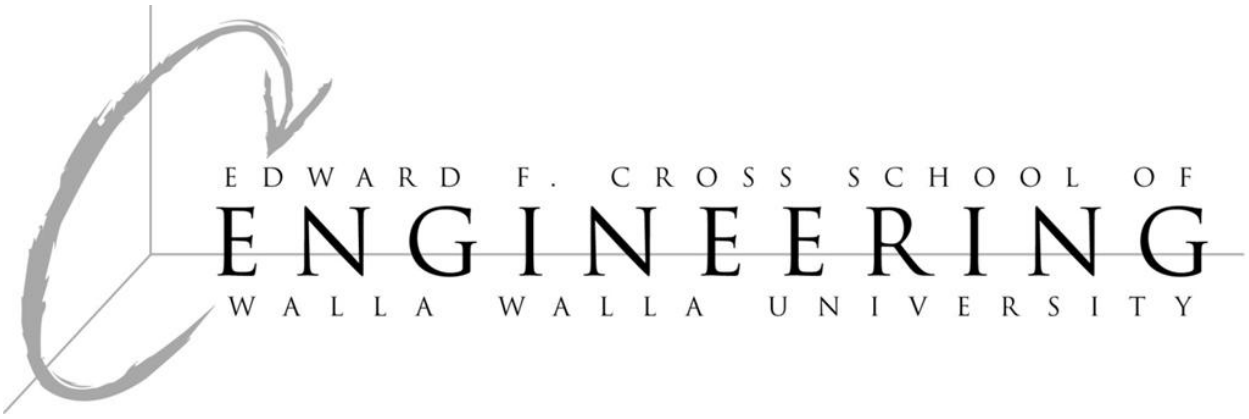

Documentation for InteliPaper USB Testing Station

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June 13, 2013

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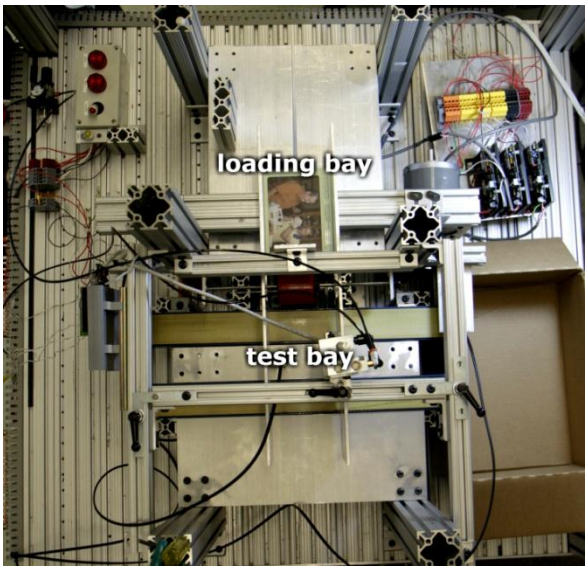
1 Instructions

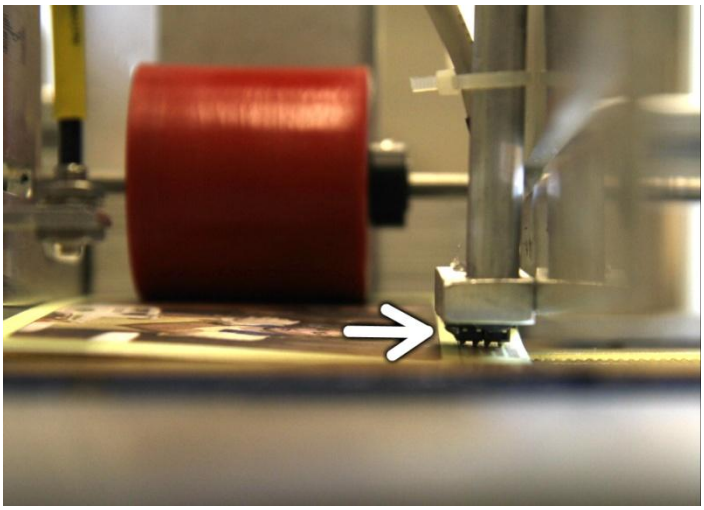
The following instructions show how to load and run the machine, and fix problems that may crop up.

1.1 Loading the Machine



1. Ensure Cards are oriented in the correct direction.
   1.1. Contacts should be facing upward.
   1.2. Contacts should be closest to the rollers.
2. Place cards on loading bay and ensure cards are fully pushed forward to center stop.
   2.1. The stack of cards should not be taller than the side walls.
3. Evenly push side stops to meet cards so that cards are centered on the loading bay.
4. Place counter weight on top of stack.

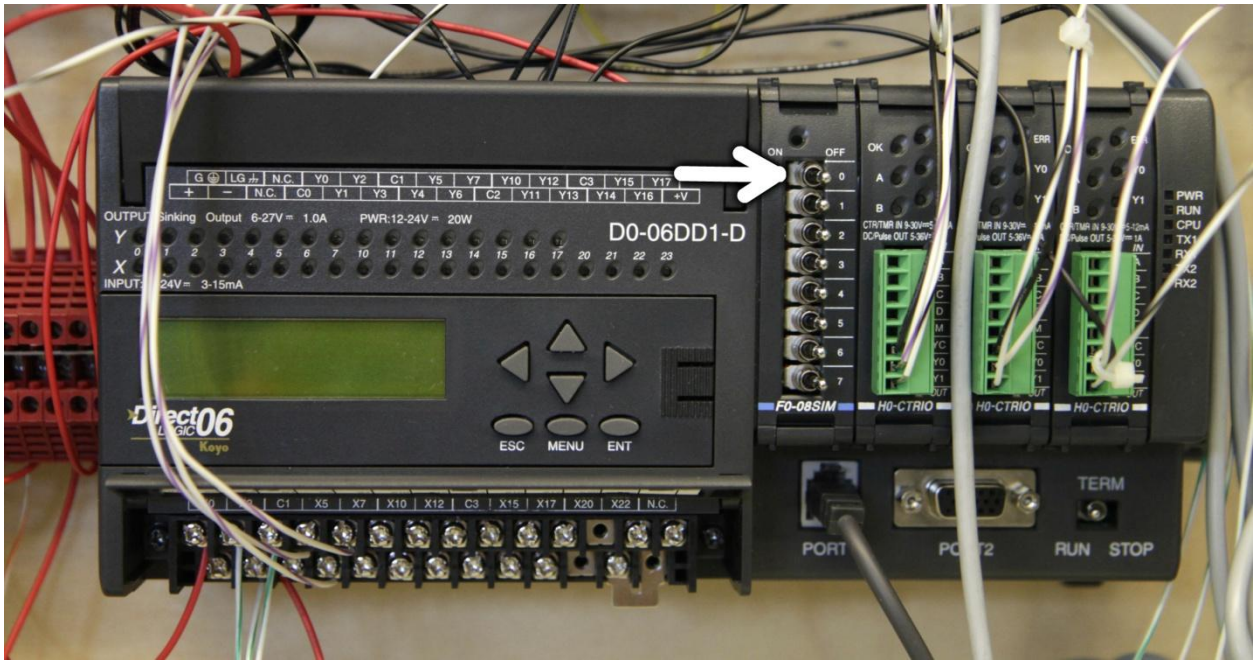
1.2 Positioning of Sensor and Tester



1. Place a card (in the same orientation) in the test bay, pushing card into the rollers till the card meets the center stop.
2. Loosen the testing sensor's hex screw.
3. Position testing sensor above front edge of paper.
4. Loosen the 'x' 'y' positioning handles on tester.
5. Position the tester directly above the contacts on the card.
6. Fully extend pneumatic tester and ensure it is pushing the card against the test bay floor.
   6.1. If height adjustment is needed, loosen 'z' axis positioning handle and adjust.
7. Tighten all positioning handles carefully, and ensure the tester contacts are directly engaged with card contacts
8. Remove card from test bay, and return to loading stack.

