ROBOT HEADLAMP ASSEMBLY PROJECT

ENGR 480

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Introduction:

This manual provides a list of instructional material, figures, and wiring diagrams, which is crucial to the operation of this machine.

Loading the Machine:

To load the machine, the back of the headlamp must be on side A in Track 1. The chip pack must be loaded on side B in track 3, and the top on side A in track 2. This loading can be done in any method as long as the parts land in the track without shingling or being in the wrong orientation. Orientation is as it should be in the assembled part, the back should be on the bottom, the chip oriented with the lens up, and the top with the outside up. Use the following images as a reference.

Figure 1: Tracks (SIDE A left, SIDE B right)

Starting the Machine:

The main power switch must be in the “on” position. The startup time of the robot arm is a few minutes. While it's starting up you should verify the PLC and Air systems are correctly connected. The key on the teach pendant must be in the “play” position. After making all the checks, press the onscreen button labeled “jobs” use the arrow pad to navigate to “flash11” and selected it. Then press the “start” button. Watch the system for a few cycles to ensure proper operation. If something is not right, depress the red emergency stop button on the pendant. The robot arm should move to track 1, retrieve the back housing part, and place it in the assembly jig. The robot should then retrieve the chip unit from track 3, and place it in the back housing. Finally, the robot will retrieve the front housing part and place it. After placing, the robot will check the alignment of the housing pieces, then snap them together. Once

snapped together, the robot will move to a waiting position, while the PLC opens the valves to cycle the ejection pneumatics to push the headlamp out of the assembly jig and on to the next stage of production.

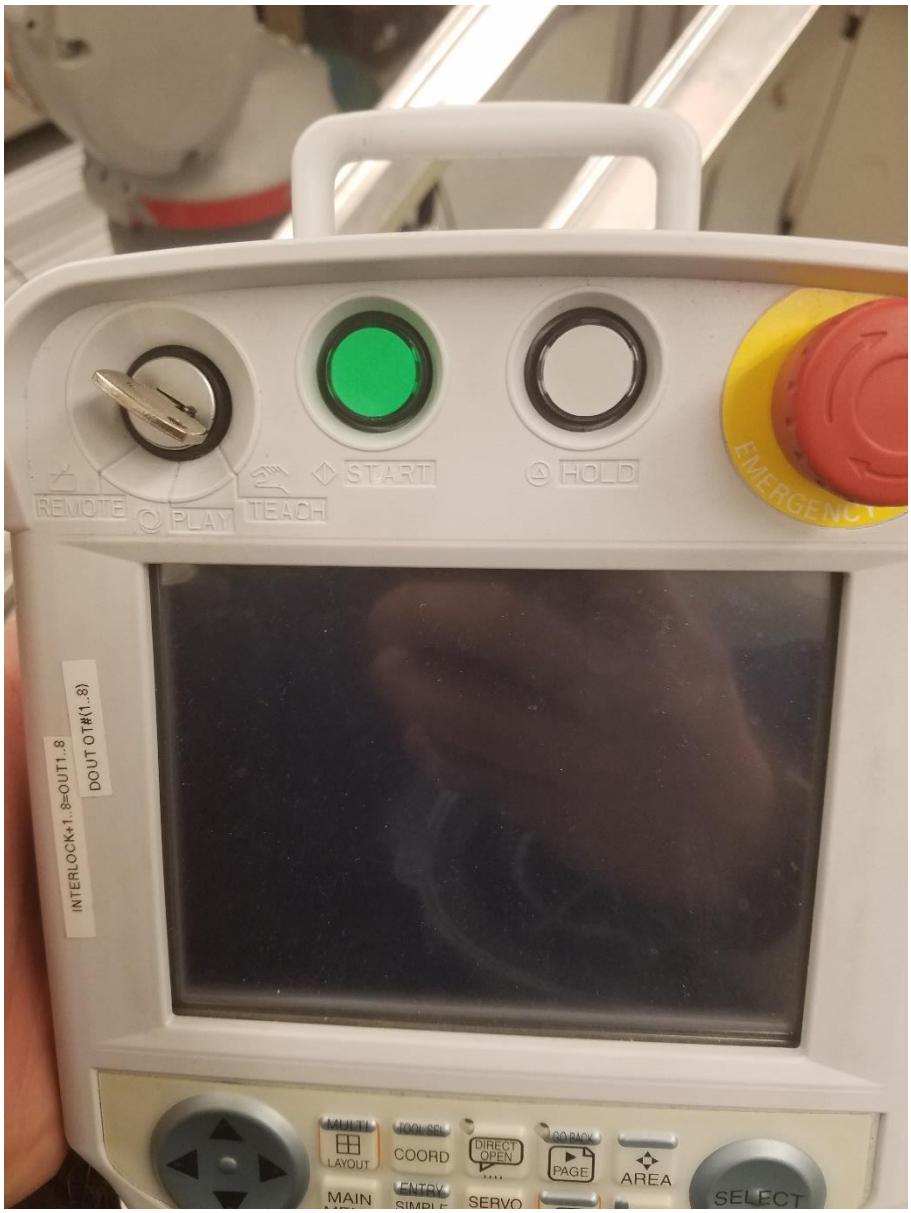


Figure 2: Motoman pendant

Clearing Jams:

If the parts become jammed or misaligned, press the emergency stop button on the pendant, then give the robot the home command and the release gripper command. After that, remove the jammed or misaligned parts and restart the assembly process, if the jam persists the tracks or the assembly jig may need to be adjusted.

