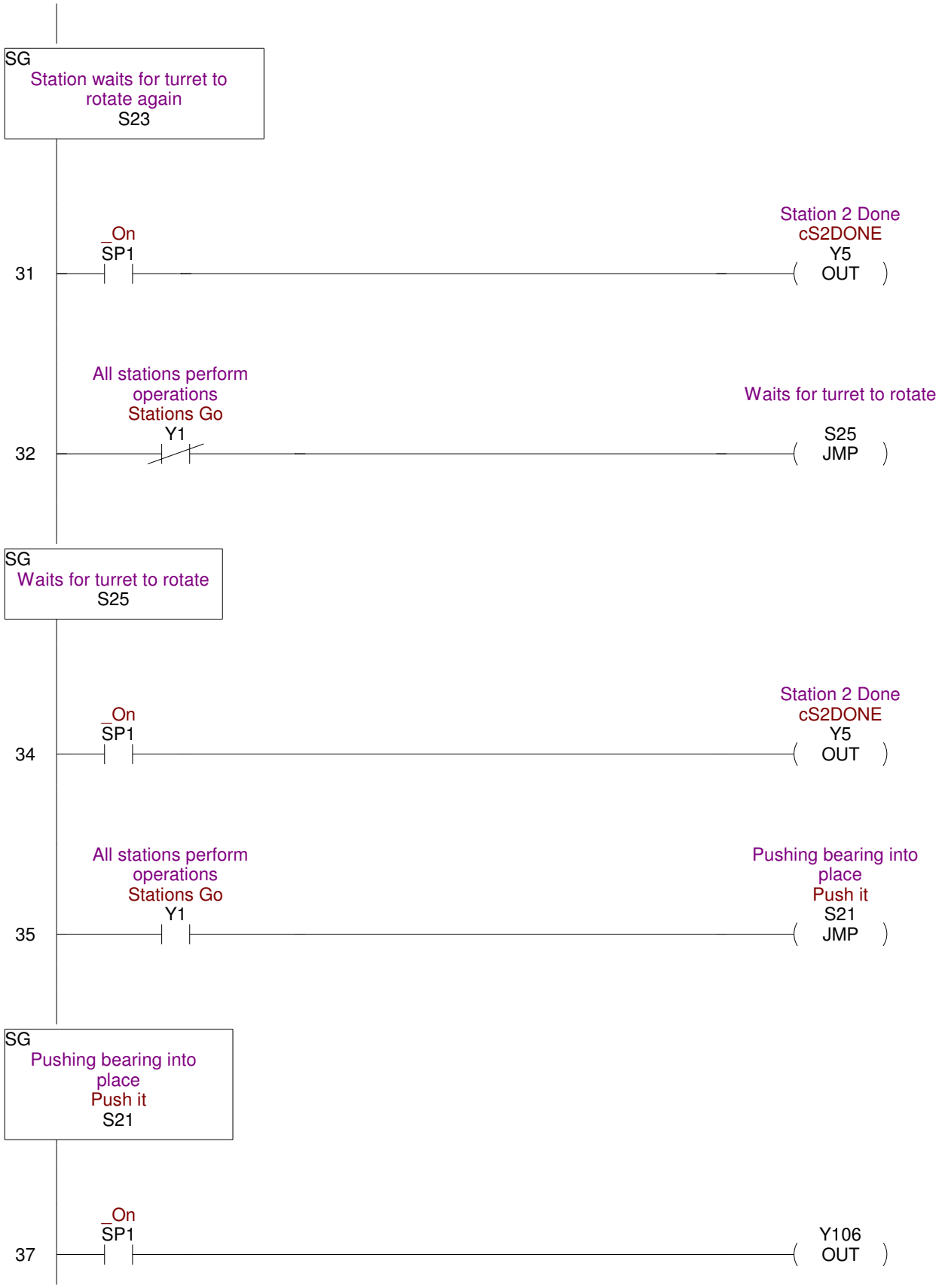
Path: c:\directsoft5\projects\bk jm turret rotate.prj
Save Date: 06/11/14 16:31:53
Creation Date: 05/14/14 10:54:43
PLC Type: 06
Class ID: DirectLogic 06 Series
Link Name: 06 KSeq

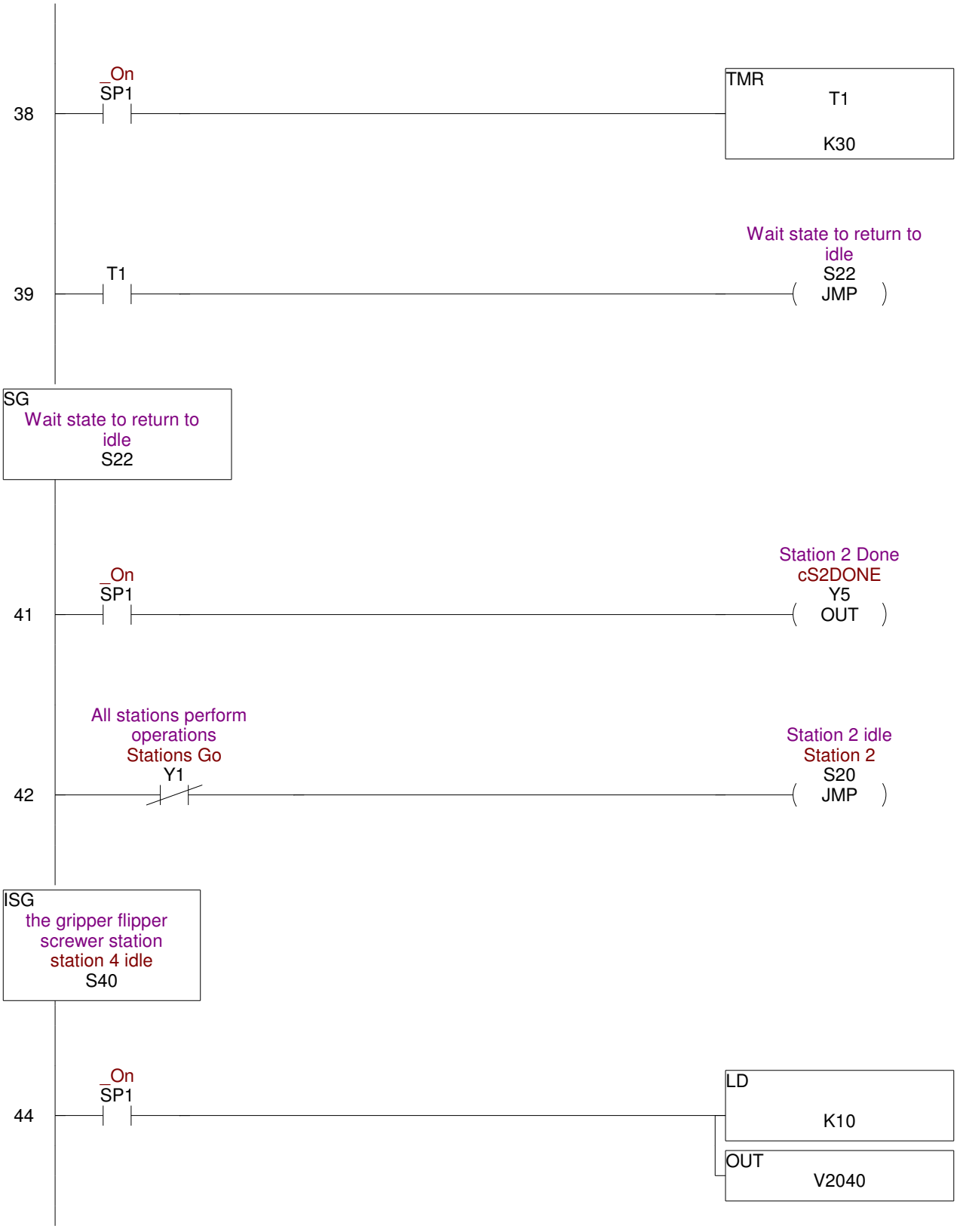

ISG
S Turret Idle
Idle state
S0
2
X0
S turret rotate
Rotate
S1
JMP
SG
S turret rotate
Rotate
S1
4
_On
SP1
turret position sensor
turret position
Y101
OUT
5
X0
S Turret Wait 1
Wait 1
S2
JMP
SG
S Turret Wait 1
Wait 1
S2
7
_On
SP1
turret position sensor
turret position
Y101
OUT
8
X0
TMR
T3
K50