1.3 Starting/Stopping the Machine

1. Cycle the power to the PLC by un-plugging and then re-plugging the wall plug.



2. Flip switch X100 to the ‘On’ position.
3. If the system needs to be paused, switch X100 can be moved to the ‘Off’ Position, provided the Error light is not lit. Also, if the Stepper motors or Pneumatics need to be switched off quickly, the E-Stop button can be pressed. Only the motors and pneumatics are wired through this button, so the error output from the PLC can still be read. However, the system will need to be reset after the E-Stop button has been used.

1.4 Clearing Jams

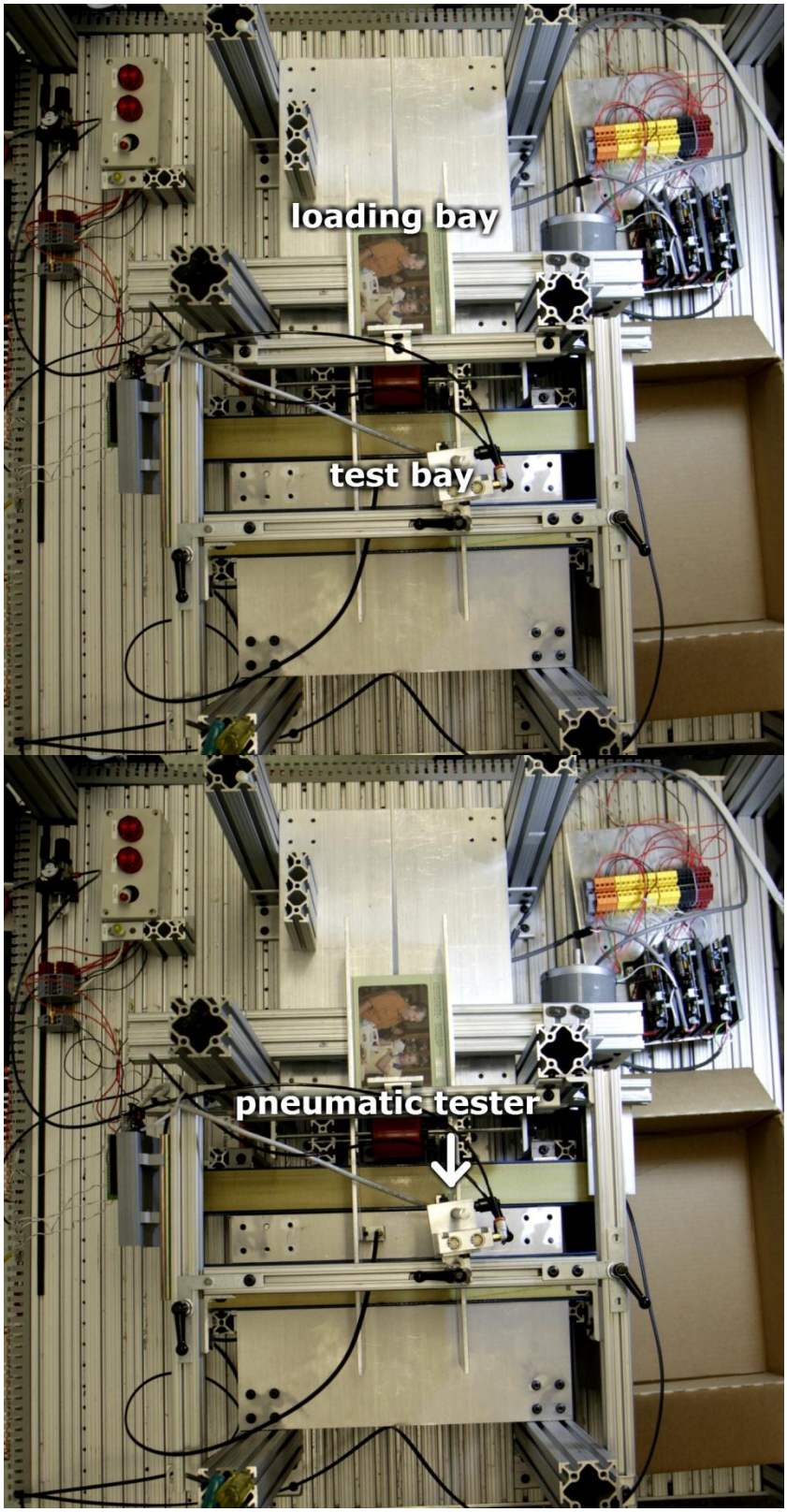
1.4.1 Conveyer Jams

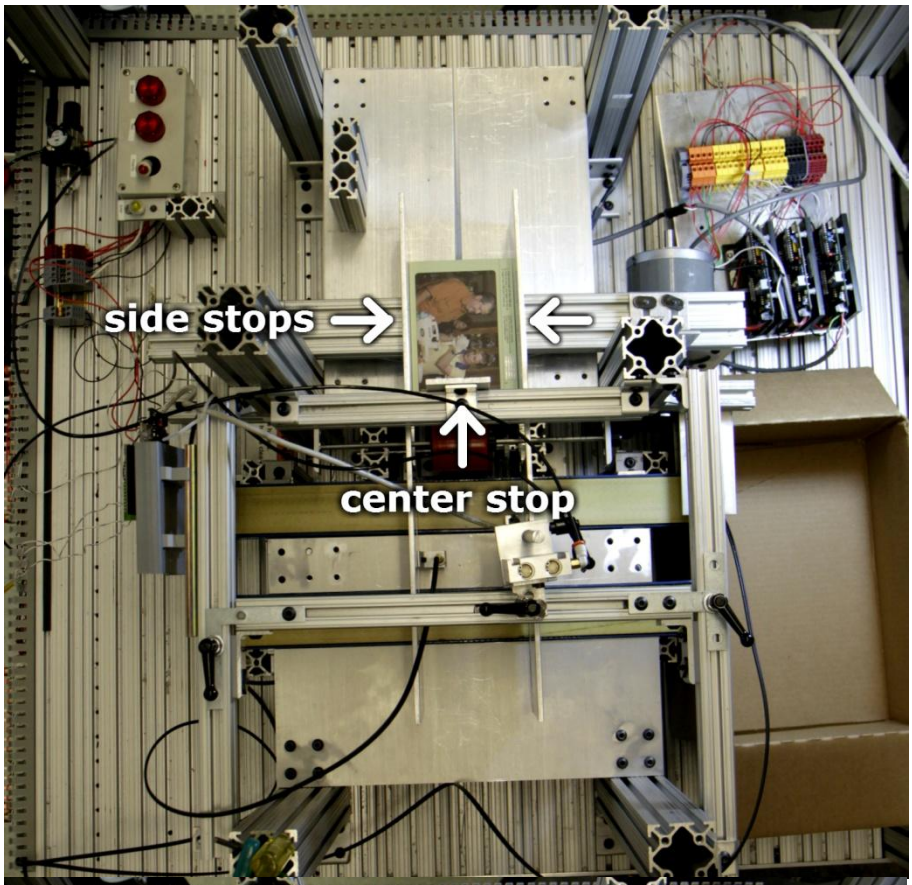
1. Press the E-Stop button to stop the motors and pneumatics.
2. Turn switch X100 to ‘Off’ and clear out the jam.
3. Pull out the E-Stop button and restart the system.
4. Turn switch X100 to ‘On’.

