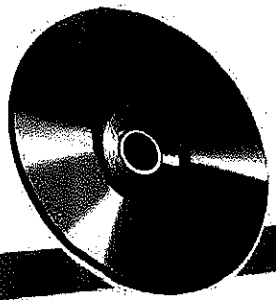


BURR BLOCKS FOR DUMMIES

NEW! Revised & Updated!

A Reference for the Rest of Us!

by Tim Nennich, David Calvert, John Cornell, & Jonny Ostojic

The Fun and Easy Way to Create You Own Burr Blocks From Any Type of Wood!

No Previous Wood-working Experience Required!

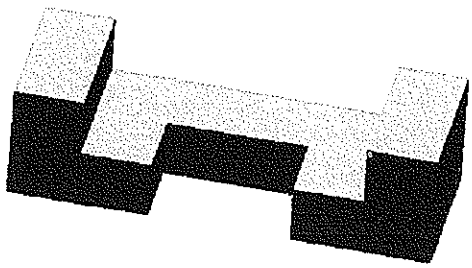
Make a Variety of Six Block Puzzles!

Table of Contents

Introduction

This is a user's manual detailing the proper use of our burr puzzle machine. Here is a brief overview of what the machine does.

The machine will cut wood blocks of sized 0.75 X 0.75 X 2.25 inches, +/- 0.003 (95%). It will cut one up to four 0.375 inch notches on one face, and up to two of the same sized notches on a second face as shown.



The blocks enter and leave via a conveyer belt. The machine is fitted with a dust collection system as well as an emergency shut-off switch