Mechanical drawings and annotated photos:

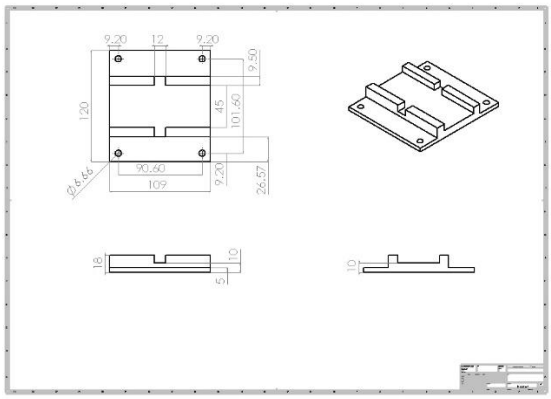


Figure 3: Assembly Jig

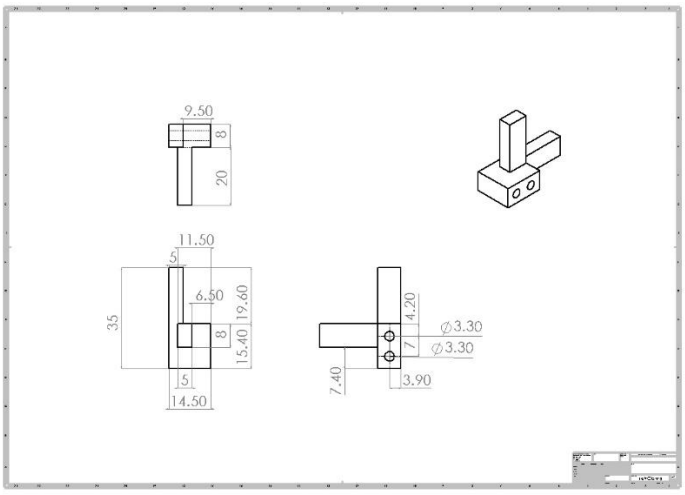


