Table of Contents

1.0. INTRODUCTION 3

2.0. OBJECTIVE 4

3.0. SIMULATION 4

3.1. Factory I/O 4

3.1.1. Feeding station 5

3.1.2. CNC machine 5

3.1.3. Sorting 6

3.1.4. Assembly 6

3.1.5. Remove excess products 7

3.1.6. Warning alarm 7

3.1.7. Conveyor speed control 8

4.0. TIA PORTAL 9

4.1. HMI 11

5.0. DRIVE LINK 13

Full production line system

1.0. INTRODUCTION

This report offers a comprehensive overview of a fully integrated production line, meticulously designed and simulated using TIA Portal and Factory I/O. The production line encompasses a spectrum of sophisticated machinery, including a Pick and Place Robot, a CNC Machine, a Sorting Station, and an Assembly Robot. Each component plays a pivotal role in the seamless operation of the manufacturing process, aimed at optimizing efficiency, accuracy, and productivity.

Through the utilization of TIA Portal, an advanced engineering framework, and Factory I/O, a powerful simulation software, this report explores the intricate interplay between digital design and real-world application. By simulating the production line in a virtual environment, engineers can anticipate potential challenges, fine-tune operational parameters, and refine automation strategies before deployment in the physical realm.

The integration of diverse elements within the production line underscores the complexity of modern manufacturing systems. From the precise movements of the Pick and Place Robot to the intricacies of CNC machining and the intricately choreographed actions of the Assembly Robot, every facet of the process is meticulously orchestrated to achieve optimal performance.

Throughout this report, we delve into the specific functionalities of each component, examining their individual contributions to the overall workflow and elucidating the synergies that exist between them. Additionally, we explore the benefits of employing TIA Portal and Factory I/O in the development and optimization of such production lines, highlighting their role in driving innovation and enhancing operational efficiency.

By elucidating the inner workings of this fully realized production line, this report aims to provide valuable insights into the evolving landscape of industrial automation, offering practical guidance for engineers and stakeholders seeking to harness the transformative potential of advanced manufacturing technologies.

2.0. OBJECTIVE

In groups of 3 students each, you are required to:

(a) Design a full functioning production line on a simulation platform (ex. FACTORY I/O)

(b) Use Siemens TIA portal software in order to control the simulated production line while incorporating the studied functions in the design process of such application.

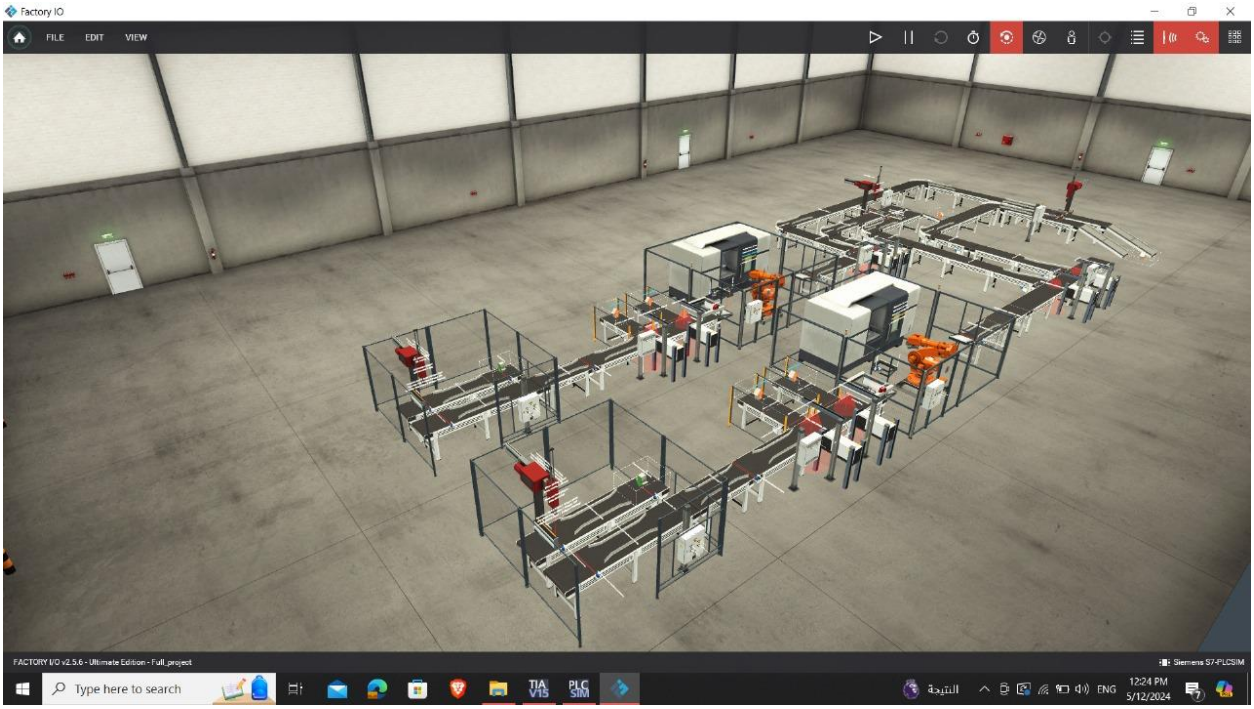
(c) Design a suitable HMI module in order to monitor and visualize the various states of the simulated production line and supply supervisory control commands

(d) Utilize field-related alarms for the detection of hardware and sequence faults.

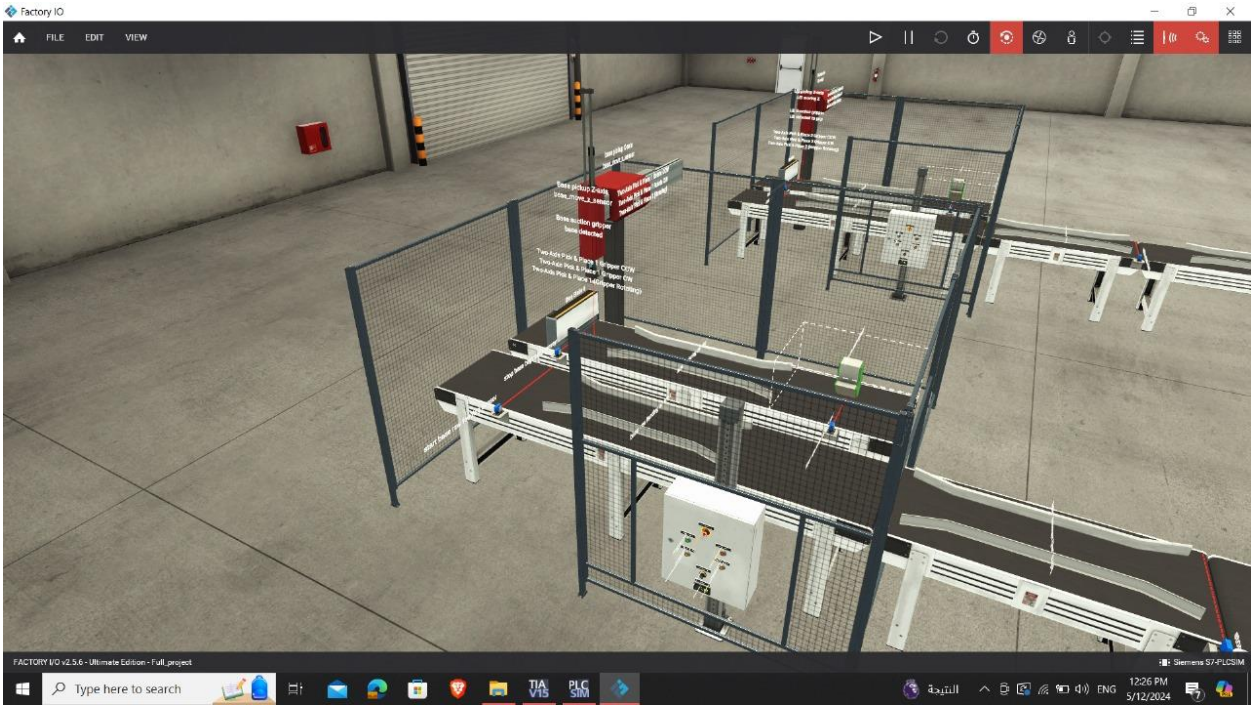
The mentioned production line performs the tasks of machining, sorting and assembly starting from raw materials to finished assembled products.

3.0. SIMULATION

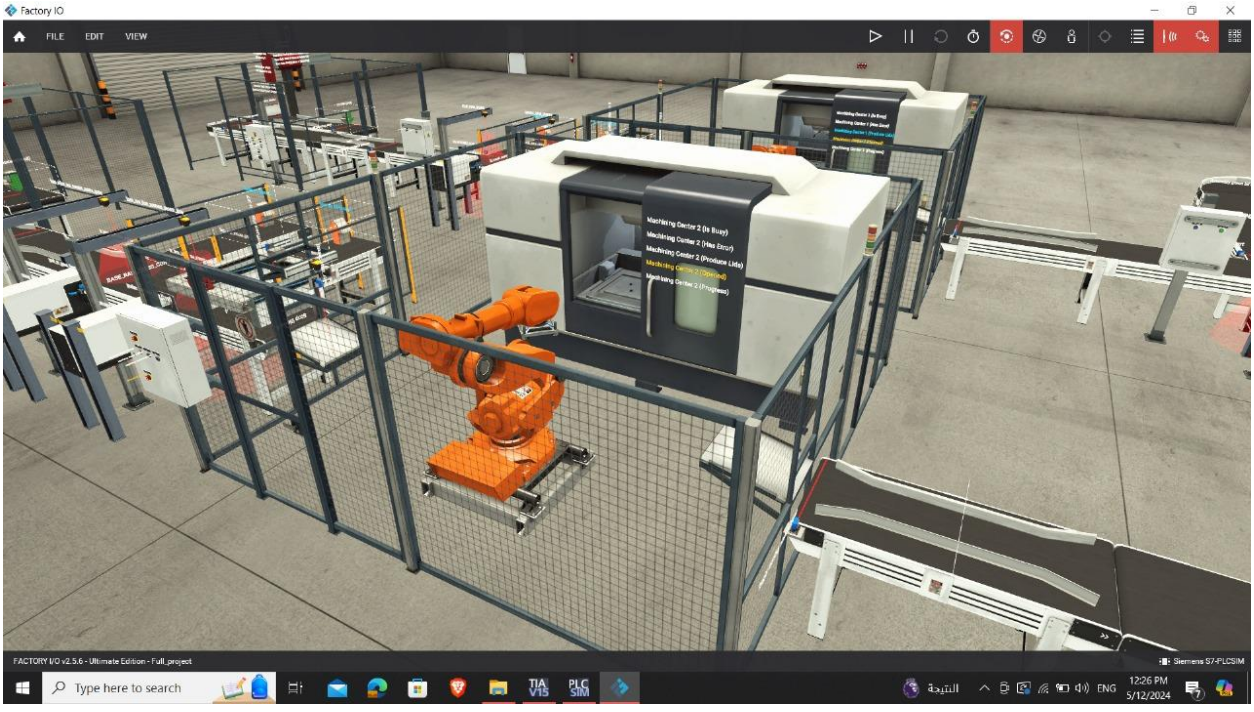
3.1. Factory I/O



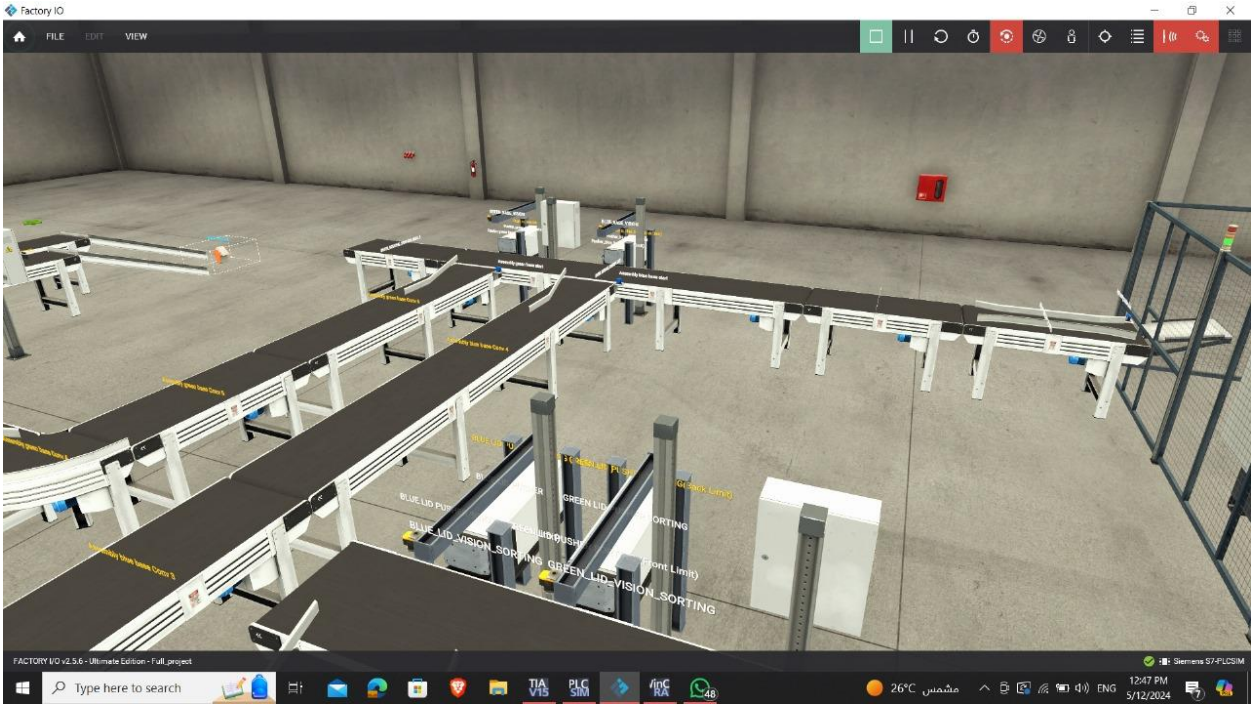
3.1.1. Feeding station



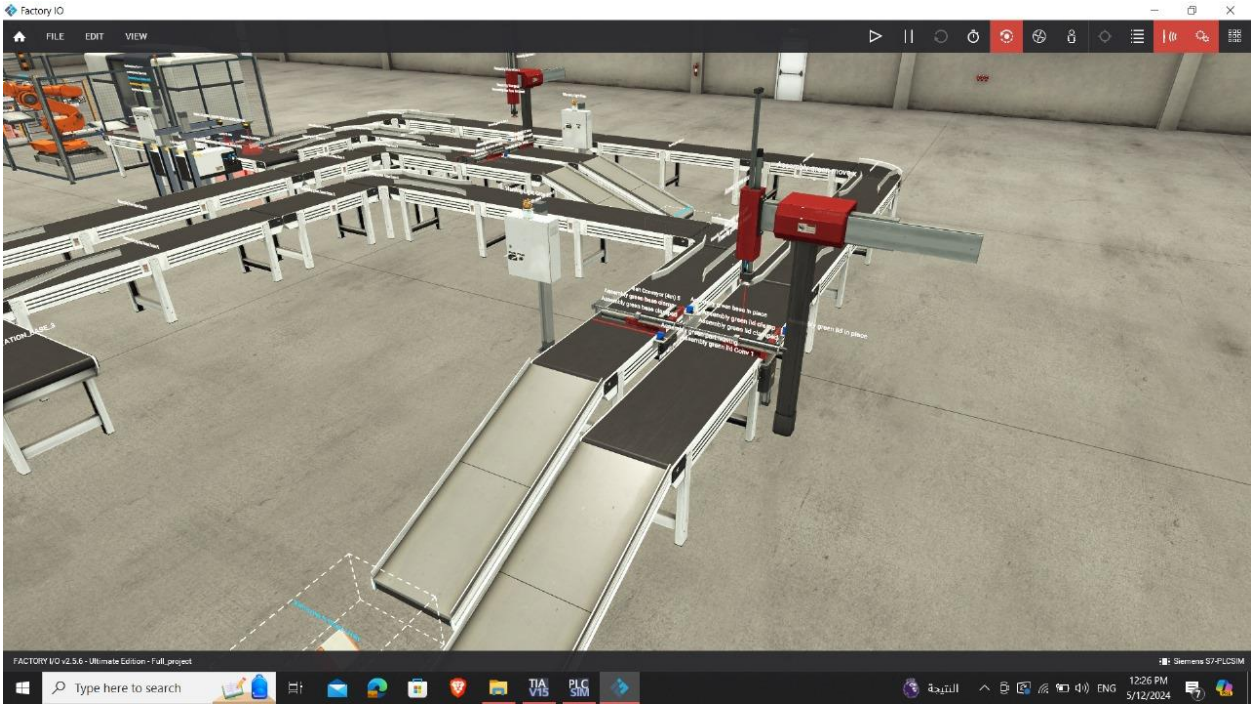
3.1.2. CNC machine



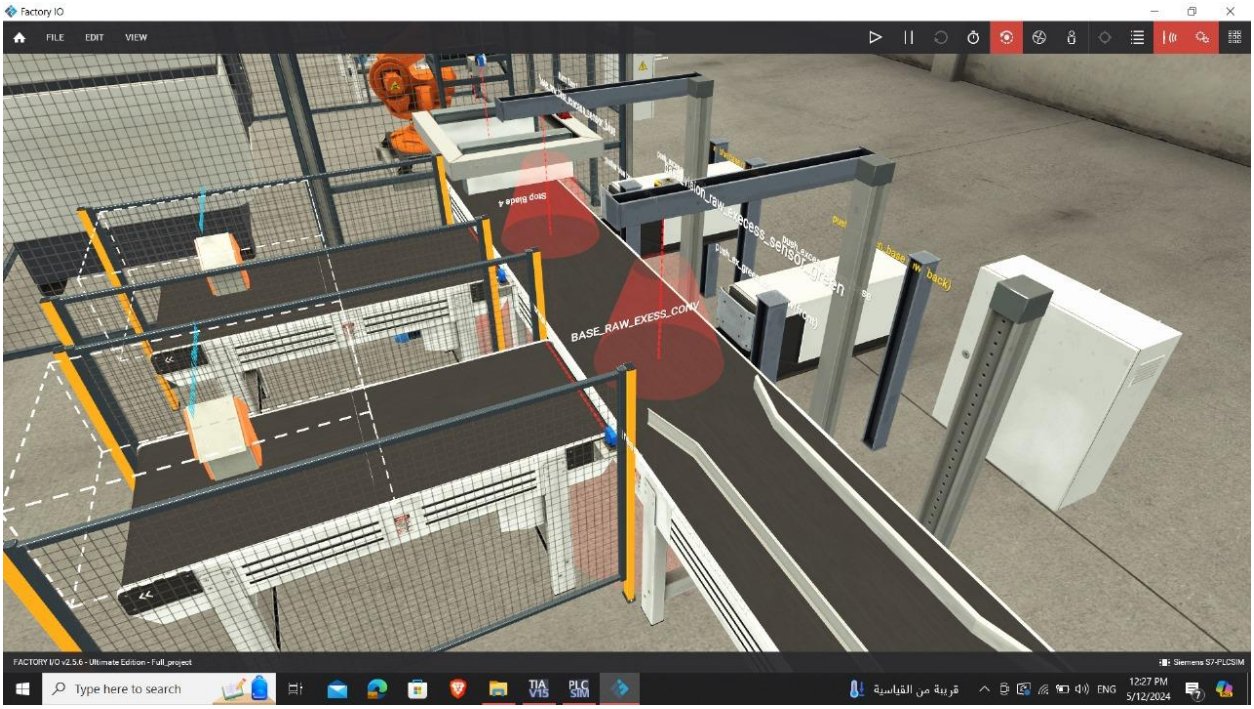
3.1.3. Sorting



3.1.4. Assembly

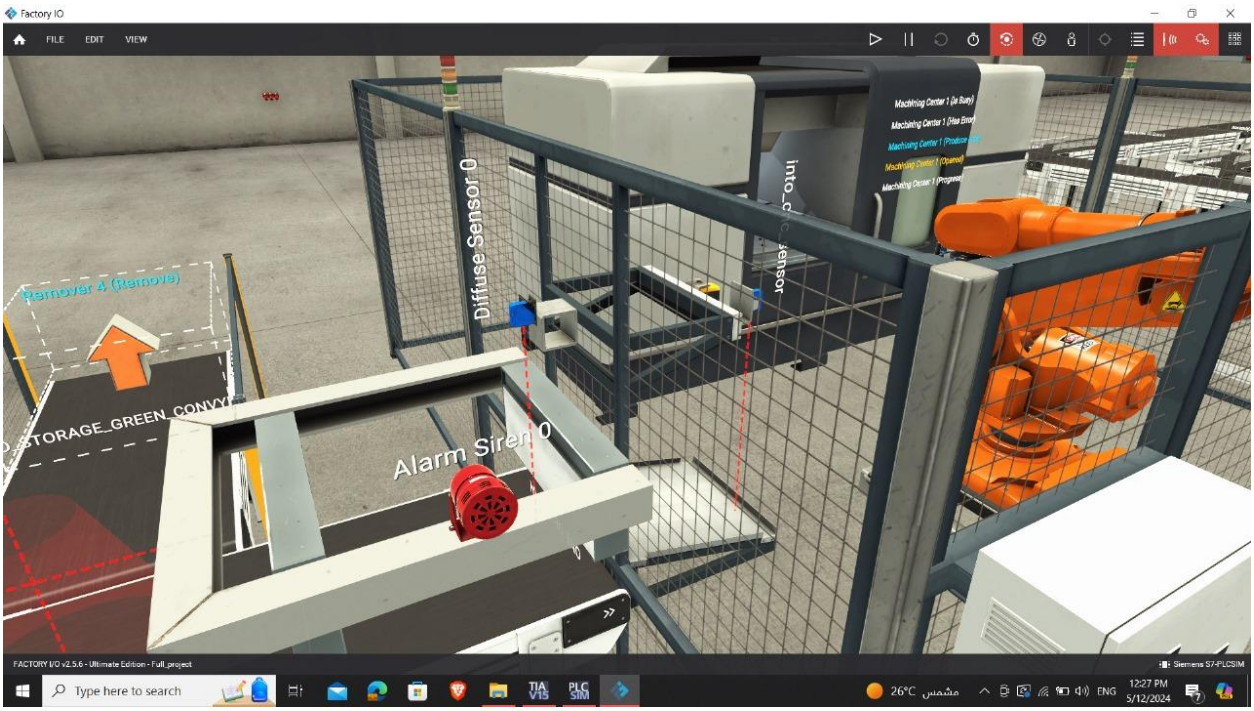


3.1.5. Remove excess products

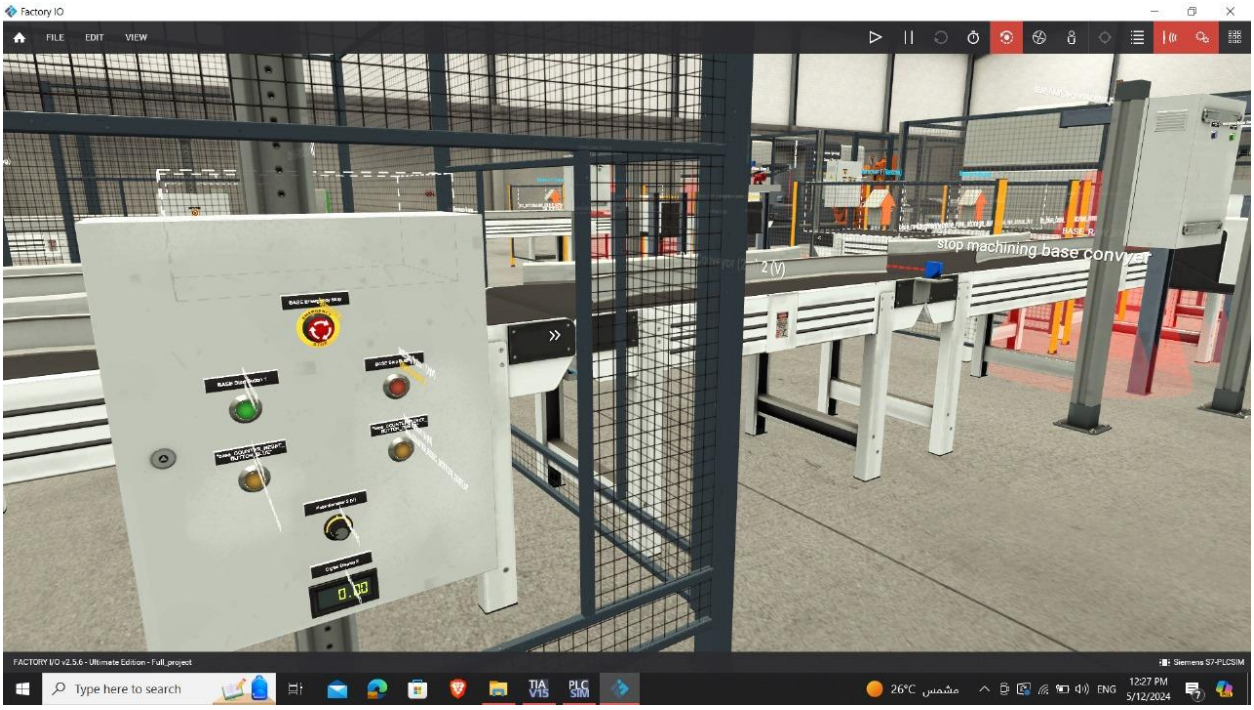


3.1.6. Warning alarm

- This warning alarm turned on when product stuck on conveyor and can’t go to CNC machine