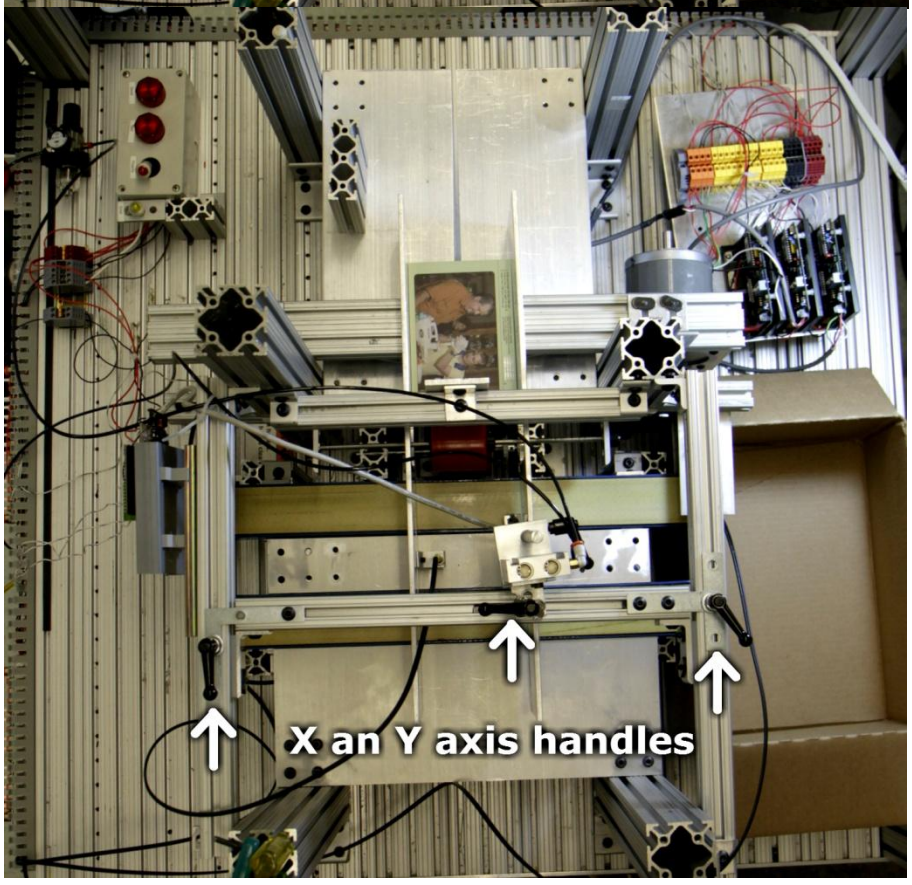
1.4.2 Feed Jams

1. Take the weight off the feed stack.
2. Move the feed stack back from the feed edge.
3. Separate the two cards that are stuck together.
4. Replace the feed stack and weight.