Figure 4: Gripper

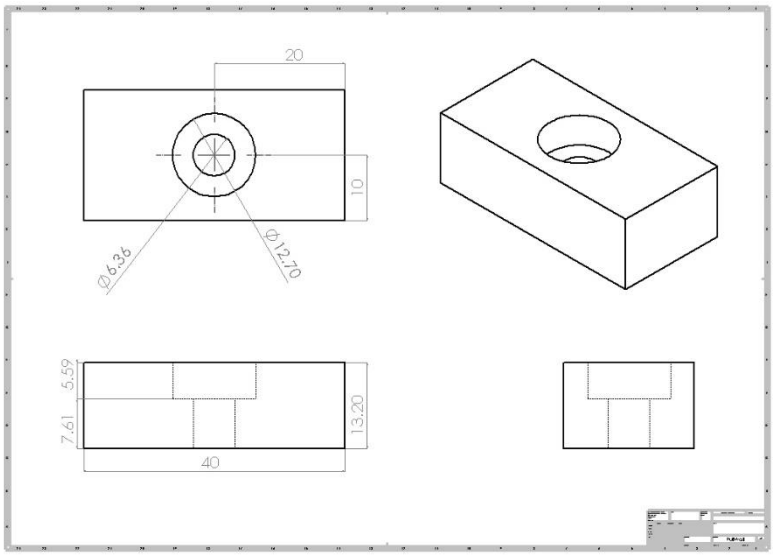


Figure 5: Push Wall

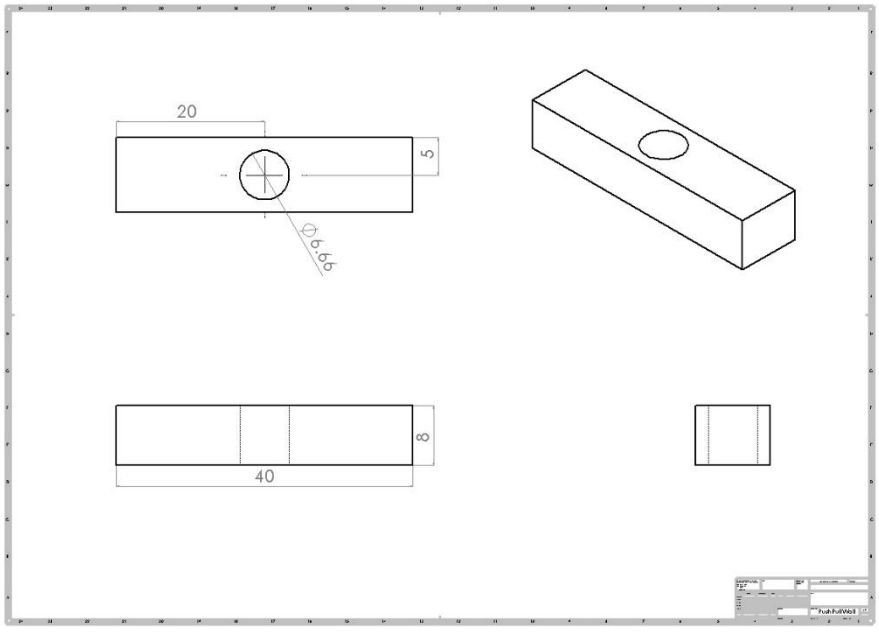
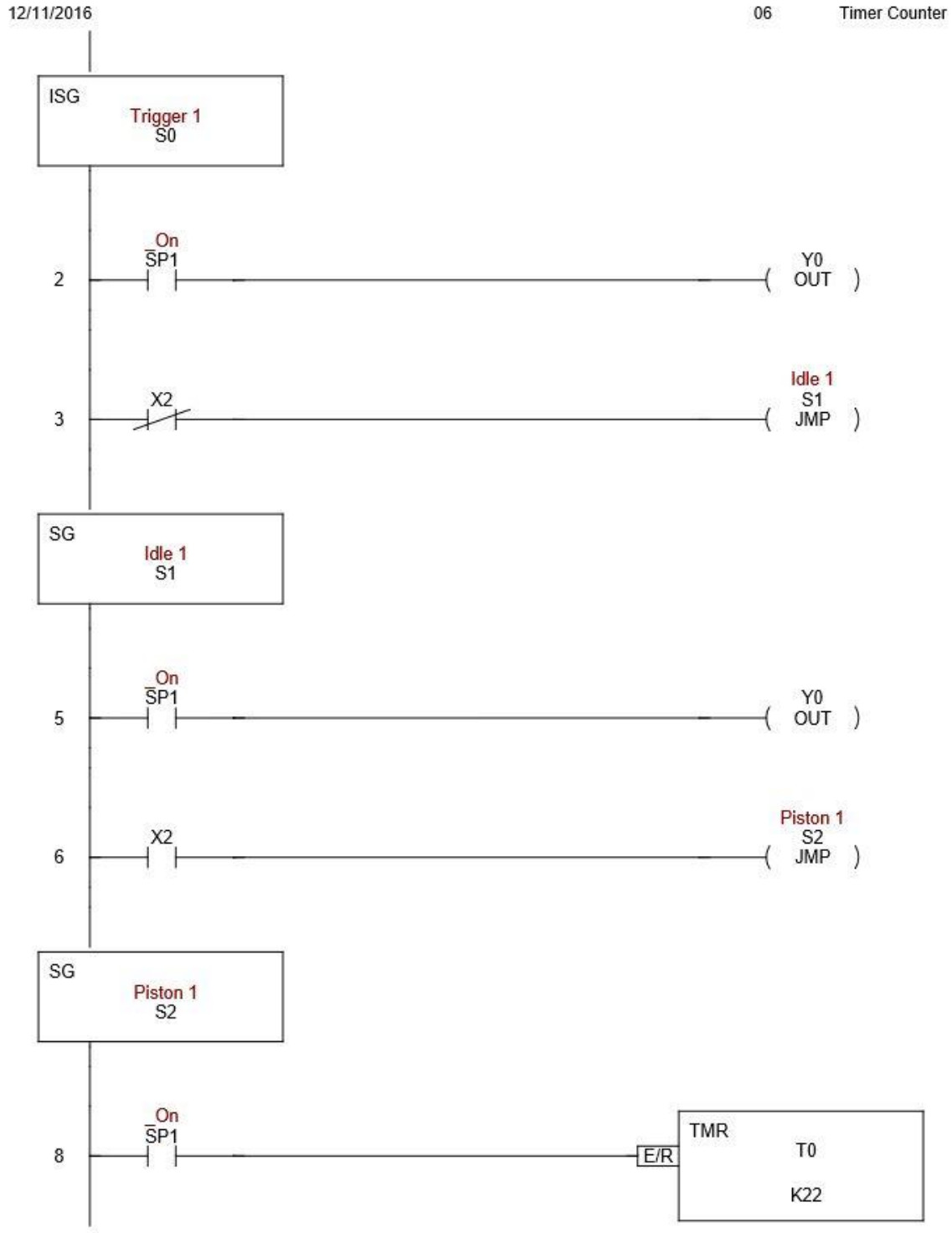