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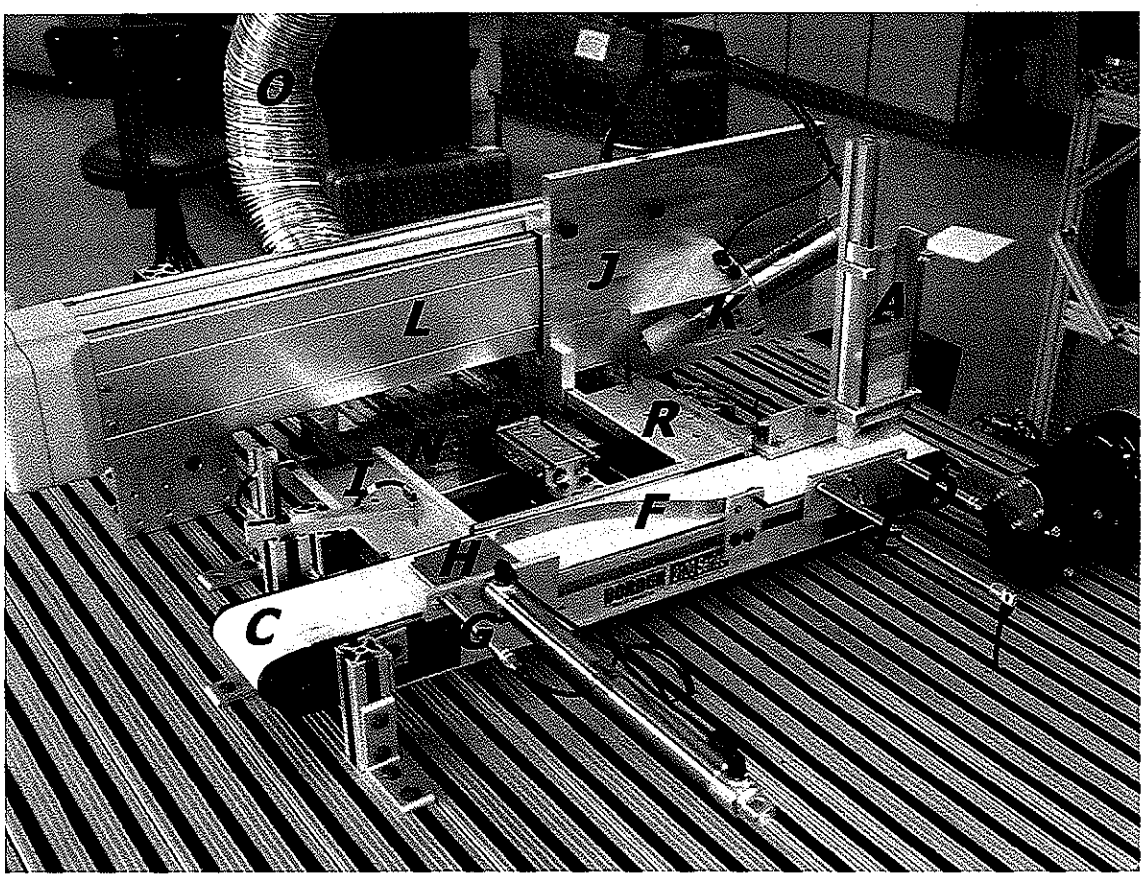
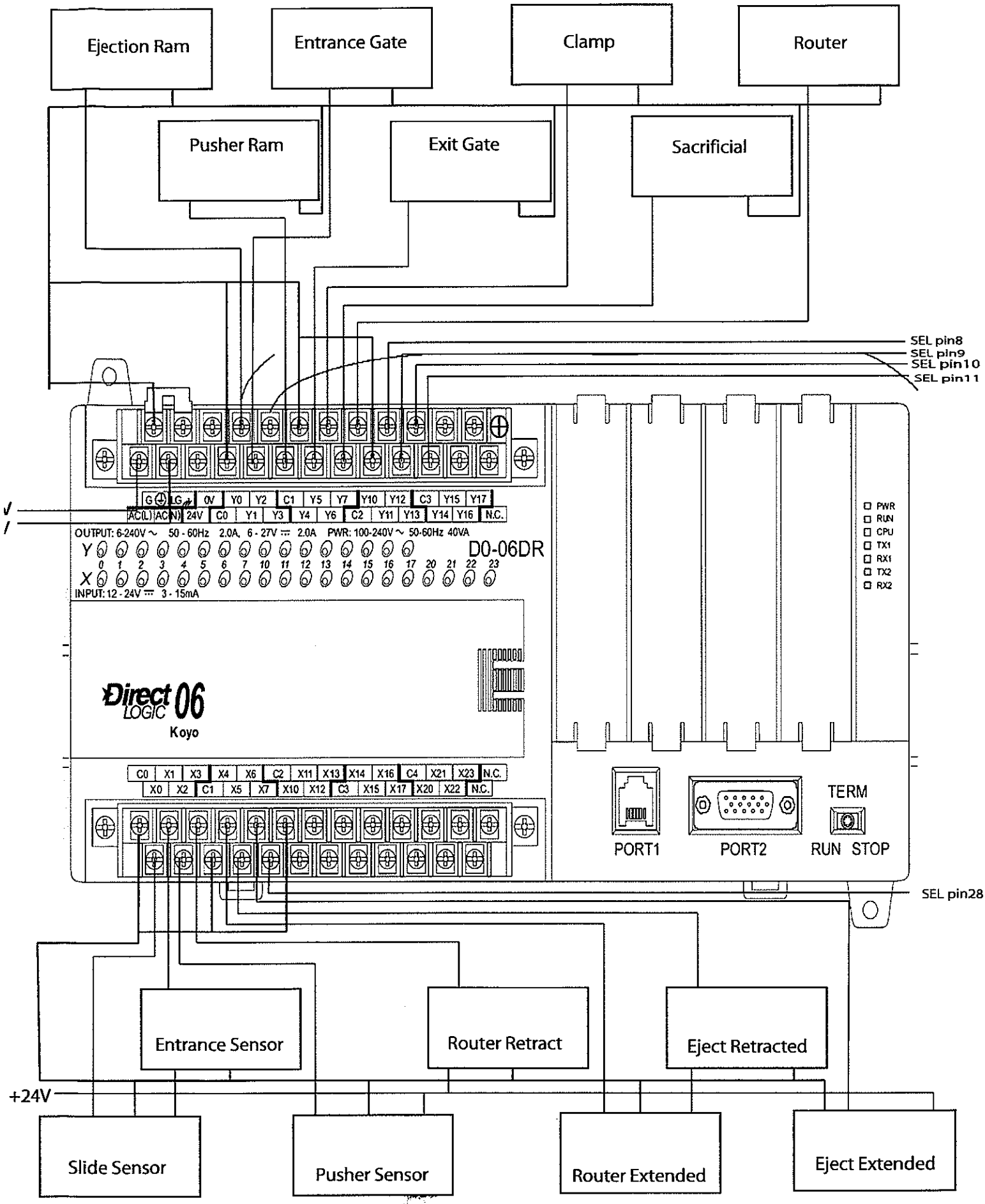
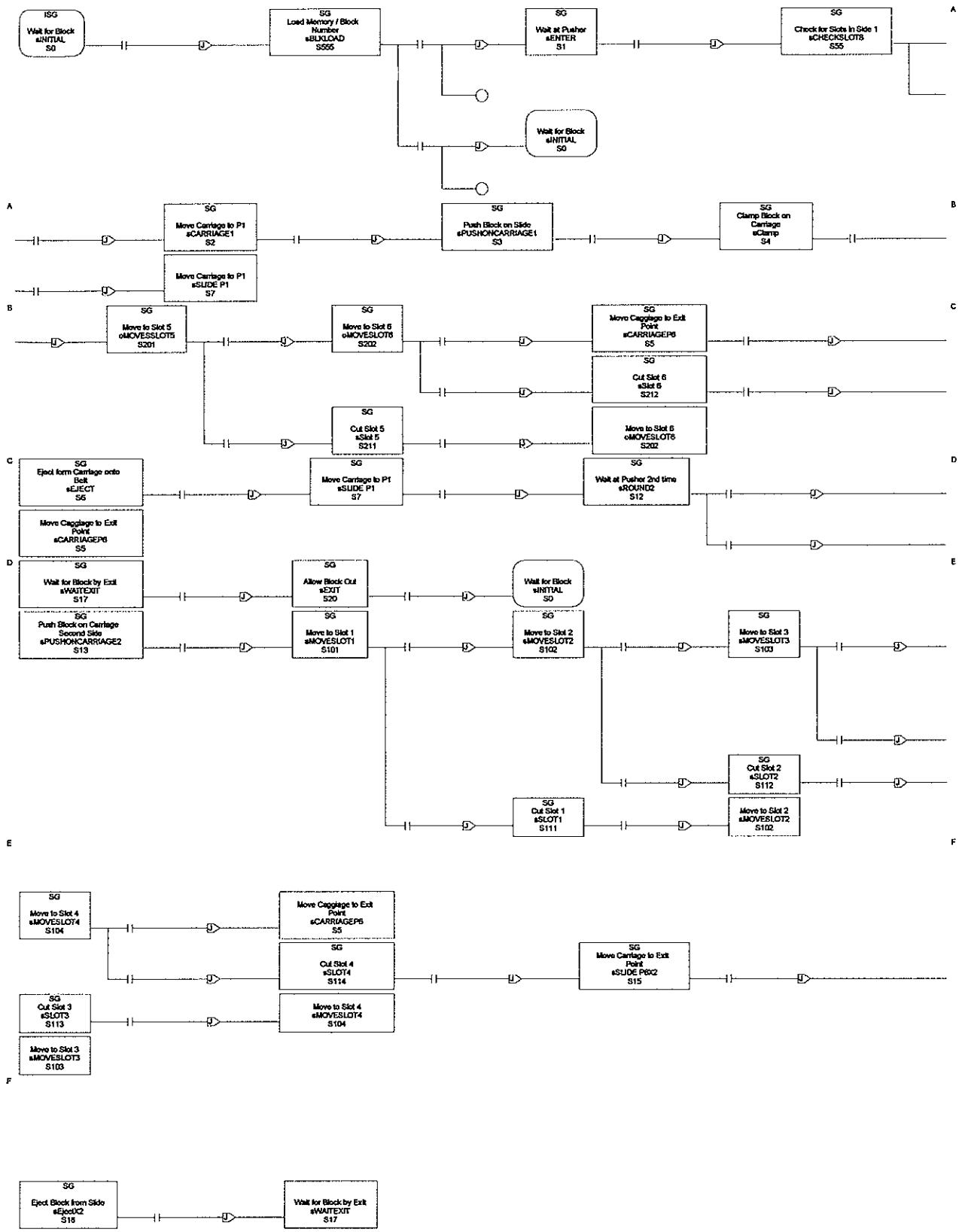
Parts List