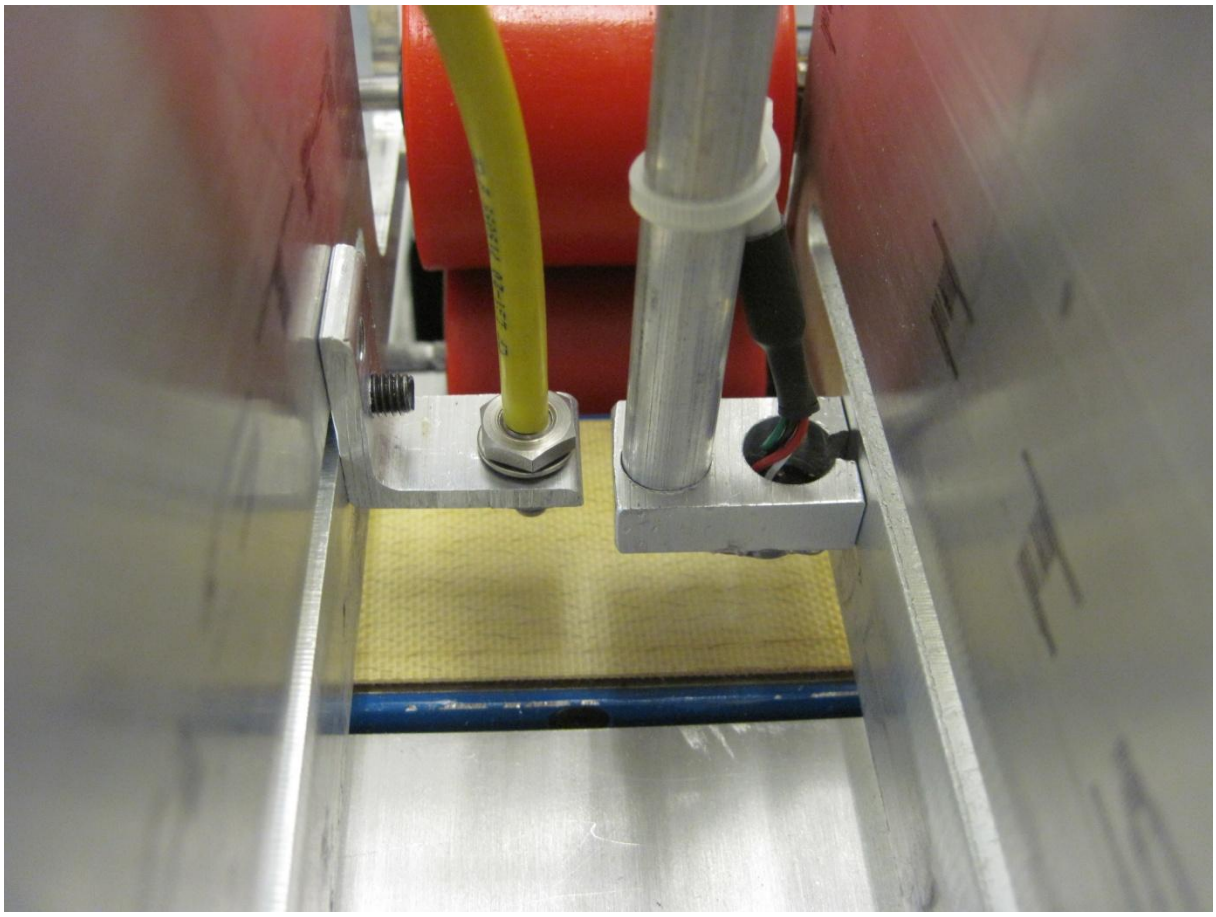
2 Diagrams

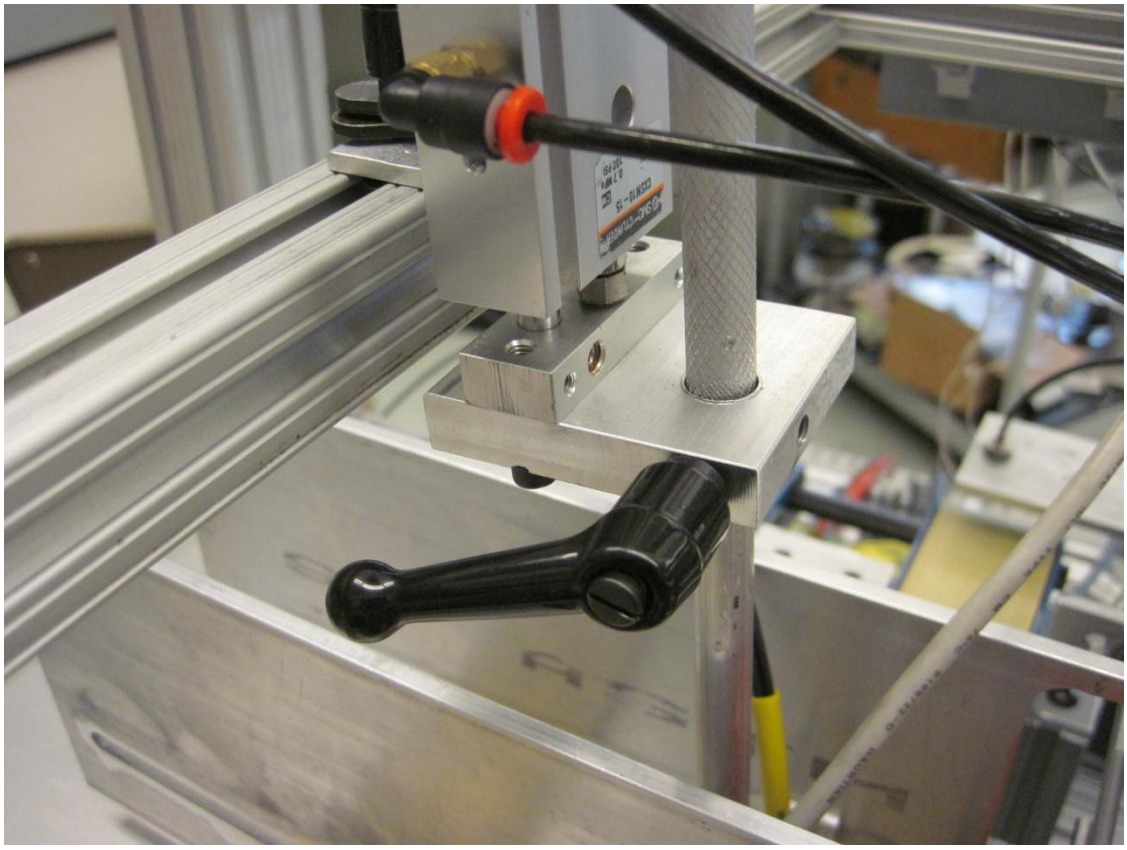



side stops
center stop

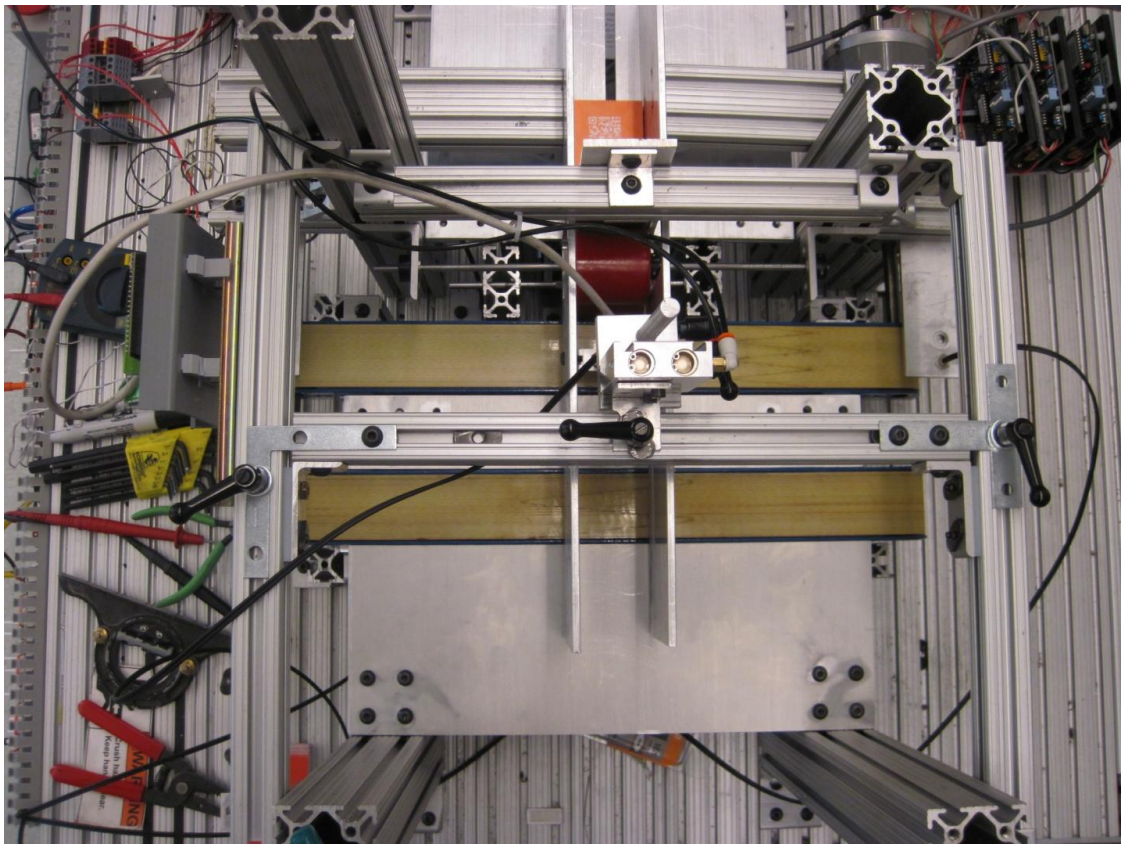

X an Y axis handles

2.1 System Photos






Good
Bad
Polarity
COMEPI
Error



2.2 PLC Ladder Logic

Located in the Appendix in a two column format.

2.3 State Machine

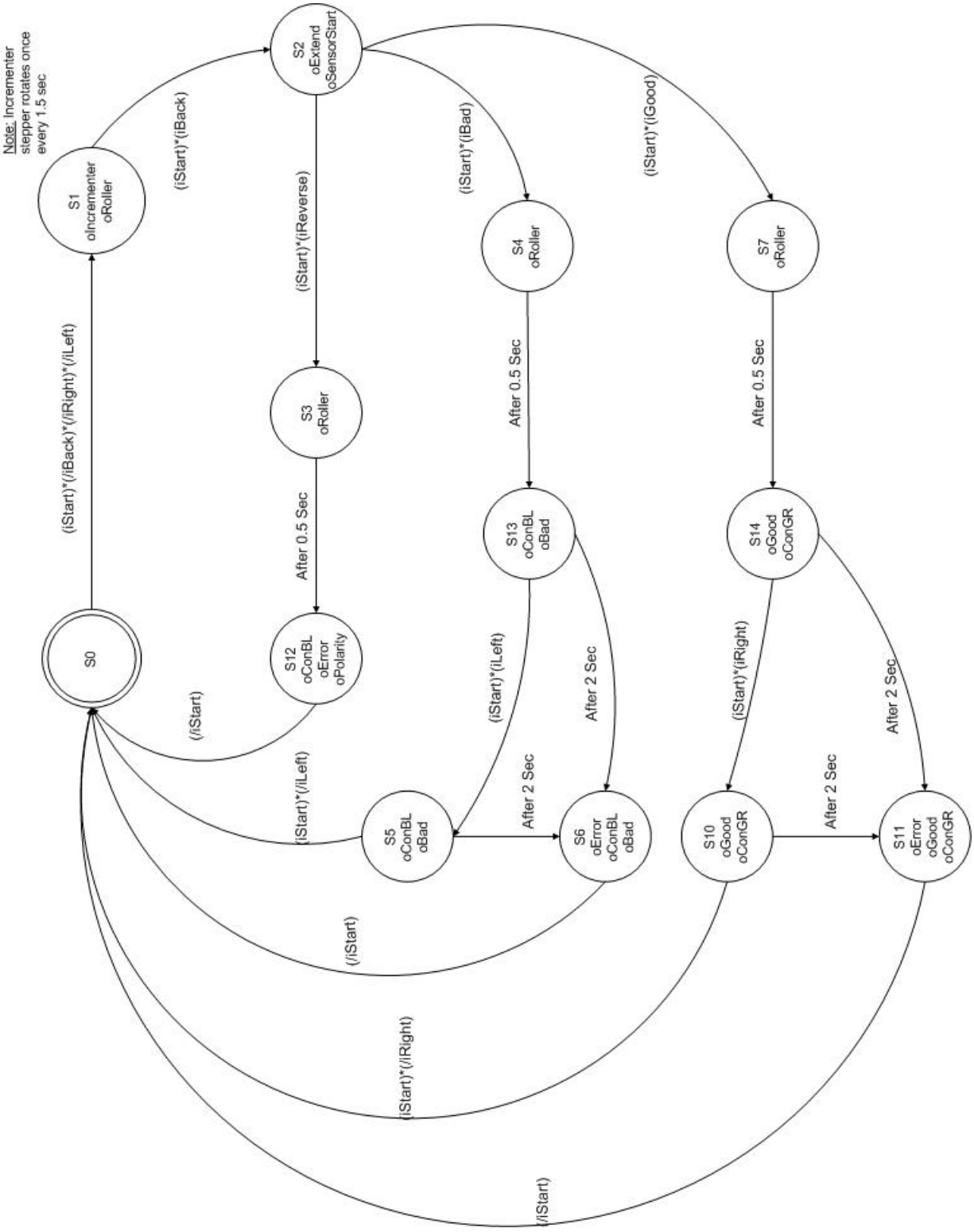


Figure 1: State Machine Diagram

2.4 Stepper Motor Configuration

Table 1 below shows the configuration for the three stepper motors used in this project. They are identified by the names Stepper, Incrementer, and Conveyer. Note: All three stepper motors use a 50% reduction of current if motor is a rest for 1 sec (Amplifier DIP switch #4).