Figure 6: Pull Wall

PLC logic: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2
On
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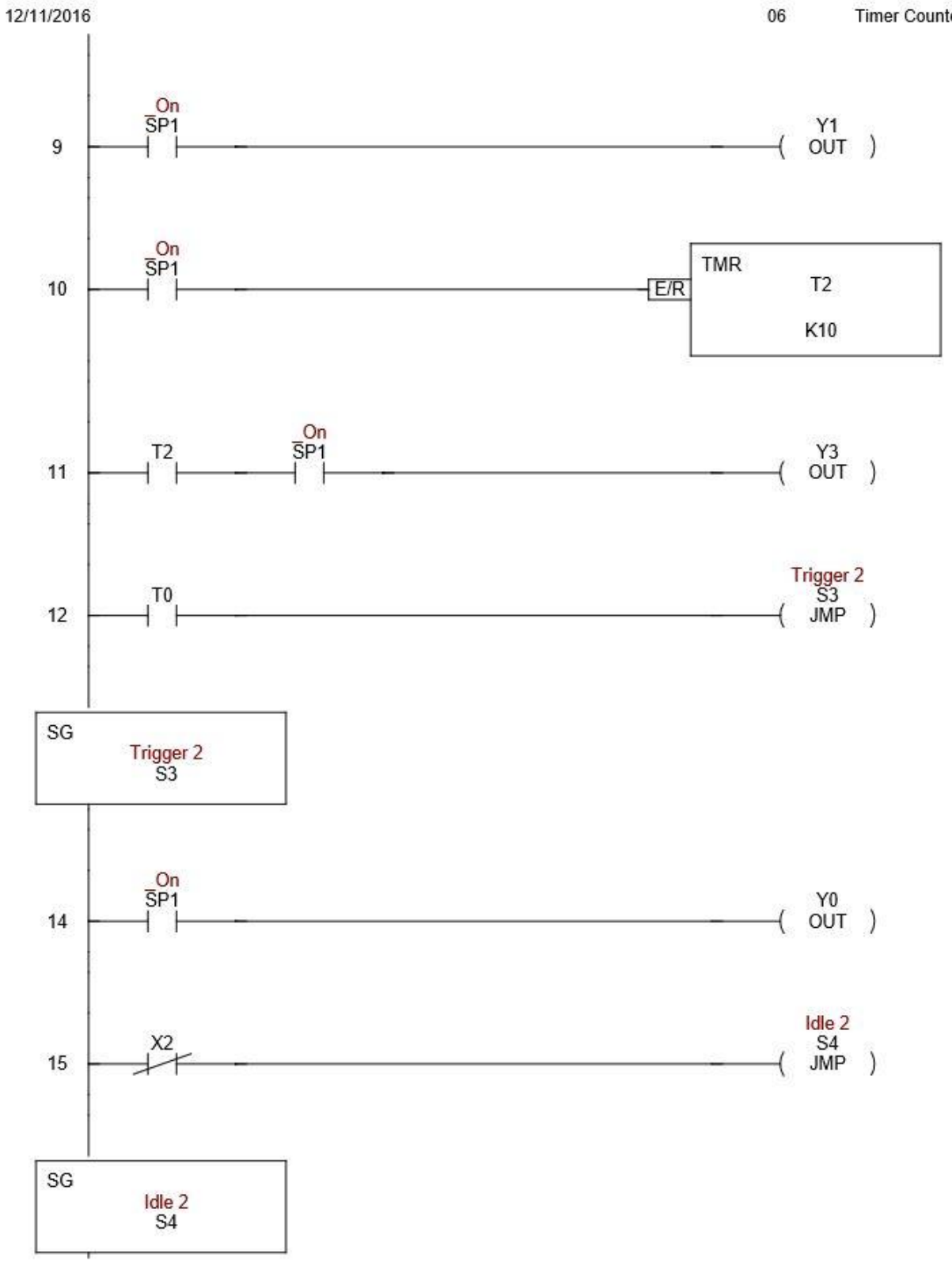
Y0
OUT
3
X2
Idle 1
S1
JMP
SG
Idle 1
S1
5
On
SP1
Y0
OUT
6
X2
Piston 1
S2
JMP
SG
Piston 1
S2
8
On
SP1
E/R
TMR
T0
K22
Page 2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T2