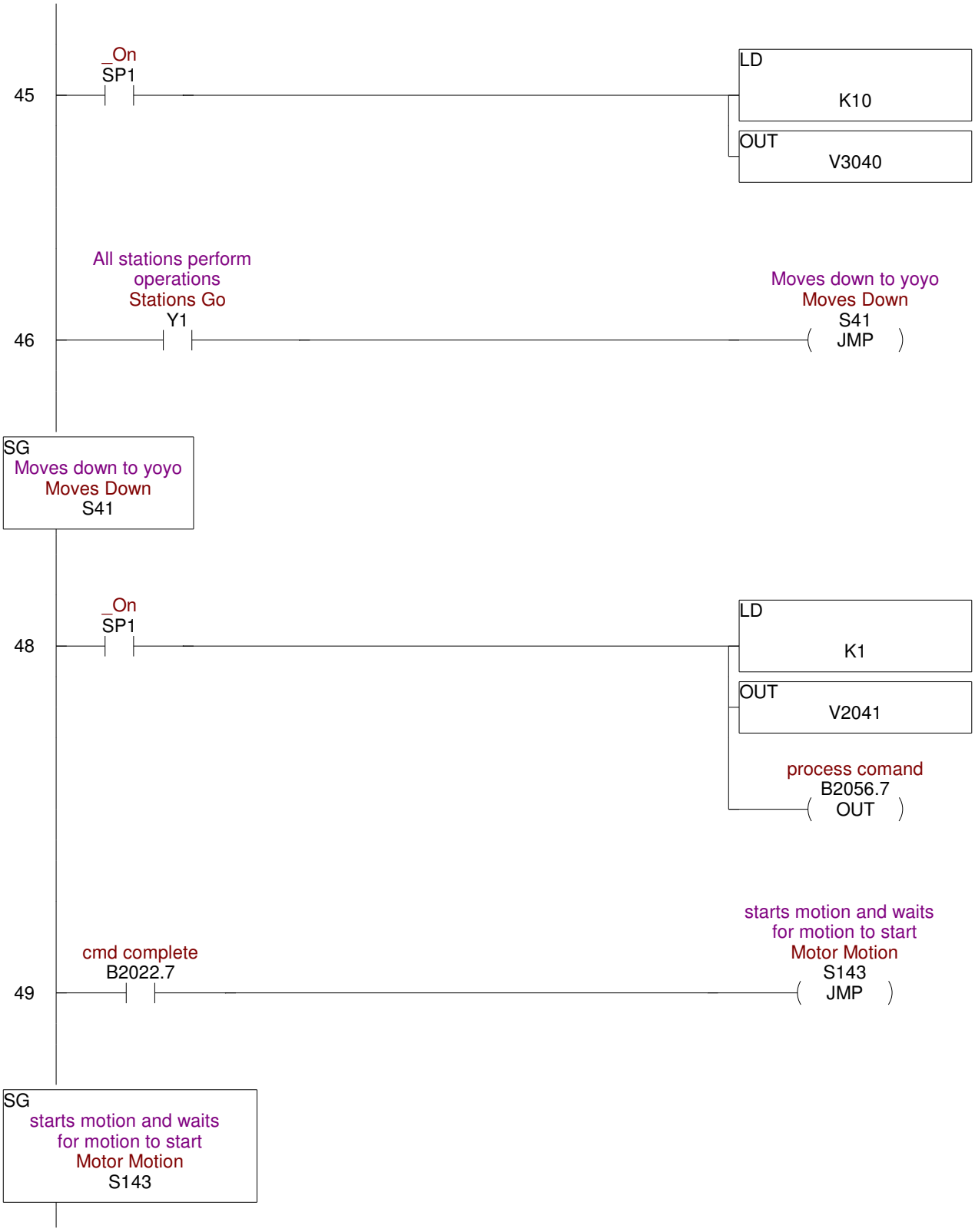

9
T3
s Turret Wait 2
Wait 2
S3
JMP
SG
s Turret Wait 2
Wait 2
S3
11
_On
SP1
T3
All stations perform
operations
Stations Go
Y1
OUT
12
Station 1 Done
cS1DONE
Y4
Station 2 Done
cS2DONE
Y5
Staiton 5 Done
Eject Done
Y10
S Turret Idle
Idle state
S0
JMP
ISG
Bearing feeder
idleStn1
S10
14
All stations perform
operations
Stations Go
Y1
X3
Bearing drop
Stn1Drop
S11
JMP
SG
Bearing drop
Stn1Drop
S11

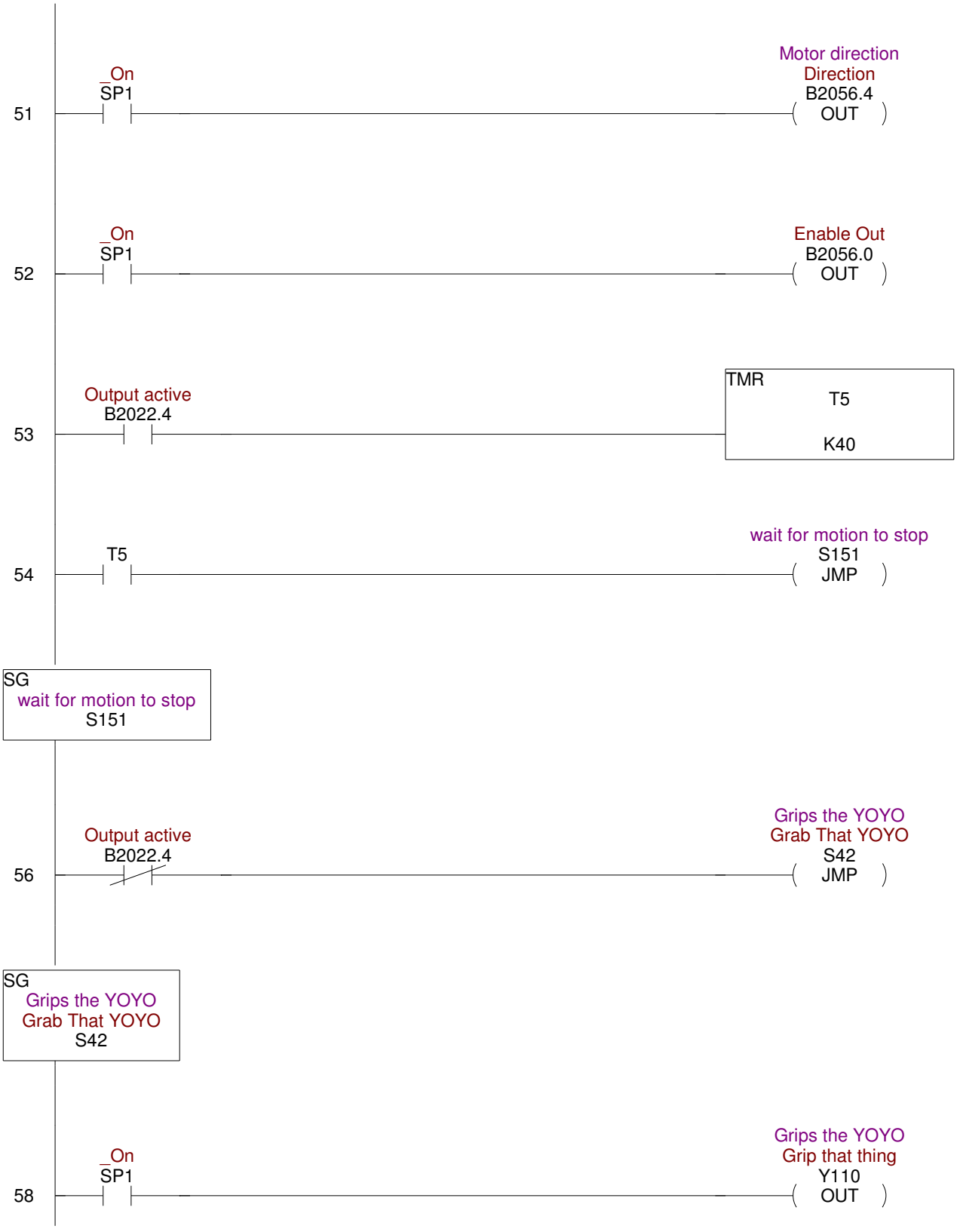

16
_On
SP1
Y103
OUT
Y104
OUT
Y105
OUT
17
_On
SP1
TMR
T0
K30
18
T0
X3
Wait for next bearing
Snt1Next
S12
JMP
SG
Wait for next bearing
Snt1Next
S12
20
_On
SP1
Station 1 Done
cS1DONE
Y4
OUT
21
X3
Station #1 Wait
sSTN1WAIT
S13
JMP
SG
Station #1 Wait
sSTN1WAIT
S13

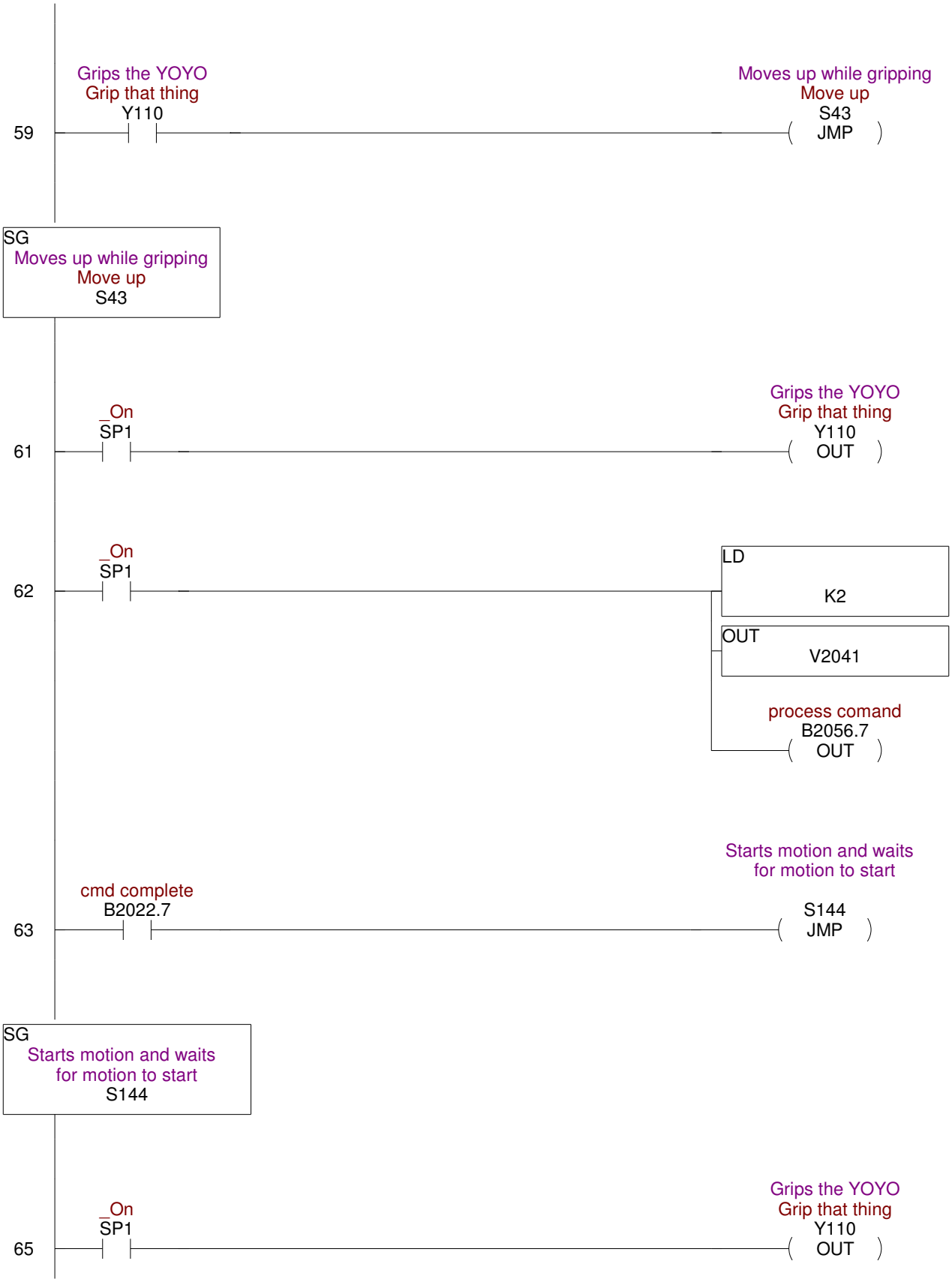

23
_On
SP1
Station 1 Done
cS1DONE
Y4
OUT
24
All stations perform
operations
Stations Go
Y1
Station #1 waits for
turret to rotate twice
ST1 EO
S14
JMP
SG
Station #1 waits for
turret to rotate twice
ST1 EO
S14
26
_On
SP1
Station 1 Done
cS1DONE
Y4
OUT
27
All stations perform
operations
Stations Go
Y1
Bearing feeder
idleStn1
S10
JMP
ISG
Station 2 idle
Station 2
S20
29
All stations perform
operations
Stations Go
Y1
Station waits for turret to
rotate again
S23
JMP