	Stepper motor (Roller)	
Module configuration	Pulse output Step/Dir	
Profile type	Dynamic Velocity	
Rates (pss)	CW Acc	50000
	CW Dec	50000
	CCW Acc	50000
	CCW Dec	5000
Velocity	-24,768 Dec	9F40 HEX
Microstepping	10,000 steps/rev	
Current Setting	0.5 Amps	
	Incrementer motor	
Module configuration	Pulse output Step/Dir	
Profile type	Trapezoid	
Total Pulses	10,000	
Accel Time	10 ms	
Decel Time	10 ms	
Start Freq	2,000 Hz	
Pos Freq	25,000 Hz	
End Freq	2,000 Hz	
Microstepping	10,000 steps/rev	
Current Setting	0.5 Amps	
	Conveyer motor (Roller)	
Module configuration	Pulse output Step/Dir	
Profile type	Dynamic Velocity	
Rates (pss)	CW Acc	50000
	CW Dec	50000
	CCW Acc	50000
	CCW Dec	5000
Velocity (Bad side)	-24,768 Dec	9F40 HEX
Velocity (Good side)	24,768 Dec	60C0 HEX
Microstepping	10,000 steps/rev	
Current Setting	3.5 Amps	

Table 1: Motor configuration

2.5 Wiring Table

Table 2 and 3 below show the electrical connections between the different components.

Connections	
From	To
PLC output side	
PLC common output (C0 + C2)	Ground
PLC (+) Output	24 volts
PLC (-) Output	Ground
PLC (+V) Output	24 volts
PLC Y0	Ground side of pneumatic extender
Power Side of pneumatic extender	24 volts through E-Stop
PLC Y1	USB tester 'Test' input
USB tester common input side	24 volts
PLC Y10	Ground side of Good light
Power side of Good light	24 volts
PLC Y11	Ground side of Bad light
Power side of Bad light	24 volts
PLC Y12	Ground side of Polarity light
Power side of Polarity light	24 volts
PLC Y13	Ground side of Error light
Power side of Error light	24 volts
PLC input side	
PLC common input (C0 + C1)	24 volts
PLC X1	Back optical sensor output (iBack)
iBack power side	24 volts
iBack ground side	Ground
PLC X2	Right (Good) optical sensor output (iRight)
iRight power side	24 volts
iRight ground side	Ground
PLC X3	Left (Bad) optical sensor output (iLeft)
iLeft power side	24 volts
iLeft ground side	Ground
PLC X4	iGood input from USB Tester output
PLC X5	iBad input from USB Tester output
PLC X6	iReverse input from USB Tester output
USB tester common output side	Ground
USB Tester	
USB tester power	24 volts
USB tester ground	Ground

Table 2: PLC and USB Tester connections

YC	Ground
Y0	Ground side of 2.2KΩ R3 resister
Power side of R3 resister	Step (-) port of Amplifier 2 (A2)
Step (+) port of A2	24 volts through E-Stop
Y1	Ground side of 2.7kΩ R4 resister
Power side of R4 resister	Dir (-) port of Amplifier 2 (A2)
Dir (+) port of A2	24 volts through E-Stop
PLC Hi-Speed IO port Module 3	
YC	Ground
Y0	Ground side of 2.7kΩ R5 resister
Power side of R5 resister	Step (-) port of Amplifier 3 (A3)
Step (+) port of A3	24 volts through E-Stop
Y1	Ground side of 2.7kΩ R6 resister
Power side of R6 resister	Dir (-) port of Amplifier 3 (A3)
Dir (+) port of A3	24 volts through E-Stop
Amplifier 1 (A1)	
A1 VDC (+) port	24 volts through E-Stop
A1 VDC (-) port	ground
A1 (+) and (-) 'A' phase	(+) and (-) 1st phase of roller (Stepper) motor
A1 (+) and (-) 'B' phase	(+) and (-) 2nd phase of roller (Stepper) motor
Amplifier 2 (A2)	
A2 VDC (+) port	24 volts through E-Stop
A2 VDC (-) port	ground
A2 (+) and (-) 'A' phase	(+) and (-) 1st phase of incrementer motor
A2 (+) and (-) 'B' phase	(+) and (-) 2nd phase of incrementer motor
Amplifier 3 (A3)	
A3 VDC (+) port	24 volts through E-Stop
A3 VDC (-) port	ground
A3 (+) and (-) 'A' phase	(+) and (-) 1st phase of conveyer motor
A3 (+) and (-) 'B' phase	(+) and (-) 2nd phase of conveyer motor

Table 3: Hi-speed and Amplifier connections

3 Descriptions

These final topics give a detailed rundown of what each section does as well as suggestions on maintenance practices and future improvements.

3.1 Operation of each Machine Section

1. The Incrementing stepper motor will begin moving the paper to the Roller, which will draw the paper into the test bay. Once the paper in the test bay has reached the Back Optical Sensor (BOS), the Roller and Incrementer will stop moving and the testing can begin.
2. First the pneumatic piston will move the USB sensor to the paper and begin testing the USB components. Once the test is complete the pneumatic piston will raise the testing sensor and one of the three possible outcomes of this test will occur:
   2.1. Good Result: The Good light will light up and the Conveyer will begin moving to the left to deposit the paper into the Good pile. Once the Good Optical Sensor (GOS) confirms the paper has left the conveyer, the system will reset and then begin the cycle again. If the paper takes longer than 2 seconds to pass the GOS, the error light will light up and the conveyer will not stop moving until the X100 switch is moved to the 'Off' position. To restart the system, fix the obstruction and move X100 to the 'On' position.
   2.2. Bad Result: The Bad light will light up and the Conveyer will begin moving to the right to deposit the paper into the Bad pile. Once the Bad Optical Sensor (DOS) confirms the paper has left the conveyer, the system will reset and then begin the cycle again. If the paper takes longer than 2 seconds to pass the DOS, the error light will light up and the conveyer will not stop moving until the X100 switch is moved to the 'Off' position. To restart the system, fix the obstruction and move X100 to the 'On' position.
   2.3. Reverse Result: The Polarity and Error lights will light up and the conveyer will move the paper to the Bad pile until switch X100 is moved to the 'Off' position. This error means the polarity of the USB tester needs to be reversed.
3. Once the result has been received, the roller will run for a fraction of a second to make sure the paper is fully on the conveyors.
4. The conveyor belt will then run either left or right depending on the good/bad/reverse result.
5. The paper will hit a 'test bay clear' sensor to tell the system that it can test a new card.

3.2 Maintenance Instructions

If the incrementer stepper motor stops driving the half roller, the likely problem is that its set screw has loosened. To fix this problem, rotate the shaft until the set screw can be accessed, then tighten the set screw.

3.3 Suggestions for future improvements

To increase the performance of the system extra testing bays could be added to the loading bay. If the order on the PLC was then optimized, up to four total testing bays could be fed by the one loading bay.

To improve tester contact, a foot could be added below the tester that would come up to meet the tester. This would make the contact between the paper and the tester more consistent.