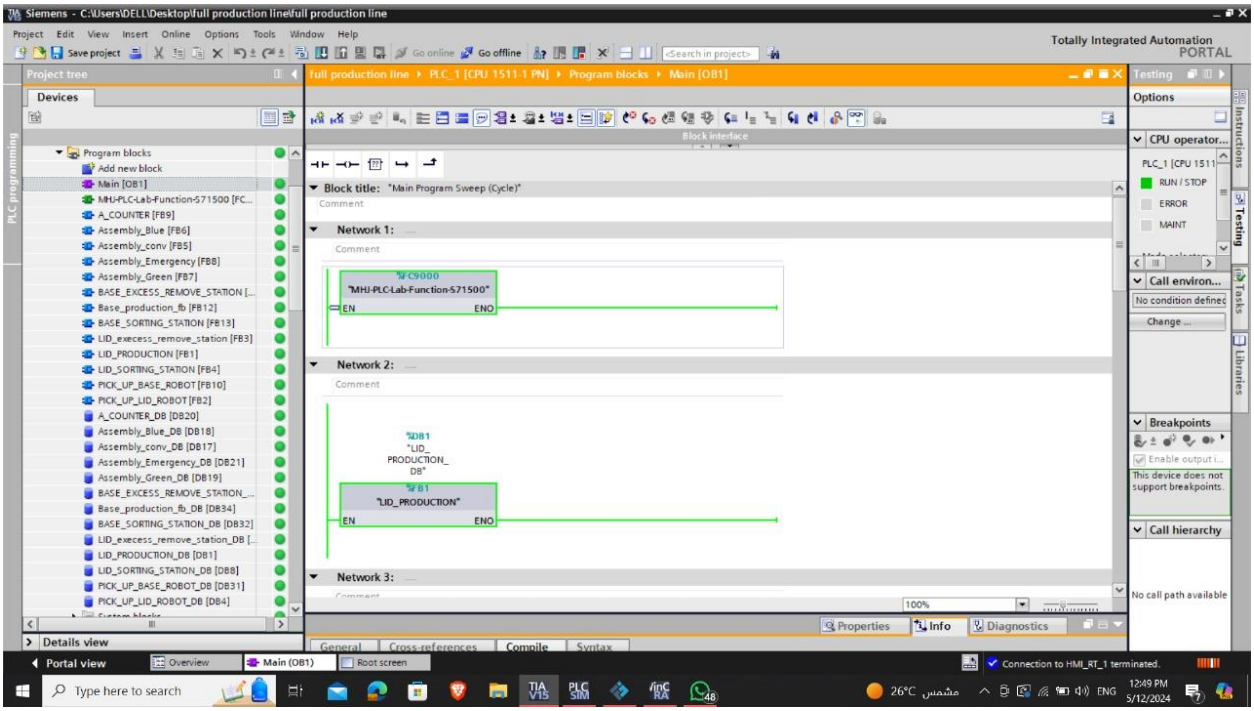


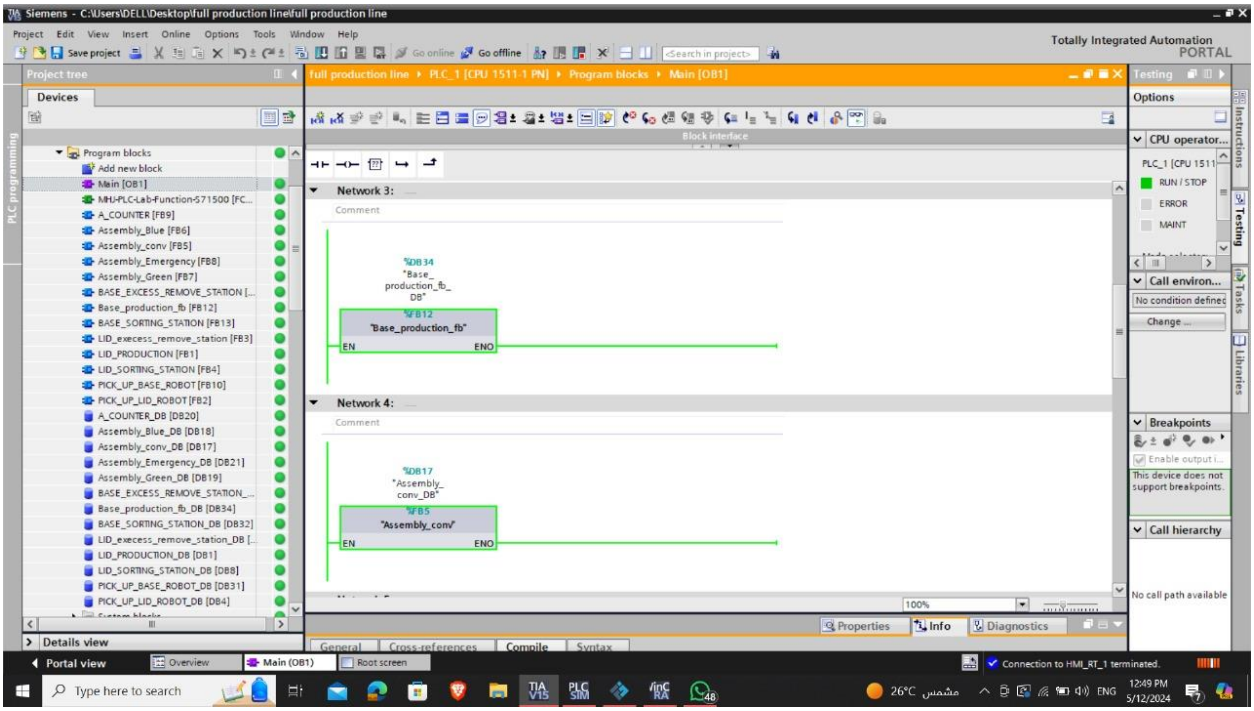
3.1.7. Conveyor speed control

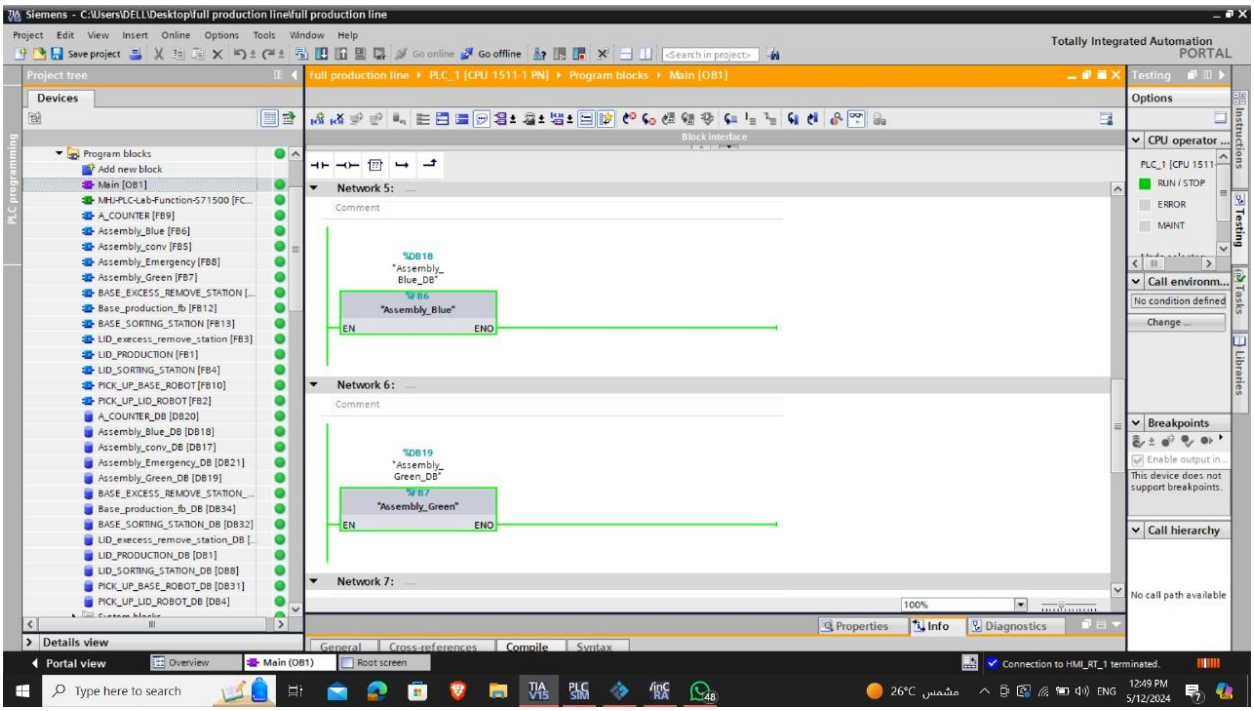


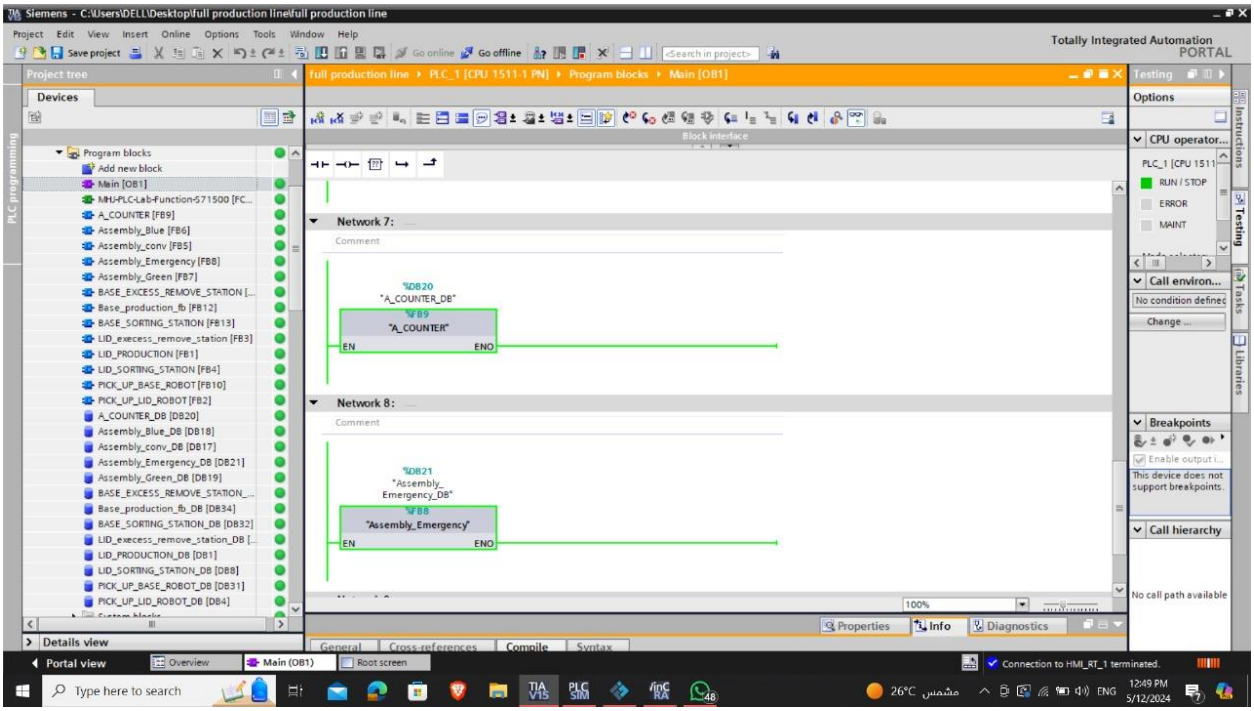
- This Control panel that controls assembly conveyor speed and the light on the top turned on as indication when we collect the desired number of products

4.0. TIA PORTAL

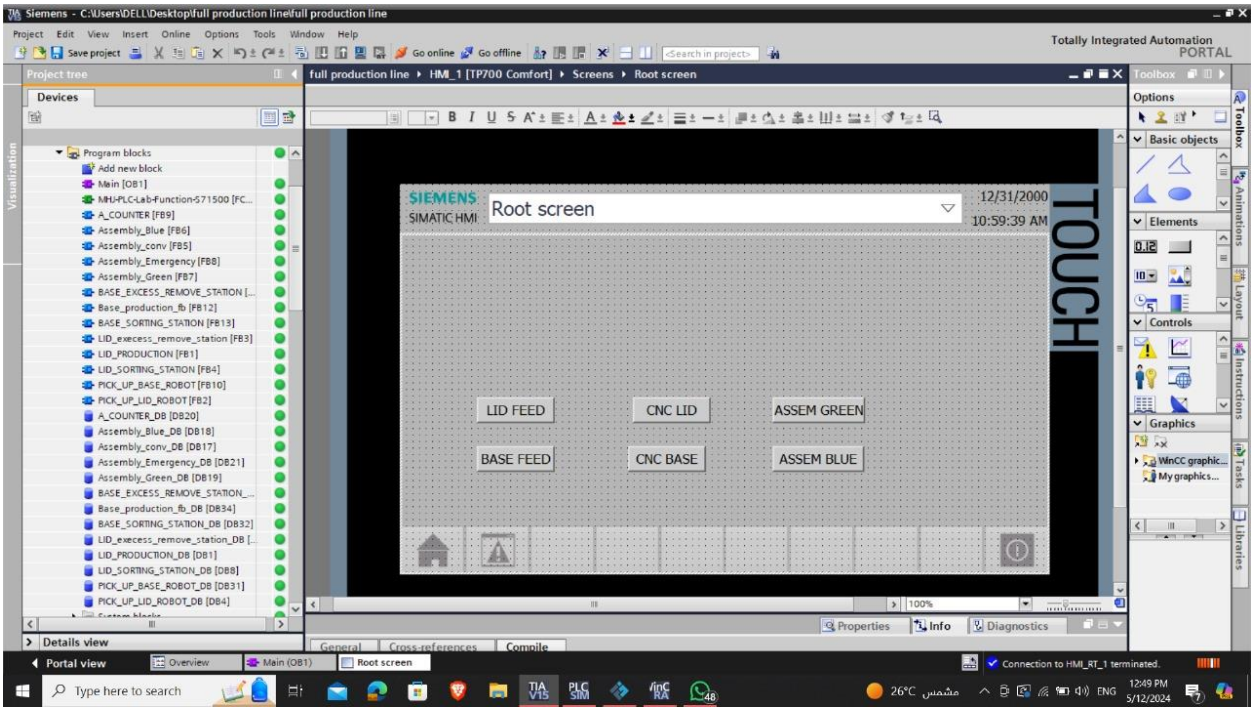




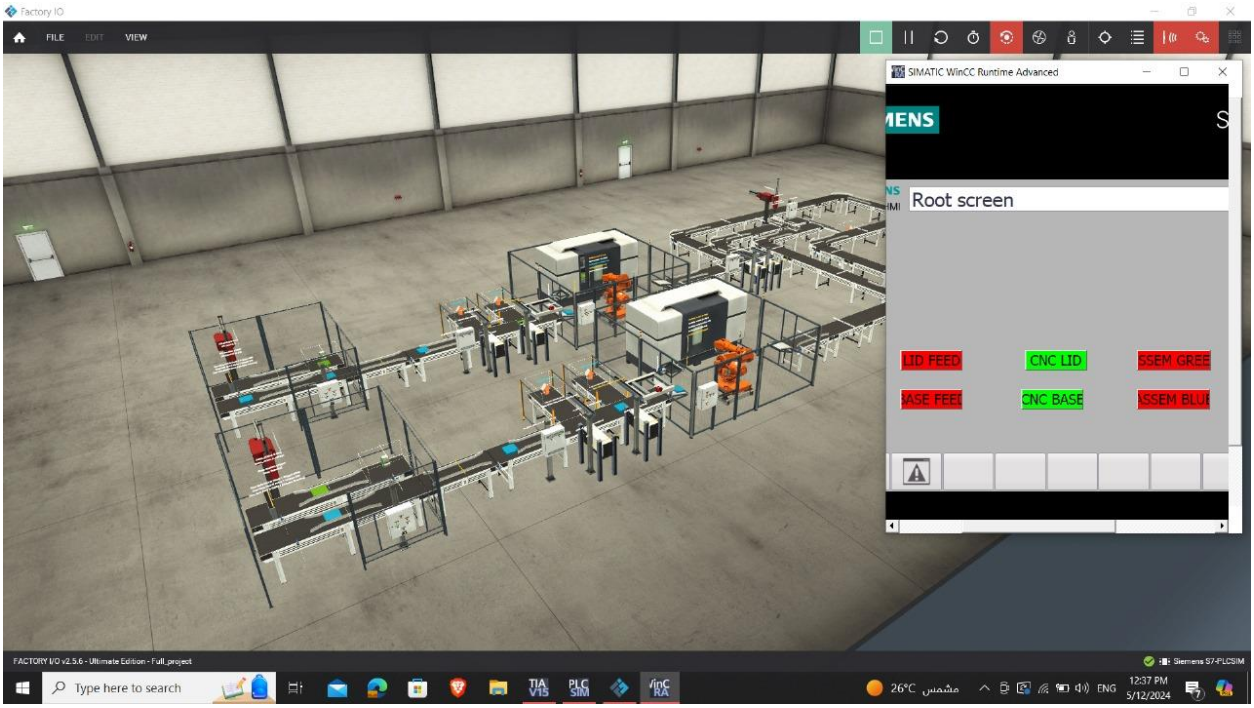

Siemens - C:\Users\DELL\Desktop\full production line\full production line
Totally Integrated Automation PORTAL
Project tree
Devices
full production line ▸ PLC_1 [CPU 1511-1 PN] ▸ Program blocks ▸ Main [OB1]
Testing
Options
Program blocks
Add new block
Main [OB1]
MHJ-PLC-Lab-Function-571500 [FC...
A_COUNTER [FB9]
Assembly_Blue [FB6]
Assembly_conv [FB5]
Assembly_Emergency [FB8]
Assembly_Green [FB7]
BASE_EXCESS_REMOVE_STATION [...
Base_production_fb [FB12]
BASE_SORTING_STATION [FB13]
LID_execess_remove_station [FB3]
LID_PRODUCTION [FB1]
LID_SORTING_STATION [FB4]
PICK_UP_BASE_ROBOT [FB10]
PICK_UP_LID_ROBOT [FB2]
A_COUNTER_DB [DB20]
Assembly_Blue_DB [DB18]
Assembly_conv_DB [DB17]
Assembly_Emergency_DB [DB21]
Assembly_Green_DB [DB19]
BASE_EXCESS_REMOVE_STATION_...
Base_production_fb_DB [DB34]
BASE_SORTING_STATION_DB [DB32]
LID_execess_remove_station_DB [...
LID_PRODUCTION_DB [DB1]
LID_SORTING_STATION_DB [DB8]
PICK_UP_BASE_ROBOT_DB [DB31]
PICK_UP_LID_ROBOT_DB [DB4]
Details view
Block interface
Network 5:
Comment
%DB18
"Assembly_ Blue_DB"
%FB6
"Assembly_Blue"
EN
ENO
Network 6:
Comment
%DB19
"Assembly_ Green_DB"
%FB7
"Assembly_Green"
EN
ENO
Network 7:
100%
Properties
Info
Diagnostics
General
Cross-references
Compile
Syntax
Options
CPU operator ...
PLC_1 [CPU 1511...
RUN / STOP
ERROR
MAINT
Call environm...
No condition defined
Change ...
Breakpoints
Enable output in...
This device does not support breakpoints.
Call hierarchy
No call path available
Portal view
Overview
Main (OB1)
Root screen
Connection to HMI_RT_1 terminated.
Type here to search
26°C مشمس
ENG
12:49 PM
5/12/2024

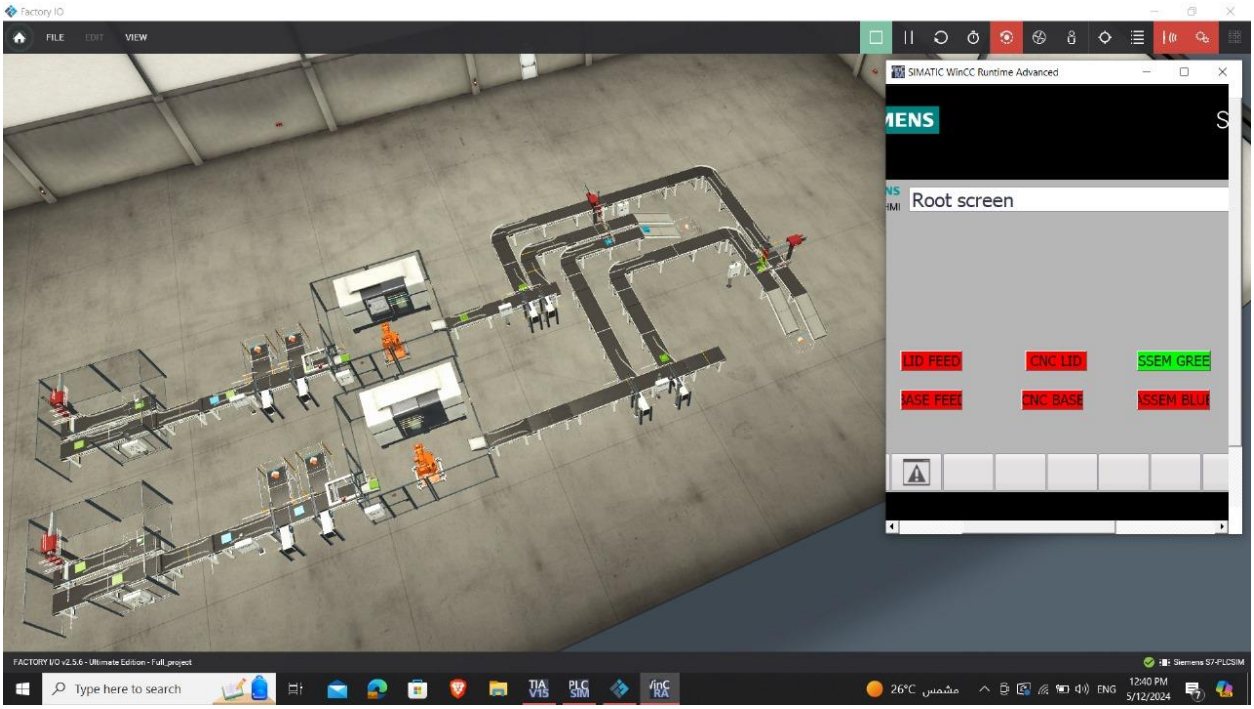

Siemens - C:\Users\DELL\Desktop\full production line\full production line
Totally Integrated Automation PORTAL
Project tree
Devices
full production line ▸ PLC_1 [CPU 1511-1 PN] ▸ Program blocks ▸ Main [OB1]
Testing
Options
Program blocks
Add new block
Main [OB1]
MHJ-PLC-Lab-Function-571500 [FC...
A_COUNTER [FB9]
Assembly_Blue [FB6]
Assembly_conv [FB5]
Assembly_Emergency [FB8]
Assembly_Green [FB7]
BASE_EXCESS_REMOVE_STATION [...
Base_production_fb [FB12]
BASE_SORTING_STATION [FB13]
LID_execess_remove_station [FB3]
LID_PRODUCTION [FB1]
LID_SORTING_STATION [FB4]
PICK_UP_BASE_ROBOT [FB10]
PICK_UP_LID_ROBOT [FB2]
A_COUNTER_DB [DB20]
Assembly_Blue_DB [DB18]
Assembly_conv_DB [DB17]
Assembly_Emergency_DB [DB21]
Assembly_Green_DB [DB19]
BASE_EXCESS_REMOVE_STATION_...
Base_production_fb_DB [DB34]
BASE_SORTING_STATION_DB [DB32]
LID_execess_remove_station_DB [...
LID_PRODUCTION_DB [DB1]
LID_SORTING_STATION_DB [DB8]
PICK_UP_BASE_ROBOT_DB [DB31]
PICK_UP_LID_ROBOT_DB [DB4]
Details view
Block interface
Network 7:
Comment
%DB20
"A_COUNTER_DB"
%FB9
"A_COUNTER"
EN
ENO
Network 8:
Comment
%DB21
"Assembly_ Emergency_DB"
%FB8
"Assembly_Emergency"
EN
ENO
100%
Properties
Info
Diagnostics
General
Cross-references
Compile
Syntax
Options
CPU operator...
PLC_1 [CPU 1511...
RUN / STOP
ERROR
MAINT
Call environ...
No condition defined
Change ...
Breakpoints
Enable output i...
This device does not support breakpoints.
Call hierarchy
No call path available
Portal view
Overview
Main (OB1)
Root screen
Connection to HMI_RT_1 terminated.
Type here to search
26°C مشمس
ENG
12:49 PM
5/12/2024

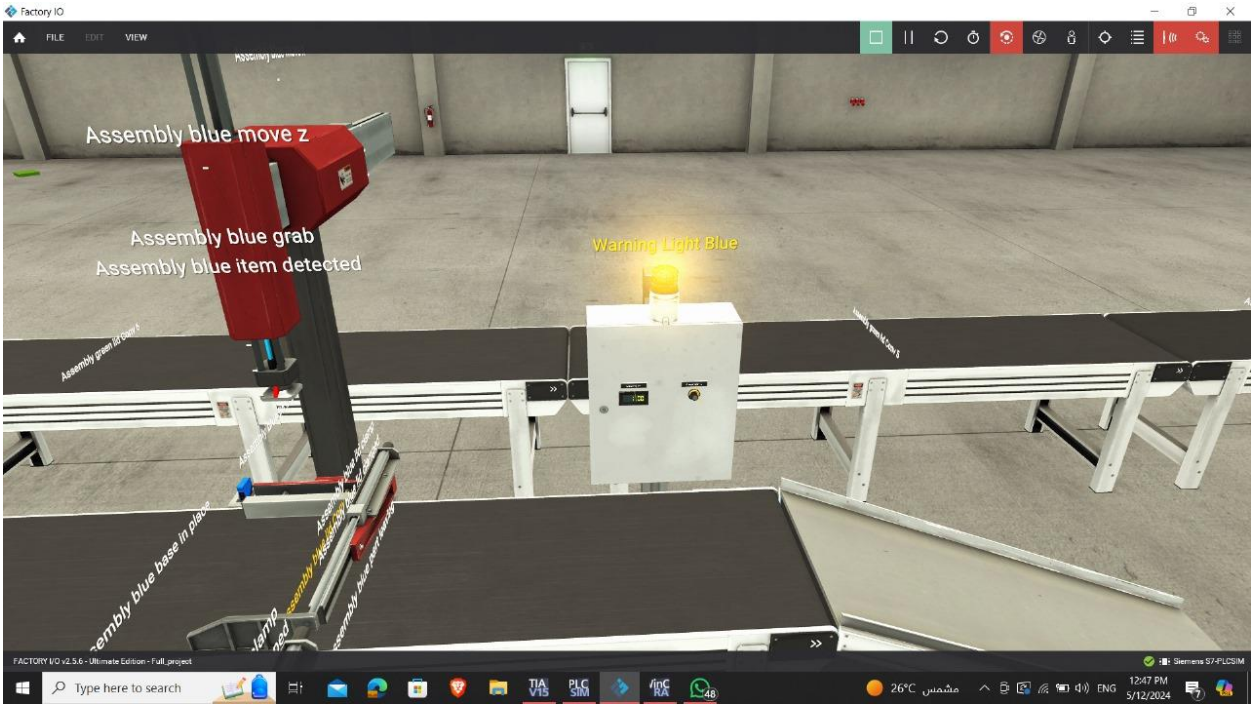
4.1. HMI



5.0. SIMULATION ON


Factory IO
FILE
EDIT
VIEW
SIMATIC WinCC Runtime Advanced
Root screen
LID FEED
CNC LID
CNC BASE
FACTORY I/O v2.5.6 - Ultimate Edition - Full_project
Siemens S7-PLCSIM
Type here to search
26°C
ENG
12:37 PM
5/12/2024


Factory IO
FILE
EDIT
VIEW
SIMATIC WinCC Runtime Advanced
Root screen
LID FEED
CNC LID
CNC BASE
FACTORY I/O v2.5.6 - Ultimate Edition - Full_project
Siemens S7-PLCSIM
Type here to search
26°C
ENG
12:40 PM
5/12/2024



6.0. DRIVE LINK

https://drive.google.com/drive/folders/1sitQrSa1rtfIVeYHHvGqFQ9XMLrEQeaJ?usp=drive_link

- this link include:
- TIA portal file
- factory i/o file
- simulation video

full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

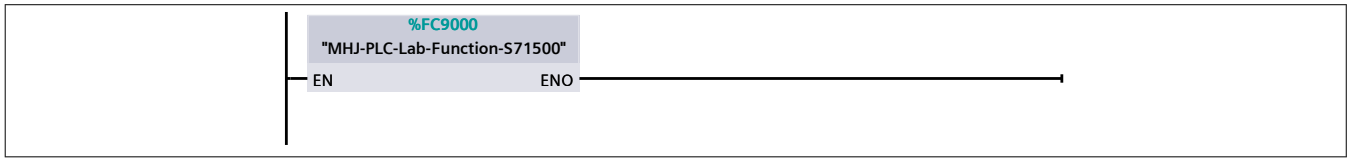
Main [OB1]

Main Properties					
General					
Name	Main	**Number**	1	**Type**	OB
Language	LAD	**Numbering**	Manual		
Information					
Title	"Main Program Sweep (Cycle)"	**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

