Appendix A

Complete Petri Net

Table A.1: Complete Transitions.

Transitions	Meaning
t_0	Initialization Button
t_1	MAG1's Cylinder Retracted
t_2	MAG2's Cylinder Retracted
t_3, t_{30}, t_{60}	Right Discharge Cylinder Retracted
t_4, t_{34}, t_{65}	Center Discharge Cylinder Retracted
t_5, t_{39}, t_{55}	Left Discharge Cylinder Retracted
$t_6, t_{18}, t_{21}, t_{40}, t_{45}, t_{47}, t_{66},$ $t_{71}, t_{85}, t_{92}, t_{96}, t_{119}, t_{120},$ $t_{142}, t_{143}, t_{144}, t_{152}$	
t_9	Safety Door Opened
t_{10}	Assembly Unit Holder Extended
t_{11}	Storage Unit Retracted and Arm Lowered and Retracted
t_{12}, t_{150}	Storage Unit Right Limit Switch
t_{13}, t_{151}	Storage Unit Inferior Limit Switch
t_{15}, t_{102}	Inductive Sensor Arm
t_{17}, t_{84}, t_{104}	ARMCOUNTER = odo{-1690}
t_{19}	Start Button
t_{20}	$\overline{\text{MAG1 Empty}}$
t_{22}	MAG1's Cylinder Extended $\uparrow$

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Transitions	Meaning
t_{23}	MAG1's Cylinder Retracted ↑
t_{26}, t_{56}	$\overline{\text{Metallic Sensor}}$
t_{27}, t_{57}, t_{61}	$\overline{\text{White Color Sensor}}$
t_{28}, t_{37}, t_{53}	Proximity Sensor Left Discharge Cylinder ↑
t_{29}, t_{59}	Right Discharge Cylinder Extended
t_{31}	White Color Sensor
t_{32}, t_{63}	Proximity Sensor Center Discharge Cylinder ↑
t_{33}, t_{64}	Center Discharge Cylinder Extended
t_{35}, t_{52}	Metallic Sensor
t_{36}, t_{67}	Concavity Downwards
t_{38}, t_{54}	Left Discharge Cylinder Extended
t_{41}, t_{62}	Concavity Upwards
t_{42}, t_{68}	Proximity Sensor End Of Conveyor Belt ↑
t_{44}	Proximity Sensor End Of Conveyor Belt ↓
t_{46}	$\overline{\text{MAG2 Empty}}$
t_{48}	MAG2's Cylinder Extended ↑
t_{49}	MAG2's Cylinder Retracted ↑
t_{58}	Proximity Sensor Right Discharge Cylinder ↑
t_{70}	Proximity Sensor End Of Conveyor Belt ↑↓
t_{72}	Arm Raised
t_{77}	ARMCOUNTER = odo{-3330}
t_{82}	HALFPIECECOUNTER=1, Assembly Unit Holder Extended and Safety Door Opened
t_{95}, t_{101}	Arm Raised, Storage Unit Right and Inferior Limit Switches
t_{97}	ARMCOUNTER = odo{-4920}
t_{100}	Arm Lowered
t_{107}	COUNTER2=0
t_{108}	COUNTER3=4
$t_{109}, t_{112}, t_{115}, t_{118}$	Vertical Encoder
t_{110}	COUNTER2=1
t_{111}	COUNTER3=3

Transitions	Meaning
t_{113}	COUNTER2=2
t_{114}	COUNTER3=2
t_{116}	COUNTER2=3
t_{117}	COUNTER3=1
t_{121}	COUNTER4=1
t_{122}	COUNTER5=1
$t_{123}, t_{126}, t_{129}, t_{132}, t_{135},$ t_{138}, t_{141}	Horizontal Encoder
t_{124}	COUNTER4=2
t_{125}	COUNTER5=2
t_{127}	COUNTER4=3
t_{128}	COUNTER5=3
t_{130}	COUNTER4=4
t_{131}	COUNTER5=4
t_{133}	COUNTER4=5
t_{134}	COUNTER5=5
t_{136}	COUNTER4=6
t_{137}	COUNTER5=8
t_{139}	COUNTER4=7
t_{140}	COUNTER5=9
t_{153}	COUNTER1<28
t_{154}	COUNTER1=28
t_7	T=15s
t_8	T=2.5s
$t_{14}, t_{98}, t_{99}, t_{105}, t_{106}, t_{145}$	T=2s
$t_{16}, t_{88}, t_{89}, t_{103}$	T=1s
$t_{24}, t_{43}, t_{50}, t_{69}$	T=0.5s
t_{25}, t_{51}	Presence $\uparrow$ T=0.5s
t_{73}, t_{80}	T=1.5s
t_{74}, t_{79}, t_{94}	T=1.5s and Arm Lowered
$t_{75}, t_{76}, t_{78}, t_{81}$	T=1.5s and Arm Raised
t_{83}	T=1.5s, HALFPIECECOUNTER=0 and Raised Arm

Transitions	Meaning
t_{86}	T=1s and Assembly Unit Holder Retracted
t_{87}	T=1s and Safety Door Closed
t_{90}	T=1s and Safety Door Opened
t_{91}	T=1s and Assembly Unit Holder Extended
t_{93}	T=1.5s and Arm Extended
t_{146}, t_{148}	T=3s
t_{147}	T=0.25s
t_{149}	T=7s

Table A.2: Complete Places.