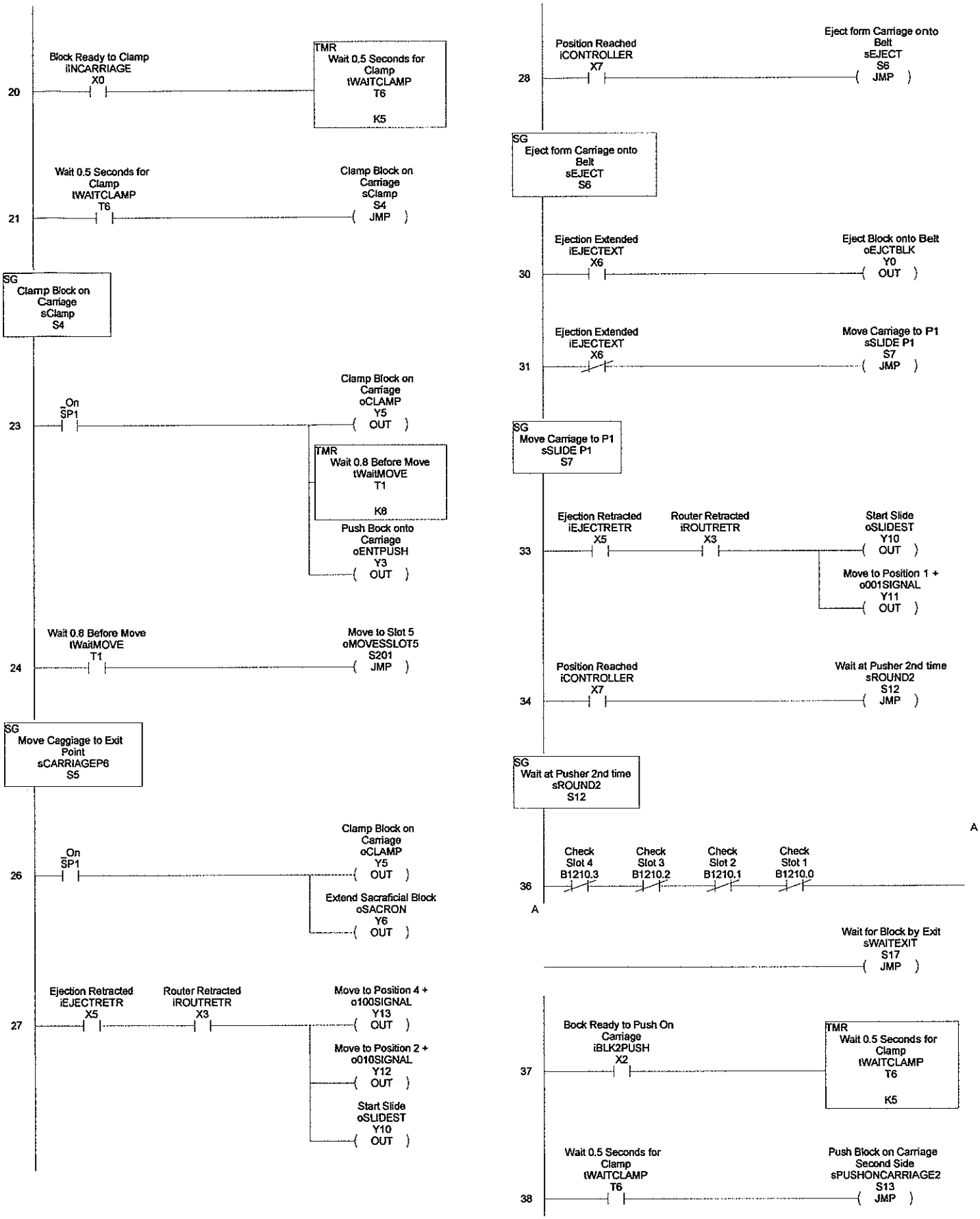
A – Block Loader
B – Motor
C – Belt
D – Entrance Stop
E – Entrance Gate
F – Fence
G – Exit Gate
H – Entrance Pusher
I – Entrance Slide
J – Carriage
K – Clamp
L – Linear Actuator
M – Router
N – Router Plate
O – Vacuum Hose
P – Sacrificial Block
Q – Ejection Pusher
R – Ejection slide