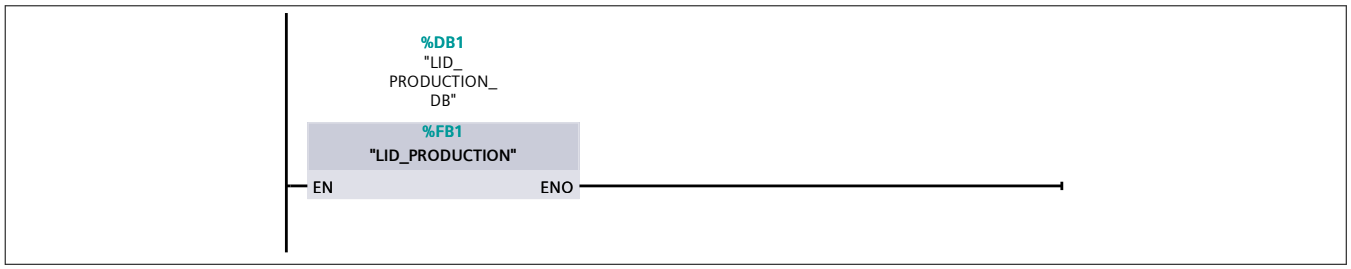
Main

Name	Data type	Offset	Default value	Comment
▼ Temp				
OB1_EV_CLASS	Byte	0.0		Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
OB1_SCAN_1	Byte	1.0		1 (Cold restart scan 1 of OB 1), 3 (Scan 2-n of OB 1)
OB1_PRIORITY	Byte	2.0		Priority of OB Execution
OB1_OB_NUMBR	Byte	3.0		1 (Organization block 1, OB1)
OB1_RESERVED_1	Byte	4.0		Reserved for system
OB1_RESERVED_2	Byte	5.0		Reserved for system
OB1_PREV_CYCLE	Int	6.0		Cycle time of previous OB1 scan (millisec-onds)
OB1_MIN_CYCLE	Int	8.0		Minimum cycle time of OB1 (milliseconds)
OB1_MAX_CYCLE	Int	10.0		Maximum cycle time of OB1 (milliseconds)
OB1_DATE_TIME	Date_And_Time	12.0		Date and time OB1 started
Constant				

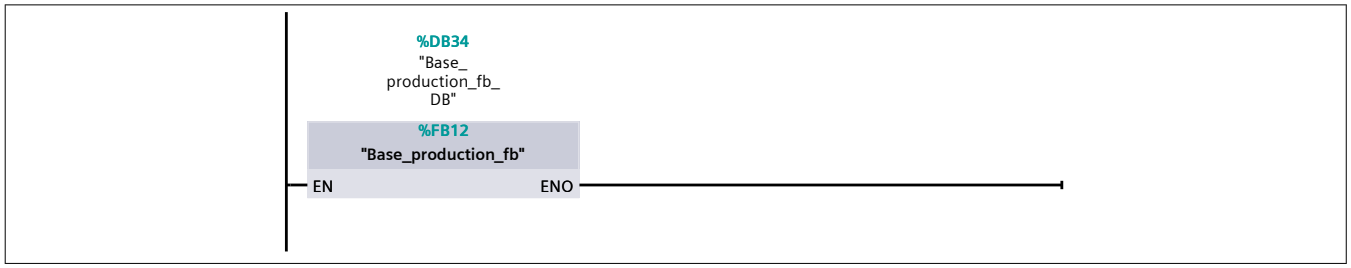
Network 1:



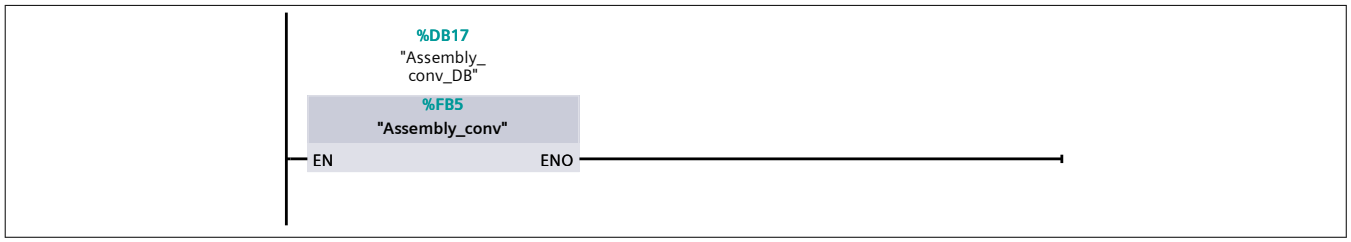
Network 2:



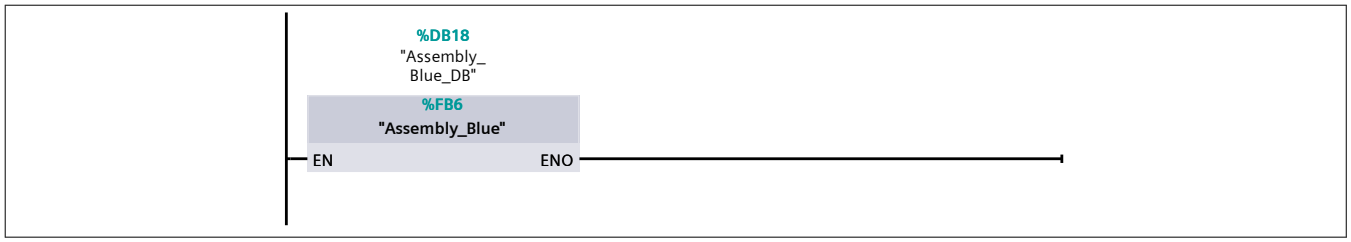
Network 3:



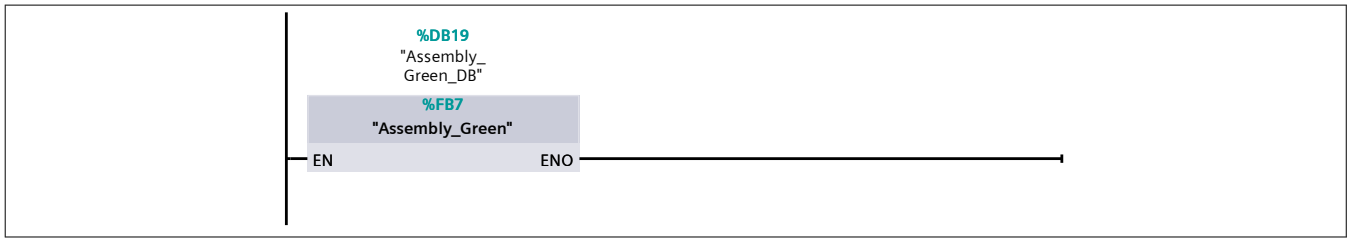
Network 4:



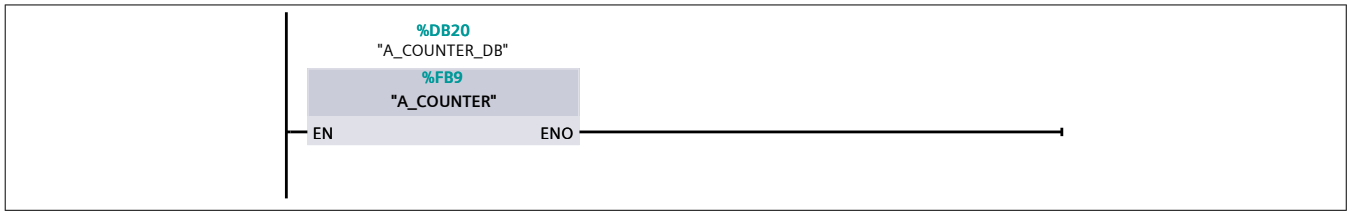
Network 5:



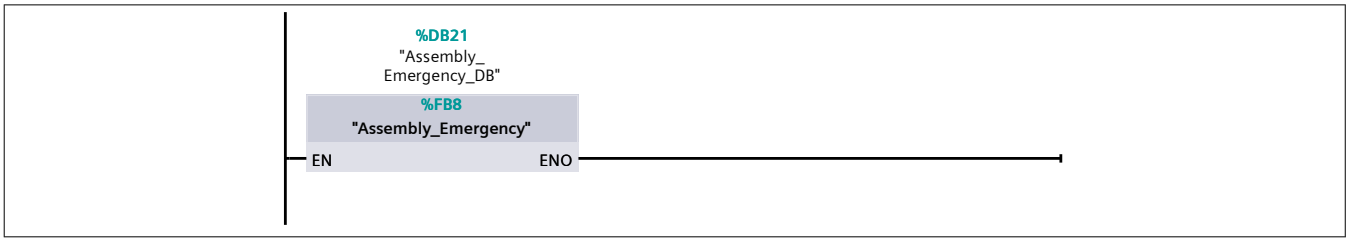
Network 6:



Network 7:



Network 8:


%DB21
"Assembly_
Emergency_DB"
%FB8
"Assembly_Emergency"
EN
ENO

full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

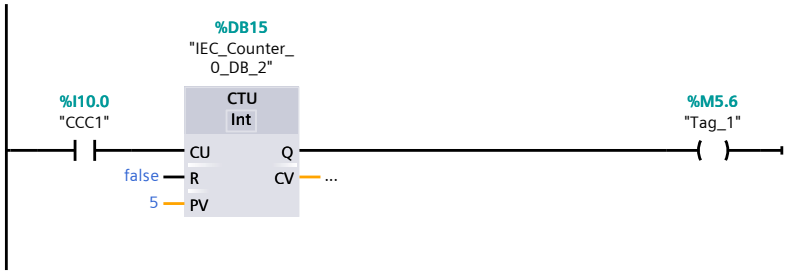
A_COUNTER [FB9]

A_COUNTER Properties					
General					
Name	A_COUNTER	**Number**	9	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

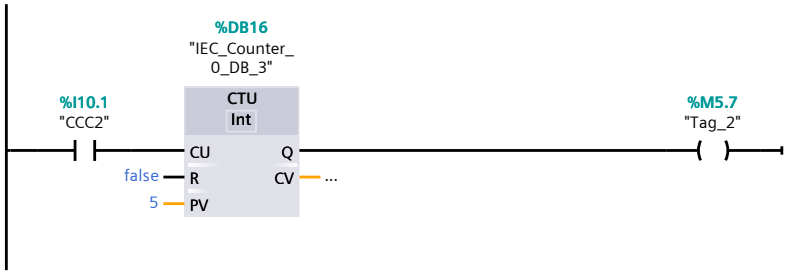
A_COUNTER

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

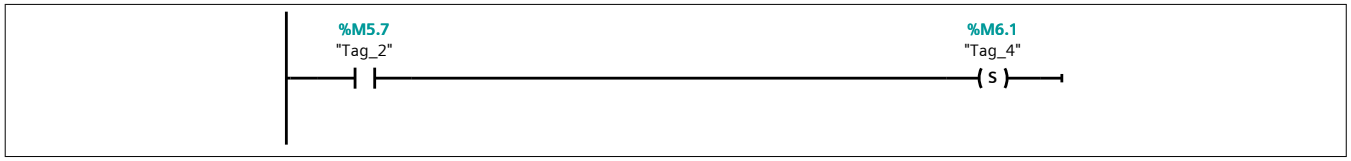
Network 1:



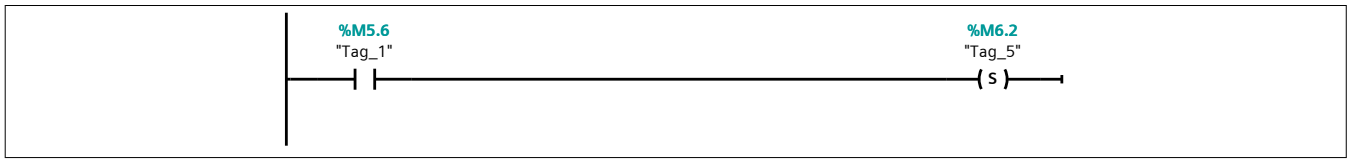
Network 2:



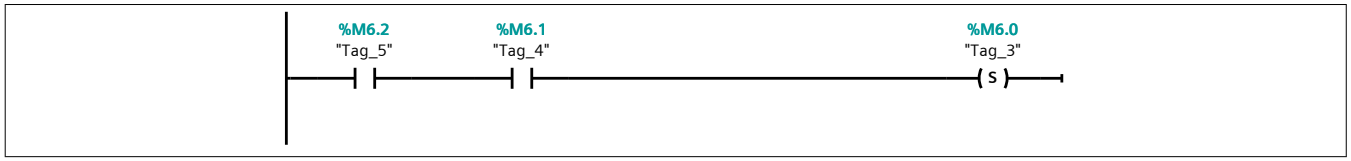
Network 3:



Network 4:

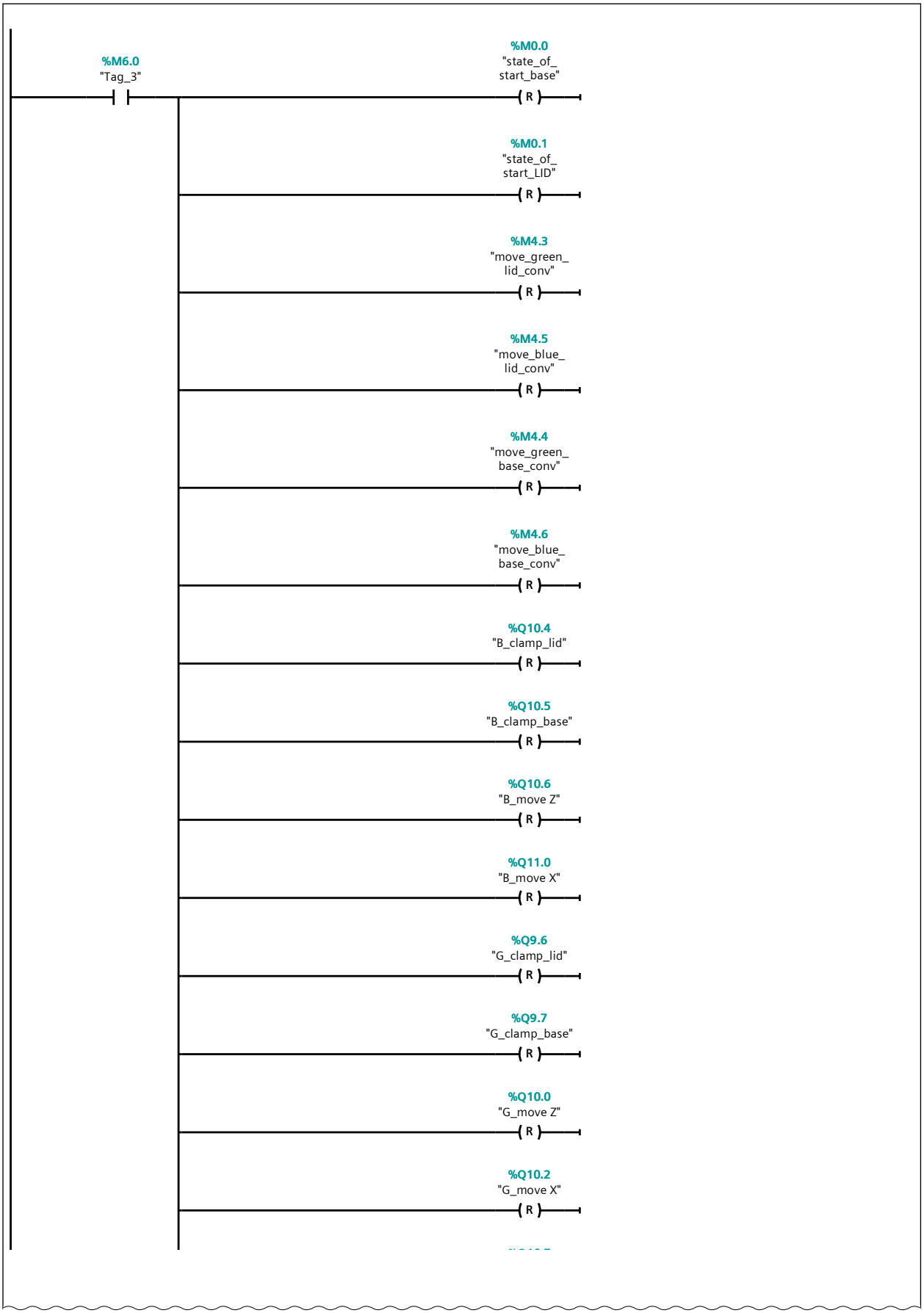


Network 5:



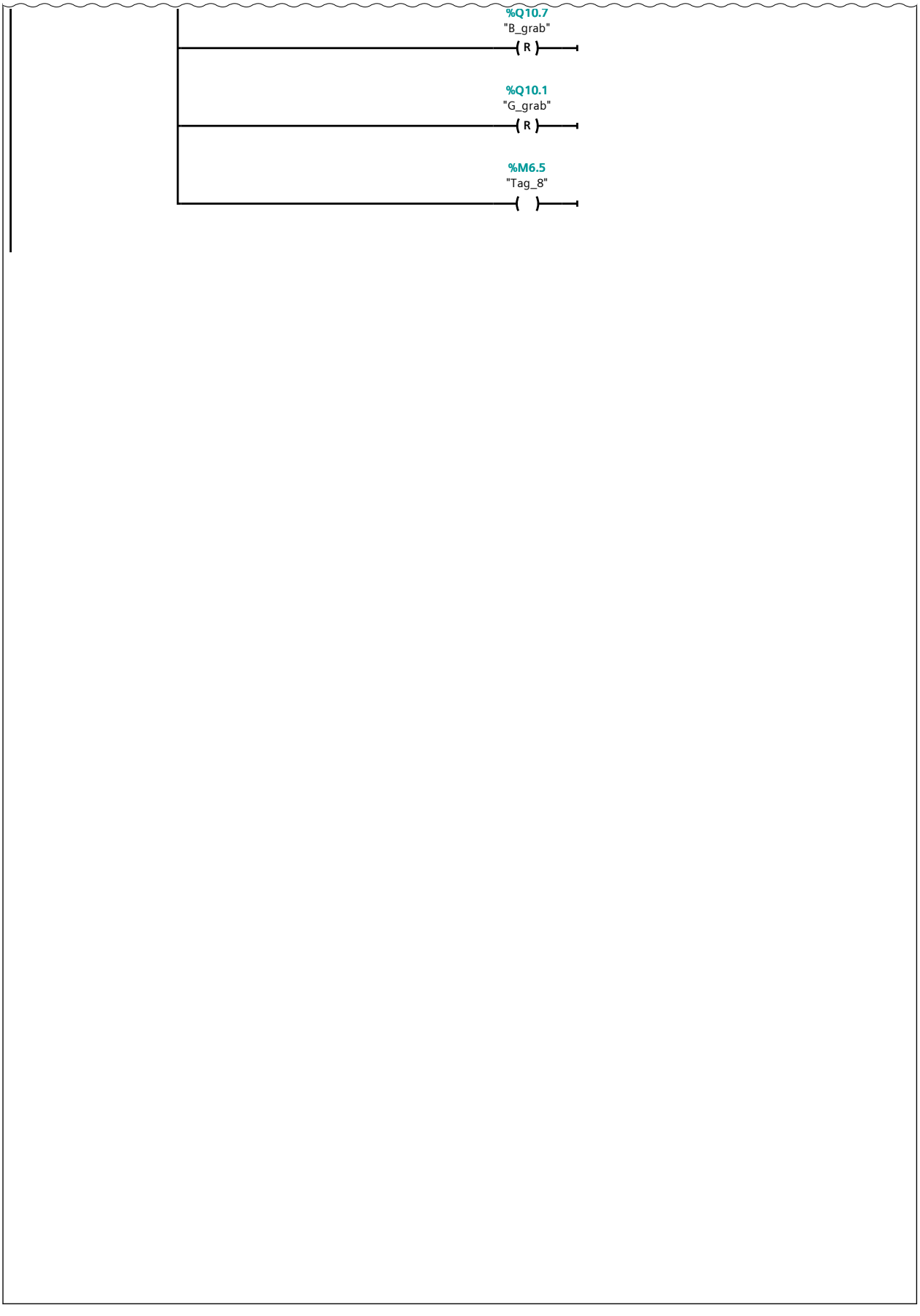
Network 6:

Network 6: (1.1 / 2.1)

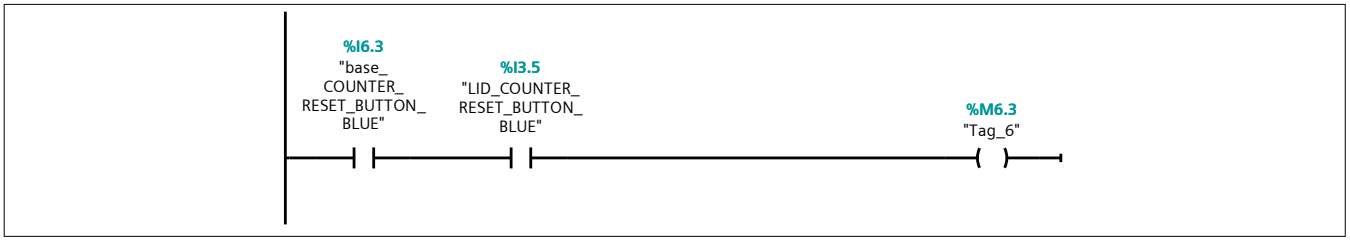


Network 6: (2.1 / 2.1)

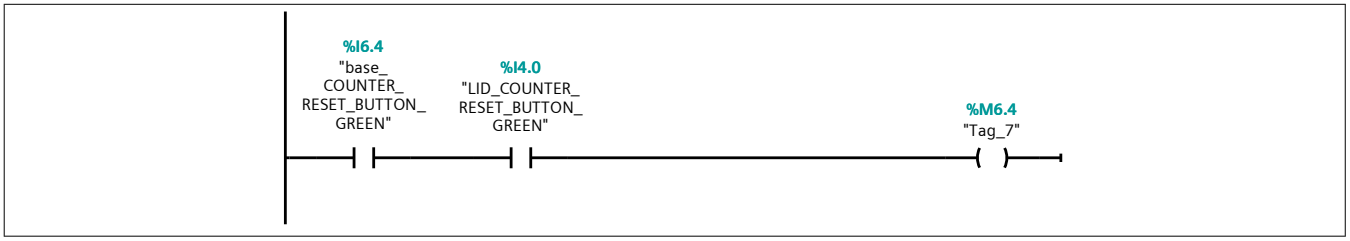
1.1 (Page1 - 3)



Network 7:



Network 8:



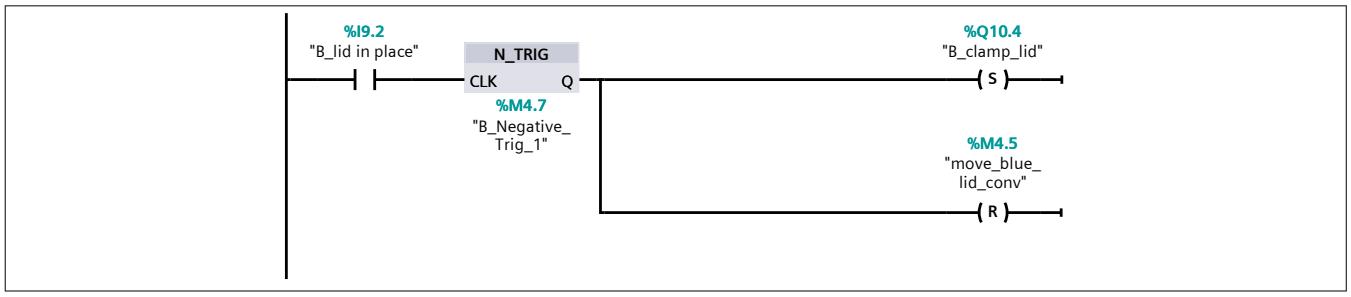
full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

Assembly_Blue [FB6]

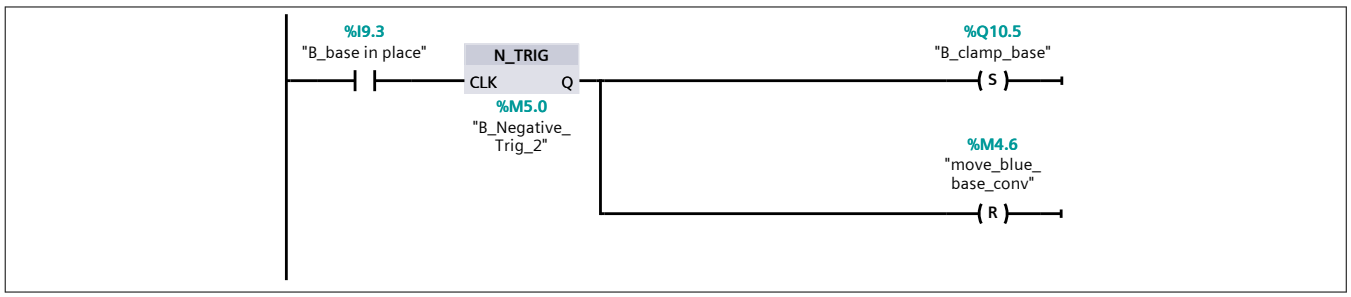
Assembly_Blue Properties					
General					
Name	Assembly_Blue	**Number**	6	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

Assembly_Blue									
Name	**Data type**	**Default value**	**Retain**	**Accessible from HMI/OPC UA**	**Writable from HMI/OPC UA**	**Visible in HMI engineering**	**Set-point**	**Supervision**	**Comment**
Input									
Output									
InOut									
Static									
Temp									
Constant									

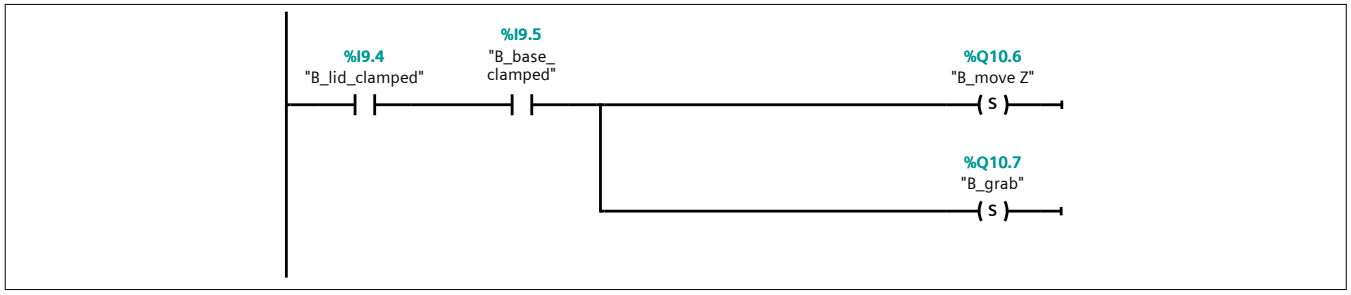
Network 1:



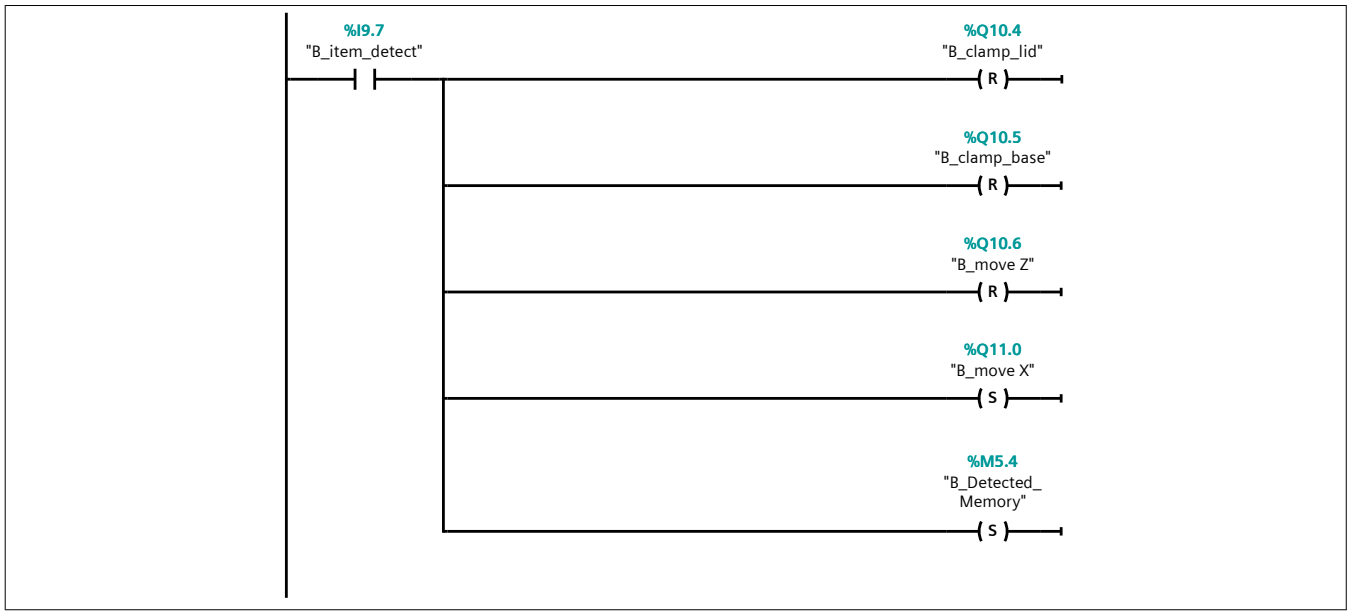
Network 2:



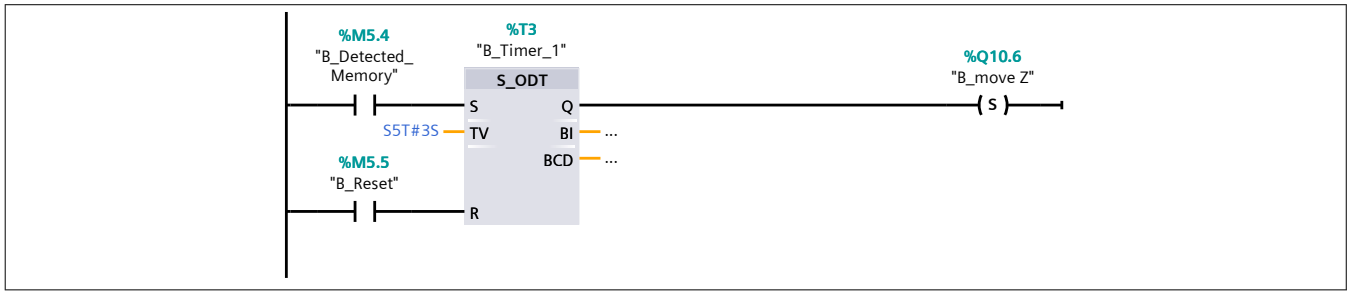
Network 3:



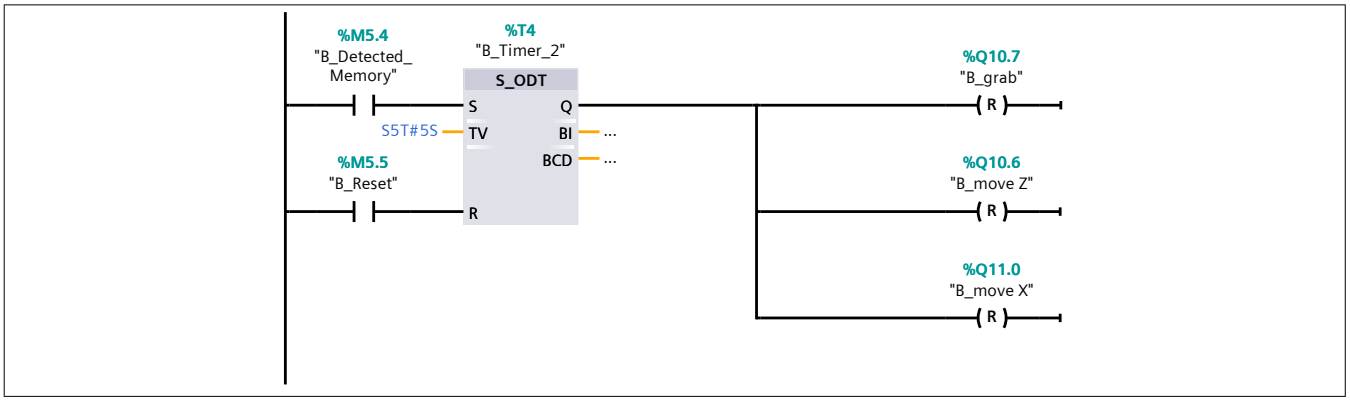
Network 4:



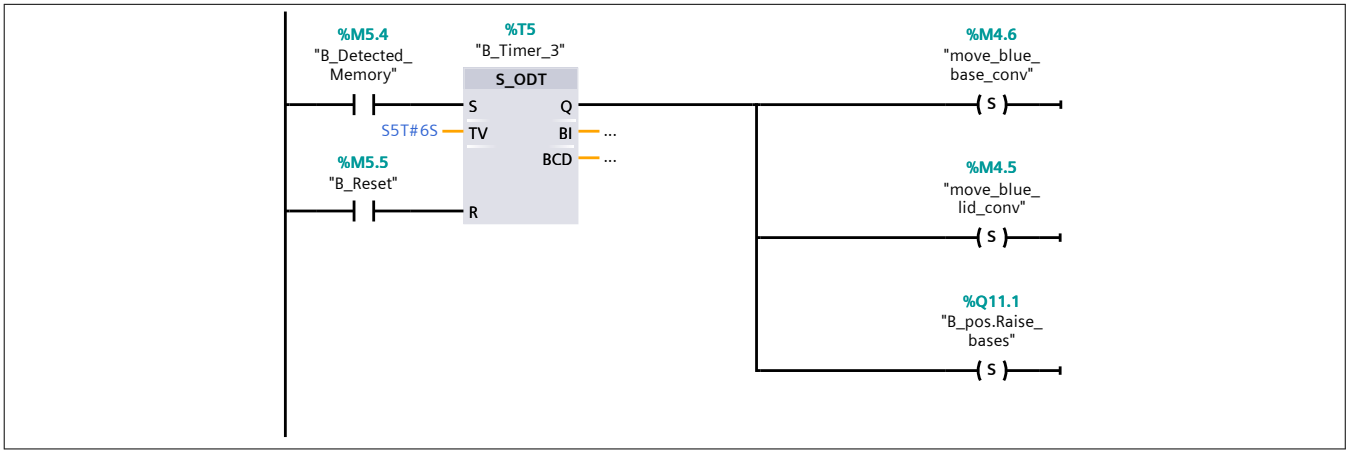
Network 5:



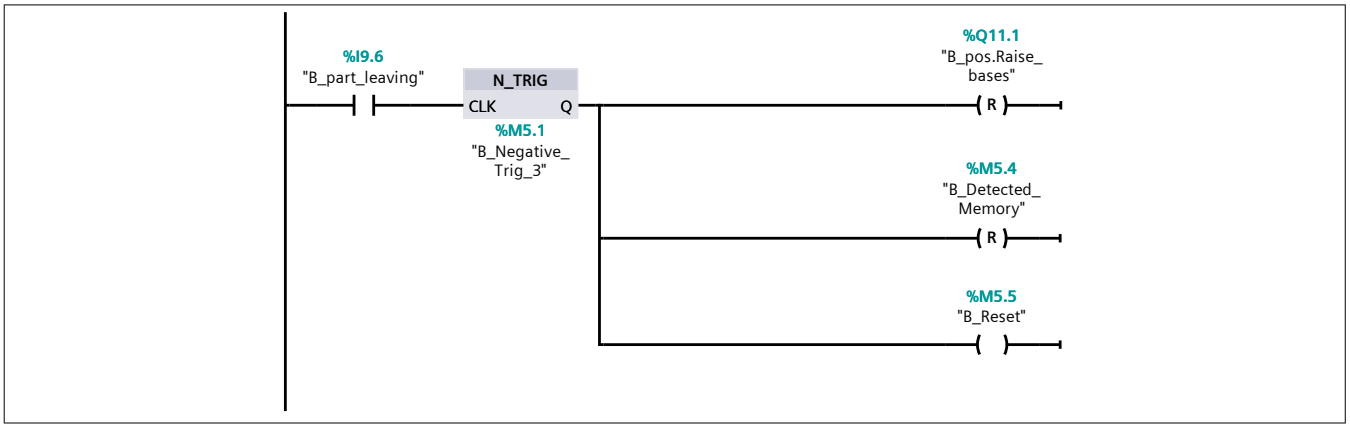
Network 6:



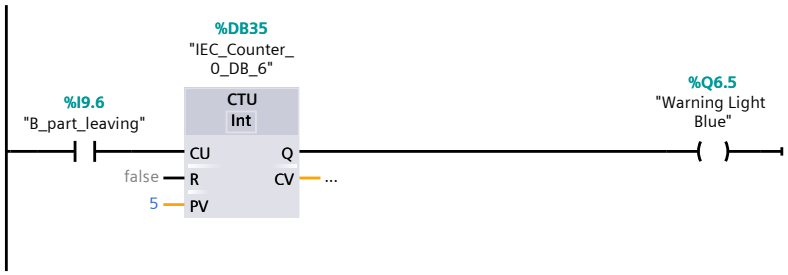
Network 7:



Network 8:



Network 9:


%DB35
"IEC_Counter_
0_DB_6"
%I9.6
"B_part_leaving"
CTU
Int
CU
Q
false
R
CV
...
5
PV
%Q6.5
"Warning Light
Blue"

full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

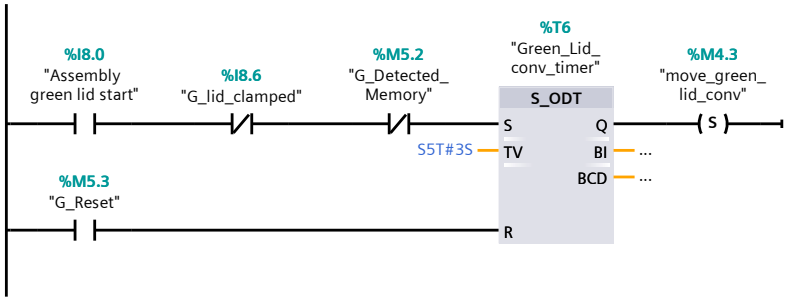
Assembly_conv [FB5]

Assembly_conv Properties					
General					
Name	Assembly_conv	**Number**	5	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

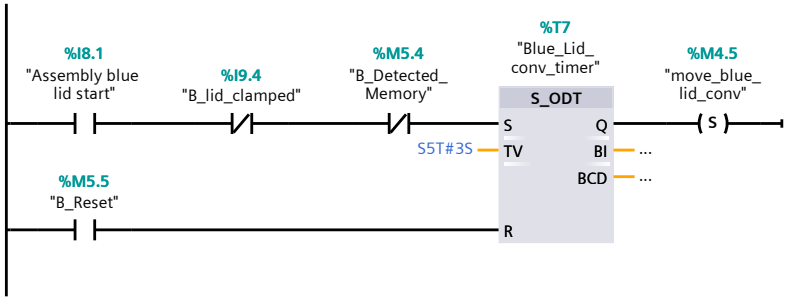
Assembly_conv

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Set-point	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

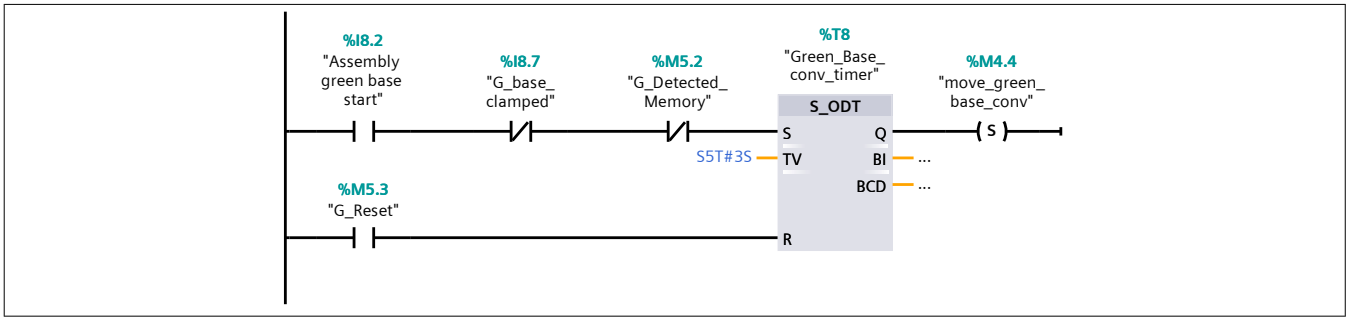
Network 1:



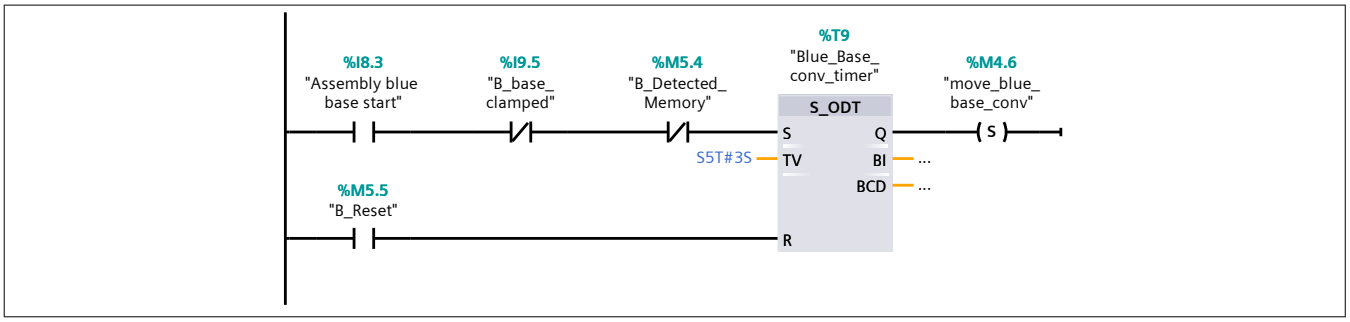
Network 2:



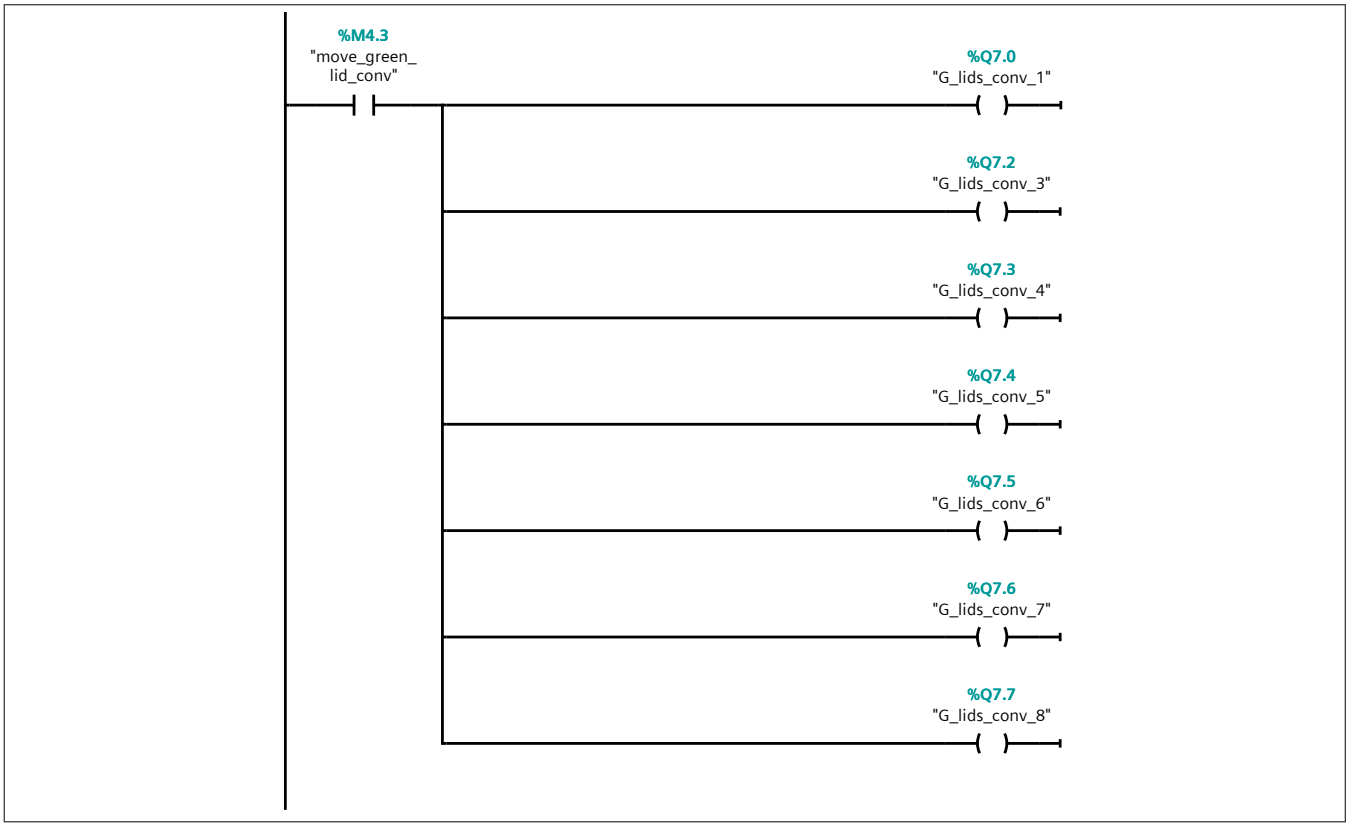
Network 3:



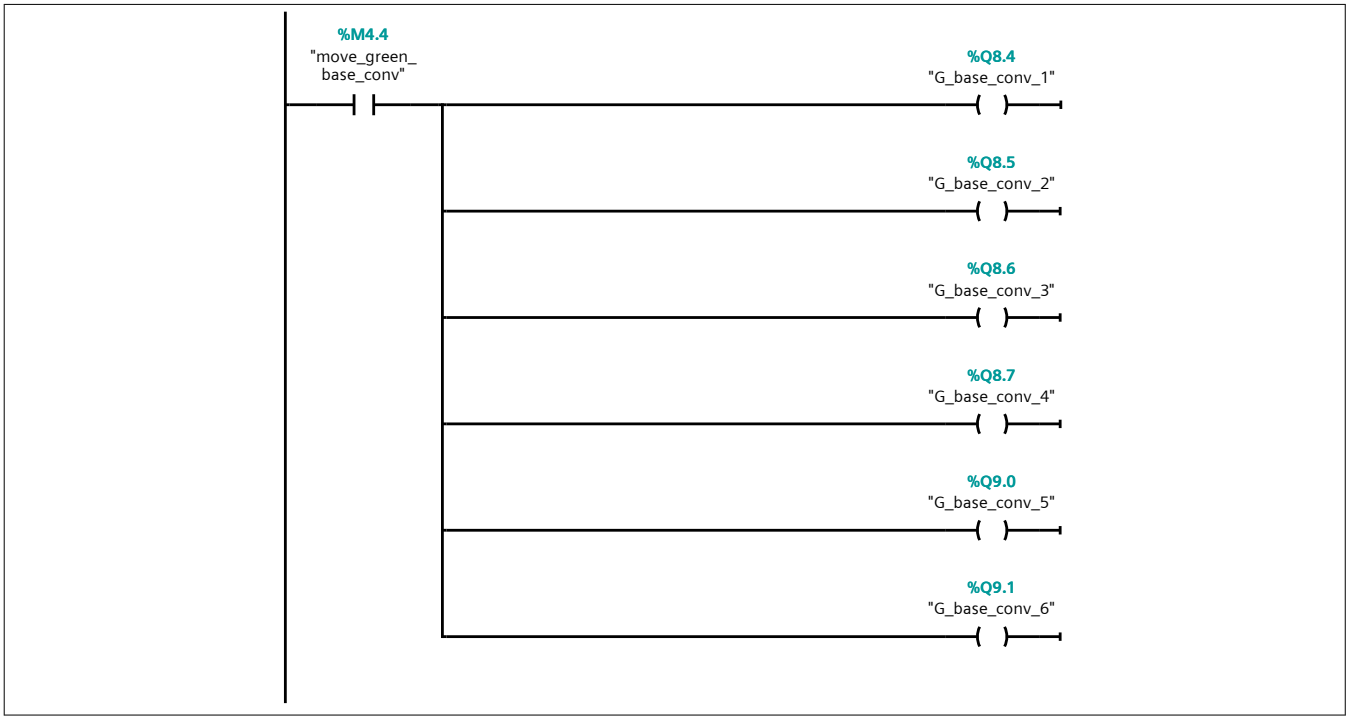
Network 4:



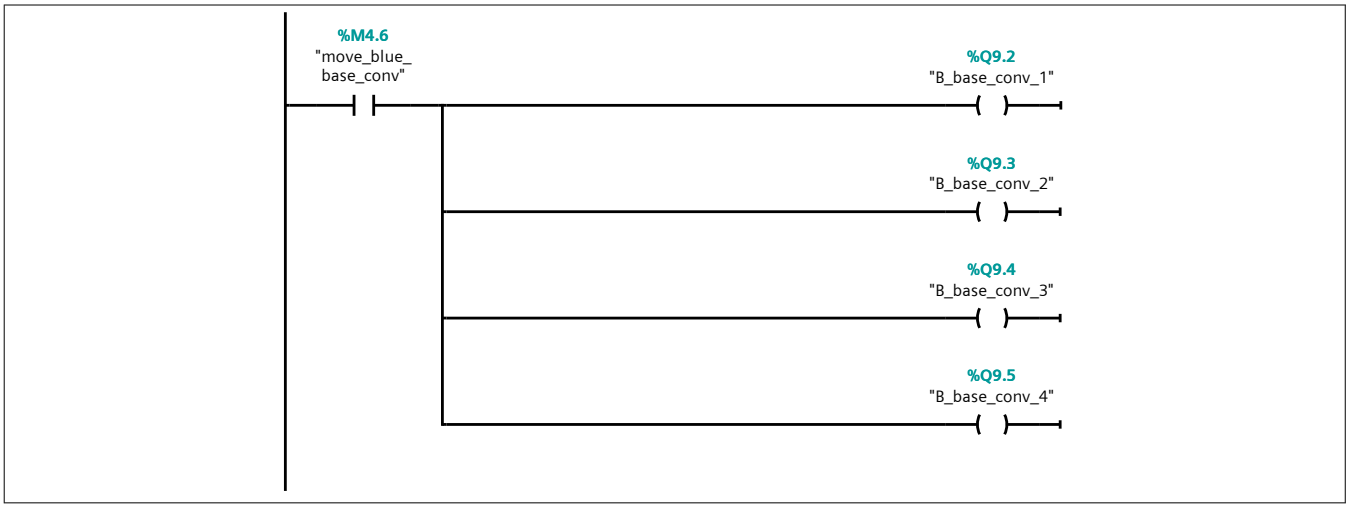
Network 5:



Network 6:

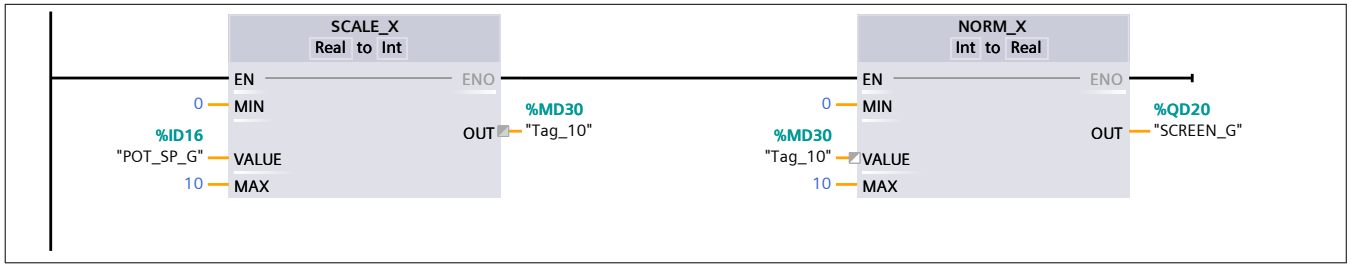


Network 7:

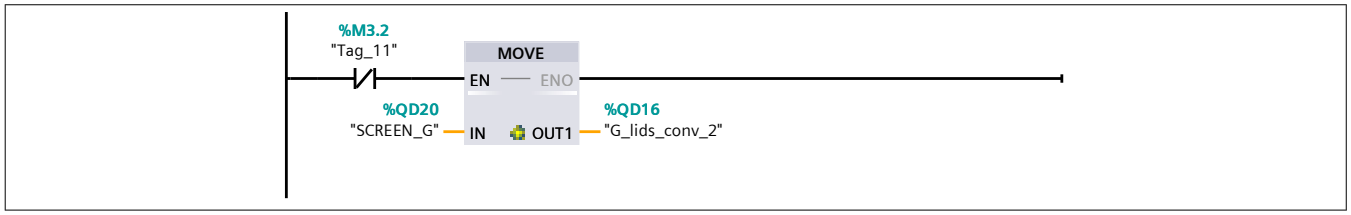


Network 8:

Network 9:

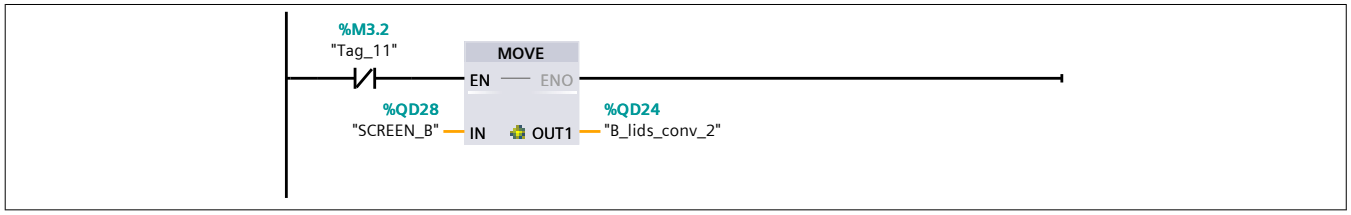


Network 10:



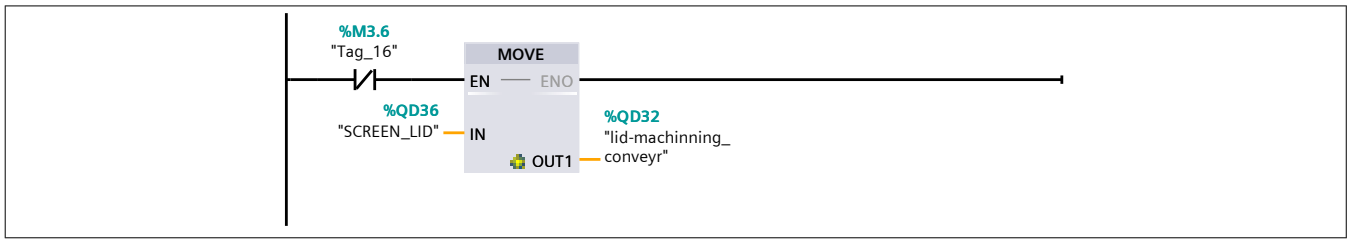
Network 11:

Network 12:

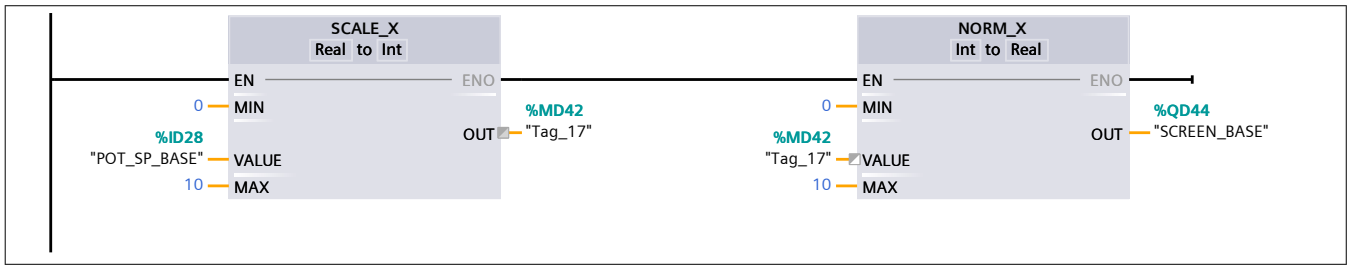


Network 13:

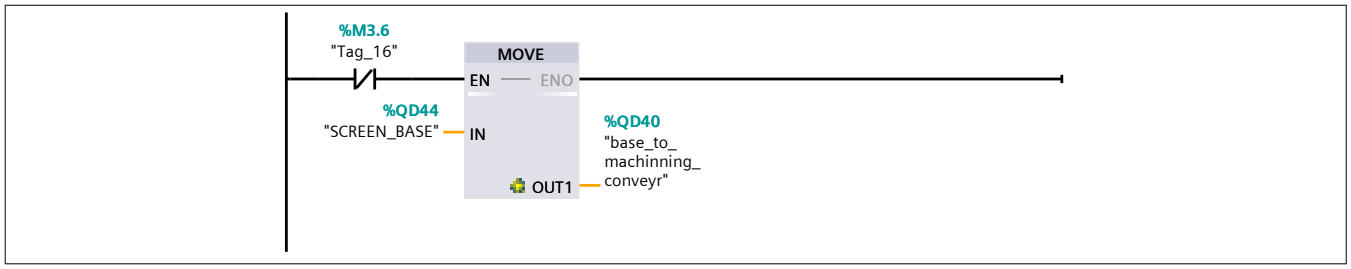
Network 14:



Network 15:



Network 16:



full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

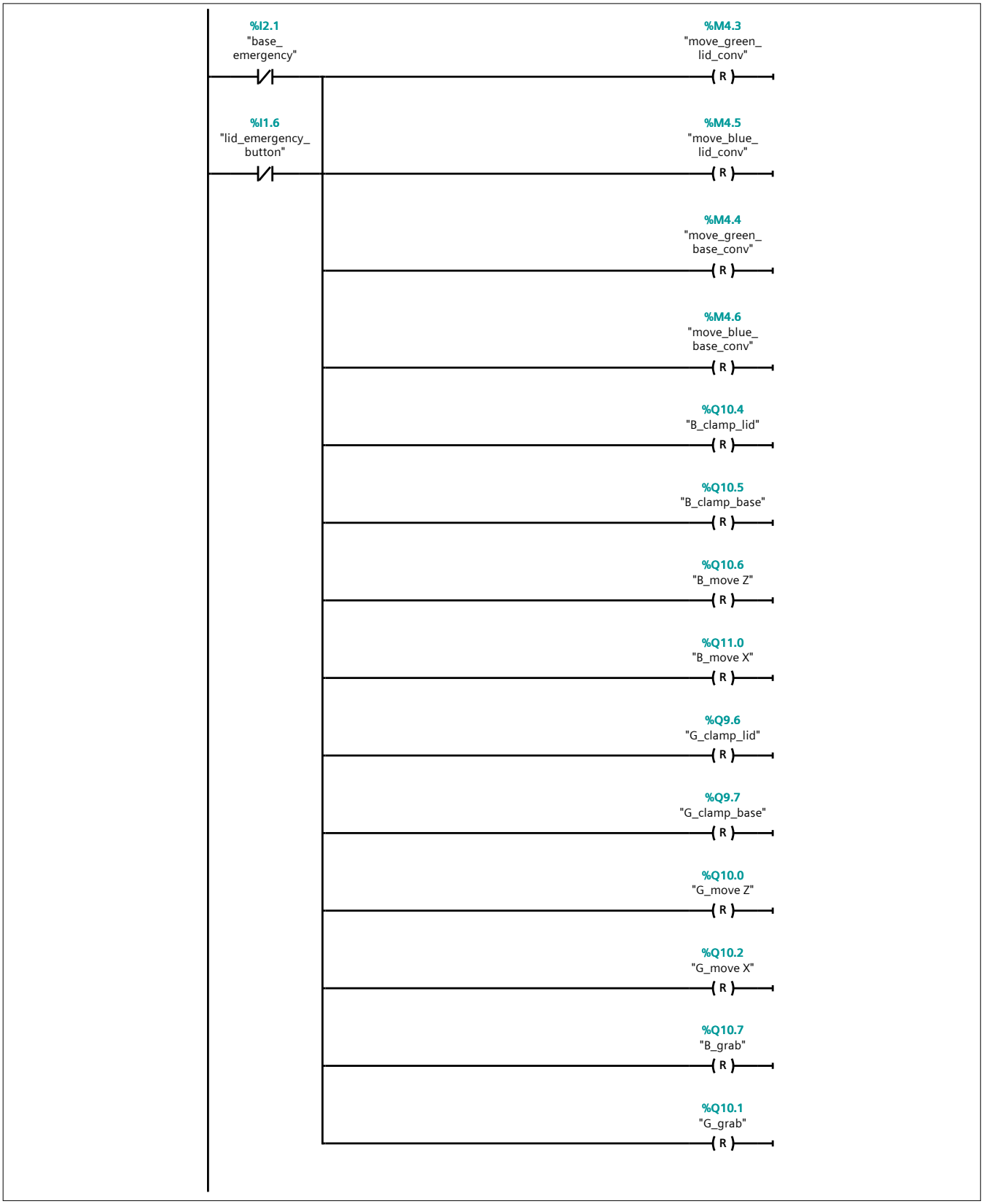
Assembly_Emergency [FB8]

Assembly_Emergency Properties					
General					
Name	Assembly_Emergency	**Number**	8	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

Assembly_Emergency

Name	Data type	Default value	Retain	Acces-sible from HMI/OPC UA	Wri ta-ble fro m HM I/O PC UA	Visible in HMI engi-neer-ing	Set-point	Super-vision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

Network 1:


%I2.1
"base_
emergency"
%M4.3
"move_green_
lid_conv"
R
%I1.6
"lid_emergency_
button"
%M4.5
"move_blue_
lid_conv"
R
%M4.4
"move_green_
base_conv"
R
%M4.6
"move_blue_
base_conv"
R
%Q10.4
"B_clamp_lid"
R
%Q10.5
"B_clamp_base"
R
%Q10.6
"B_move Z"
R
%Q11.0
"B_move X"
R
%Q9.6
"G_clamp_lid"
R
%Q9.7
"G_clamp_base"
R
%Q10.0
"G_move Z"
R
%Q10.2
"G_move X"
R
%Q10.7
"B_grab"
R
%Q10.1
"G_grab"
R

full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

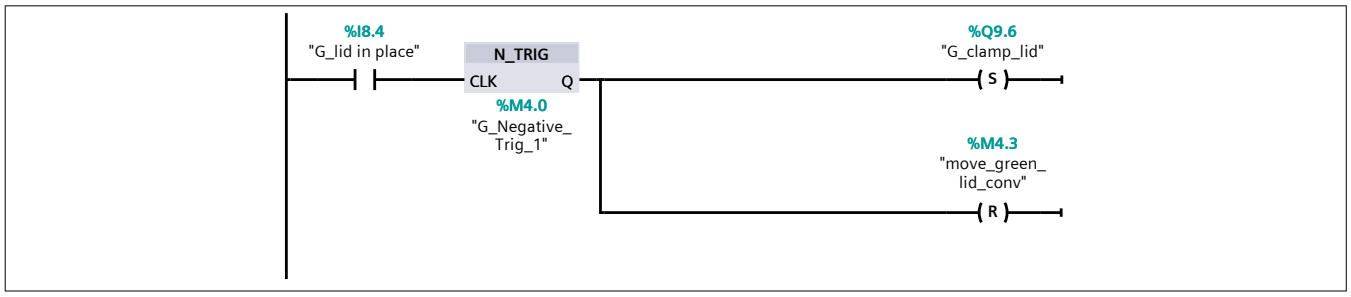
Assembly_Green [FB7]

Assembly_Green Properties					
General					
Name	Assembly_Green	**Number**	7	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

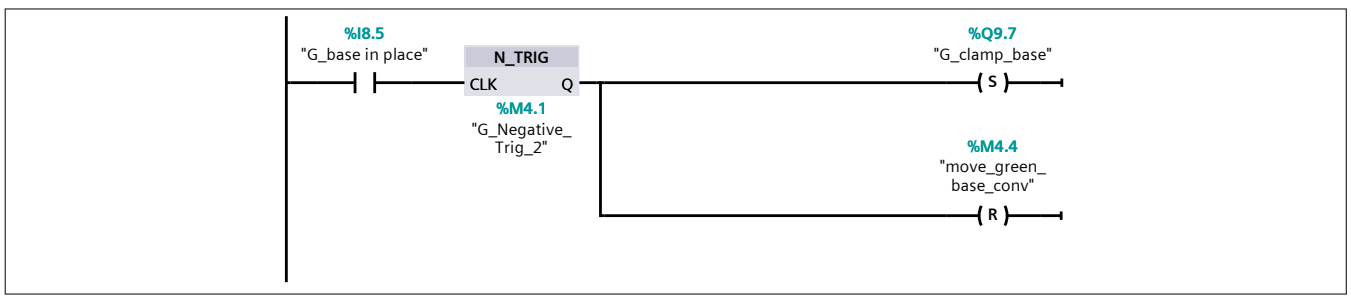
Assembly_Green

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Set-point	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

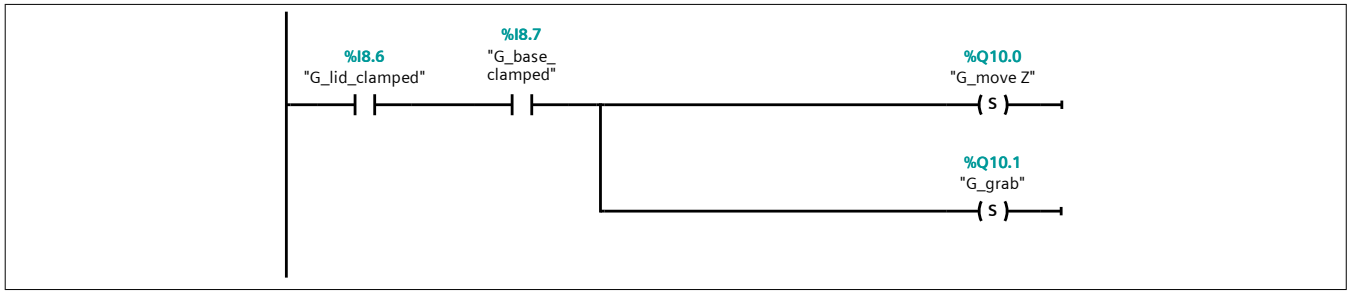
Network 1:



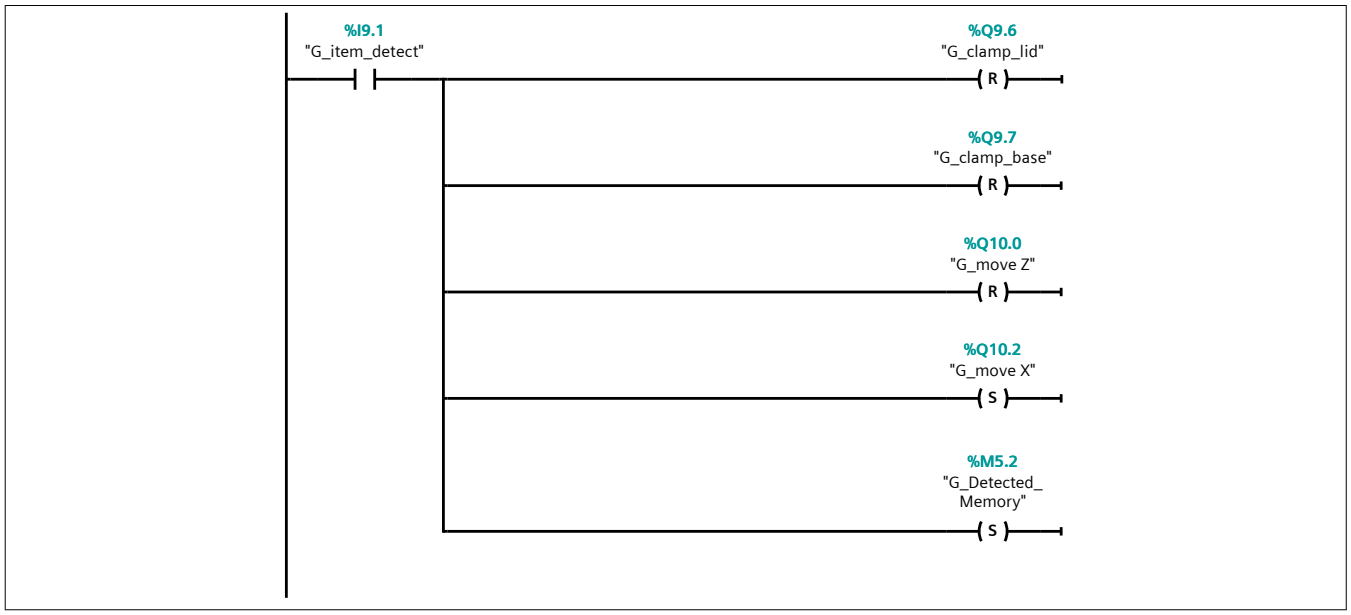
Network 2:



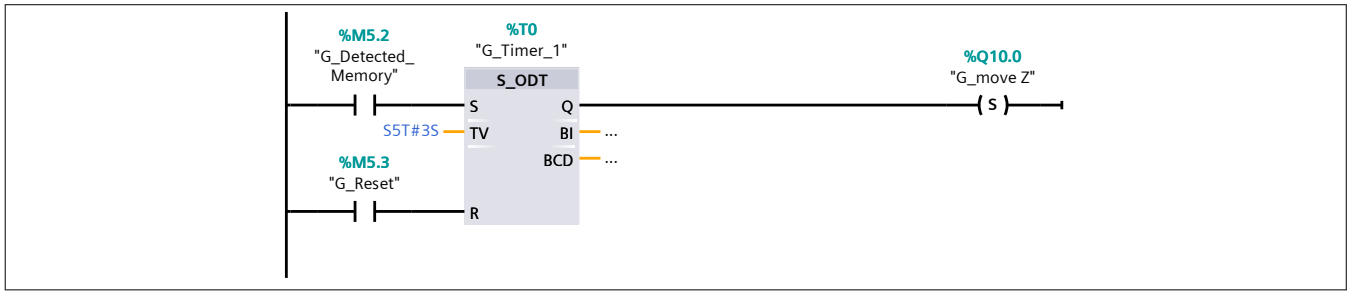
Network 3:



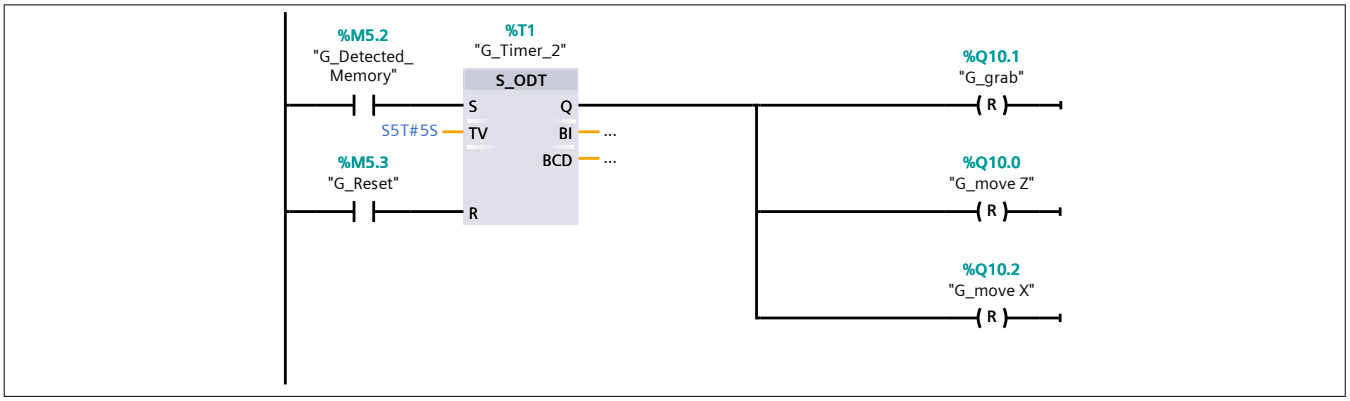
Network 4:



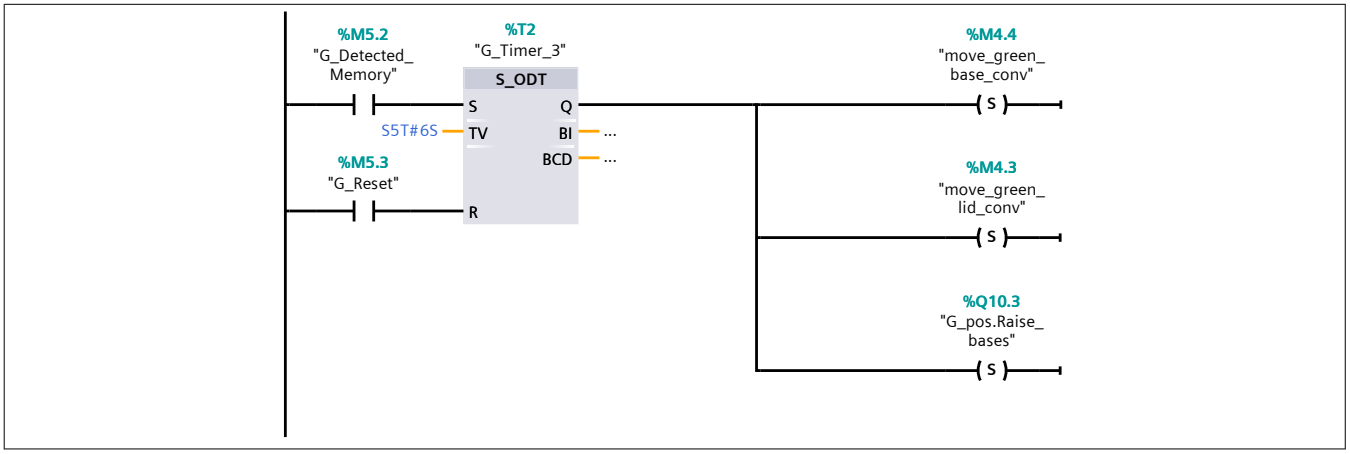
Network 5:



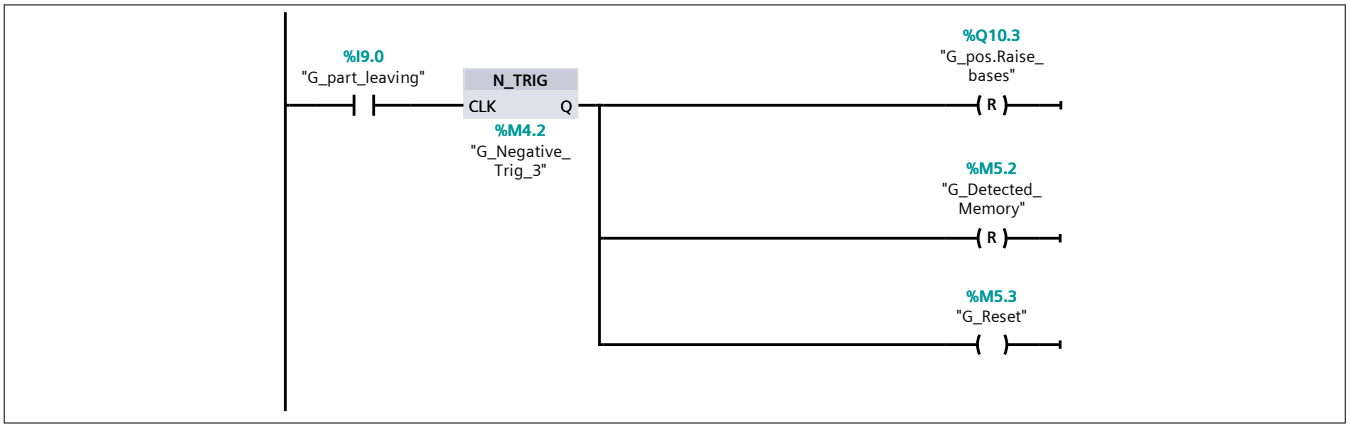
Network 6:



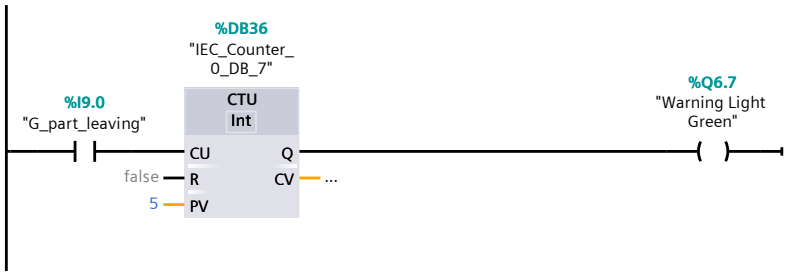
Network 7:



Network 8:



Network 9:


%DB36
"IEC_Counter_
0_DB_7"
%I9.0
"G_part_leaving"
CTU
Int
CU
Q
false
R
CV
...
5
PV
%Q6.7
"Warning Light
Green"

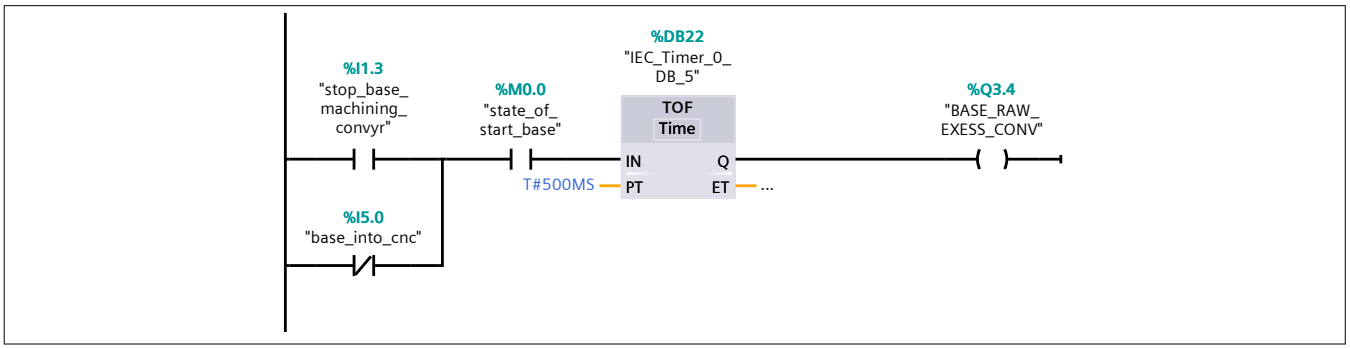
full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

BASE_EXCESS_REMOVE_STATION [FB11]

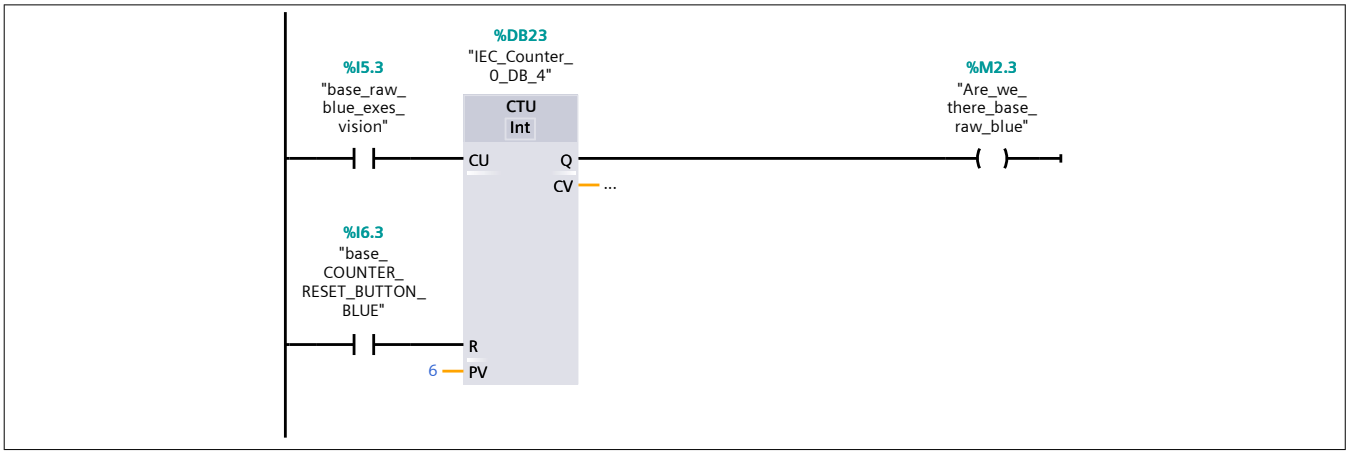
BASE_EXCESS_REMOVE_STATION Properties					
General					
Name	BASE_EXCESS_RE-MOVE_STATION	**Number**	11	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

BASE_EXCESS_REMOVE_STATION									
Name	**Data type**	**Default value**	**Retain**	**Acces-sible from HMI/OPC UA**	**Wri ta-ble fro m HM I/O PC UA**	**Visible in HMI engi-neer-ing**	**Set-point**	**Super-vision**	**Comment**
Input									
Output									
InOut									
Static									
Temp									
Constant									

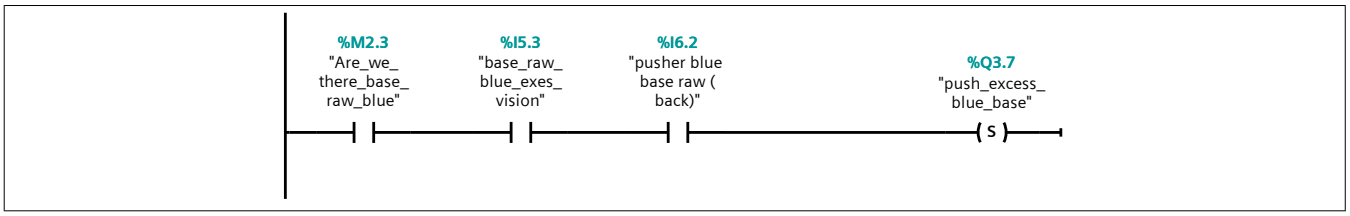
Network 1: LID_BELT_EXCESS_CONVEYOR_HANDLER