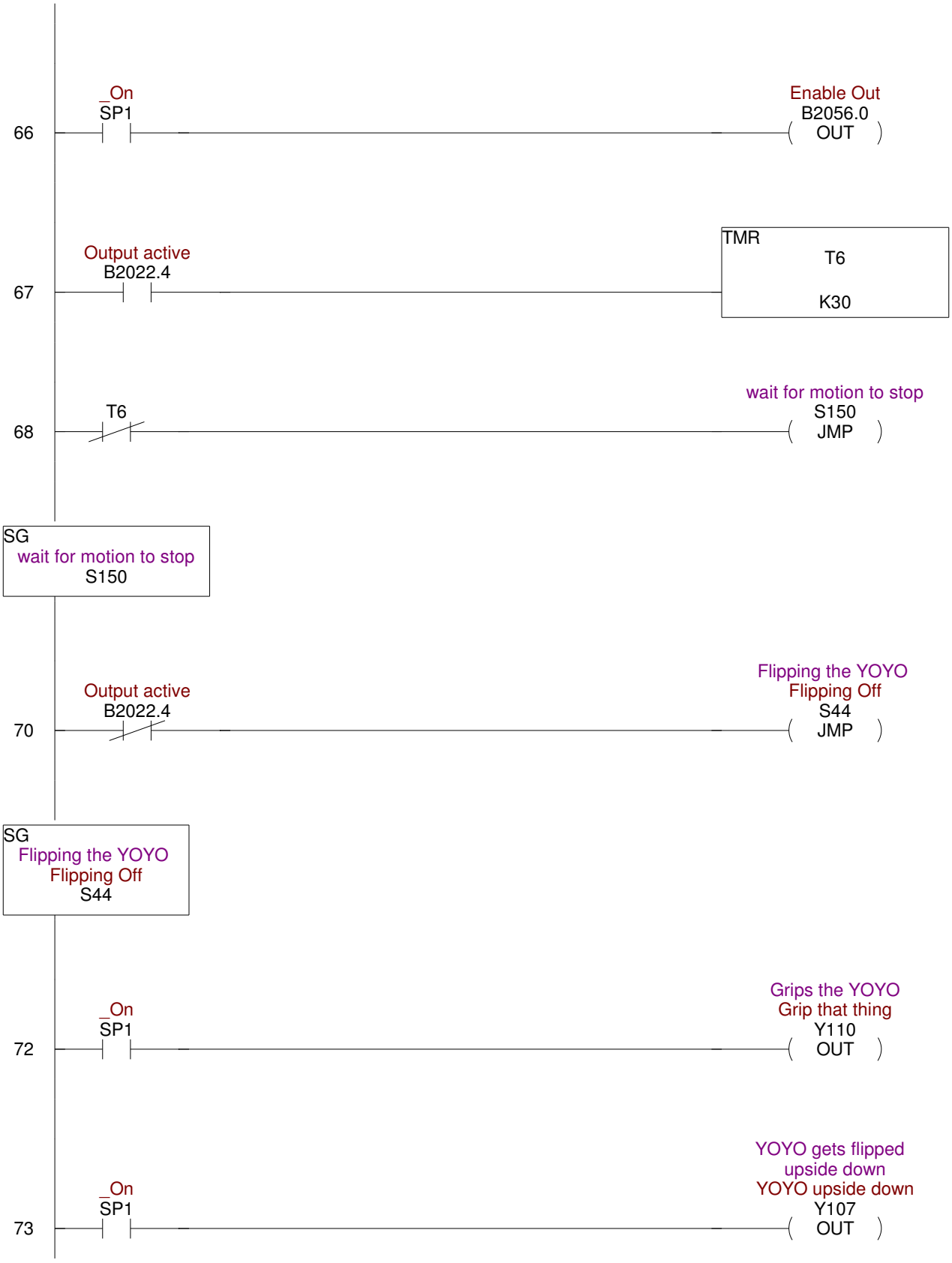

SG
Station waits for turret to rotate again
S23
31
_On
SP1
Station 2 Done
cS2DONE
Y5
OUT
32
All stations perform operations
Stations Go
Y1
Waits for turret to rotate
S25
JMP
SG
Waits for turret to rotate
S25
34
_On
SP1
Station 2 Done
cS2DONE
Y5
OUT
35
All stations perform operations
Stations Go
Y1
Pushing bearing into place
Push it
S21
JMP
SG
Pushing bearing into place
Push it
S21
37
_On
SP1
Y106
OUT

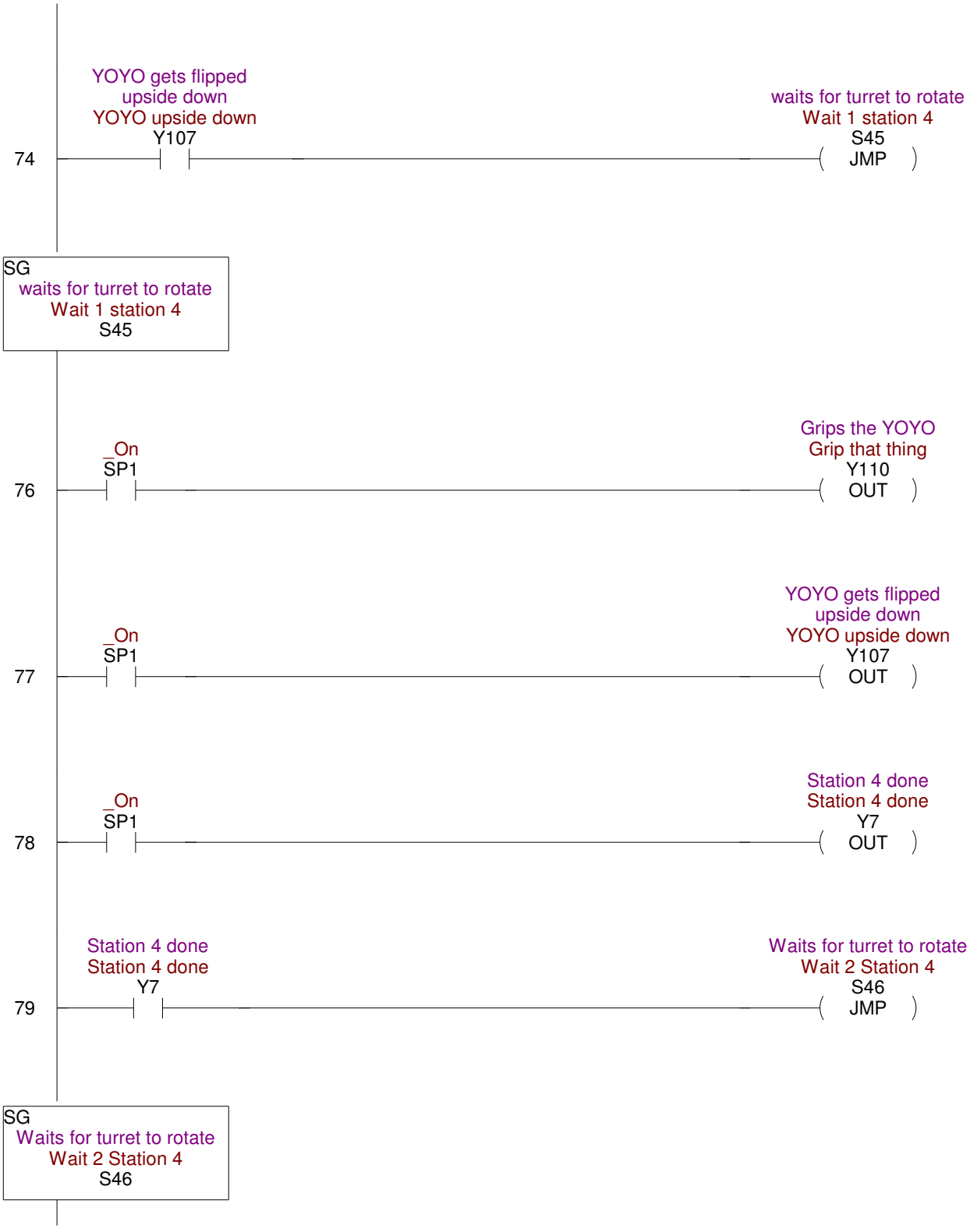

38
_On
SP1
TMR
T1
K30
39
T1
Wait state to return to idle
S22
JMP
SG
Wait state to return to idle
S22
41
_On
SP1
Station 2 Done
cS2DONE
Y5
OUT
42
All stations perform operations
Stations Go
Y1
Station 2 idle
Station 2
S20
JMP
ISG
the gripper flipper screwer station
station 4 idle
S40
44
_On
SP1
LD
K10
OUT
V2040