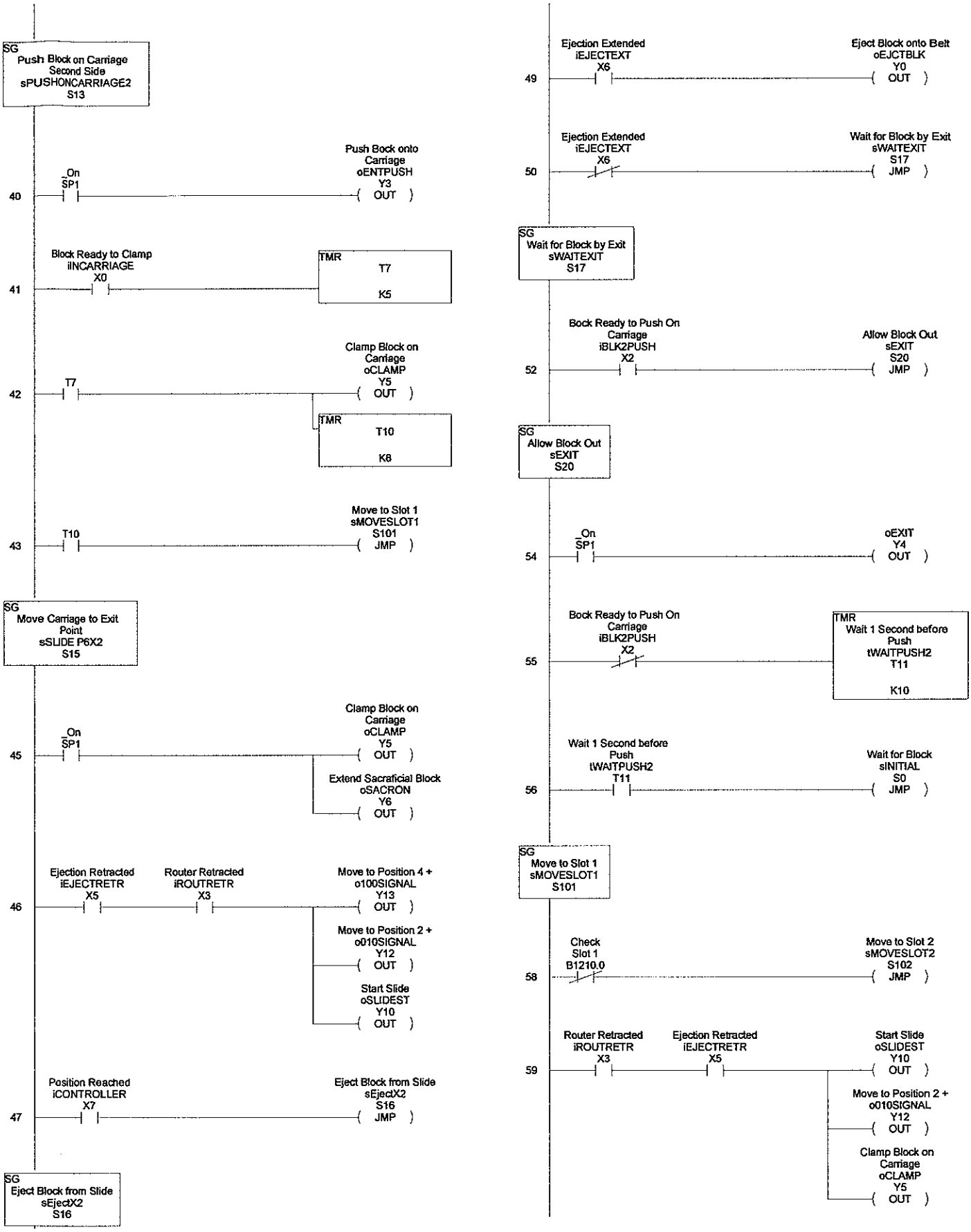


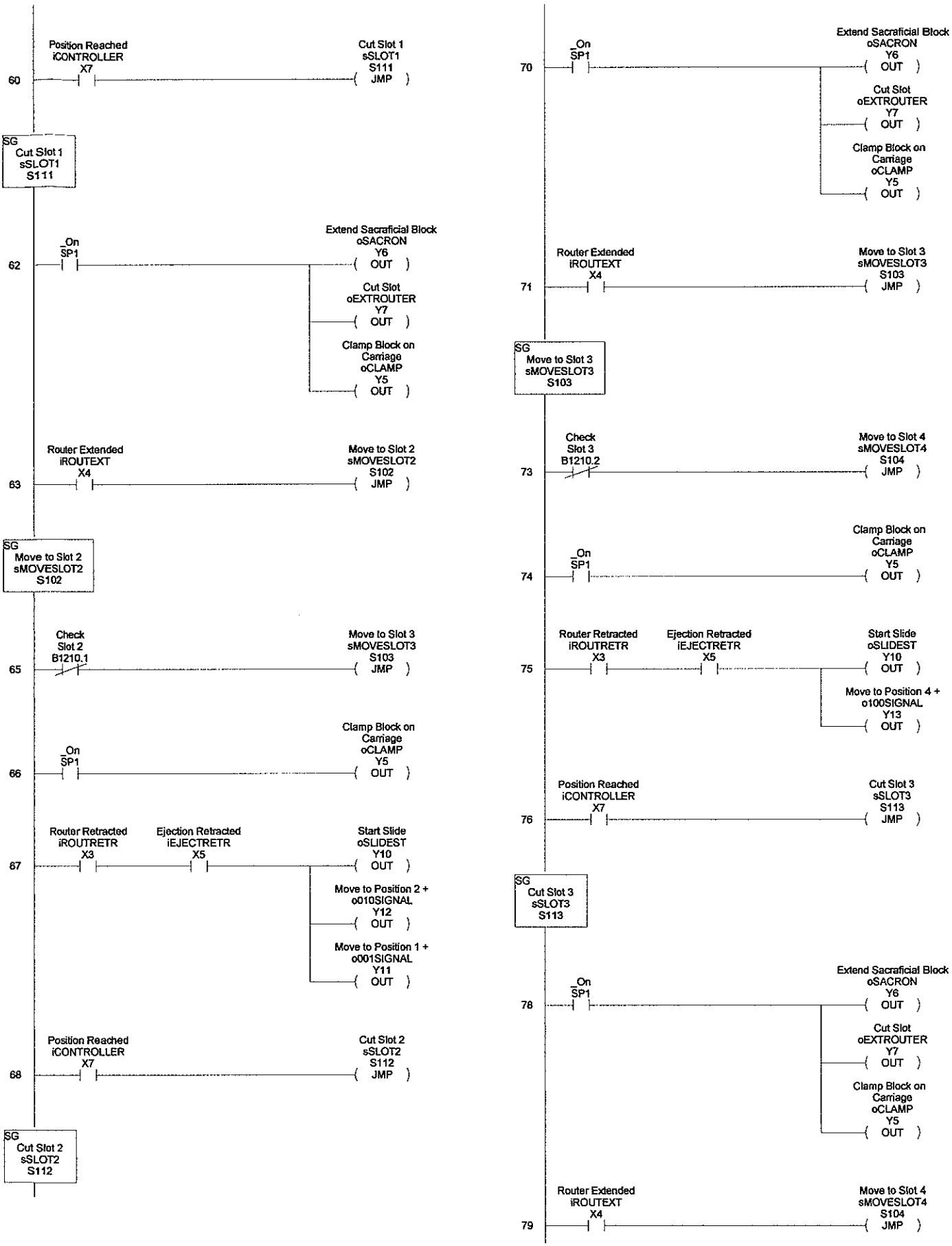

Ejection Ram
Entrance Gate
Clamp
Router
Pusher Ram
Exit Gate
Sacrificial
SEL pin8
SEL pin9
SEL pin10
SEL pin11
G LG 0V Y0 Y2 C1 Y5 Y7 Y10 Y12 C3 Y15 Y17
AC(L) AC(N) 24V C0 Y1 Y3 Y4 Y6 C2 Y11 Y13 Y14 Y16 N.C.
OUTPUT: 6-240V ~ 50 - 60Hz 2.0A, 6 - 27V ⎓ 2.0A PWR: 100-240V ~ 50-60Hz 40VA
D0-06DR
INPUT: 12 - 24V ⎓ 3 - 15mA
PWR
RUN
CPU
TX1
RX1
TX2
RX2
Direct LOGIC 06
Koyo
C0 X1 X3 X4 X6 C2 X11 X13 X14 X16 C4 X21 X23 N.C.
X0 X2 C1 X5 X7 X10 X12 C3 X15 X17 X20 X22 N.C.
PORT1
PORT2
TERM
RUN STOP
SEL pin28
Entrance Sensor
Router Retract
Eject Retracted
+24V
Slide Sensor
Pusher Sensor
Router Extended
Eject Extended