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11
T2
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SP1
Y3
OUT
12
T0
Trigger 2
S3
JMP
SG
Trigger 2
S3
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On
SP1
Y0
OUT
15
X2
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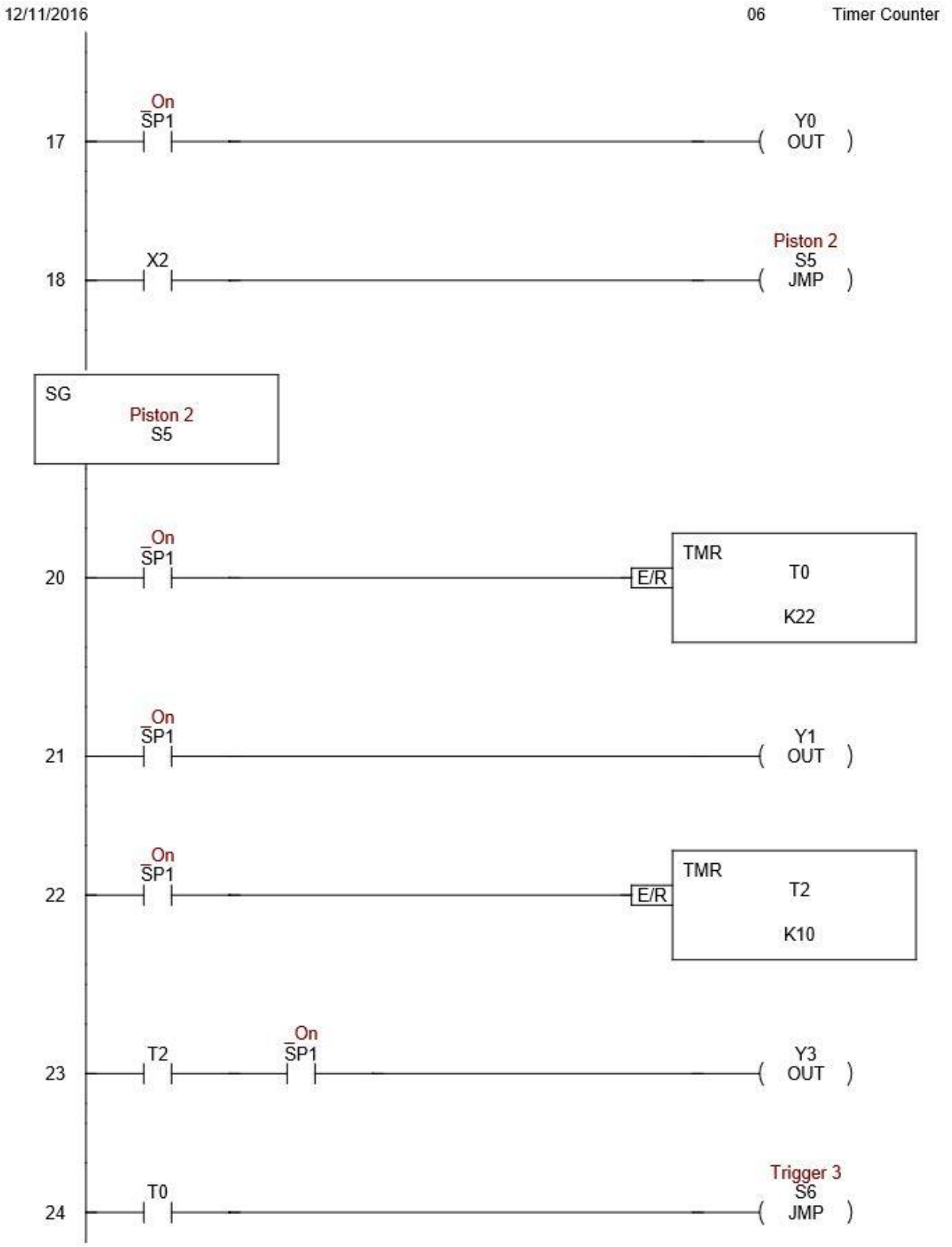
S4
JMP
SG
Idle 2
S4