3.4 Performance Data

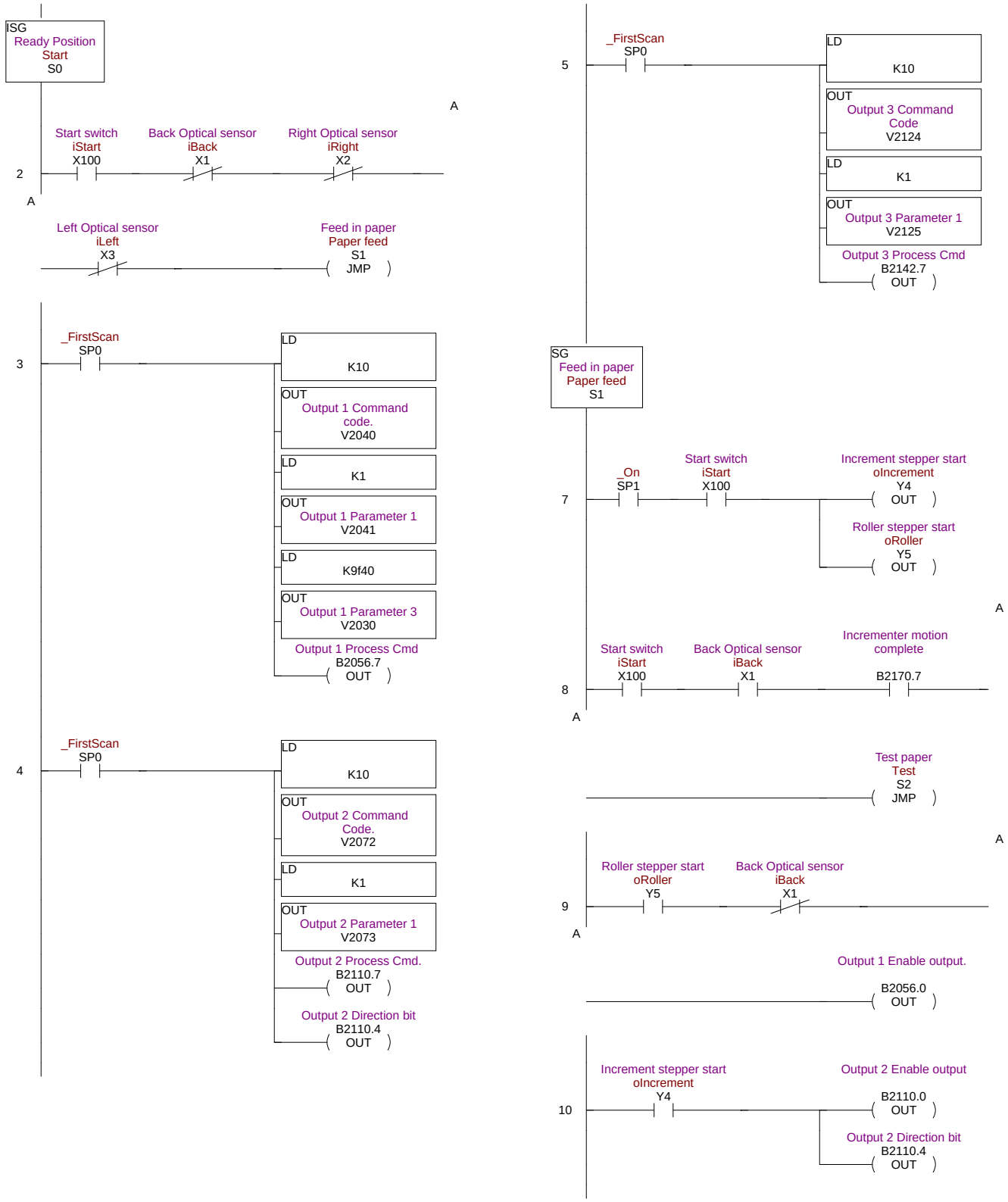
Currently our performance is based on running a variable number of one type of card through our system. The results of these tests are located in Table 4 below.

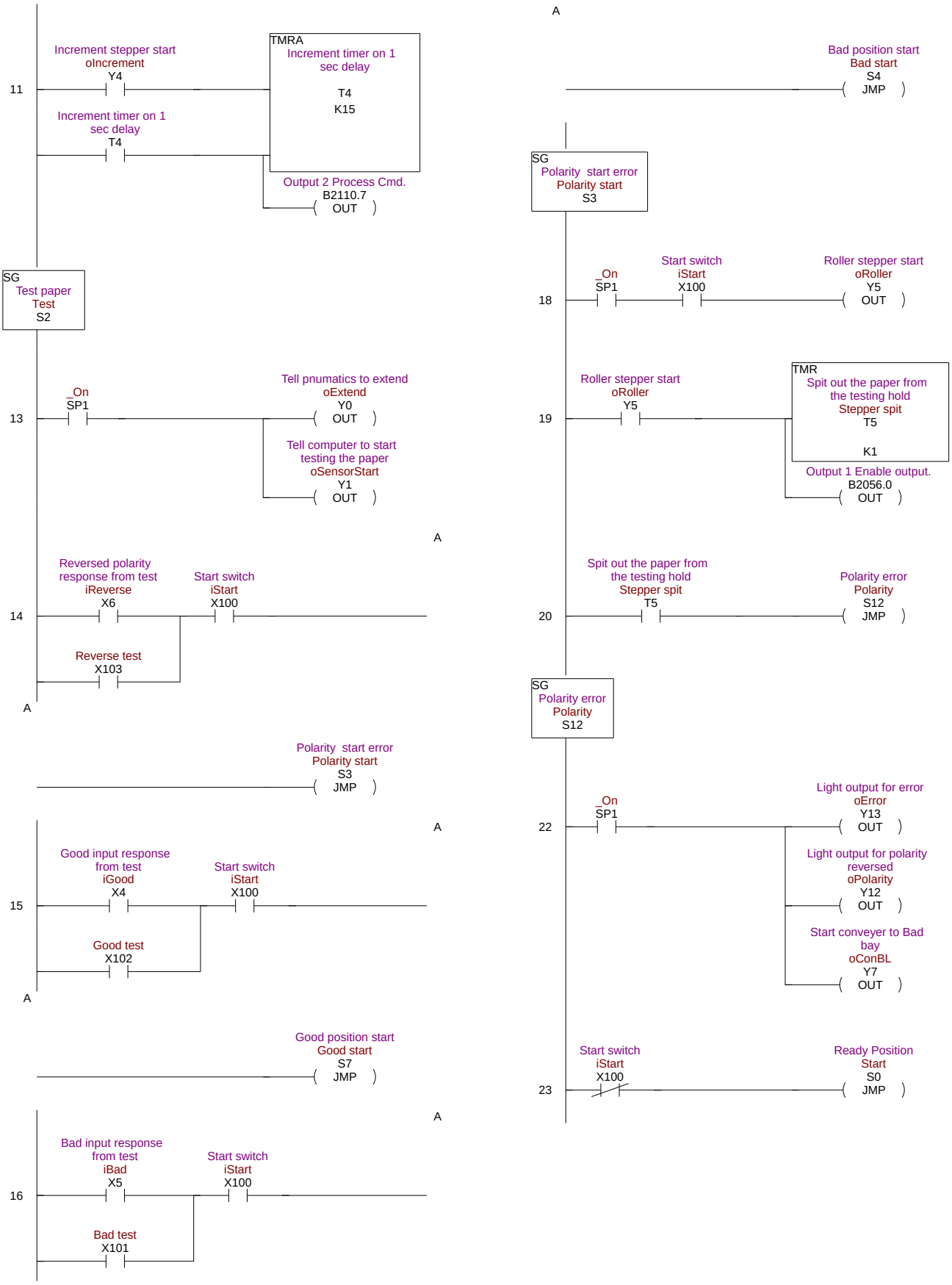
Test #	# Cards	Pass rate	Time/card
1	10	80%	4.50
2	20	65%	5.20
3	20	95%	4.25
4	47	87%	4.57
5	45	89%	3.33
6	47	62%	2.96
Averages		82%	4.63