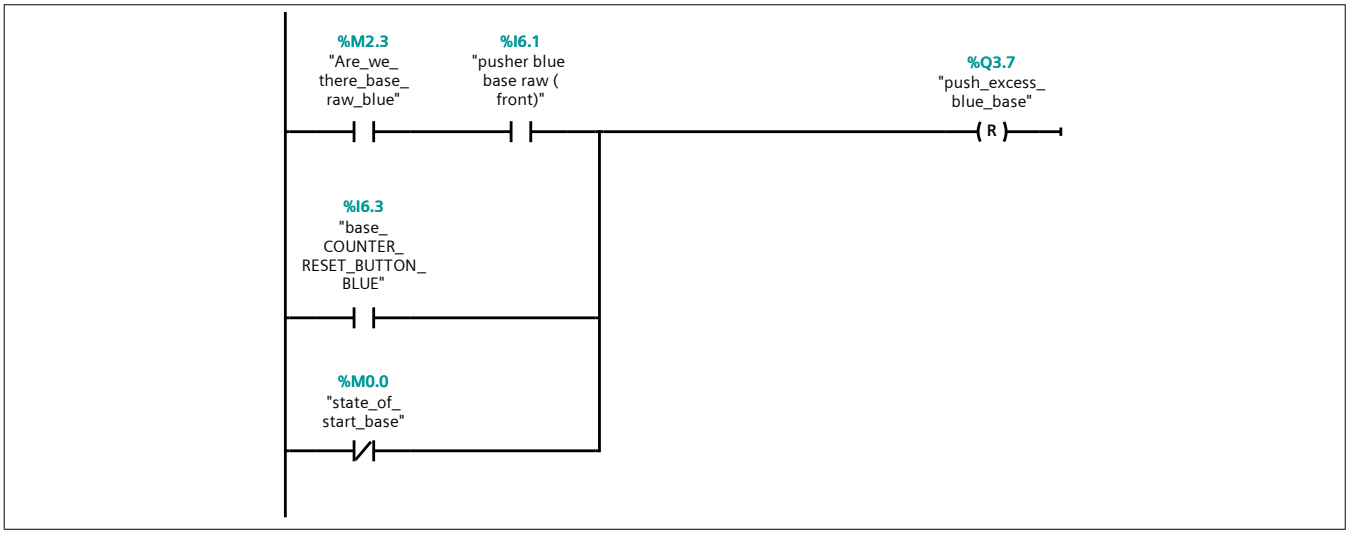
Network 2: COUNTING NUMBER OF BLUE MATERIAL



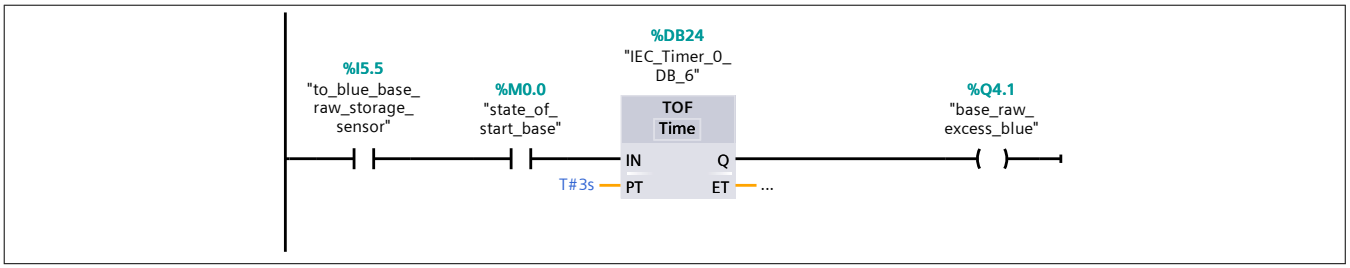
Network 3: PUSH_FORWARD_EXCESS_BLUE



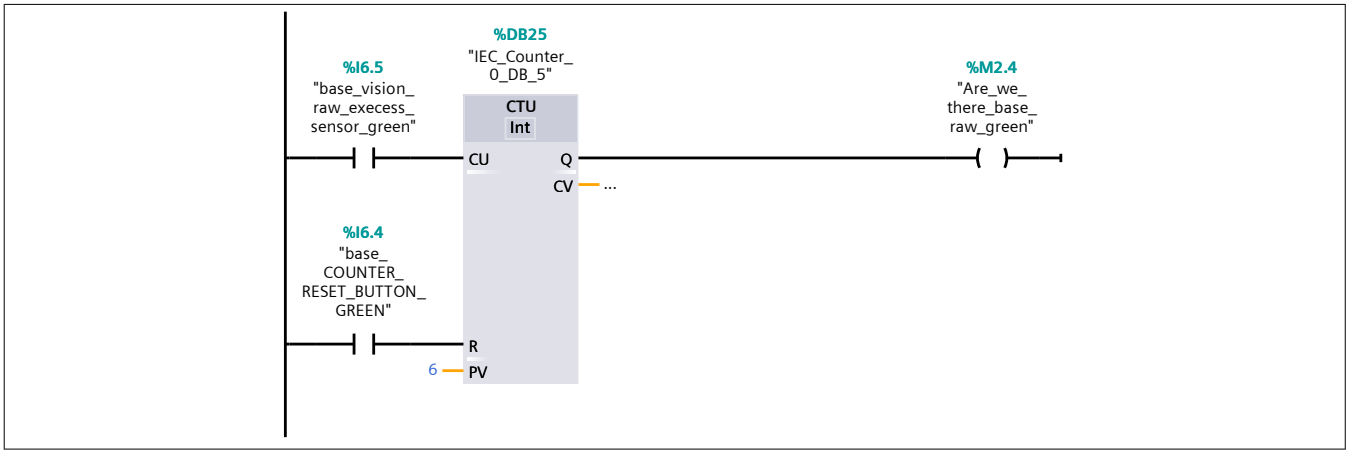
Network 4: PUSH_RETURN_EXECESS_BLUE



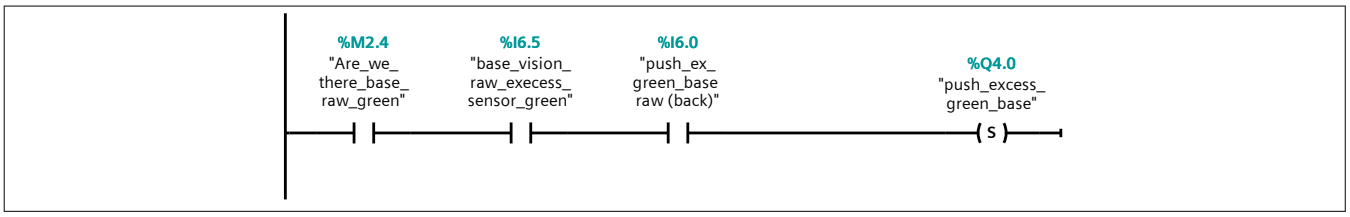
Network 5: RETURN_EXCESS_BLUE_TO_STORAGE



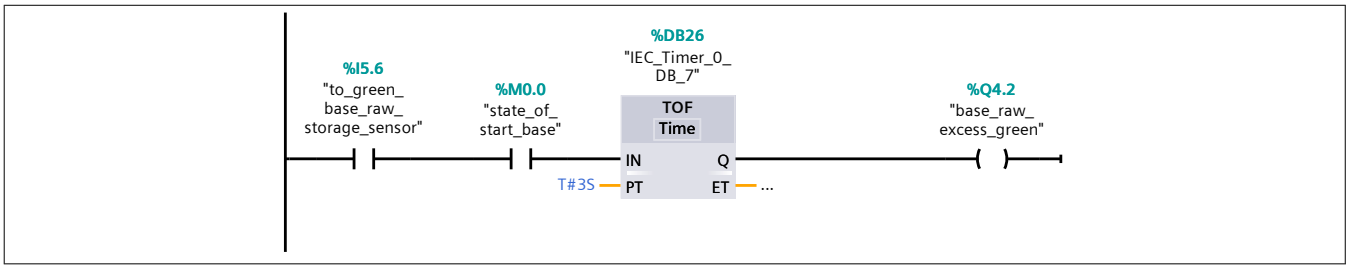
Network 6: COUNTING NUMBER OF GREEN MATERIAL



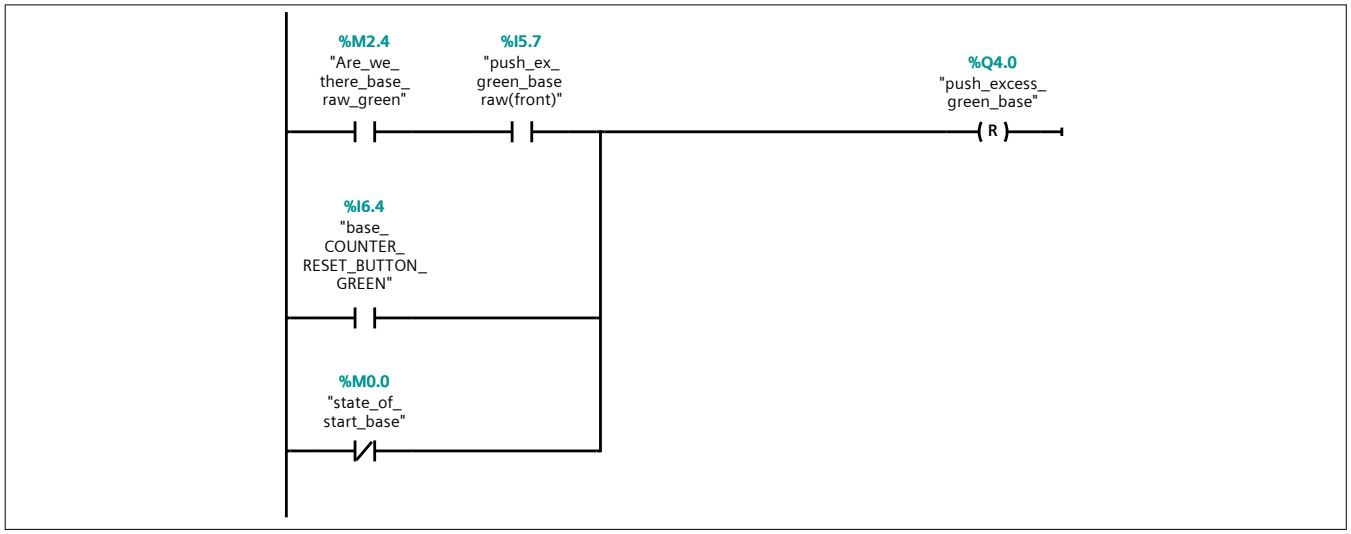
Network 7: PUSH_FORWARD_ECESS_GREEN



Network 8: RETURN_EXCESS_GREEN_TO_STORAGE

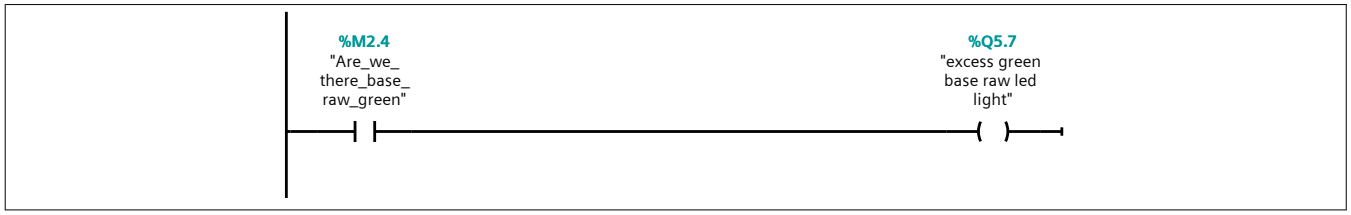


Network 9: OUSH_RETURN_GREEN

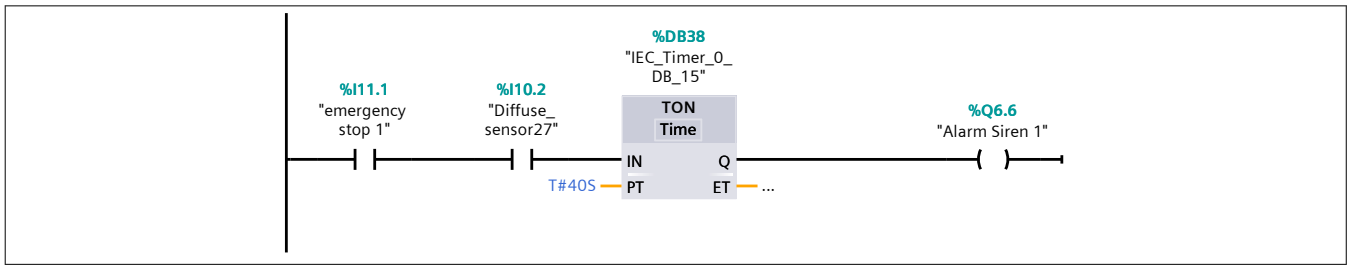


Network 10: EXCESS BLUE LIGHT

Network 11:



Network 12:



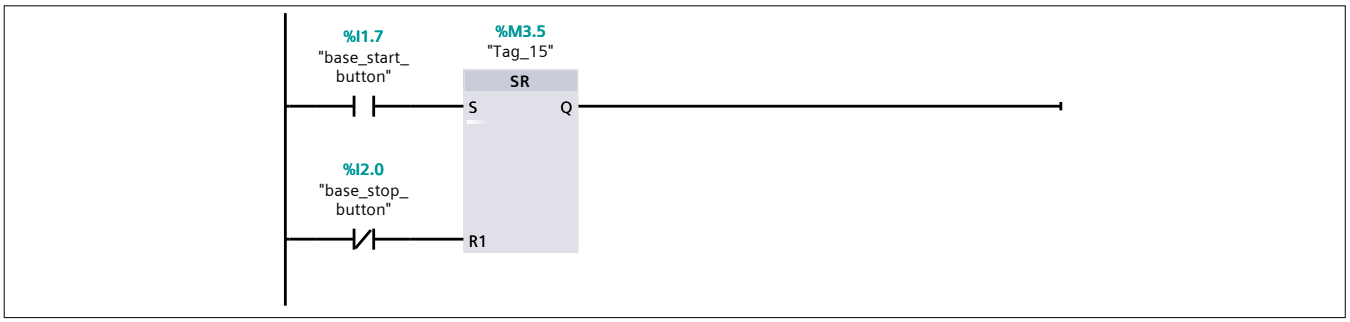
full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

Base_production_fb [FB12]

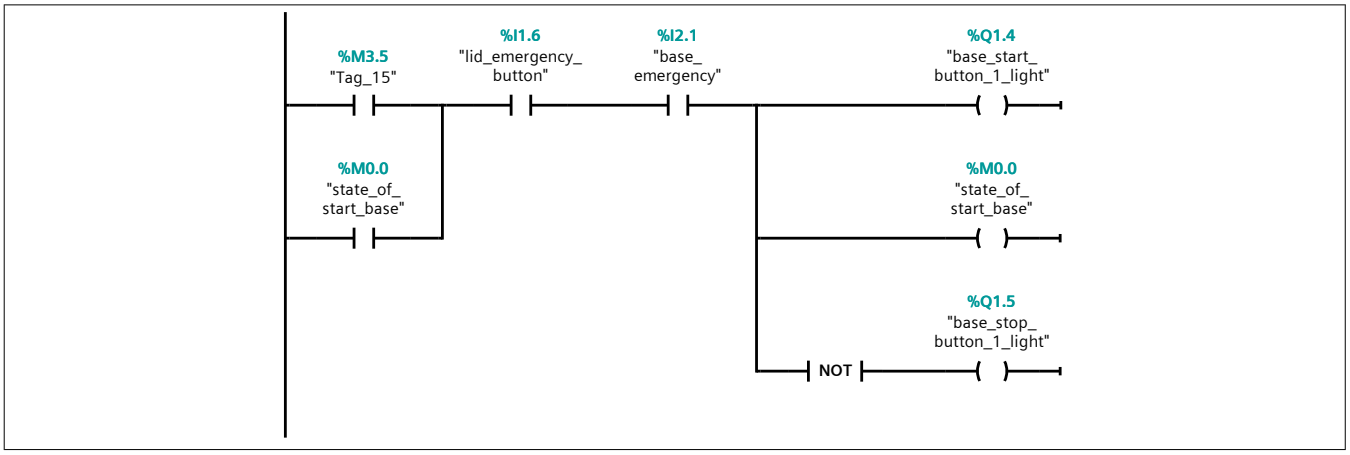
Base_production_fb Properties					
General					
Name	Base_production_fb	**Number**	12	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

Base_production_fb									
Name	**Data type**	**Default value**	**Retain**	**Accessible from HMI/OPC UA**	**Writable from HMI/OPC UA**	**Visible in HMI engineering**	**Set-point**	**Supervision**	**Comment**
Input									
Output									
InOut									
Static									
Temp									
Constant									

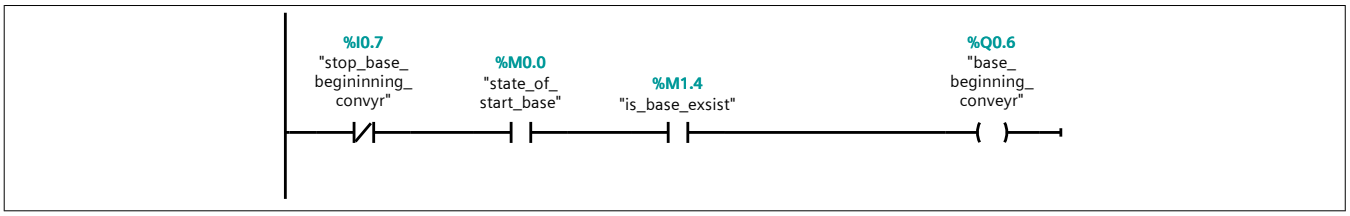
Network 1:



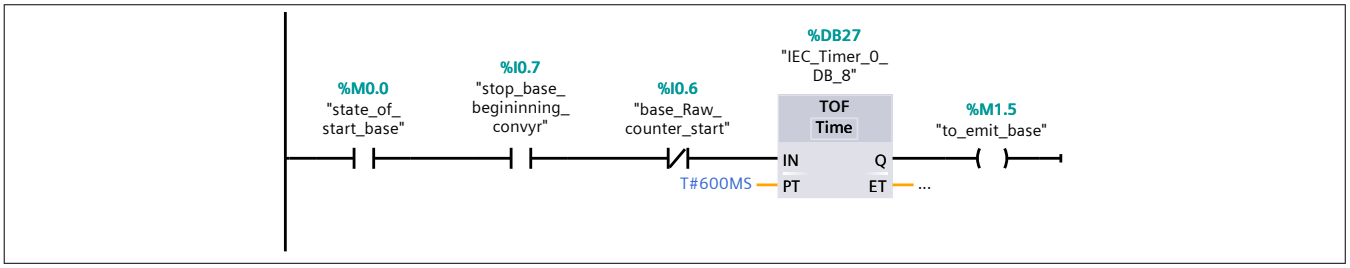
Network 2: base_production_station



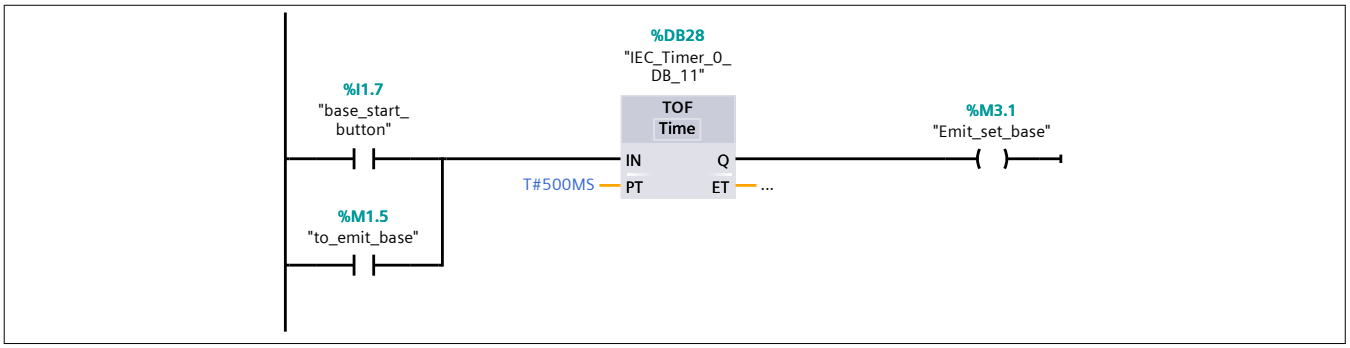
Network 3: base_begin_conveyor



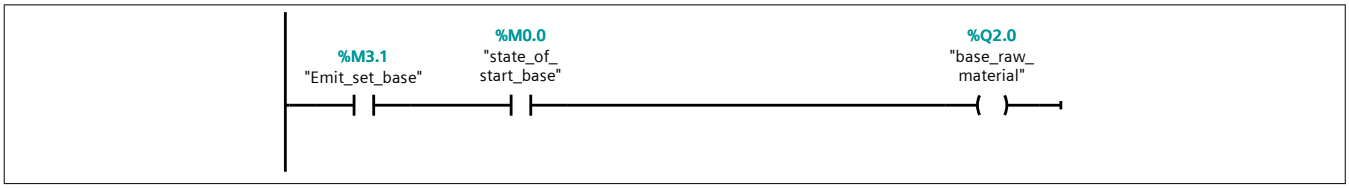
Network 4: emit_base_handler



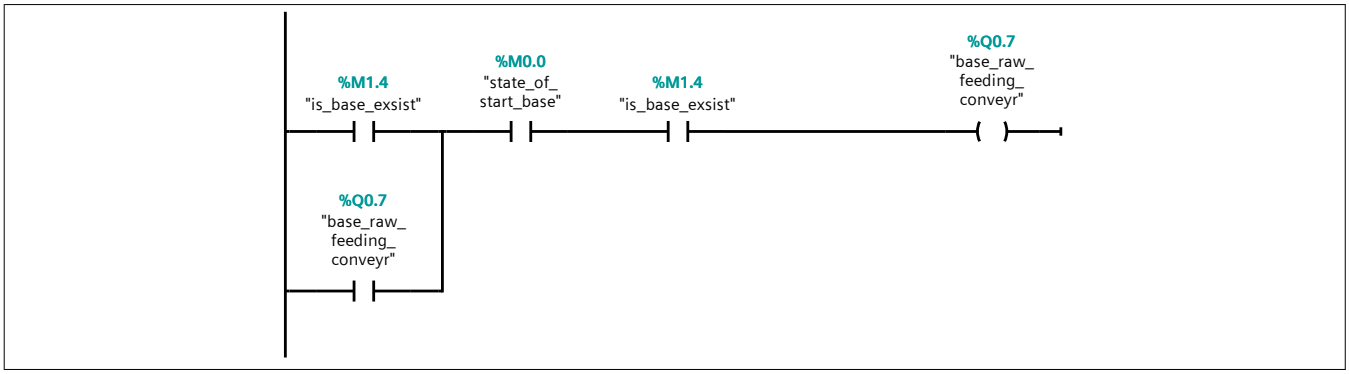
Network 5: EMITTING_BASE



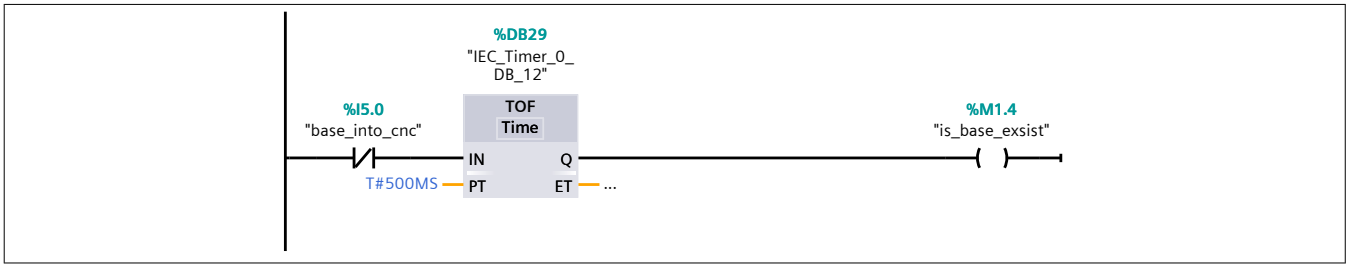
Network 6: EMIT_EMERGENCY_HANDLER_BASE



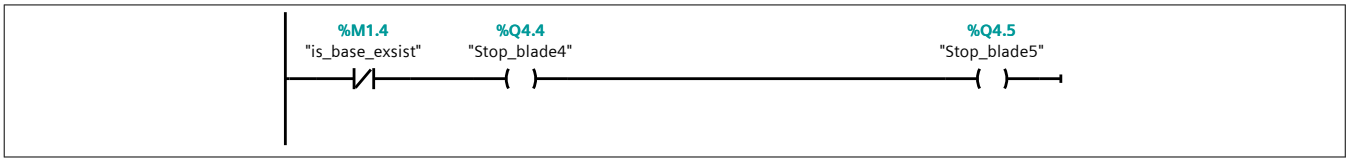
Network 7: FEEDING_CONVEYOR_HANDLER_BASE



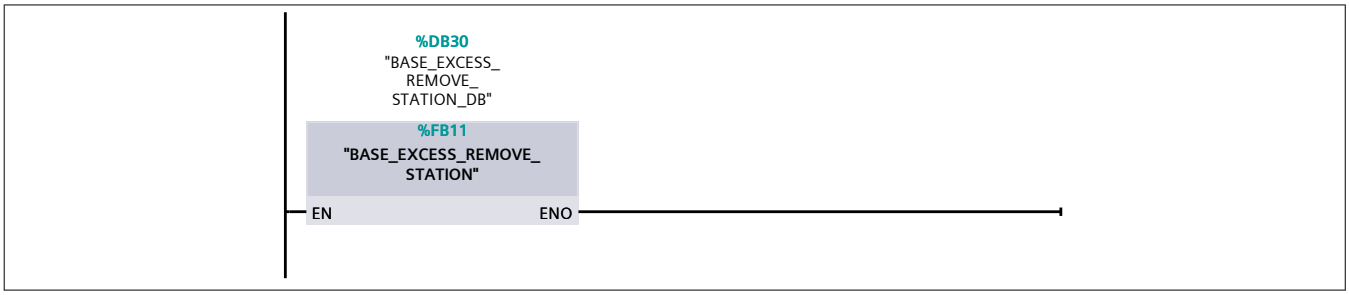
Network 8: BASE_RAW_INTO_CNC



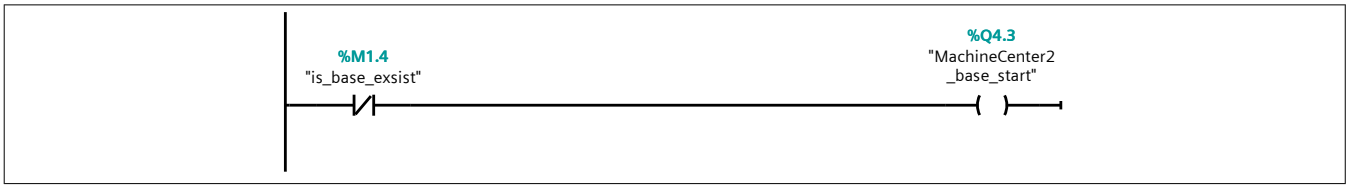
Network 9: BASE_KEEP_DISTANCE



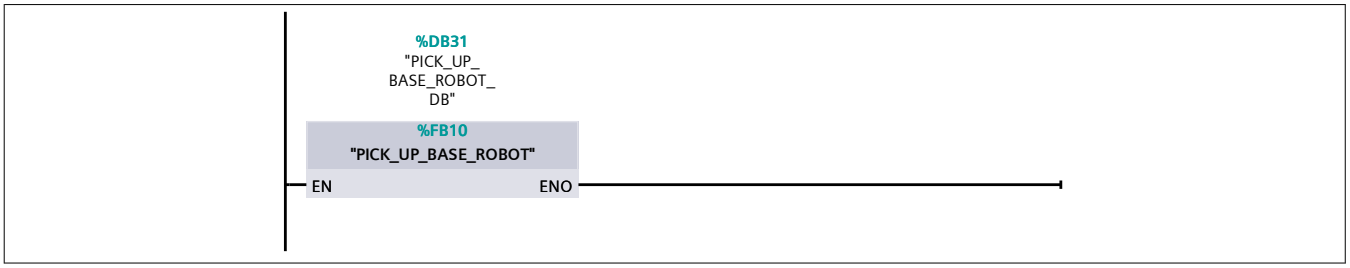
Network 10: BASE_EXCESS



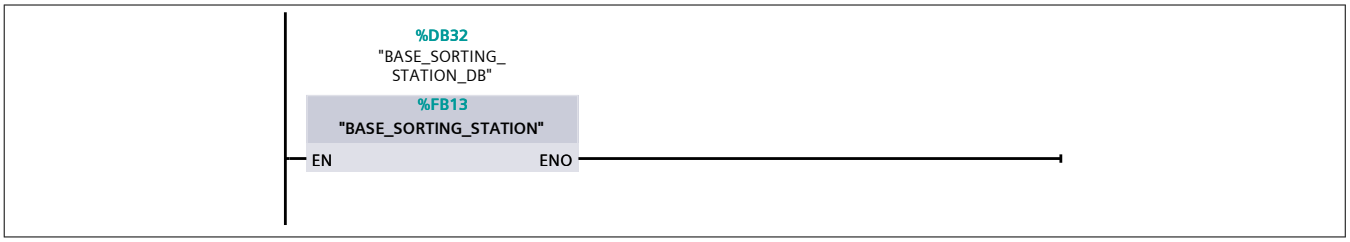
Network 11: CNC_BASE



Network 12: PICK_AND_PLACE_BASE



Network 13: BASE SORTING



full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

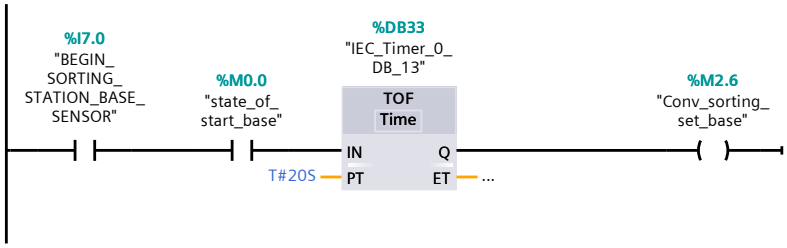
BASE_SORTING_STATION [FB13]