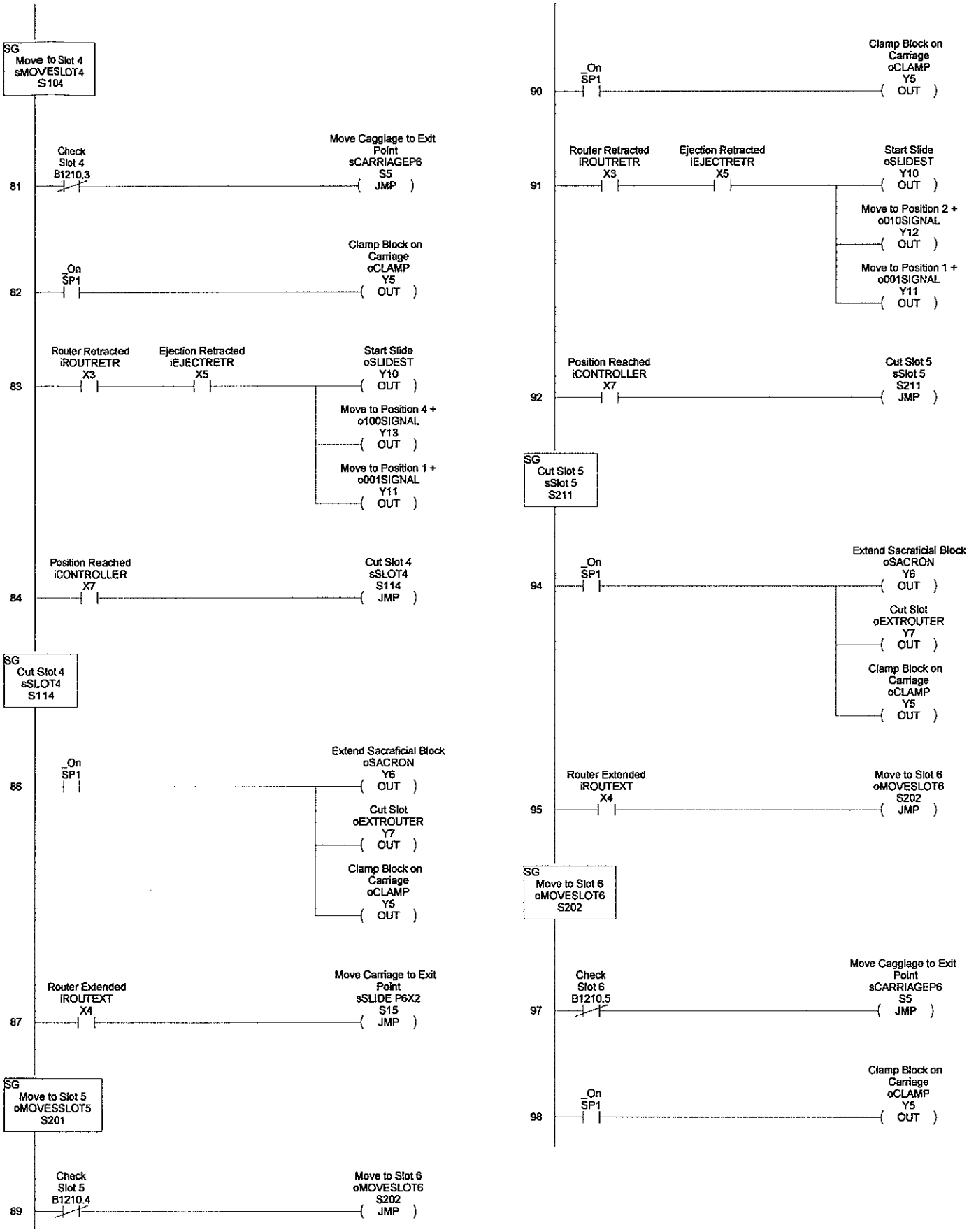

ISG
Wait for Block
sINITIAL
S0
SG
Load Memory / Block Number
sBLKLOAD
S555
SG
Wait at Pusher
sENTER
S1
SG
Check for Slots In Side 1
sCHECKSLOTS
S55
Wait for Block
sINITIAL
S0
SG
Move Carriage to P1
sCARRIAGE1
S2
SG
Push Block on Slide
sPUSHONCARRIAGE1
S3
SG
Clamp Block on Carriage
sClamp
S4
Move Carriage to P1
sSLIDE P1
S7
SG
Move to Slot 5
oMOVESSLOT5
S201
SG
Move to Slot 6
oMOVESLOT6
S202
SG
Move Cagglage to Exit Point
sCARRIAGEP6
S5
SG
Cut Slot 6
sSlot 6
S212
SG
Cut Slot 5
sSlot 5
S211
Move to Slot 6
oMOVESLOT6
S202
SG
Eject form Carriage onto Belt
sEJECT
S6
SG
Move Carriage to P1
sSLIDE P1
S7
SG
Wait at Pusher 2nd time
sROUND2
S12
Move Cagglage to Exit Point
sCARRIAGEP6
S5
SG
Wait for Block by Exit
sWAITEXIT
S17
SG
Allow Block Out
sEXIT
S20
Wait for Block
sINITIAL
S0
SG
Push Block on Carriage Second Side
sPUSHONCARRIAGE2
S13
SG
Move to Slot 1
sMOVESLOT1
S101
SG
Move to Slot 2
sMOVESLOT2
S102
SG
Move to Slot 3
sMOVESLOT3
S103
SG
Cut Slot 2
sSLOT2
S112
SG
Cut Slot 1
sSLOT1
S111
Move to Slot 2
sMOVESLOT2
S102
SG
Move to Slot 4
sMOVESLOT4
S104
Move Cagglage to Exit Point
sCARRIAGEP6
S5
SG
Cut Slot 4
sSLOT4
S114
SG
Move Carriage to Exit Point
sSLIDE P6X2
S15
SG
Cut Slot 3
sSLOT3
S113
Move to Slot 4
sMOVESLOT4
S104
Move to Slot 3
sMOVESLOT3
S103
SG
Eject Block from Slide
sEjectX2
S16
Wait for Block by Exit
sWAITEXIT
S17