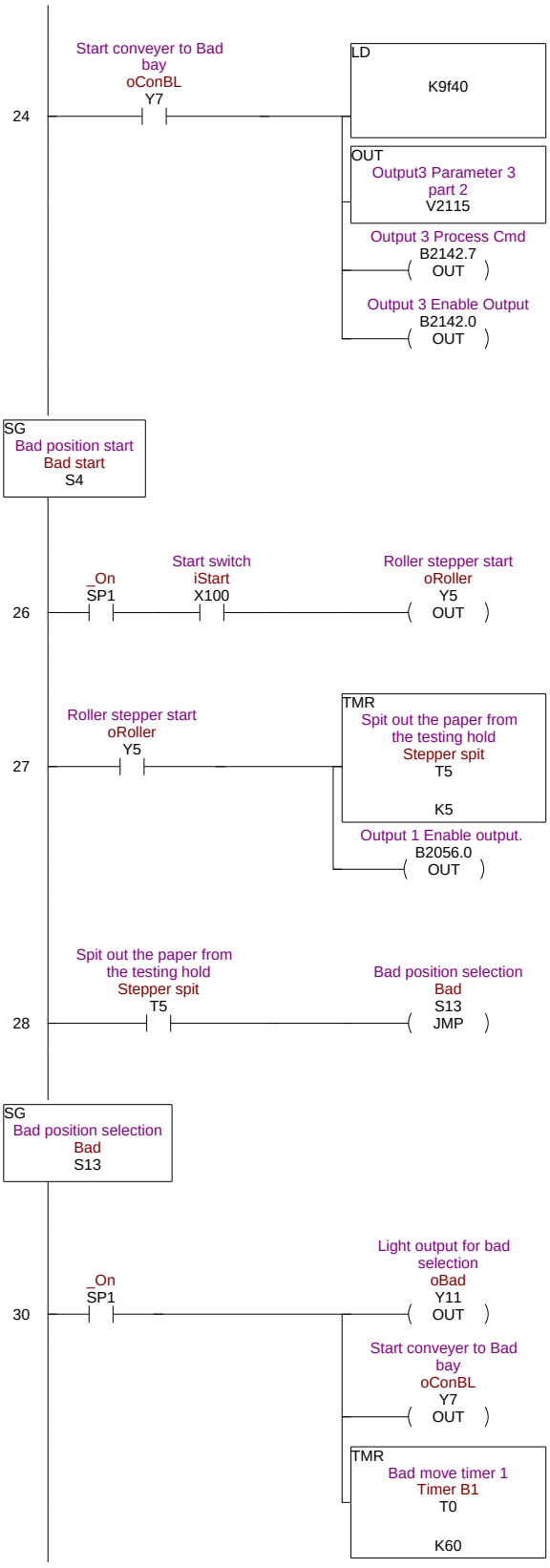
Table 4: Performance Data.

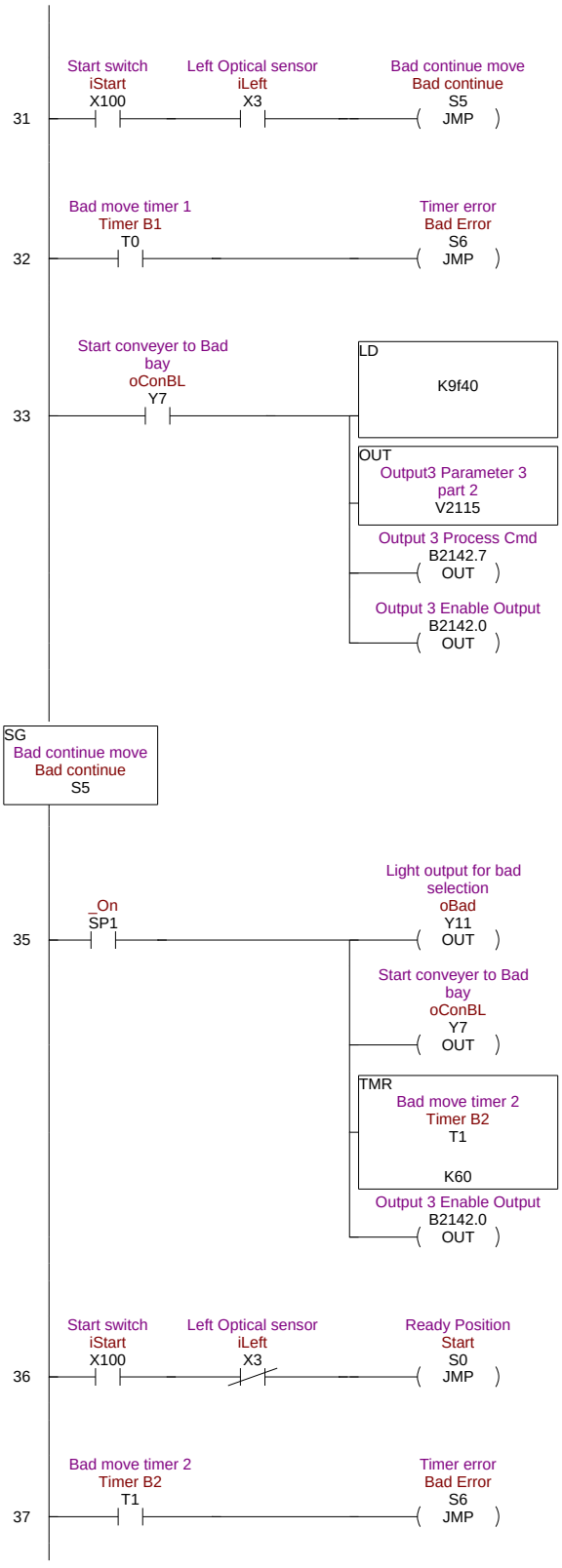
Appendix

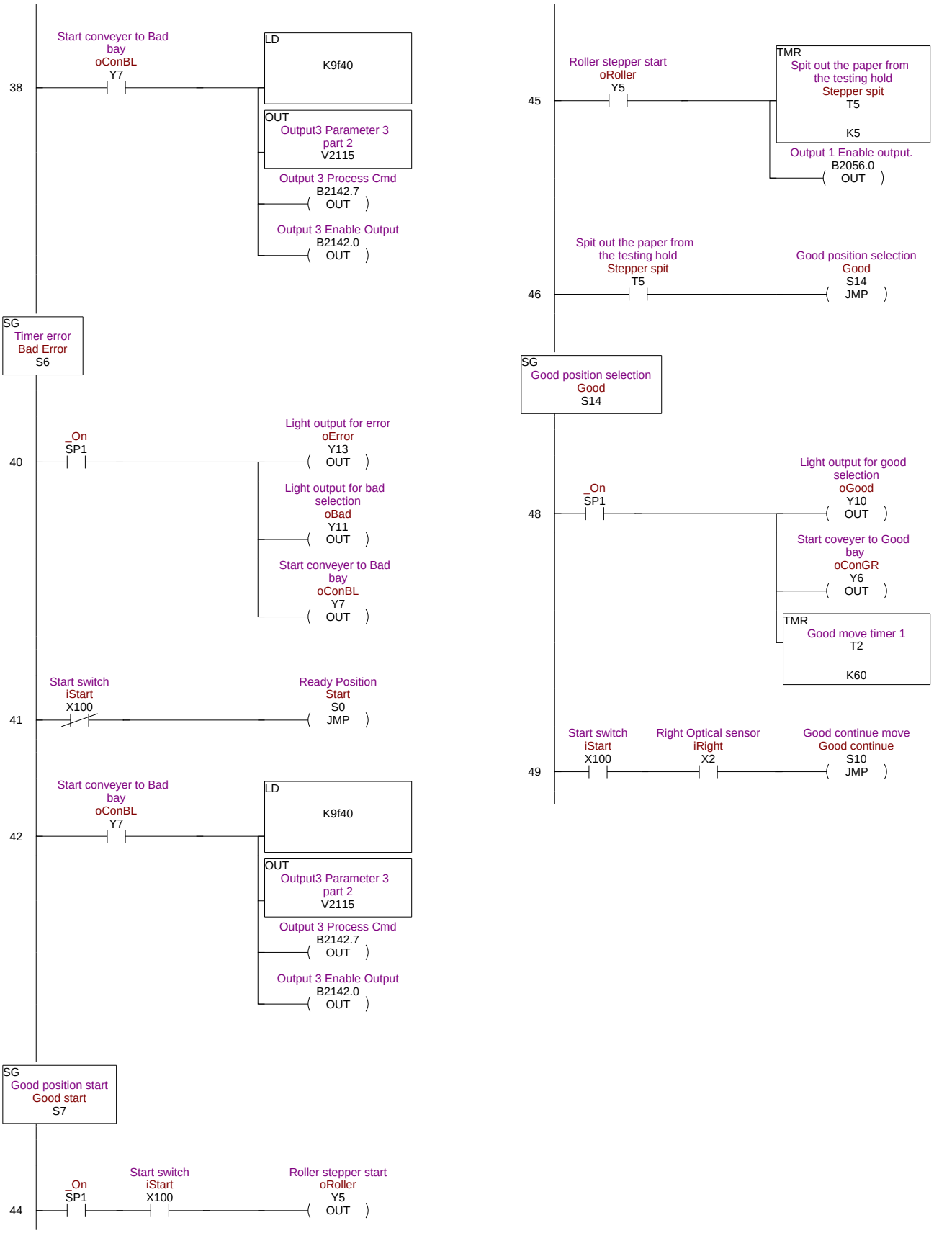
PLC Ladder logic on the next page.