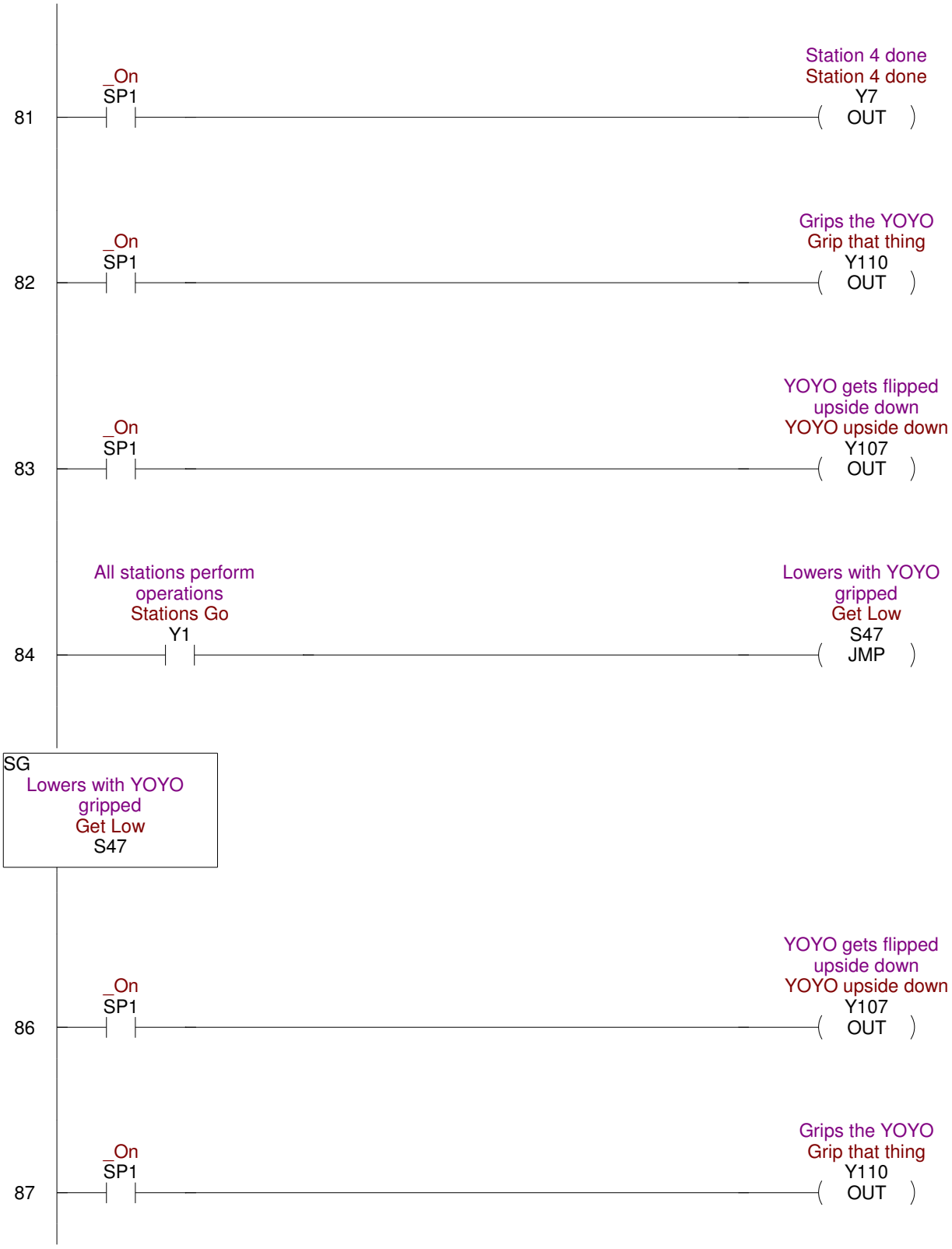

45
_On
SP1
LD
K10
OUT
V3040
All stations perform
operations
Stations Go
Y1
46
Moves down to yoyo
Moves Down
S41
JMP
SG
Moves down to yoyo
Moves Down
S41
48
_On
SP1
LD
K1
OUT
V2041
process comand
B2056.7
OUT
starts motion and waits
for motion to start
Motor Motion
S143
JMP
cmd complete
B2022.7
49
SG
starts motion and waits
for motion to start
Motor Motion
S143

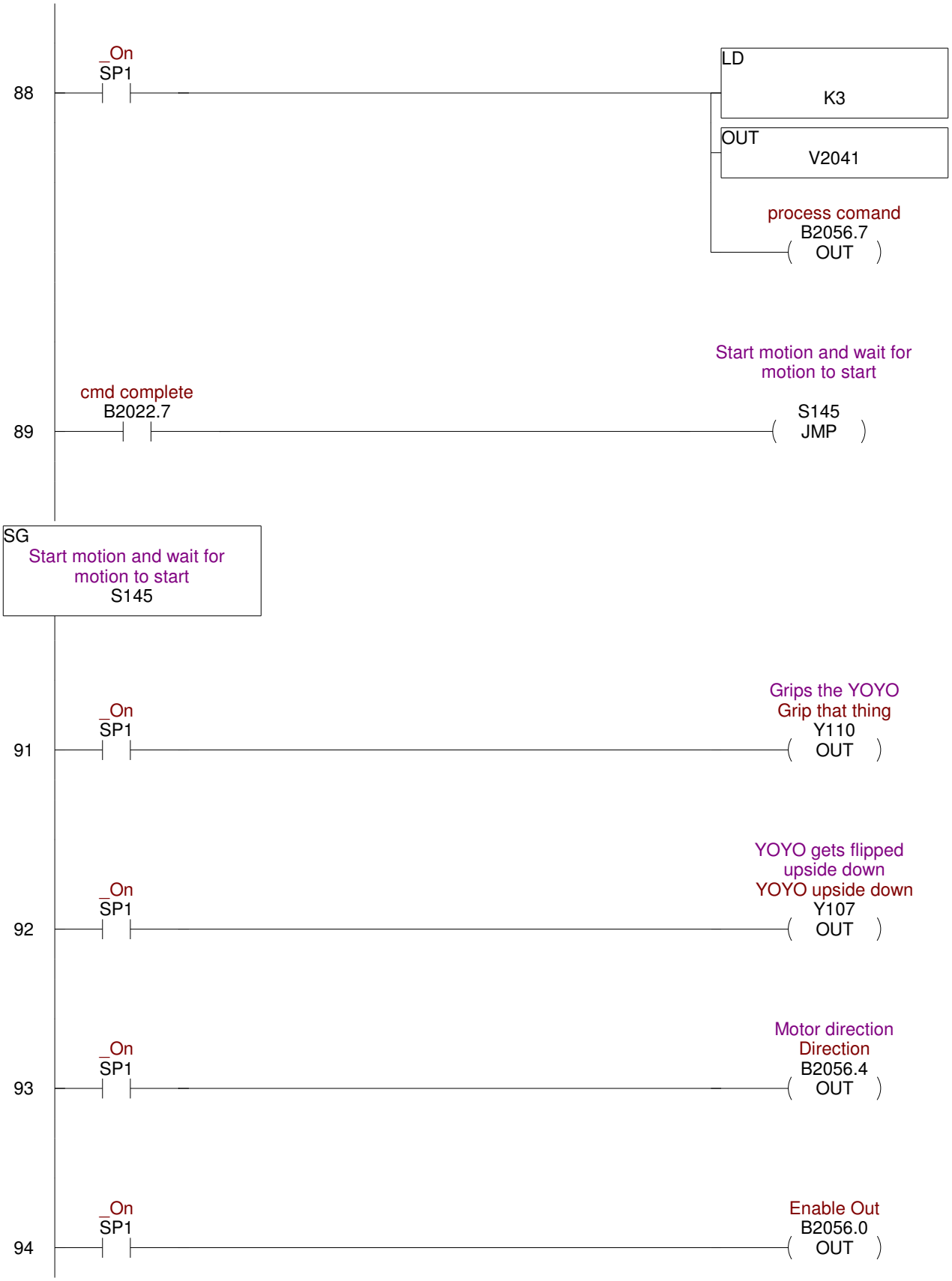

51
_On
SP1
Motor direction
Direction
B2056.4
OUT
52
_On
SP1
Enable Out
B2056.0
OUT
53
Output active
B2022.4
TMR
T5
K40
54
T5
wait for motion to stop
S151
JMP
SG
wait for motion to stop
S151
56
Output active
B2022.4
Grips the YOYO
Grab That YOYO
S42
JMP
SG
Grips the YOYO
Grab That YOYO
S42
58
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT

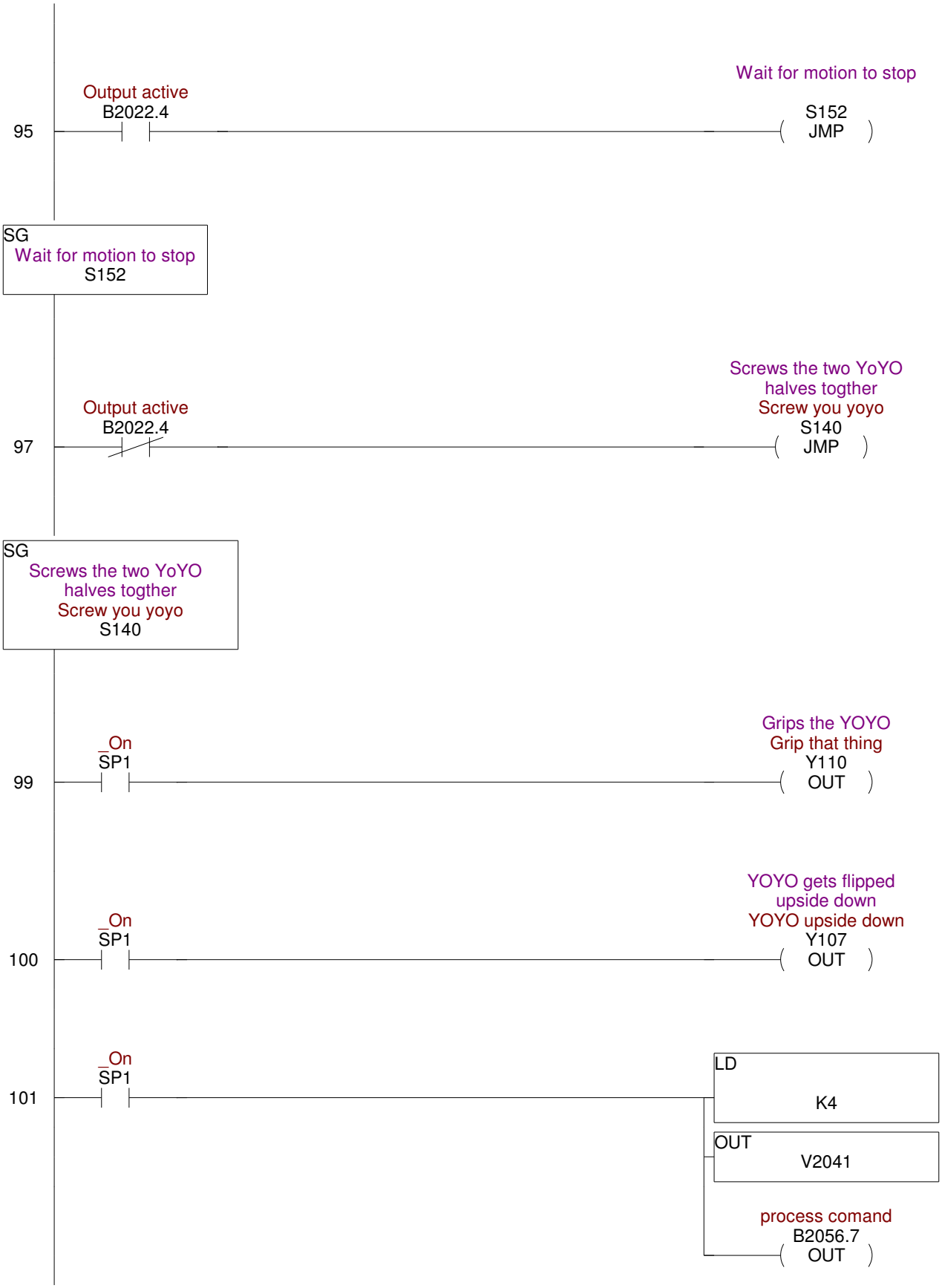

Grips the YOYO
Grip that thing
Y110
59
Moves up while gripping
Move up
S43
JMP
SG
Moves up while gripping
Move up
S43
_On
SP1
61
Grips the YOYO
Grip that thing
Y110
OUT
_On
SP1
62
LD
K2
OUT
V2041
process comand
B2056.7
OUT
Starts motion and waits
for motion to start
cmd complete
B2022.7
63
S144
JMP
SG
Starts motion and waits
for motion to start
S144
_On
SP1
65
Grips the YOYO
Grip that thing
Y110
OUT

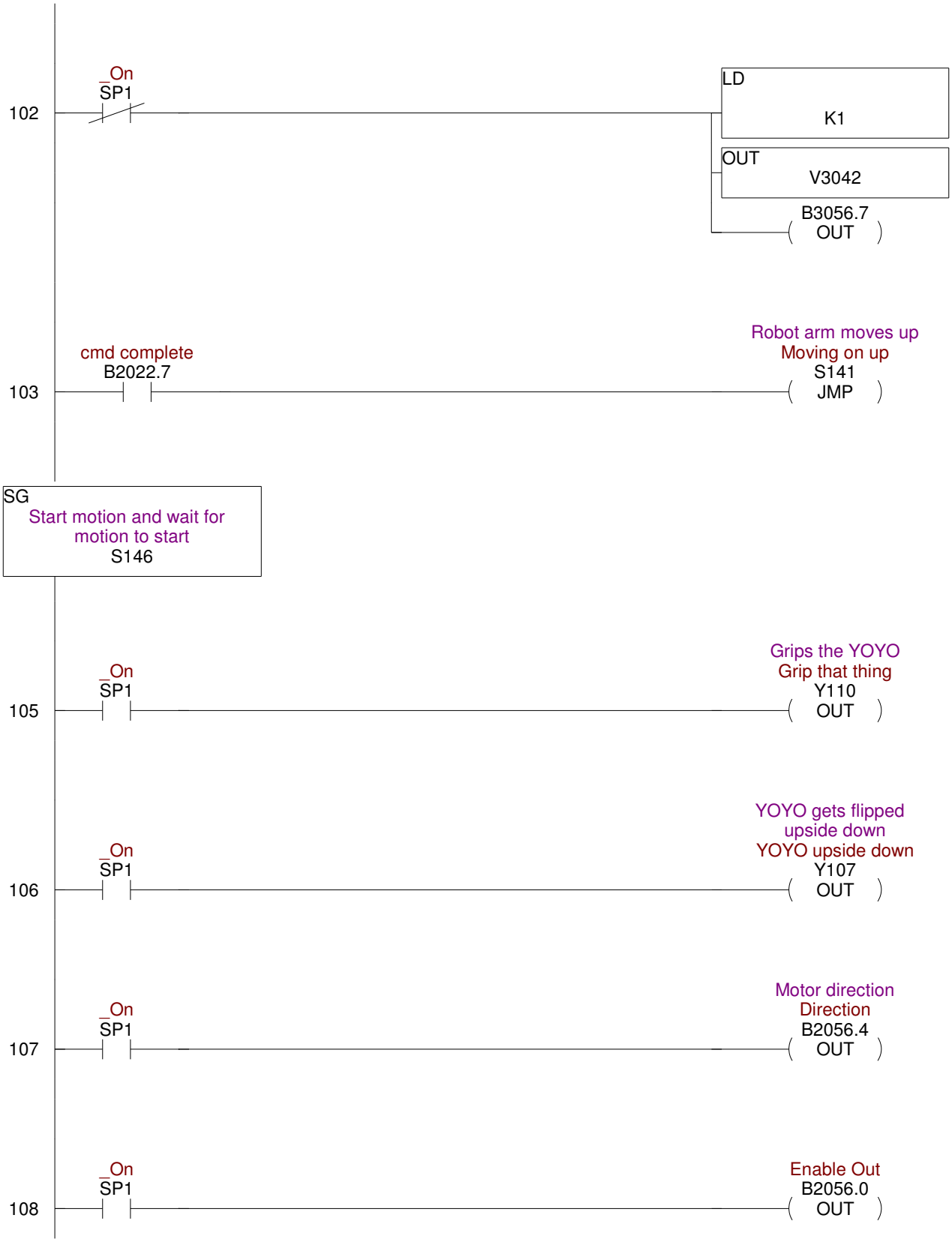

66
_On
SP1
Enable Out
B2056.0
OUT
67
Output active
B2022.4
TMR
T6
K30
68
T6
wait for motion to stop
S150
JMP
SG
wait for motion to stop
S150
70
Output active
B2022.4
Flipping the YOYO
Flipping Off
S44
JMP
SG
Flipping the YOYO
Flipping Off
S44
72
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT
73
_On
SP1
YOYO gets flipped
upside down
YOYO upside down
Y107
OUT