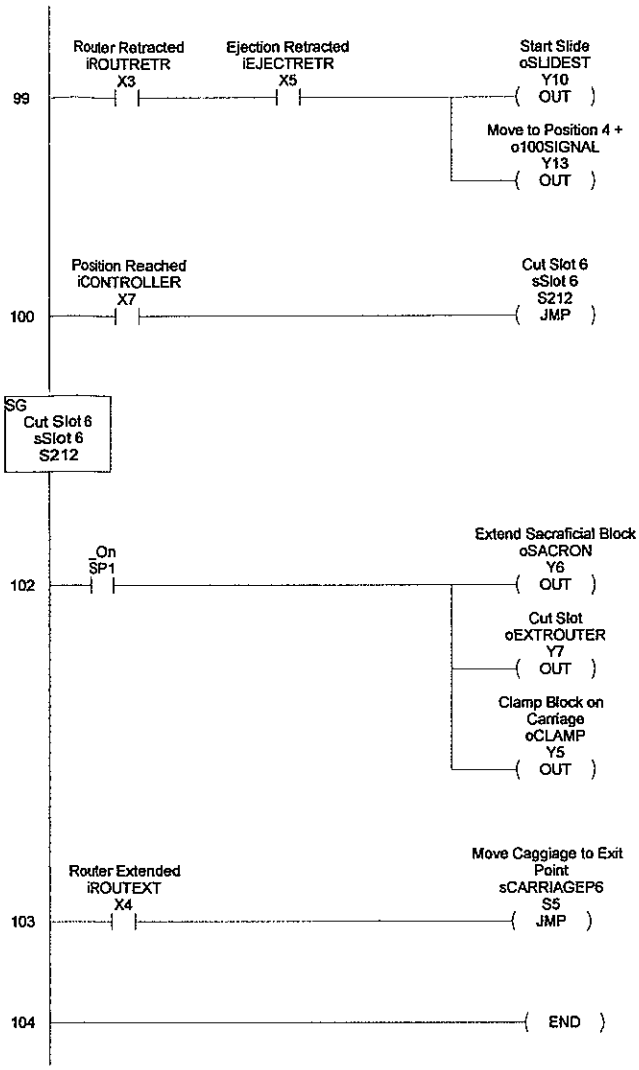

1
_FirstScan
SP0
LD
K0
OUT
Block Number
vBLKNUM
V1220
SG
Wait for Block
sINITIAL
S0
3
Block Entering
iBLKENT
X1
Load Memory / Block
Number
sBLKLOAD
S555
JMP
SG
Load Memory / Block
Number
sBLKLOAD
S555
5
_On
SP1
Allow Block In
oBLKIN
Y1
OUT
LD
Block Number
vBLKNUM
V1220
LDX
Block Table
vBLKTBL
V1200
OUT
Current Block Value
vCURRBLK
V1210
LD
K0
OUT
Slot Number Counter
vSLOTNUM
V1221
6
Block Number
vBLKNUM
V1220
<
K7
INC
Block Number
vBLKNUM
V1220
Wait at Pusher
sENTER
S1
JMP
7
Block Number
vBLKNUM
V1220
≥
K7
LD
K0
OUT
Block Number
vBLKNUM
V1220
Wait for Block
sINITIAL
S0
JMP
SG
Wait at Pusher
sENTER
S1
9
_On
SP1
Allow Block In
oBLKIN
Y1
OUT
10
Bock Ready to Push On
Carriage
iBLK2PUSH
X2
TMR
Wait 1 Second before
Push
tWAITPUSH
T0
K10
11
Wait 1 Second before
Push
tWAITPUSH
T0
Check for Slots in Side 1
sCHECKSLOTS
S55
JMP
SG
Check for Slots in Side 1
sCHECKSLOTS
S55
13
Check
Slot 5
B1210.4
Check
Slot 6
B1210.5
Move Carriage to P1
sCARRIAGE1
S2
JMP
14
Check
Slot 5
B1210.4
Check
Slot 6
B1210.5
Move Carriage to P1
sSLIDE P1
S7
JMP
SG
Move Carriage to P1
sCARRIAGE1
S2
16
Ejection Retracted
iEJECTRETR
X5
Router Retracted
iROUTRETR
X3
Start Slide
oSLIDEST
Y10
OUT
Move to Position 1 +
o001SIGNAL
Y11
OUT
17
Position Reached
iCONTROLLER
X7
Push Block on Slide
sPUSHONCARRIAGE1
S3
JMP
SG
Push Block on Slide
sPUSHONCARRIAGE1
S3
19
_On
SP1
Push Bock onto
Carriage
oENTPUSH
Y3
OUT


20
Block Ready to Clamp
iINCARRIAGE
X0
TMR
Wait 0.5 Seconds for
Clamp
tWAITCLAMP
T6
K5
21
Wait 0.5 Seconds for
Clamp
tWAITCLAMP
T6
Clamp Block on
Carriage
sClamp
S4
JMP
SG
Clamp Block on
Carriage
sClamp
S4
23
On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT
TMR
Wait 0.8 Before Move
tWaitMOVE
T1
K8
Push Bock onto
Carriage
oENTPUSH
Y3
OUT
24
Wait 0.8 Before Move
tWaitMOVE
T1
Move to Slot 5
oMOVESSLOT5
S201
JMP
SG
Move Caggiage to Exit
Point
sCARRIAGEP6
S5
26
On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT
Extend Sacraficial Block
oSACRON
Y6
OUT
27
Ejection Retracted
iEJECTRETR
X5
Router Retracted
iROUTRETR
X3
Move to Position 4 +
o100SIGNAL
Y13
OUT
Move to Position 2 +
o010SIGNAL
Y12
OUT
Start Slide
oSLIDEST
Y10
OUT
28
Position Reached
iCONTROLLER
X7
Eject form Carriage onto
Belt
sEJECT
S6
JMP
SG
Eject form Carriage onto
Belt
sEJECT
S6
30
Ejection Extended
iEJECTEXT
X6
Eject Block onto Belt
oEJCTBLK
Y0
OUT
31
Ejection Extended
iEJECTEXT
X6
Move Carriage to P1
sSLIDE P1
S7
JMP
SG
Move Carriage to P1
sSLIDE P1
S7
33
Ejection Retracted
iEJECTRETR
X5
Router Retracted
iROUTRETR
X3
Start Slide
oSLIDEST
Y10
OUT
Move to Position 1 +
o001SIGNAL
Y11
OUT
34
Position Reached
iCONTROLLER
X7
Wait at Pusher 2nd time
sROUND2
S12
JMP
SG
Wait at Pusher 2nd time
sROUND2
S12
A
36
Check
Slot 4
B1210.3
Check
Slot 3
B1210.2
Check
Slot 2
B1210.1
Check
Slot 1
B1210.0
A
Wait for Block by Exit
sWAITEXIT
S17
JMP
37
Bock Ready to Push On
Carriage
iBLK2PUSH
X2
TMR
Wait 0.5 Seconds for
Clamp
tWAITCLAMP
T6
K5
38
Wait 0.5 Seconds for
Clamp
tWAITCLAMP
T6
Push Block on Carriage
Second Side
sPUSHONCARRIAGE2
S13
JMP