Page 3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E/R
TMR
T0
K22
21
On
SP1
Y1
OUT
22
On
SP1
E/R
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T2
K10
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T2
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SP1
Y3
OUT
24
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Trigger 3
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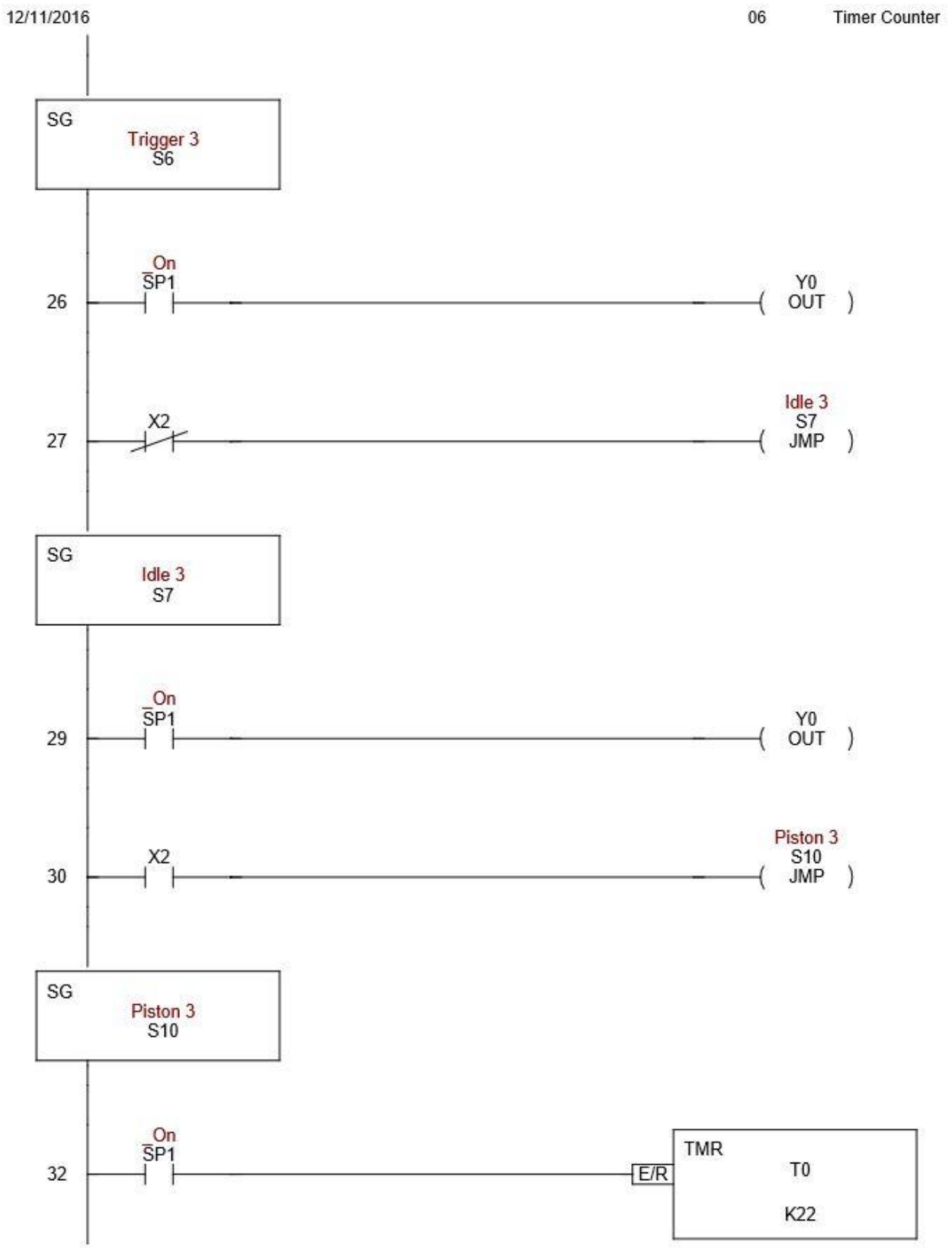
JMP
Page 4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SP1
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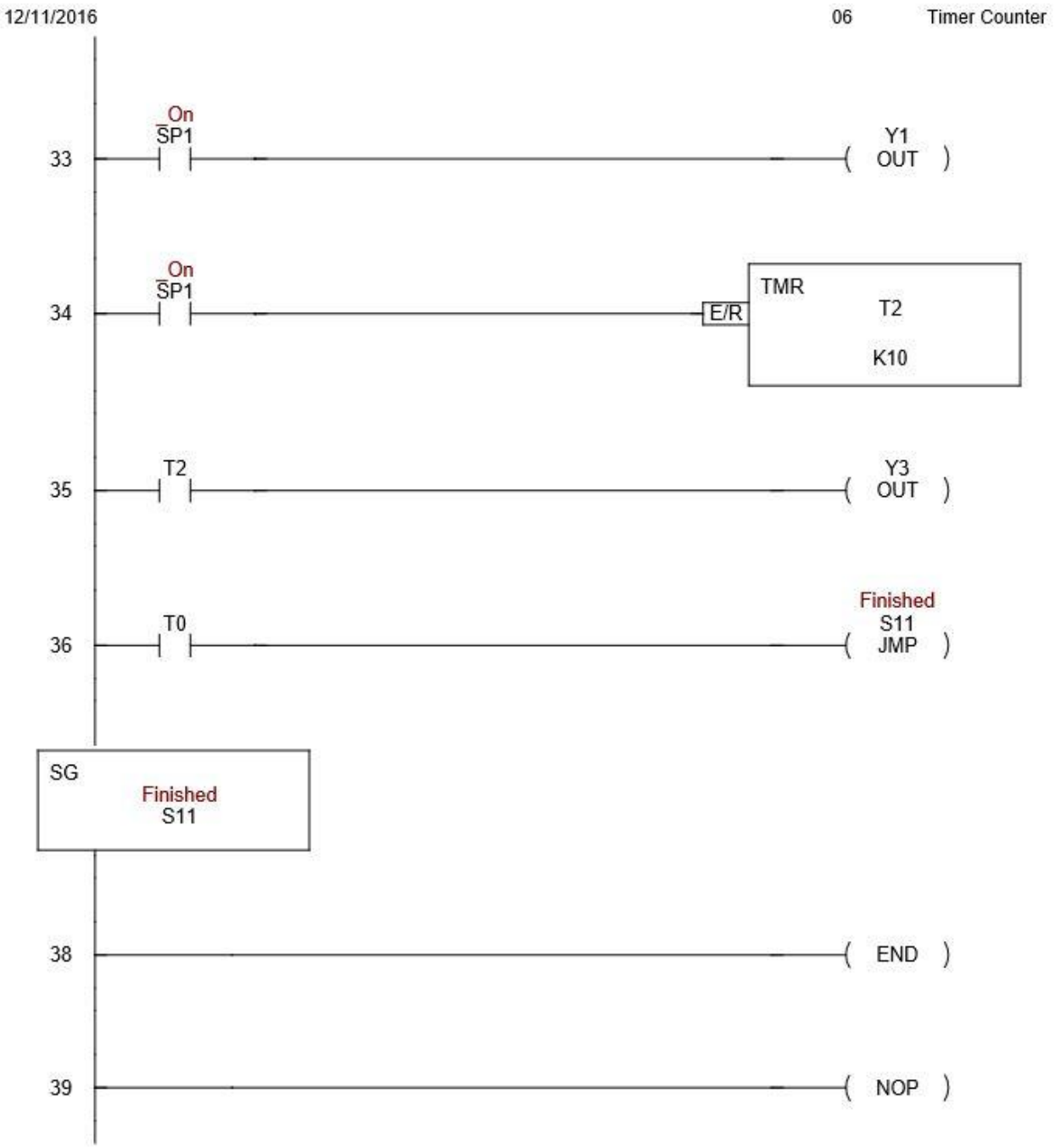
Y0
OUT
X2
27
Idle 3
S7
JMP
SG
Idle 3
S7
_On
SP1
29
Y0
OUT
X2
30
Piston 3
S10
JMP
SG
Piston 3
S10
_On
SP1
32
E/R
TMR
T0
K22
Page 5