ISG
Ready Position
Start
S0
A
Start switch
iStart
X100
Back Optical sensor
iBack
X1
Right Optical sensor
iRight
X2
2
A
Left Optical sensor
iLeft
X3
Feed in paper
Paper feed
S1
JMP
_FirstScan
SP0
3
LD
K10
OUT
Output 1 Command code.
V2040
LD
K1
OUT
Output 1 Parameter 1
V2041
LD
K9f40
OUT
Output 1 Parameter 3
V2030
Output 1 Process Cmd
B2056.7
OUT
_FirstScan
SP0
4
LD
K10
OUT
Output 2 Command Code.
V2072
LD
K1
OUT
Output 2 Parameter 1
V2073
Output 2 Process Cmd.
B2110.7
OUT
Output 2 Direction bit
B2110.4
OUT
_FirstScan
SP0
5
LD
K10
OUT
Output 3 Command Code
V2124
LD
K1
OUT
Output 3 Parameter 1
V2125
Output 3 Process Cmd
B2142.7
OUT
SG
Feed in paper
Paper feed
S1
_On
SP1
Start switch
iStart
X100
Increment stepper start
oIncrement
Y4
OUT
7
Roller stepper start
oRoller
Y5
OUT
A
Start switch
iStart
X100
Back Optical sensor
iBack
X1
Incrementer motion complete
B2170.7
8
A
Test paper
Test
S2
JMP
A
Roller stepper start
oRoller
Y5
Back Optical sensor
iBack
X1
9
A
Output 1 Enable output.
B2056.0
OUT
Increment stepper start
oIncrement
Y4
Output 2 Enable output
B2110.0
OUT
10
Output 2 Direction bit
B2110.4
OUT


11
Increment stepper start
oIncrement
Y4
TMRA
Increment timer on 1 sec delay
T4
K15
Increment timer on 1 sec delay
T4
Output 2 Process Cmd.
B2110.7
OUT
SG
Test paper
Test
S2
13
_On
SP1
Tell pnumatics to extend
oExtend
Y0
OUT
Tell computer to start testing the paper
oSensorStart
Y1
OUT
A
14
Reversed polarity response from test
iReverse
X6
Start switch
iStart
X100
Reverse test
X103
A
Polarity start error
Polarity start
S3
JMP
A
15
Good input response from test
iGood
X4
Start switch
iStart
X100
Good test
X102
A
Good position start
Good start
S7
JMP
A
16
Bad input response from test
iBad
X5
Start switch
iStart
X100
Bad test
X101
A
Bad position start
Bad start
S4
JMP
SG
Polarity start error
Polarity start
S3
18
_On
SP1
Start switch
iStart
X100
Roller stepper start
oRoller
Y5
OUT
19
Roller stepper start
oRoller
Y5
TMR
Spit out the paper from the testing hold
Stepper spit
T5
K1
Output 1 Enable output.
B2056.0
OUT
20
Spit out the paper from the testing hold
Stepper spit
T5
Polarity error
Polarity
S12
JMP
SG
Polarity error
Polarity
S12
22
_On
SP1
Light output for error
oError
Y13
OUT
Light output for polarity reversed
oPolarity
Y12
OUT
Start conveyer to Bad bay
oConBL
Y7
OUT
23
Start switch
iStart
X100
Ready Position
Start
S0
JMP


24
Start conveyer to Bad bay
oConBL
Y7
LD
K9f40
OUT
Output3 Parameter 3 part 2
V2115
Output 3 Process Cmd
B2142.7
OUT
Output 3 Enable Output
B2142.0
OUT
SG
Bad position start
Bad start
S4
26
_On
SP1
Start switch
iStart
X100
Roller stepper start
oRoller
Y5
OUT
27
Roller stepper start
oRoller
Y5
TMR
Spit out the paper from the testing hold
Stepper spit
T5
K5
Output 1 Enable output.
B2056.0
OUT
28
Spit out the paper from the testing hold
Stepper spit
T5
Bad position selection
Bad
S13
JMP
SG
Bad position selection
Bad
S13
30
_On
SP1
Light output for bad selection
oBad
Y11
OUT
Start conveyer to Bad bay
oConBL
Y7
OUT
TMR
Bad move timer 1
Timer B1
T0
K60


31
Start switch
iStart
X100
Left Optical sensor
iLeft
X3
Bad continue move
Bad continue
S5
JMP
32
Bad move timer 1
Timer B1
T0
Timer error
Bad Error
S6
JMP
33
Start conveyer to Bad bay
oConBL
Y7
LD
K9f40
OUT
Output3 Parameter 3 part 2
V2115
Output 3 Process Cmd
B2142.7
OUT
Output 3 Enable Output
B2142.0
OUT
SG
Bad continue move
Bad continue
S5
35
_On
SP1
Light output for bad selection
oBad
Y11
OUT
Start conveyer to Bad bay
oConBL
Y7
OUT
TMR
Bad move timer 2
Timer B2
T1
K60
Output 3 Enable Output
B2142.0
OUT
36
Start switch
iStart
X100
Left Optical sensor
iLeft
X3
Ready Position
Start
S0
JMP
37
Bad move timer 2
Timer B2
T1
Timer error
Bad Error
S6
JMP


38
Start conveyer to Bad bay
oConBL
Y7
LD
K9f40
OUT
Output3 Parameter 3 part 2
V2115
Output 3 Process Cmd
B2142.7
OUT
Output 3 Enable Output
B2142.0
OUT
SG
Timer error
Bad Error
S6
40
_On
SP1
Light output for error
oError
Y13
OUT
Light output for bad selection
oBad
Y11
OUT
Start conveyer to Bad bay
oConBL
Y7
OUT
41
Start switch
iStart
X100
Ready Position
Start
S0
JMP
42
Start conveyer to Bad bay
oConBL
Y7
LD
K9f40
OUT
Output3 Parameter 3 part 2
V2115
Output 3 Process Cmd
B2142.7
OUT
Output 3 Enable Output
B2142.0
OUT
SG
Good position start
Good start
S7
44
_On
SP1
Start switch
iStart
X100
Roller stepper start
oRoller
Y5
OUT
45
Roller stepper start
oRoller
Y5
TMR
Spit out the paper from the testing hold
Stepper spit
T5
K5
Output 1 Enable output.
B2056.0
OUT
46
Spit out the paper from the testing hold
Stepper spit
T5
Good position selection
Good
S14
JMP
SG
Good position selection
Good
S14
48
_On
SP1
Light output for good selection
oGood
Y10
OUT
Start coveyer to Good bay
oConGR
Y6
OUT
TMR
Good move timer 1
T2
K60
49
Start switch
iStart
X100
Right Optical sensor
iRight
X2
Good continue move
Good continue
S10
JMP