SG
Push Block on Carriage Second Side
sPUSHONCARRIAGE2
S13
40
_On
SP1
Push Bock onto Carriage
oENTPUSH
Y3
OUT
41
Block Ready to Clamp
iINCARRIAGE
X0
TMR
T7
K5
42
T7
Clamp Block on Carriage
oCLAMP
Y5
OUT
TMR
T10
K8
43
T10
Move to Slot 1
sMOVESLOT1
S101
JMP
SG
Move Carriage to Exit Point
sSLIDE P6X2
S15
45
_On
SP1
Clamp Block on Carriage
oCLAMP
Y5
OUT
Extend Sacraficial Block
oSACRON
Y6
OUT
46
Ejection Retracted
iEJECTRETR
X5
Router Retracted
iROUTRETR
X3
Move to Position 4 +
o100SIGNAL
Y13
OUT
Move to Position 2 +
o010SIGNAL
Y12
OUT
Start Slide
oSLIDEST
Y10
OUT
47
Position Reached
iCONTROLLER
X7
Eject Block from Slide
sEjectX2
S16
JMP
SG
Eject Block from Slide
sEjectX2
S16
49
Ejection Extended
iEJECTEXT
X6
Eject Block onto Belt
oEJCTBLK
Y0
OUT
50
Ejection Extended
iEJECTEXT
X6
Wait for Block by Exit
sWAITEXIT
S17
JMP
SG
Wait for Block by Exit
sWAITEXIT
S17
52
Bock Ready to Push On Carriage
iBLK2PUSH
X2
Allow Block Out
sEXIT
S20
JMP
SG
Allow Block Out
sEXIT
S20
54
_On
SP1
oEXIT
Y4
OUT
55
Bock Ready to Push On Carriage
iBLK2PUSH
X2
TMR
Wait 1 Second before Push
tWAITPUSH2
T11
K10
56
Wait 1 Second before Push
tWAITPUSH2
T11
Wait for Block
sINITIAL
S0
JMP
SG
Move to Slot 1
sMOVESLOT1
S101
58
Check Slot 1
B1210.0
Move to Slot 2
sMOVESLOT2
S102
JMP
59
Router Retracted
iROUTRETR
X3
Ejection Retracted
iEJECTRETR
X5
Start Slide
oSLIDEST
Y10
OUT
Move to Position 2 +
o010SIGNAL
Y12
OUT
Clamp Block on Carriage
oCLAMP
Y5
OUT


60
Position Reached
iCONTROLLER
X7
Cut Slot 1
sSLOT1
S111
JMP
SG
Cut Slot 1
sSLOT1
S111
62
_On
SP1
Extend Sacraficial Block
oSACRON
Y6
OUT
Cut Slot
oEXTROUTER
Y7
OUT
Clamp Block on
Carriage
oCLAMP
Y5
OUT
63
Router Extended
iROUTEXT
X4
Move to Slot 2
sMOVESLOT2
S102
JMP
SG
Move to Slot 2
sMOVESLOT2
S102
65
Check
Slot 2
B1210.1
Move to Slot 3
sMOVESLOT3
S103
JMP
66
_On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT
67
Router Retracted
iROUTRETR
X3
Ejection Retracted
iEJECTRETR
X5
Start Slide
oSLIDEST
Y10
OUT
Move to Position 2 +
o010SIGNAL
Y12
OUT
Move to Position 1 +
o001SIGNAL
Y11
OUT
68
Position Reached
iCONTROLLER
X7
Cut Slot 2
sSLOT2
S112
JMP
SG
Cut Slot 2
sSLOT2
S112
70
_On
SP1
Extend Sacraficial Block
oSACRON
Y6
OUT
Cut Slot
oEXTROUTER
Y7
OUT
Clamp Block on
Carriage
oCLAMP
Y5
OUT
71
Router Extended
iROUTEXT
X4
Move to Slot 3
sMOVESLOT3
S103
JMP
SG
Move to Slot 3
sMOVESLOT3
S103
73
Check
Slot 3
B1210.2
Move to Slot 4
sMOVESLOT4
S104
JMP
74
_On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT
75
Router Retracted
iROUTRETR
X3
Ejection Retracted
iEJECTRETR
X5
Start Slide
oSLIDEST
Y10
OUT
Move to Position 4 +
o100SIGNAL
Y13
OUT
76
Position Reached
iCONTROLLER
X7
Cut Slot 3
sSLOT3
S113
JMP
SG
Cut Slot 3
sSLOT3
S113
78
_On
SP1
Extend Sacraficial Block
oSACRON
Y6
OUT
Cut Slot
oEXTROUTER
Y7
OUT
Clamp Block on
Carriage
oCLAMP
Y5
OUT
79
Router Extended
iROUTEXT
X4
Move to Slot 4
sMOVESLOT4
S104
JMP


SG
Move to Slot 4
sMOVESLOT4
S104
81
Check
Slot 4
B1210.3
Move Caggiage to Exit
Point
sCARRIAGEP6
S5
JMP
82
_On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT
83
Router Retracted
iROUTRETR
X3
Ejection Retracted
iEJECTRETR
X5
Start Slide
oSLIDEST
Y10
OUT
Move to Position 4 +
o100SIGNAL
Y13
OUT
Move to Position 1 +
o001SIGNAL
Y11
OUT
84
Position Reached
iCONTROLLER
X7
Cut Slot 4
sSLOT4
S114
JMP
SG
Cut Slot 4
sSLOT4
S114
86
_On
SP1
Extend Sacraficial Block
oSACRON
Y6
OUT
Cut Slot
oEXTROUTER
Y7
OUT
Clamp Block on
Carriage
oCLAMP
Y5
OUT
87
Router Extended
iROUTEXT
X4
Move Carriage to Exit
Point
sSLIDE P6X2
S15
JMP
SG
Move to Slot 5
oMOVESSLOT5
S201
89
Check
Slot 5
B1210.4
Move to Slot 6
oMOVESLOT6
S202
JMP
90
_On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT
91
Router Retracted
iROUTRETR
X3
Ejection Retracted
iEJECTRETR
X5
Start Slide
oSLIDEST
Y10
OUT
Move to Position 2 +
o010SIGNAL
Y12
OUT
Move to Position 1 +
o001SIGNAL
Y11
OUT
92
Position Reached
iCONTROLLER
X7
Cut Slot 5
sSlot 5
S211
JMP
SG
Cut Slot 5
sSlot 5
S211
94
_On
SP1
Extend Sacraficial Block
oSACRON
Y6
OUT
Cut Slot
oEXTROUTER
Y7
OUT
Clamp Block on
Carriage
oCLAMP
Y5
OUT
95
Router Extended
iROUTEXT
X4
Move to Slot 6
oMOVESLOT6
S202
JMP
SG
Move to Slot 6
oMOVESLOT6
S202
97
Check
Slot 6
B1210.5
Move Caggiage to Exit
Point
sCARRIAGEP6
S5
JMP
98
_On
SP1
Clamp Block on
Carriage
oCLAMP
Y5
OUT