Motoman program:

/JOB
//NAME FLASH11

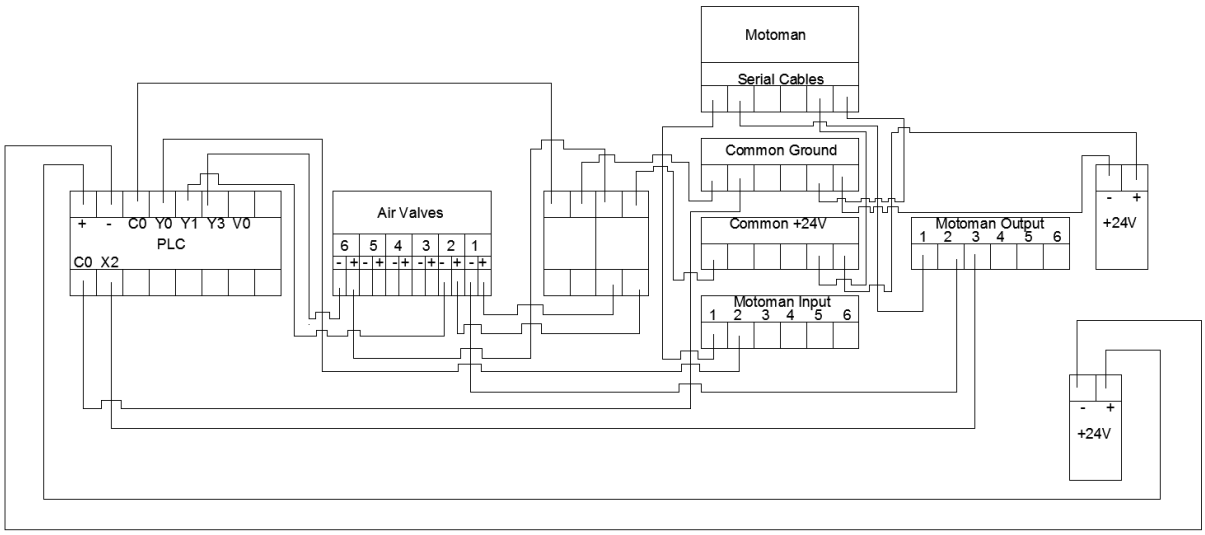
```
//POS
///NPOS 48,0,0,0,0,0
///TOOL 2
///POSTYPE PULSE
///PULSE
C00000=-1,0,0,0,-8,0
C00001=-1,1,-1,0,-8,-128967
C00002=45903,-9267,-36251,-52069,34341,-99776
C00003=54934,34331,-61862,-39597,43883,-120858
C00004=56437,40550,-63456,-37862,47658,-123418
C00005=55984,41398,-62889,-37506,47683,-123499
C00006=55165,33943,-62153,-39782,43874,-120805
C00007=47139,12402,-44372,-61242,26283,-100696
C00008=48108,17388,-48678,-34629,51629,-115216
C00009=-2588,18387,-67613,3095,60004,-129405
C00010=-2301,61178,-64191,2149,83210,-128578
C00011=-2301,74396,-60900,2161,88804,-128435
C00012=-2193,44857,-66670,2096,75149,-128787
C00013=-46478,21244,-53313,33692,56377,-139834
C00014=-76498,29496,-28913,22851,-64166,-4096
C00015=-76498,46692,-33060,25857,-52189,-8301
C00016=-79297,52454,-35635,28147,-46939,-9663
C00017=-78328,49000,-34642,26744,-49507,-8752
C00018=-78328,25360,-28781,22447,-66065,-2867
C00019=-42134,14905,-37343,-52,-46985,-9703
C00020=-2281,51652,-65055,-3272,-4623,-22961
C00021=-2071,68206,-61784,-5103,2947,-21803
C00022=-2271,-11549,-55101,-350,-50026,-24890
C00023=72904,32266,-45344,-62941,42516,-109182
C00024=73914,44685,-46916,-56647,45460,-115664
C00025=74822,47753,-48154,-55252,46954,-117549
C00026=73889,44409,-47384,-56494,45530,-115795
C00027=73889,12669,-40396,-79481,38861,-95326
C00028=-2382,17796,-68448,1144,61740,-129724
C00029=-2514,17798,-68446,1608,61744,-129843
C00030=-2551,61345,-65643,1509,86002,-129386
C00031=-2551,72702,-62871,1526,90854,-129298
C00032=-2520,65131,-63957,1488,87074,-129364
C00033=-2520,74517,-61492,1496,90953,-129289
C00034=-2450,72562,-62157,1306,90252,-129332
C00035=-2382,72820,-62848,1062,90912,-129360
C00036=-2382,26697,-68961,1094,67482,-129660
C00037=-19935,50211,-44727,93504,87191,-140710
C00038=-19913,72427,-41028,94185,84745,-134150
C00039=-19937,74072,-40699,94230,84570,-133688
C00040=-19937,73343,-40896,94219,84640,-133869
C00041=-21867,73519,-40339,95368,84903,-134024
C00042=-21867,74428,-40093,95387,84810,-133800
```