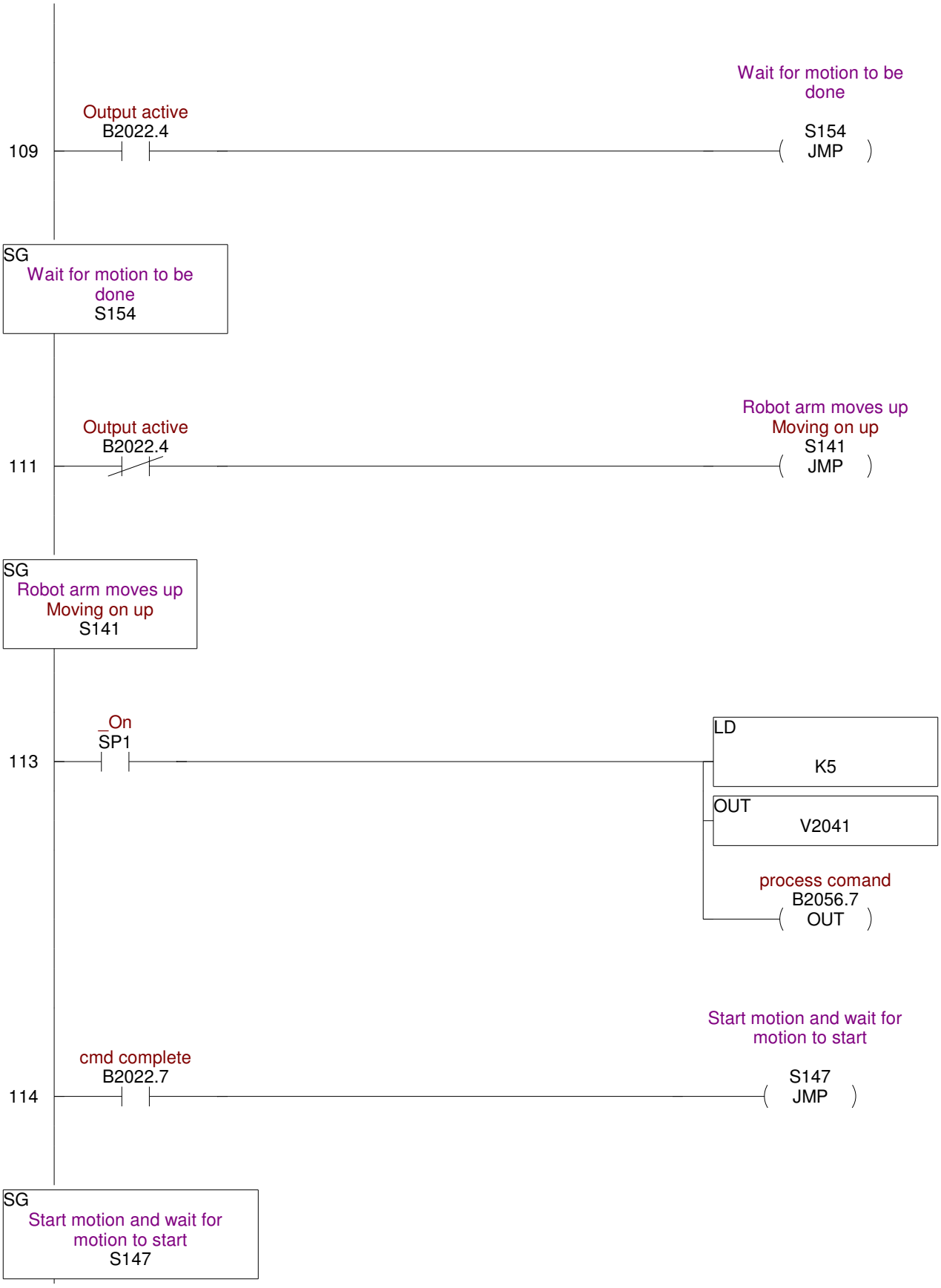

YOYO gets flipped
upside down
YOYO upside down
Y107
74
waits for turret to rotate
Wait 1 station 4
S45
JMP
SG
waits for turret to rotate
Wait 1 station 4
S45
_On
SP1
76
Grips the YOYO
Grip that thing
Y110
OUT
_On
SP1
77
YOYO gets flipped
upside down
YOYO upside down
Y107
OUT
_On
SP1
78
Station 4 done
Station 4 done
Y7
OUT
Station 4 done
Station 4 done
Y7
79
Waits for turret to rotate
Wait 2 Station 4
S46
JMP
SG
Waits for turret to rotate
Wait 2 Station 4
S46

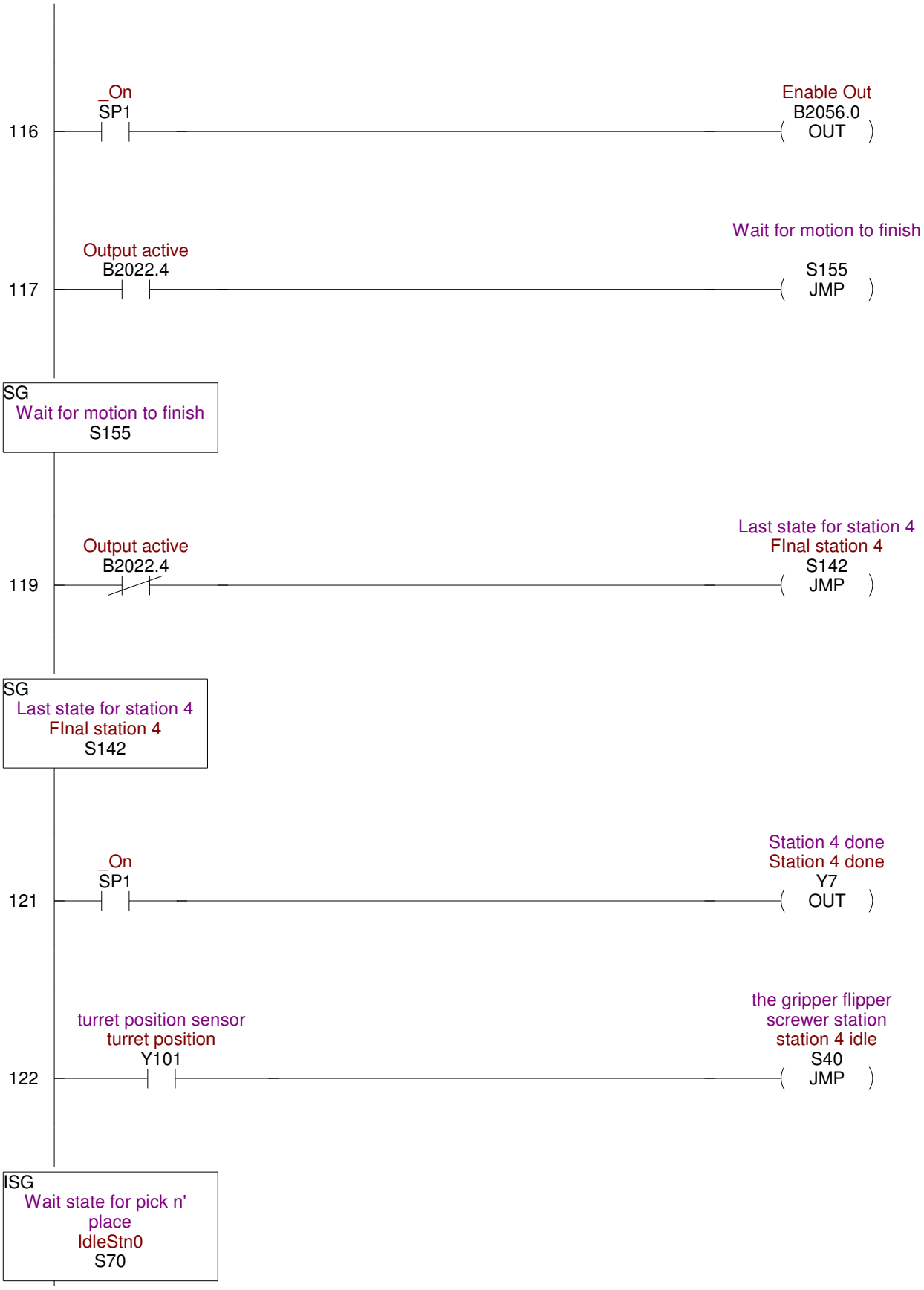

81
_On
SP1
Station 4 done
Station 4 done
Y7
OUT
82
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT
83
_On
SP1
YOYO gets flipped
upside down
YOYO upside down
Y107
OUT
84
All stations perform
operations
Stations Go
Y1
Lowers with YOYO
gripped
Get Low
S47
JMP
SG
Lowers with YOYO
gripped
Get Low
S47
86
_On
SP1
YOYO gets flipped
upside down
YOYO upside down
Y107
OUT
87
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT

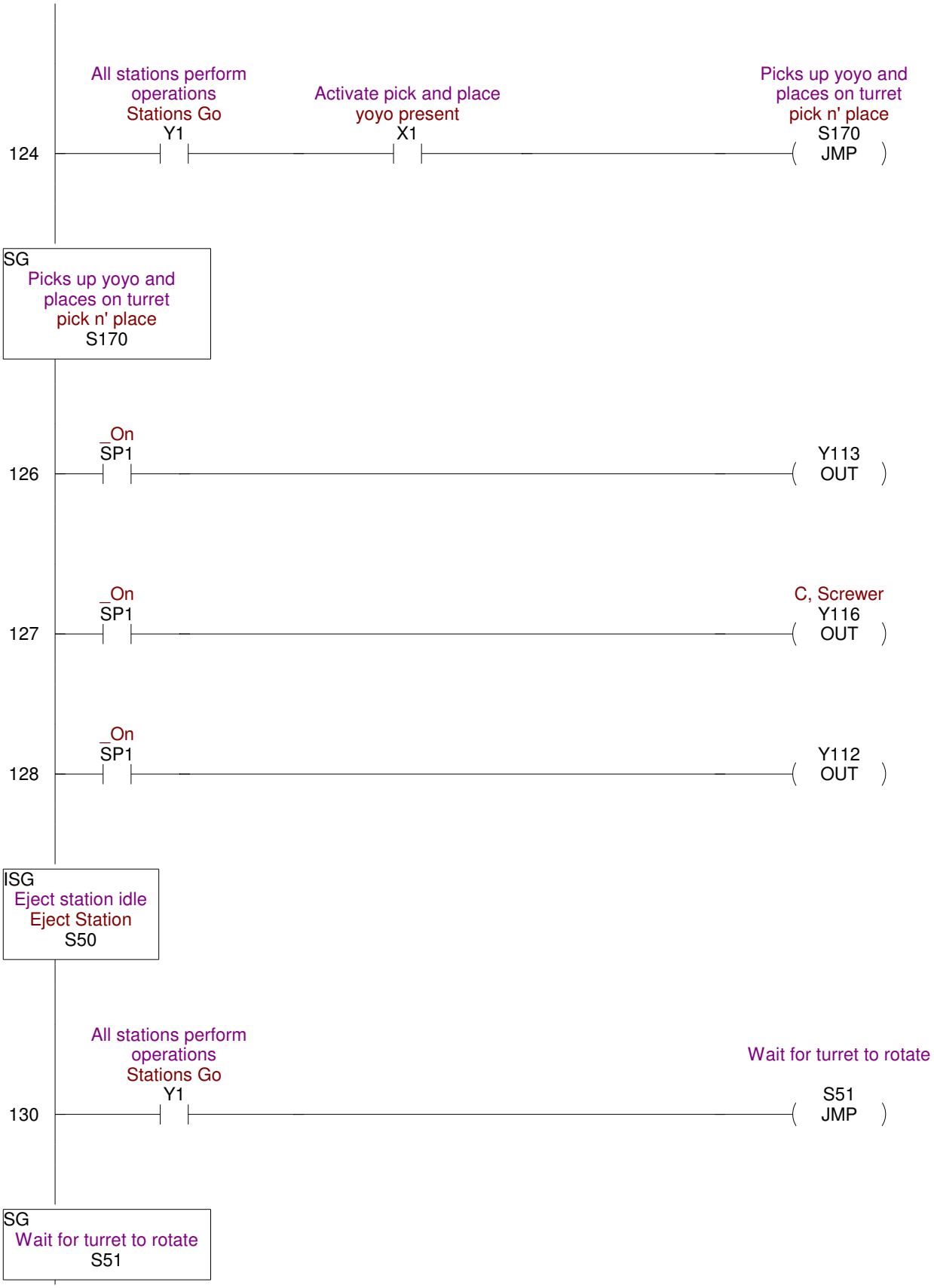

88
_On
SP1
LD
K3
OUT
V2041
process comand
B2056.7
OUT
Start motion and wait for
motion to start
89
cmd complete
B2022.7
S145
JMP
SG
Start motion and wait for
motion to start
S145
91
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT
92
_On
SP1
YOYO gets flipped
upside down
YOYO upside down
Y107
OUT
93
_On
SP1
Motor direction
Direction
B2056.4
OUT
94
_On
SP1
Enable Out
B2056.0
OUT