Router Retracted
iROUTRETR
X3
Ejection Retracted
iEJECTRETR
X5
Start Slide
oSLIDEST
Y10
OUT
99
Move to Position 4 +
o100SIGNAL
Y13
OUT
Position Reached
iCONTROLLER
X7
Cut Slot 6
sSlot 6
S212
JMP
100
SG
Cut Slot 6
sSlot 6
S212
Extend Sacraficial Block
oSACRON
Y6
OUT
_On
SP1
102
Cut Slot
oEXTROUTER
Y7
OUT
Clamp Block on
Carriage
oCLAMP
Y5
OUT
Move Caggiage to Exit
Point
sCARRIAGEP6
S5
JMP
Router Extended
iROUTEXT
X4
103
104
END

Startup Procedure

This startup procedure is assuming that the program is already loaded into the PLC

1. Load six blocks into the loader on the right end of the conveyor.

2. Flip the switch on the PLC to "Stop" mode. This will ensure that the PLC initializes back to its initial state when powered up. Make sure all people and items are away from moving parts.

3. Turn large red knob clockwise to pressurize the system. This will also power up the PLC and start the linear actuator initialization sequence. Affirm that the air pressure is approximately 60 psi.

4. Wait for the linear actuator to initialize. It will home on the right side. The slide will move rapidly to the right end and then slowly move to its "home" position. Once it stops moving, you are ready to go.

5. Plug in the router.

6. Turn on the central vacuum motor. There is a green "Start" button located on top of the motor of the central vacuum system. Make sure that the gate in the vacuum piping directly above the machine is open.

7. Flip the PLC switch to the "Run" position. This will initialize the PLC into the initial state.

8. Flip the switch on the motor speed control up to the "On" position. The switch has some sort of loose connection, and you sometimes have to wiggle it a bit in the up position to complete the circuit. This will complete the startup procedure.

Block Cycle Order

Six blocks are placed into the block loader to start with. The emergency shut-off button is released, the router is plugged in, and the conveyor belt is turned on. This causes the first block to move forward on the belt, breaking the beam of the through-beam sensor x1. As soon as the block breaks this beam, the entrance stop is pressurized and holds the next block so that only one block is in the system at one time. The first block then continues on down the belt being guided to the inside of the belt by the fence. At the end of the fence, the block is detected by sensor x2. The PLC uses this count to know whether to cut the block or let it continue past the exit gate.

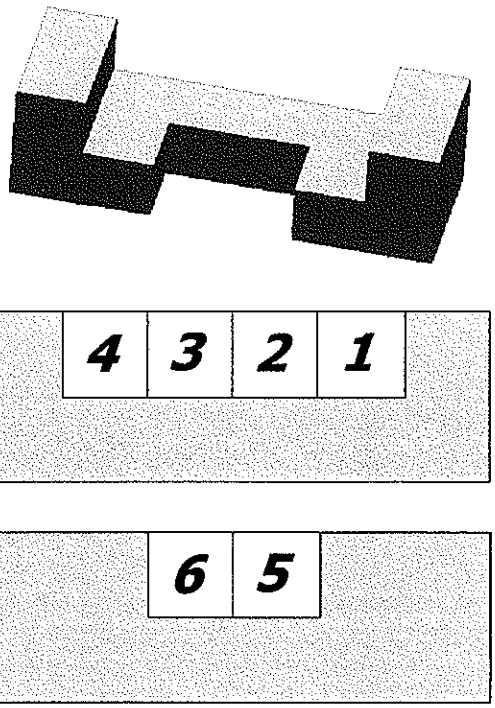
If the block is to be cut, the exit gate stays closed and stops the block. Also, the PLC uses this count to release the entrance stop and let the next block proceed to the entrance gate. While that block is waiting to go, the entrance fence keeps it from sliding around due to the belt moving beneath it. Next the entrance pusher pushes the first block off the belt, down the entrance slide, and into the carriage. Sensor x0 tells the PLC that the block is in place in the carriage and the clamp is ready to be activated. The entrance pusher holds the block secure while the clamp moves into place to hold the block tightly in the carriage. The entrance pusher then releases and the linear actuator moves the carriage with the block over the router plate where the router is mounted. Once the carriage is in the proper location, a sacrificial block is pressed against the block to be cut for support as the router cuts through. The router goes to the end of its stroke and triggers x4. The PLC tells the router to go back where it triggers x3 once it is fully retracted.

If more cuts are needed, the linear actuator moves the carriage a small amount, the sacrificial block is pressed against the puzzle block, and the router makes another cut. Once this is done, the linear actuator takes the block further to the ejection slide where the clamp will disengage and the ejection pusher pushes the block back onto the belt. The ejection slide is designed to be slightly higher than the belt so that when the block comes to the end of the slide, it rolls once onto the belt. The block then goes down the belt, past the fence, and to the exit gate. If the block is to be cut on the next side, the whole process repeats. If not, the exit gate retracts and the block rolls off the end of the belt allowing the next block in line to be released into the system. This process is repeated for all six blocks.

Changing Puzzle Types

Here is the procedure for changing out the puzzle types.

1. Make sure that the PLC is turned on and in terminal mode.
2. Open the DirectSOFT32 software.
3. Open the memory editor (shortcut is CTRL+Y).
4. Memory locations V1200 through V1205 correspond to the six blocks. Within each memory slot will be a binary number series where a 1 represents a cut. Digits 0-5 correspond to the six notches, 6 5 4 3 2 1. If you wanted to cut slots 3, 5 and 6, the binary sequence would look like "0000000000110100". The order and slot numbers are shown below.



Troubleshooting

Being that this is a prototype machine, there are still a few kinks that need to be smoothed out. Here are some things to look out for.

1. The cuts that the router makes sometimes leave a thin overhang of wood that is attached to one side of the notch. This can sometimes cause the burr blocks to do a double rotation as it slides off the exit slide. This can be minimized by adjusting the router extension speed, and keeping the router bit sharp.

2. The sensor bracket for the sensor that senses when the router is extended will sometimes get misaligned. This is easy to spot because the router will fail to retract. A simple adjustment re-aligns the sensor.

3. Make sure that if for any reason you have to shut down the machine in mid-cycle, that when you restart the machine you first put the PLC back into stop mode, otherwise the linear actuator might home in the wrong location.

4. The power switch on the conveyor belt has a loose connection and sometimes needs to be nudged down slightly once it is in the "up" position.