all of these are saved locations. Referenced in the movj functions later in the programs

```
C00043=-21867,73507,-40342,95371,84905,-134026
C00044=-17727,73154,-41471,92898,84366,-133715
C00045=-17727,74492,-41106,92915,84251,-133382
C00046=-17727,56899,-44679,92530,85906,-138308
C00047=-2,1,-2,0,-10,-128970
//INST
///DATE 2016/12/09 14:48
///ATTR SC,RW
///GROUP1 RB1
NOP
*FLASH                  denotes the start of the assembly program.
DOUT OT#(3) ON          handshakes and verifies the PLC is ready.
WAIT IN#(2)=ON
DOUT OT#(3) OFF         Verifies the gripper is off.
MOVJ C00000 VJ=15.00    this command tells the robot arm to move to the position of C00000 at
MOVJ C00001 VJ=15.00    the velocity of 15 cm/min?
MOVJ C00002 VJ=5.00
MOVJ C00003 VJ=5.00
MOVJ C00004 VJ=5.00
MOVJ C00005 VJ=5.00
TIMER T=1.00            this starts a 1-second timer when the timer finishes it starts the next
                        command.
DOUT OT#(1) ON          this activates the gripper.
TIMER T=1.00
MOVJ C00006 VJ=15.00
MOVJ C00007 VJ=5.00
MOVJ C00008 VJ=5.00
MOVJ C00009 VJ=5.00
MOVJ C00010 VJ=5.00
MOVJ C00011 VJ=5.00
TIMER T=1.00
DOUT OT#(1) OFF         this command turns the gripper off.
TIMER T=1.00
MOVJ C00012 VJ=5.00
MOVJ C00013 VJ=5.00
MOVJ C00014 VJ=5.00
MOVJ C00015 VJ=5.00
MOVJ C00016 VJ=5.00
TIMER T=1.00
DOUT OT#(1) ON
TIMER T=1.00
MOVJ C00017 VJ=15.00
MOVJ C00018 VJ=5.00
MOVJ C00019 VJ=5.00
MOVJ C00020 VJ=5.00
MOVJ C00021 VJ=5.00
TIMER T=1.00
DOUT OT#(1) OFF
```

```
TIMER T=1.00
MOVJ C00022 VJ=5.00
MOVJ C00023 VJ=5.00
MOVJ C00024 VJ=5.00
MOVJ C00025 VJ=5.00
TIMER T=1.00
DOUT OT#(1) ON
TIMER T=1.00
MOVJ C00026 VJ=15.00
MOVJ C00027 VJ=5.00
MOVJ C00028 VJ=5.00
MOVJ C00029 VJ=5.00
MOVJ C00030 VJ=5.00
MOVJ C00031 VJ=5.00
TIMER T=1.00
DOUT OT#(1) OFF
TIMER T=1.00
MOVJ C00032 VJ=5.00
MOVJ C00033 VJ=5.00
TIMER T=1.00
DOUT OT#(1) ON
TIMER T=1.00
TIMER T=1.00
DOUT OT#(1) OFF
TIMER T=1.00
MOVJ C00034 VJ=5.00
MOVJ C00035 VJ=5.00
MOVJ C00036 VJ=5.00
MOVJ C00037 VJ=5.00
MOVJ C00038 VJ=5.00
MOVJ C00039 VJ=0.50
MOVJ C00040 VJ=5.00
MOVJ C00041 VJ=5.00
MOVJ C00042 VJ=0.50
MOVJ C00043 VJ=5.00
MOVJ C00044 VJ=5.00
MOVJ C00045 VJ=0.50
MOVJ C00046 VJ=5.00
MOVJ C00047 VJ=5.00
DOUT OT#(3) ON          this command tells the PLC to run its program.
WAIT IN#(2)=OFF         this command receives the go-ahead from the PLC to move forward.
JUMP *FLASH             this command restarts the program to assemble the next piece.
END
```

Wiring diagram:



Description of Machine Operation:

Slides:

The slides are perhaps on of the most important features in the assembly, if anything goes wrong with the slide then the whole system has to be recalibrated. These slides also hold all the yet to be used parts for the assembly. The angle of the slides is somewhat arbitrary. They must be steep enough to let the parts slide down them, but shallow enough to keep the parts from shingling.

Assembly Jig:

The assembly jig was precisely machined to ensure the parts all mate together properly. Without it, the housing halves could easily not align with the chip, or with each other. The jig must be close enough to the moving walls to prevent them turning out of alignment, but far enough to keep the walls from binding. The system must be recalibrated if the assembly jig gets moved. If it isn’t then the parts won't mate properly.

Robot:

The robot is the workhorse of this assembly system. It moves, aligns and snaps all the parts together. The robot consists of an articulating arm. The arm moves by servos, and follows the fastest most efficient path between 2 points. This causes a slight issue in programming as you have to be sure the robot won't accidently run into anything. It has a pair of grippers run by a pneumatic to pick and place parts of the assembly. On one of the grippers is rubber, used to seal the assembly by pushing it shut.

PLC:

The PLC is the master in the system. It tells the Motoman and the air cylinders when to do their jobs. The PLC handshakes with the Motoman I/O and is in direct control of the air cylinders.

Air Cylinders:

The pair of cylinders have two jobs in the system, act as walls of the assembly jig and to move the finished assembly to packaging. It begins with one extended and the other retracted which we'll now call 1 and 2 respectively. When they receive the signal from the PLC, 1 extends to push the finished assembly out into packaging while 2 retracts to allow entry into packaging. These are directly controlled by the PLC unit

Maintenance:

Maintenance on the robot arm or the PLC should be done by a licensed repair technician from motorman or the PLC manufacturer. Maintenance on the rails or assembly jig can be done by any in-house engineer depending on the issue needing to be repaired.

Future Improvements:

Future improvements would include a sensor to make the ejection program more efficient. As well as a jam detection sensor, and a sensor to determine if there are enough parts to continue the assembly process. We would also redesign the slides to make them more rigid and less likely to slip out of alignment. It would also be nice to design some grippers that are a little stickier. To prevent slippage during grabbing or alignment commands