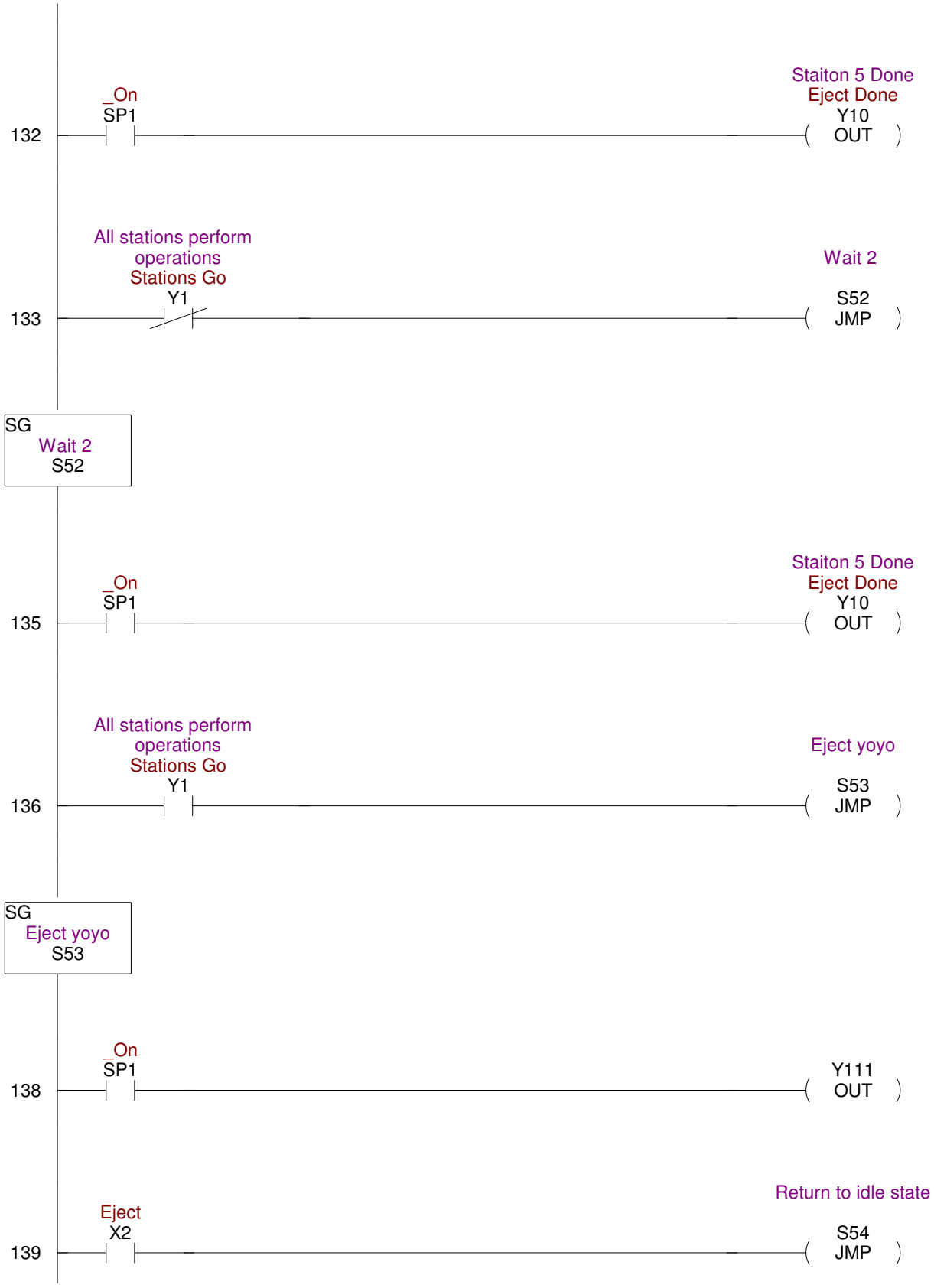

95
Output active
B2022.4
Wait for motion to stop
S152
JMP
SG
Wait for motion to stop
S152
97
Output active
B2022.4
Screws the two YoYO halves togther
Screw you yoyo
S140
JMP
SG
Screws the two YoYO halves togther
Screw you yoyo
S140
99
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT
100
_On
SP1
YOYO gets flipped upside down
YOYO upside down
Y107
OUT
101
_On
SP1
LD
K4
OUT
V2041
process comand
B2056.7
OUT

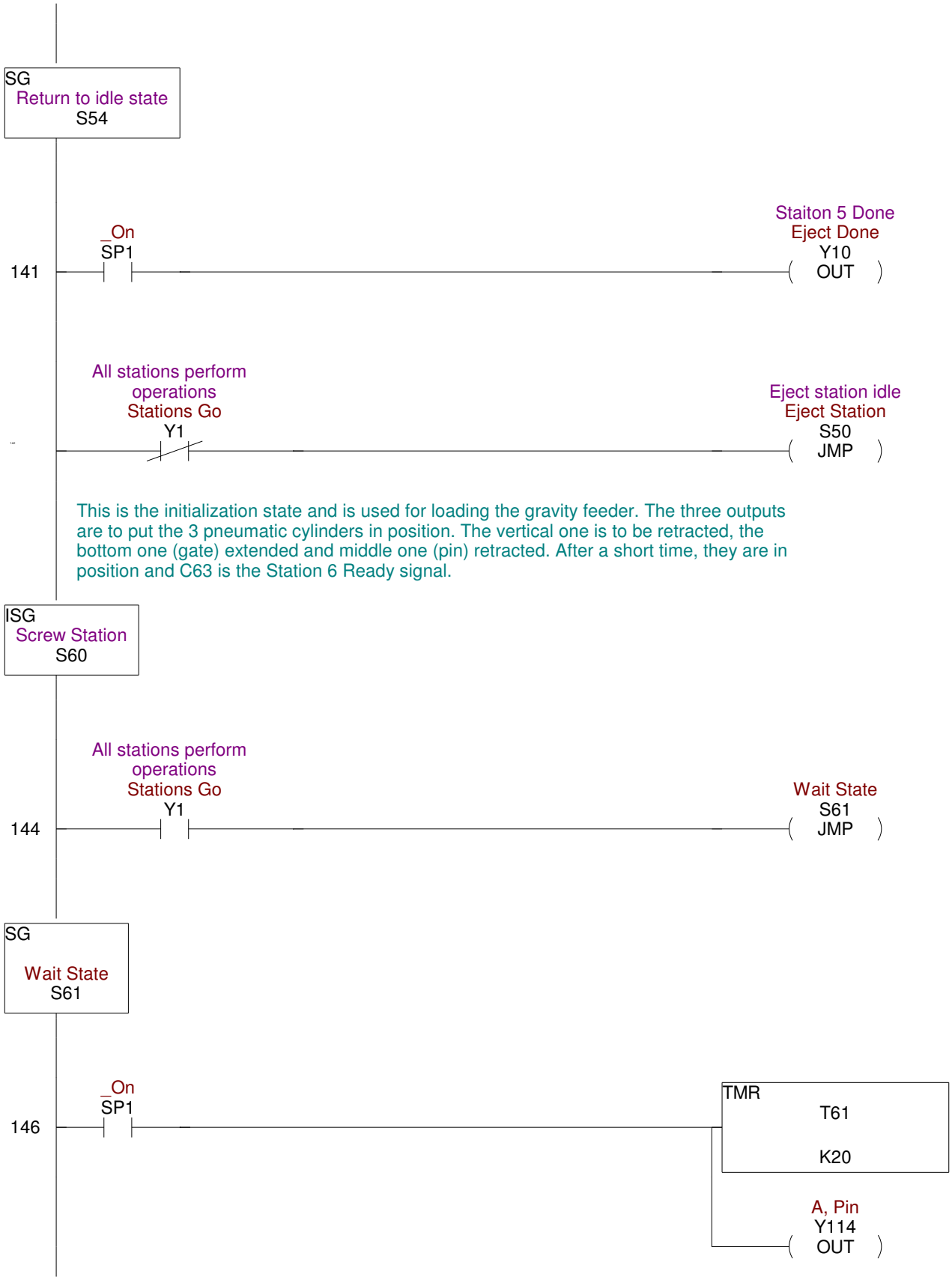

102
_On
SP1
LD
K1
OUT
V3042
B3056.7
OUT
103
cmd complete
B2022.7
Robot arm moves up
Moving on up
S141
JMP
SG
Start motion and wait for
motion to start
S146
105
_On
SP1
Grips the YOYO
Grip that thing
Y110
OUT
106
_On
SP1
YOYO gets flipped
upside down
YOYO upside down
Y107
OUT
107
_On
SP1
Motor direction
Direction
B2056.4
OUT
108
_On
SP1
Enable Out
B2056.0
OUT