Places	Meaning
p_0	System Stopped
p_1, p_{31}	Retract MAG1's Cylinder *
p_2, p_{32}	MAG1's Cylinder Retracted
p_3, p_{54}	Retract MAG2's Cylinder *
p_4, p_{55}	MAG2's Cylinder Retracted
p_5, p_{38}, p_{64}	Retract Right Discharge Cylinder *
p_6	Right Discharge Cylinder Retracted
p_7	Retract Center Discharge Cylinder
p_8	Center Discharge Cylinder Retracted
p_9, p_{46}, p_{60}	Retract Left Discharge Cylinder *
p_{10}	Left Discharge Cylinder Retracted
p_{11}	Turn Conveyor Belt On (Reverse)
p_{12}	No Pieces On Conveyor Belt
p_{13}	Reset Variables
p_{14}	Raise Press
p_{15}	Open Safety Door
p_{16}	Extend Assembly Unit Holder
p_{17}	Assembly Unit Ready
p_{18}	Arm Lowered and Retracted, and Storage Unit Retracted

Places	Meaning
p_{19}, p_{109}, p_{134}	Move Storage Unit to the Right
p_{20}	Storage Unit ready (horizontal)
p_{21}	Move Storage Device Downwards
p_{22}	Storage Unit ready (vertical)
p_{23}	Rotate Arm CCW
p_{24}	Arm Stopped
p_{25}	Rotate Arm CW e Turn HSC ON
p_{26}, p_{107}	Arm Stopped (facing conveyor belt)
p_{27}	System Ready
p_{28}	MAG1 Empty
p_{29}	MAG1 Not Empty
p_{30}	Extend MAG1's Cylinder *
p_{33}, p_{36}, p_{39}, p_{44}, p_{47}, p_{48}, p_{56}, p_{58}, p_{62}, p_{66}, p_{70}, p_{71}	Turn Conveyor Belt On
p_{34}, p_{42}, p_{57}, p_{69}, p_{110}, p_{117}, p_{129}, p_{138}	
p_{35}	Plastic Half-cube
p_{37}, p_{63}	Extend Right Discharge Cylinder *
p_{40}, p_{67}	Extend Center Discharge Cylinder *
p_{41}, p_{68}	Retract Center Discharge Cylinder *
p_{43}, p_{61}	Metal Half-cube
p_{45}, p_{59}	Extend Left Discharge Cylinder *
p_{49}	Metal Half-cube Ready
p_{50}, p_{73}	Conveyor Belt Stopped
p_{51}	MAG2 Empty
p_{52}	MAG2 Not Empty
p_{53}	Extend MAG2's Cylinder *
p_{65}	White Half-Cube
p_{72}	Plastic Half-cube Ready
p_{74}, p_{84}, p_{95}	Raise Arm
p_{75}	Raise and Extend Arm, and Turn Vacuum On
p_{76}, p_{81}, p_{94}, p_{101}	Extend Arm and Turn Vacuum On

Places	Meaning
p_{77}, p_{80}, p_{97}, p_{100}	Raise and Extend Arm and Turn Vacuum On
p_{78}	Raise Arm and Turn Vacuum On
p_{79}	Turn HSC On e Raise Arm, Turn Vacuum On and Rotate Arm CW
p_{82}, p_{102}	Extend Arm
p_{83}, p_{103}	Raise and Extend Arm
p_{85}	Turn HSC On, Raise Arm and Rotate Arm CCW
p_{86}	Raise Arm and HALFPIECE-COUNTER:=HALFPIECECOUNTER+1
p_{87}	Retract Assembly Unit Holder *
p_{88}	Close Safety Door *
p_{89}	Lower Press *
p_{90}	Raise Press *
p_{91}	Open Safety Door *
p_{92}	Extend Assembly Unit Holder *
p_{93}	Cube Ready
p_{96}	Extend Arm e Turn Vacuum On
p_{98}	Reset HALFPIECECOUNTER*, Raise Arm and Turn Vacuum On
p_{99}	Turn HSC On, Raise Arm, Turn Vacuum On, Rotate Arm CW
p_{104}	Turn Arm CCW
p_{105}	Arm Stoppen
p_{106}	Turn HSC On, Turn Arm CW
p_{108}	Cube on Storage Unit
p_{111}, p_{112}, p_{113}, p_{114}	Move Storage Unit Upwards
p_{115}	COUNTER3:=COUNTER3+1
p_{116}	RESET COUNTER3*
p_{118}	COUNTER1:=COUNTER1+1 e COUNTER4:=COUNTER4+1
p_{119}, p_{120}, p_{121}, p_{122}, p_{123}, p_{124}, p_{125}	Move Storage Unit to the Left

Places	Meaning
p_{126}	COUNTER5:=COUNTER5+1
p_{127}	Reset COUNTER5*
p_{128}	Reset COUNTER4* , COUNTER2:=COUNTER2+1
p_{130}, p_{132}	Extend Storage Unit
p_{131}	Extend Storage Unit and Move Storage Unit Downwards
p_{133}	Piece Stored
p_{135}	Storage Unit Ready (horizontal)
p_{136}	Move Storage Unit Downwards
p_{137}	Storage Unit Ready (vertical)
p_{139}	Storage Unit Ready

Metal Piece

Arm From Belt to Press

Press

Arm From Press to Storage

Plastic Piece

Storage (x)

Store Piece

Storage (y)

Initialization