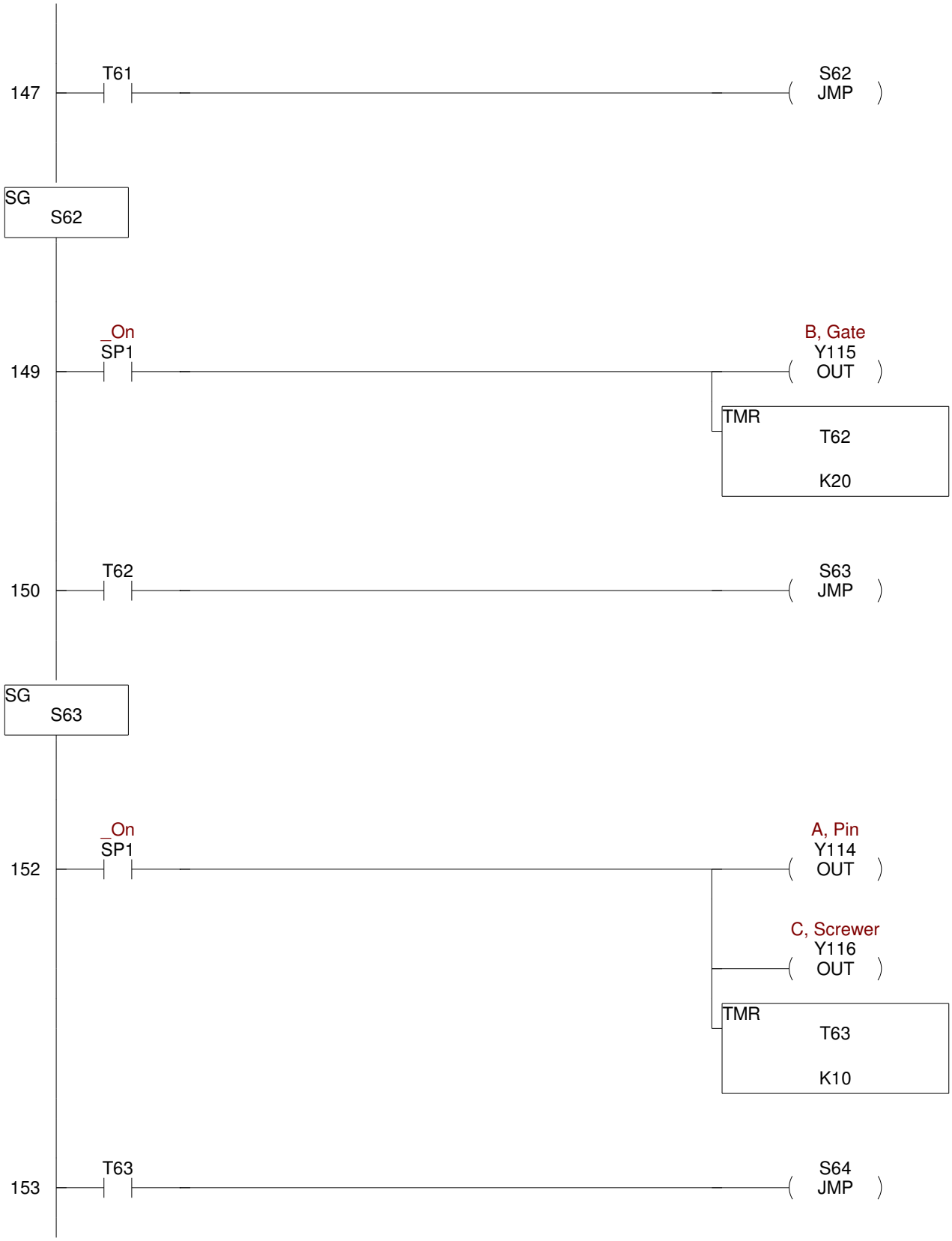

Wait for motion to be done
Output active
B2022.4
109
S154
JMP
SG
Wait for motion to be done
S154
Robot arm moves up Moving on up
Output active
B2022.4
111
S141
JMP
SG
Robot arm moves up Moving on up
S141
_On
SP1
113
LD
K5
OUT
V2041
process comand
B2056.7
OUT
Start motion and wait for motion to start
cmd complete
B2022.7
114
S147
JMP
SG
Start motion and wait for motion to start
S147

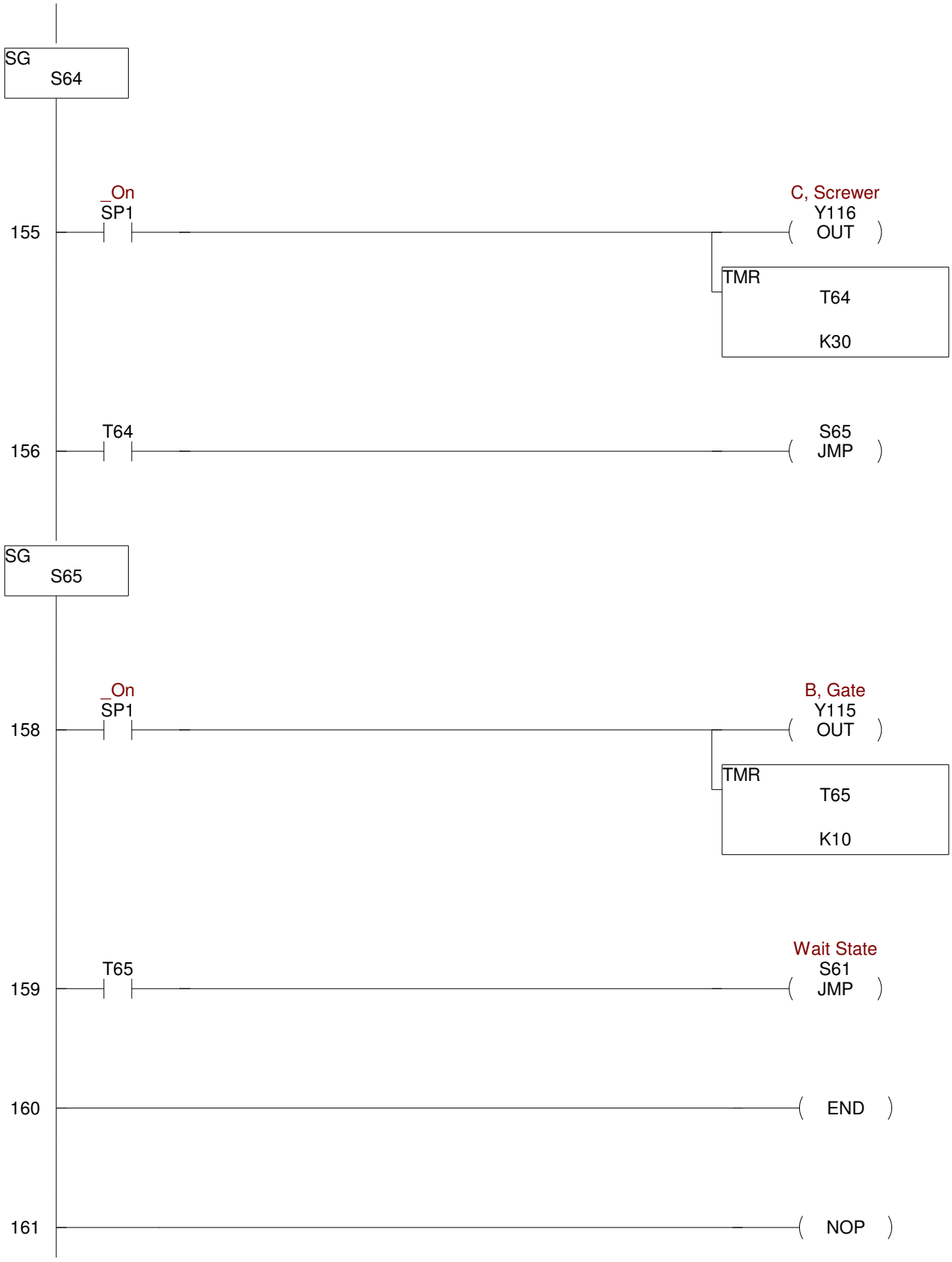

116
_On
SP1
Enable Out
B2056.0
OUT
117
Output active
B2022.4
Wait for motion to finish
S155
JMP
SG
Wait for motion to finish
S155
119
Output active
B2022.4
Last state for station 4
FInal station 4
S142
JMP
SG
Last state for station 4
FInal station 4
S142
121
_On
SP1
Station 4 done
Station 4 done
Y7
OUT
122
turret position sensor
turret position
Y101
the gripper flipper
screwer station
station 4 idle
S40
JMP
ISG
Wait state for pick n'
place
IdleStn0
S70


All stations perform operations
Stations Go
Y1
Activate pick and place yoyo present
X1
Picks up yoyo and places on turret pick n' place
S170
JMP
124
SG
Picks up yoyo and places on turret pick n' place
S170
_On
SP1
Y113
OUT
126
_On
SP1
C, Screwer
Y116
OUT
127
_On
SP1
Y112
OUT
128
ISG
Eject station idle
Eject Station
S50
All stations perform operations
Stations Go
Y1
Wait for turret to rotate
S51
JMP
130
SG
Wait for turret to rotate
S51


132
_On
SP1
Staiton 5 Done
Eject Done
Y10
OUT
133
All stations perform
operations
Stations Go
Y1
Wait 2
S52
JMP
SG
Wait 2
S52
135
_On
SP1
Staiton 5 Done
Eject Done
Y10
OUT
136
All stations perform
operations
Stations Go
Y1
Eject yoyo
S53
JMP
SG
Eject yoyo
S53
138
_On
SP1
Y111
OUT
139
Eject
X2
Return to idle state
S54
JMP


SG
Return to idle state
S54
_On
SP1
141
Staiton 5 Done
Eject Done
Y10
OUT
All stations perform
operations
Stations Go
Y1
Eject station idle
Eject Station
S50
JMP
This is the initialization state and is used for loading the gravity feeder. The three outputs are to put the 3 pneumatic cylinders in position. The vertical one is to be retracted, the bottom one (gate) extended and middle one (pin) retracted. After a short time, they are in position and C63 is the Station 6 Ready signal.
ISG
Screw Station
S60
All stations perform
operations
Stations Go
Y1
144
Wait State
S61
JMP
SG
Wait State
S61
_On
SP1
146
TMR
T61
K20
A, Pin
Y114
OUT


147
T61
S62
JMP
SG
S62
149
_On
SP1
B, Gate
Y115
OUT
TMR
T62
K20
150
T62
S63
JMP
SG
S63
152
_On
SP1
A, Pin
Y114
OUT
C, Screwer
Y116
OUT
TMR
T63
K10
153
T63
S64
JMP


SG
S64
_On
SP1
155
C, Screwer
Y116
OUT
TMR
T64
K30
T64
156
S65
JMP
SG
S65
_On
SP1
158
B, Gate
Y115
OUT
TMR
T65
K10
Wait State
T65
S61
159
JMP
160
END
161
NOP