BASE_SORTING_STATION Properties					
General					
Name	BASE_SORTING_STATION	**Number**	13	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

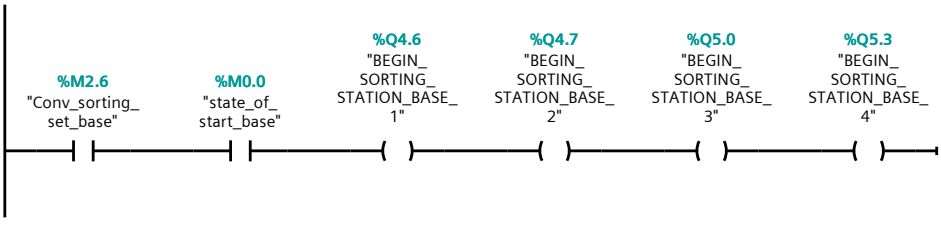
BASE_SORTING_STATION

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Set-point	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

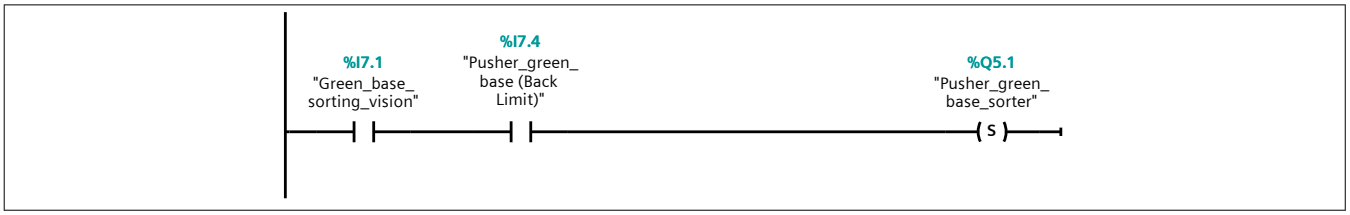
Network 1: BEGIN SORTING CONVEYOR



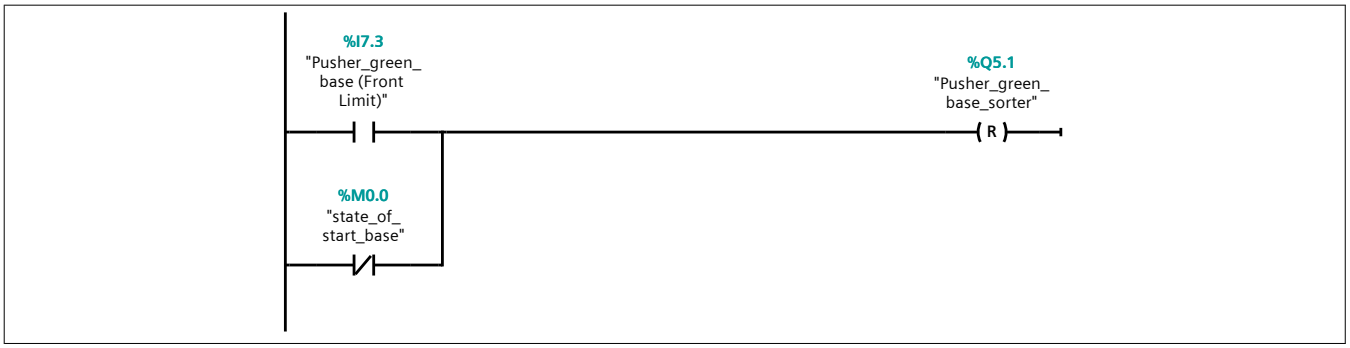
Network 2: CONV BASE SORTING HANDLE



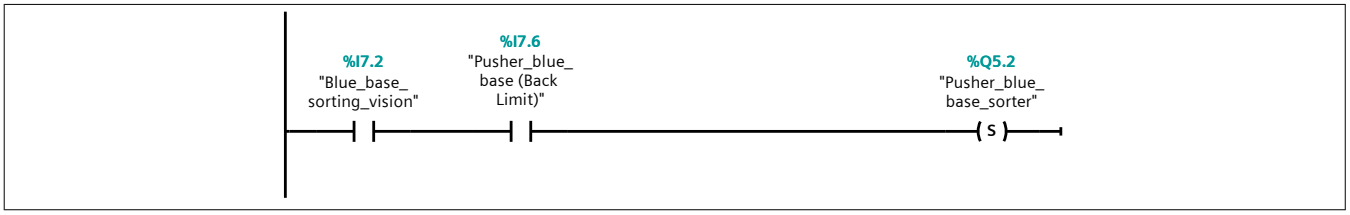
Network 3: GREEN BASE PUSH FRONT



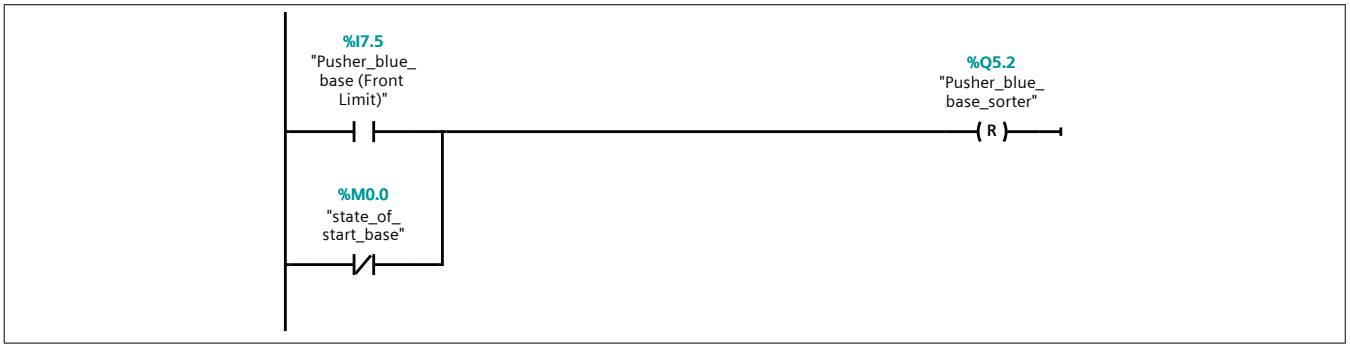
Network 4: GREEN PUSHER SORTING RETURN



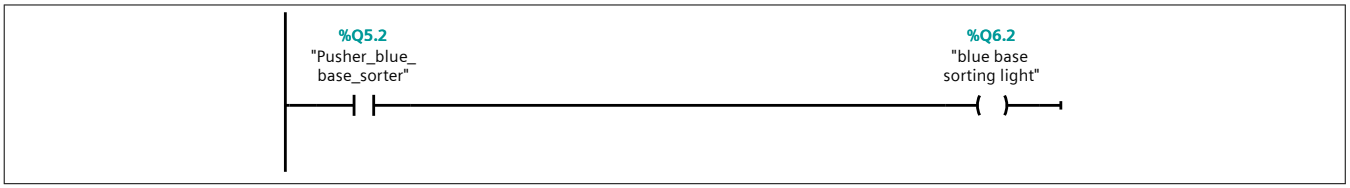
Network 5: BLUE PUSHER SORTING PUSH



Network 6: BLUE PUSHER SORTING RETURN



Network 7: LIGHT BLUE



Network 8: LIGHT GREEN

full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

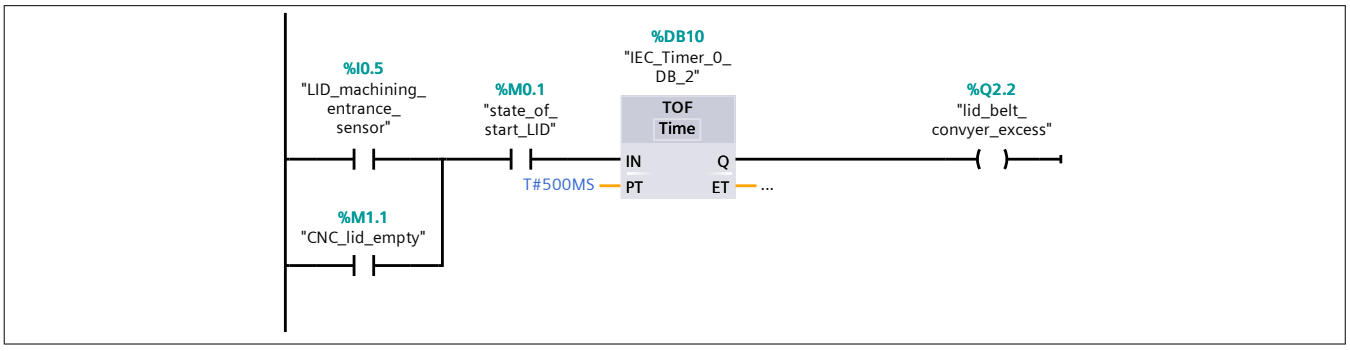
LID_execess_remove_station [FB3]

LID_execess_remove_station Properties					
General					
Name	LID_execess_remove_station	**Number**	3	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

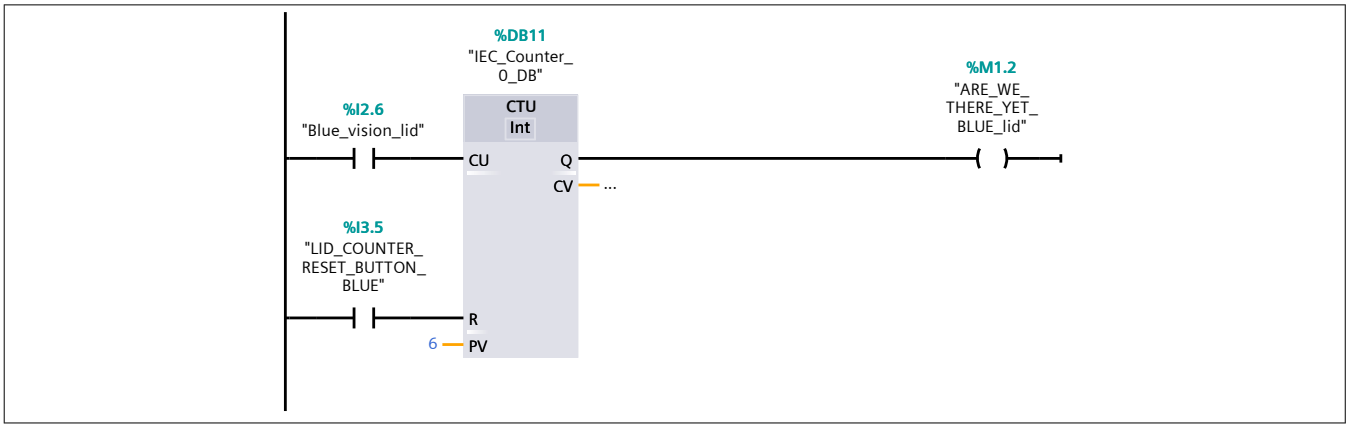
LID_execess_remove_station

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Setpoint	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

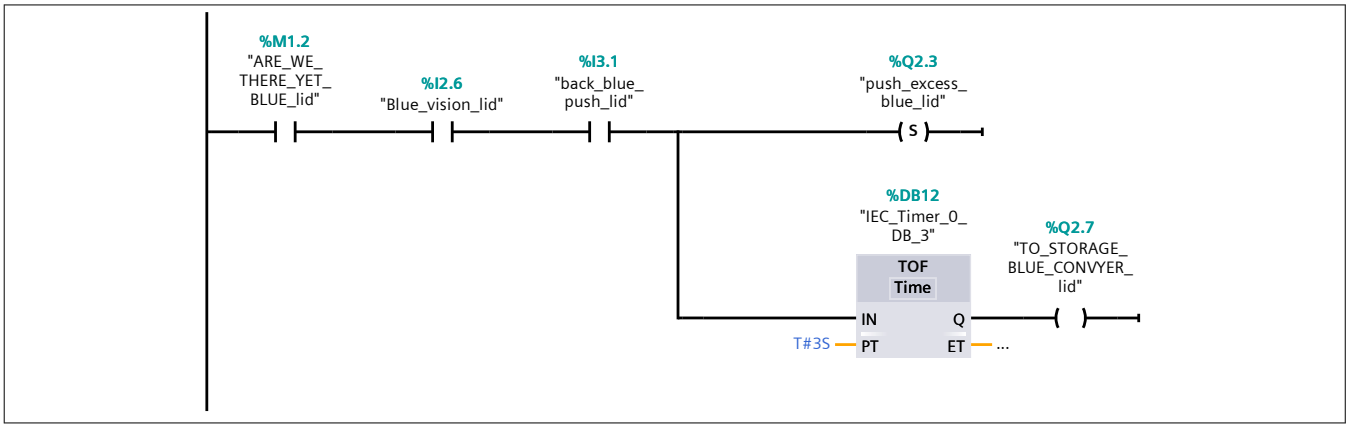
Network 1: LID_BELT_EXECESS_CONVEYOR_HANDLER



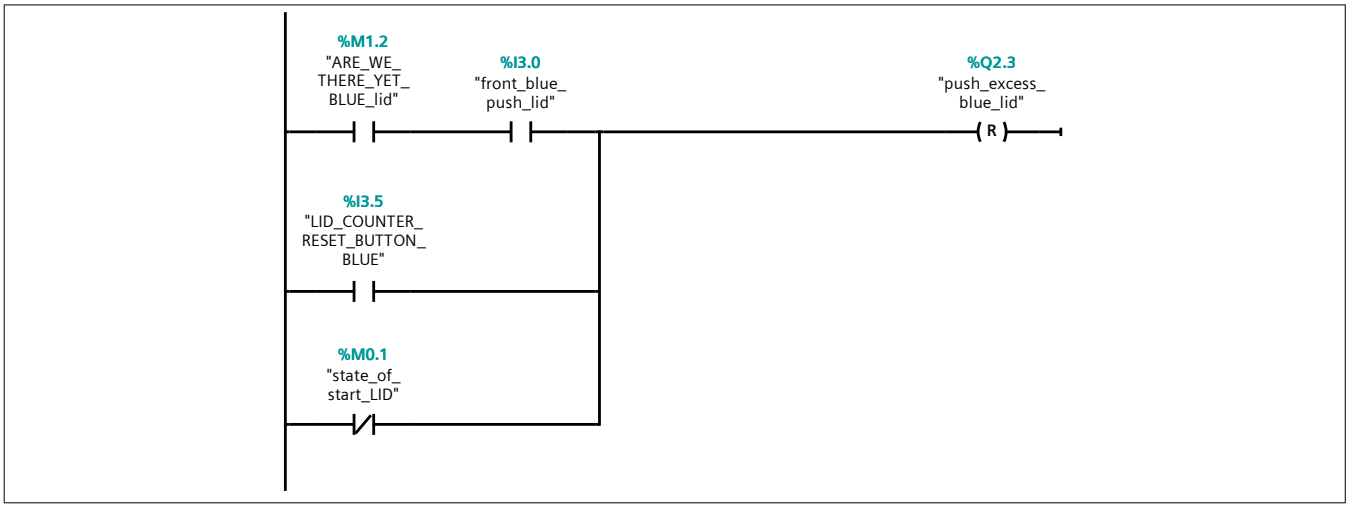
Network 2: COUNTING NUMBER OF BLUE MATERIAL OF EXECES



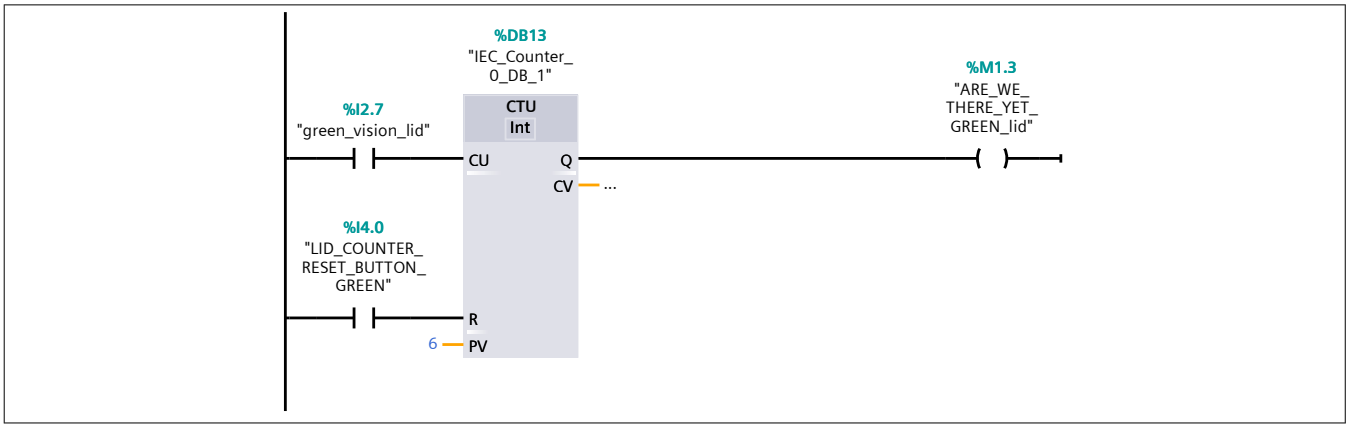
Network 3: PUSH_FORWARD_EXECESS_BLUE



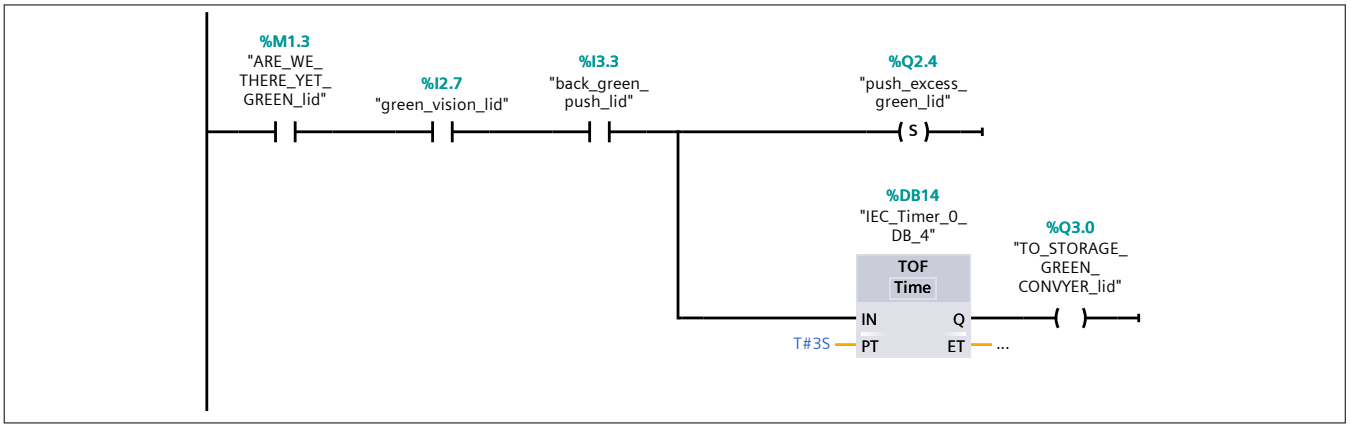
Network 4: PUSH_RETURN_EXECESS_BLUE



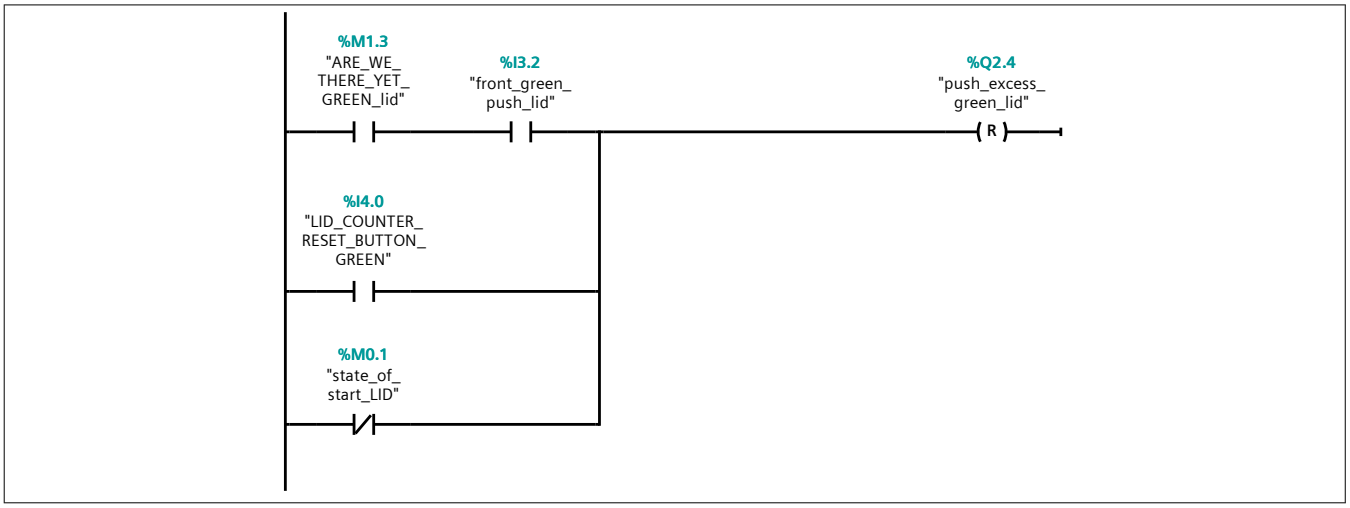
Network 5: COUNTING_NUMBER_OF_GREEN



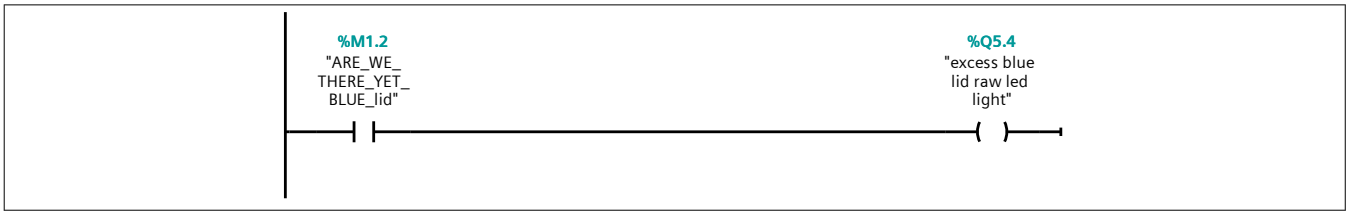
Network 6: PUSH_FORWARD_EXCESS_GREEN



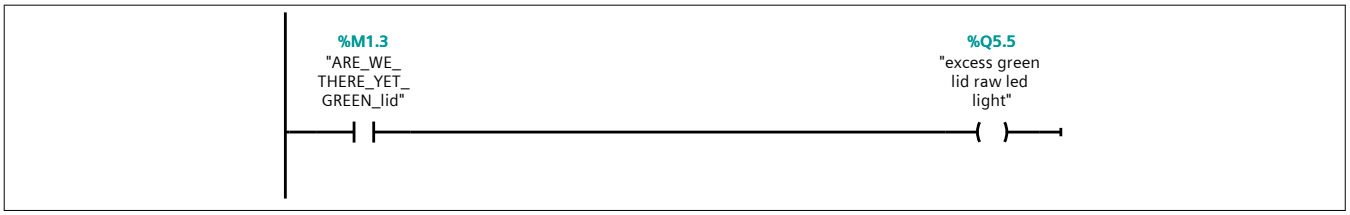
Network 7: PUSH_RETURN_GREEN



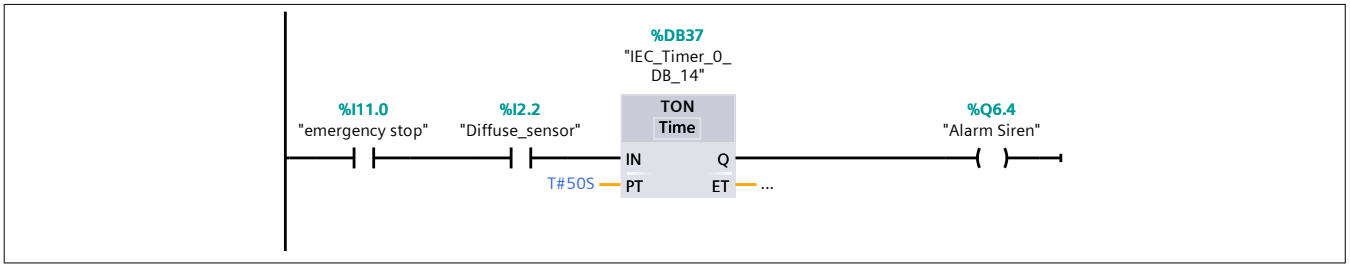
Network 8: LIGHT_BLUE_IF_REACHED



Network 9: LIGHT_GREEN_IF_REACHED



Network 10:



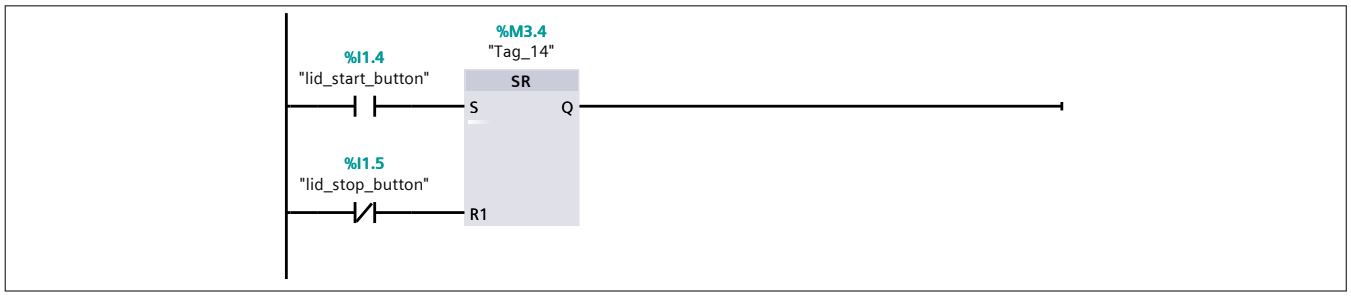
full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

LID_PRODUCTION [FB1]

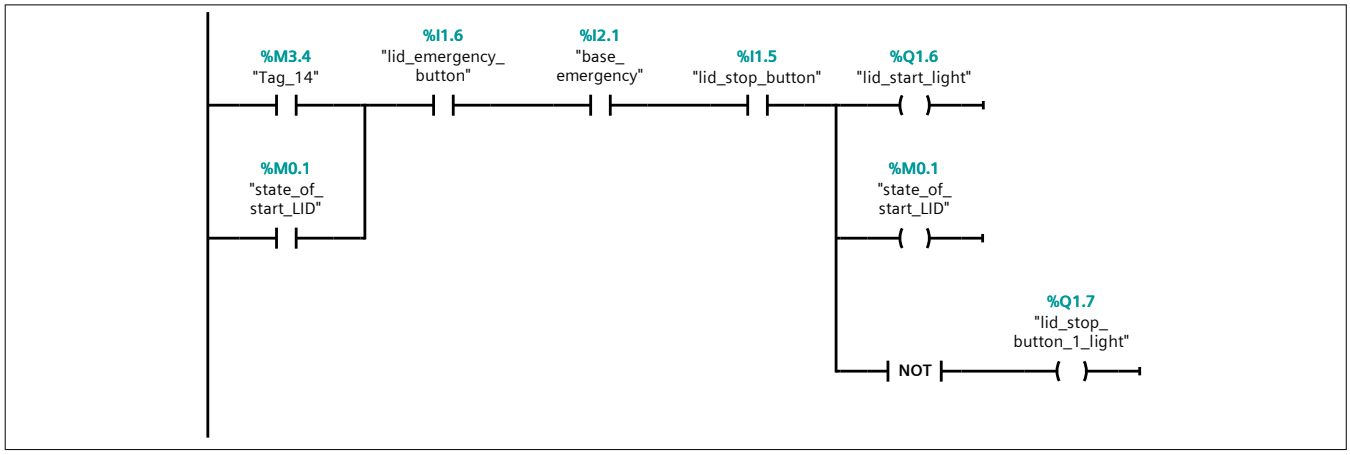
LID_PRODUCTION Properties					
General					
Name	LID_PRODUCTION	**Number**	1	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

LID_PRODUCTION									
Name	**Data type**	**Default value**	**Retain**	**Accessible from HMI/OPC UA**	**Writable from HMI/OPC UA**	**Visible in HMI engineering**	**Set-point**	**Supervision**	**Comment**
Input									
Output									
InOut									
Static									
Temp									
Constant									

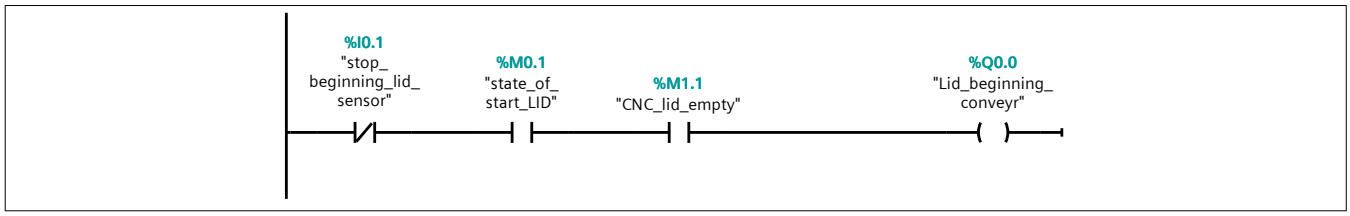
Network 1:



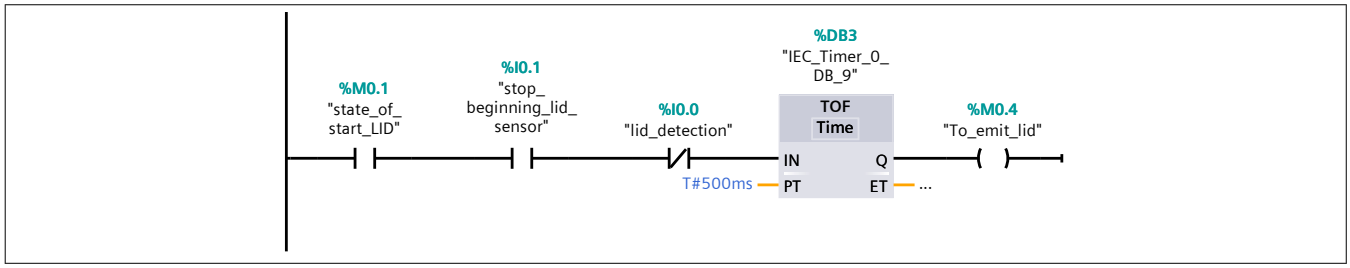
Network 2: LID STARTING GANDLE



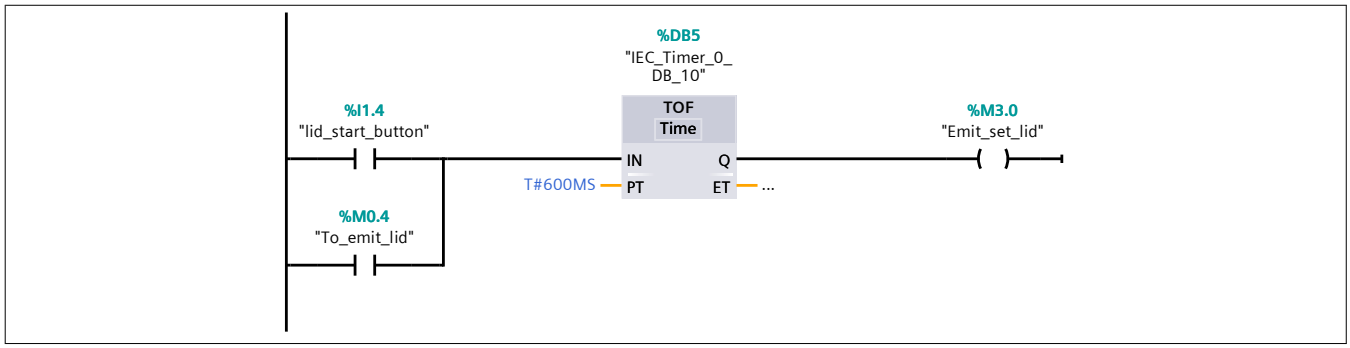
Network 3: LID_BEGINNING CONVEYOR



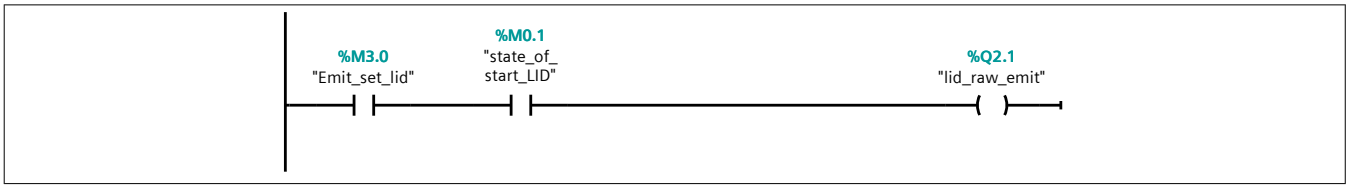
Network 4: LID_EMITTER_HANDLER



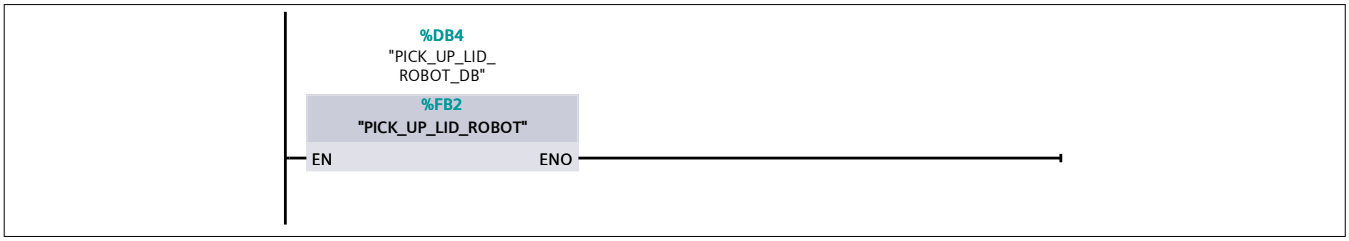
Network 5: FIRST LID TO EMIT



Network 6: EMIT EMERGENCY HANDLE LID

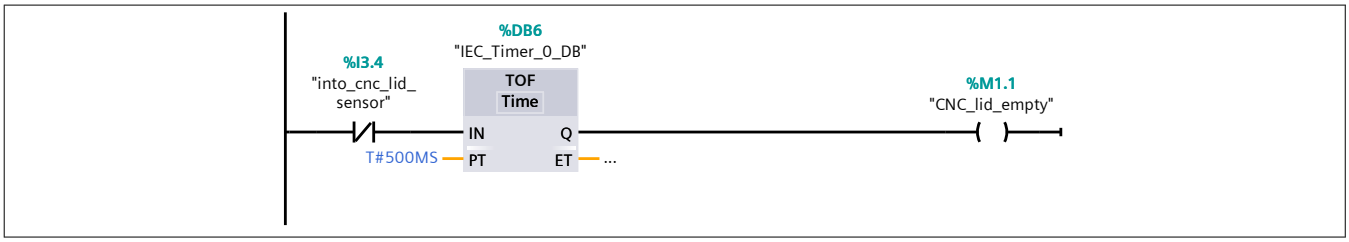


Network 7: LID_PICKUP_ROBOT

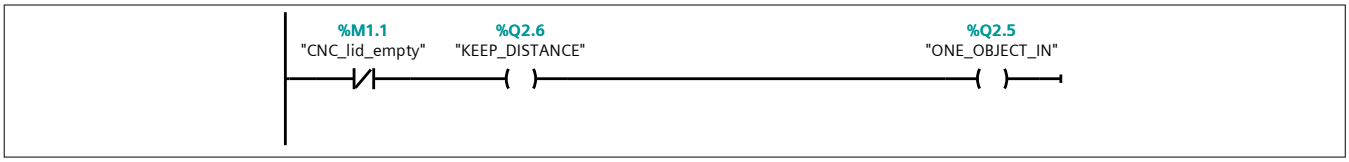


Network 8: FEEDING_CONVEYOR_HANDLER_LID

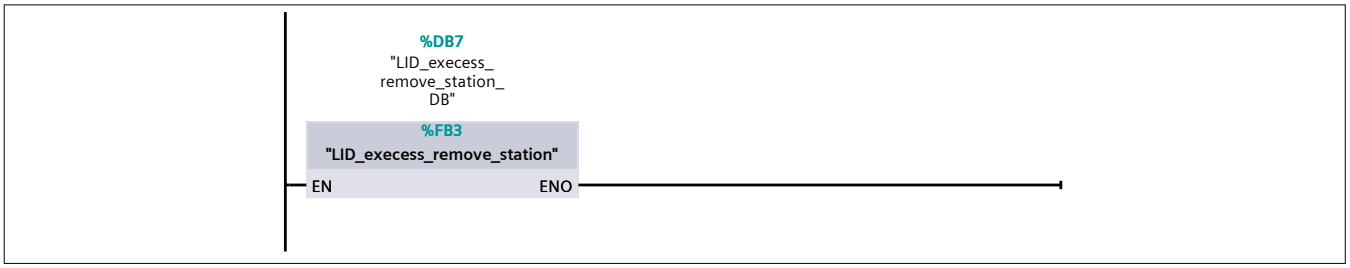
Network 9:



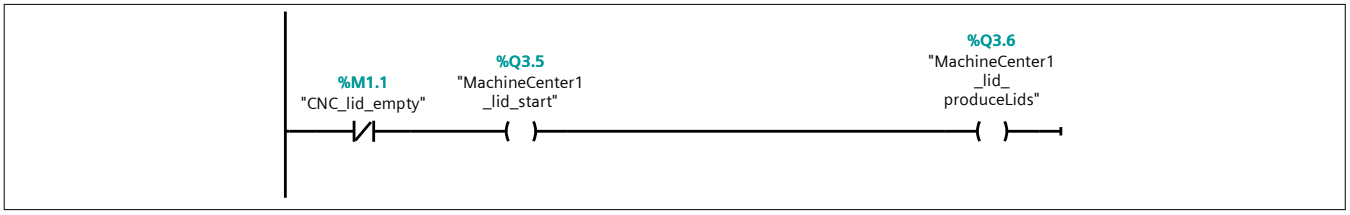
Network 10: LID_KEEP_DISTANCE



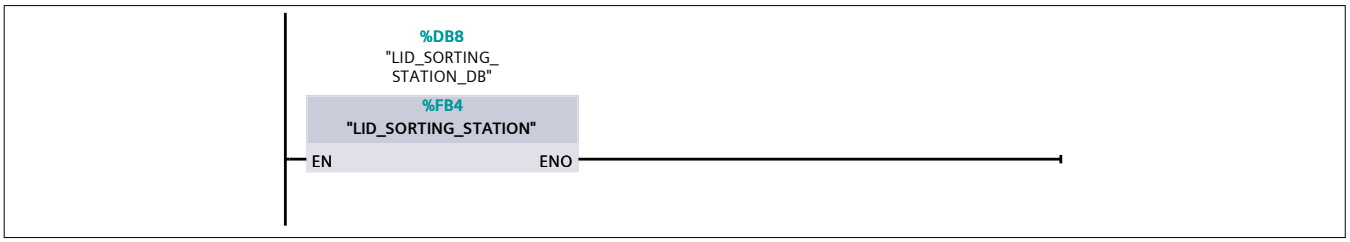
Network 11: LID_execess_station



Network 12: CNC



Network 13:



full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

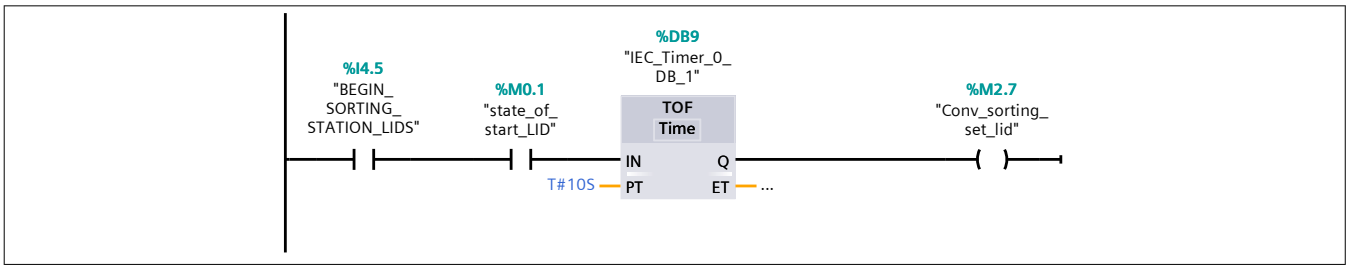
LID_SORTING_STATION [FB4]

LID_SORTING_STATION Properties					
General					
Name	LID_SORTING_STATION	**Number**	4	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

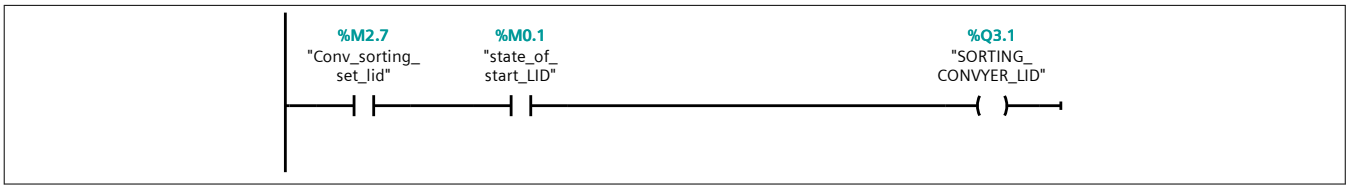
LID_SORTING_STATION

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Set-point	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

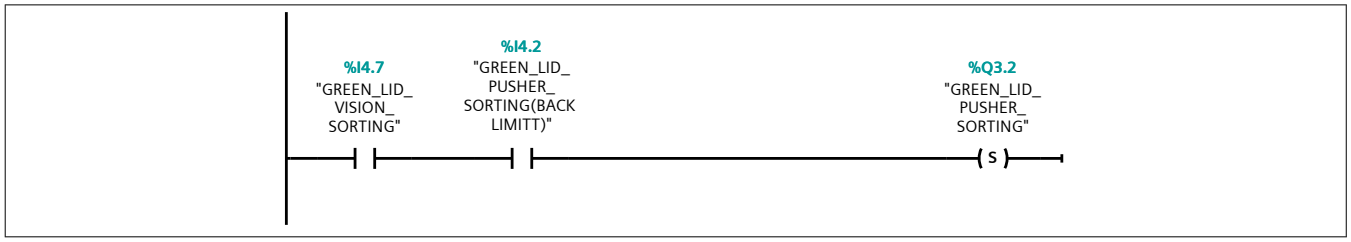
Network 1: BEGIN SORTING CONVEYOR



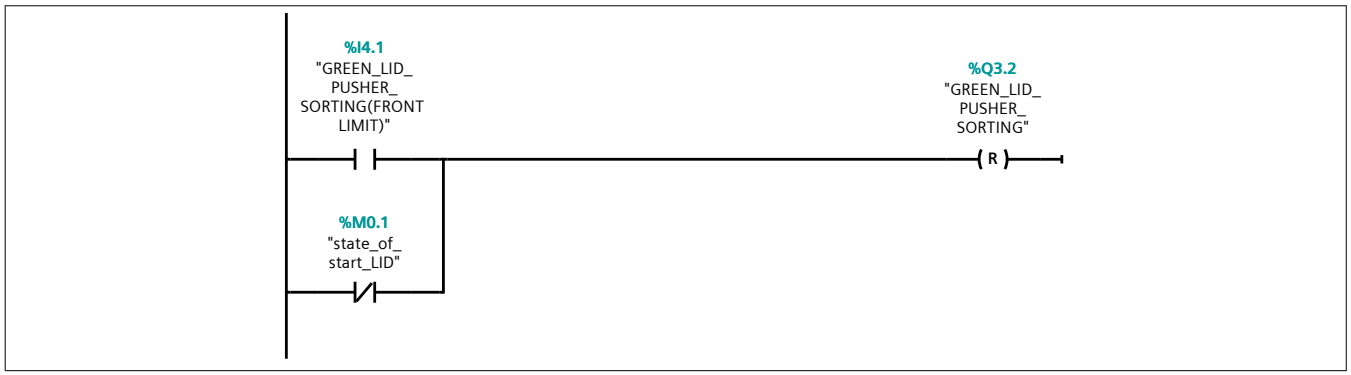
Network 2:



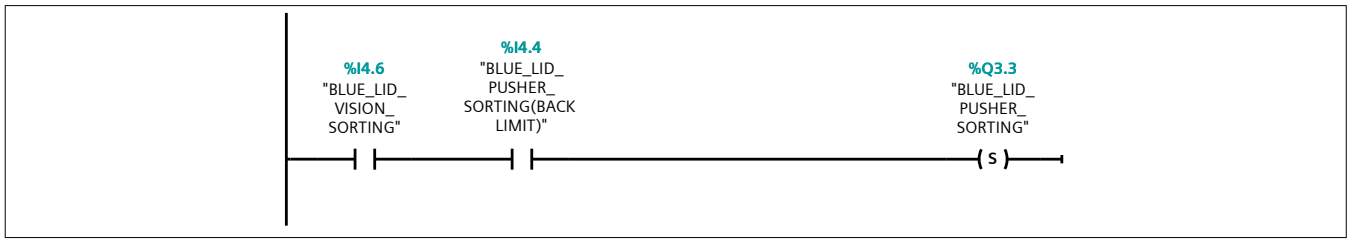
Network 3: GREEN LID PUSH FRONT



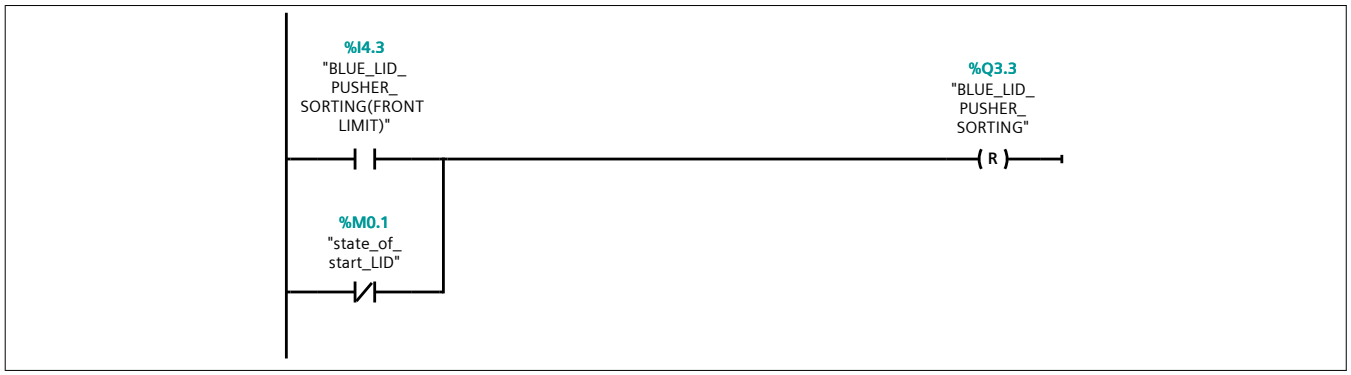
Network 4: GREEN PUSHER SORTING RETURN



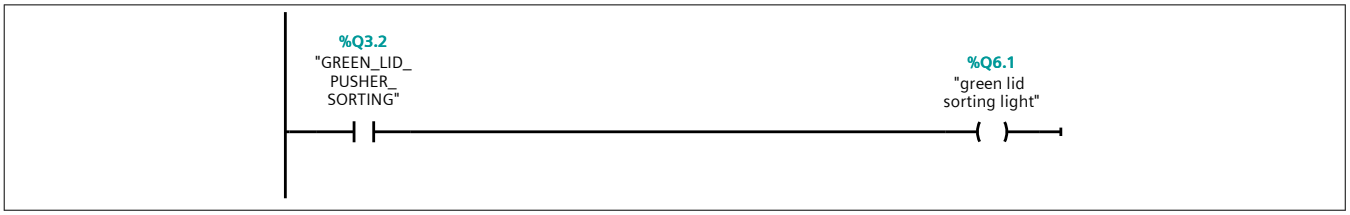
Network 5: BLUE PUSHER SORTING PUSH



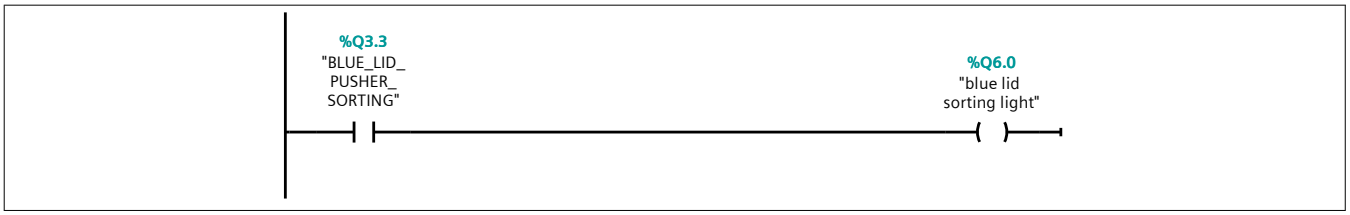
Network 6: BLUE_PUSHER_SORTING_RETURN



Network 7: GREEN LID IF BLUE



Network 8: BLUE LID



full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

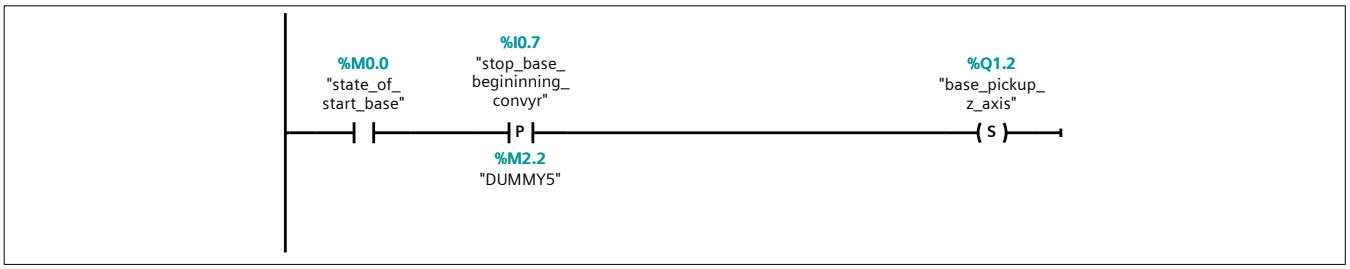
PICK_UP_BASE_ROBOT [FB10]

PICK_UP_BASE_ROBOT Properties					
General					
Name	PICK_UP_BASE_ROBOT	**Number**	10	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

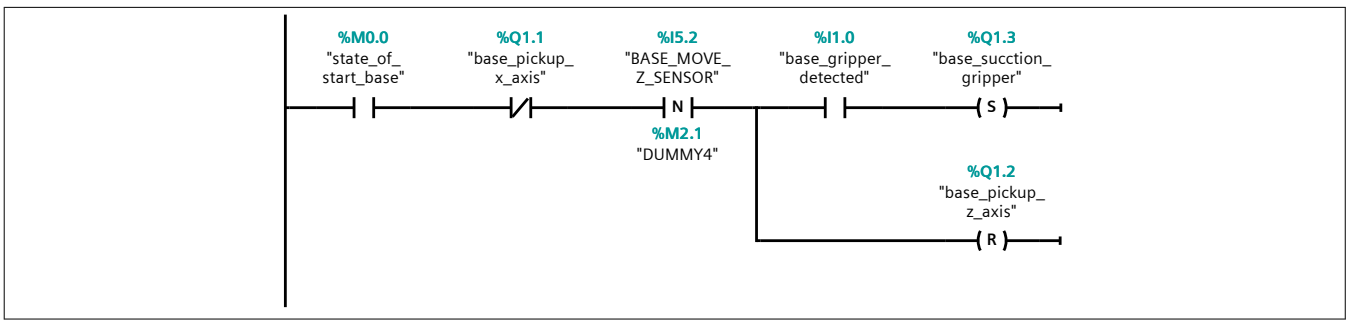
PICK_UP_BASE_ROBOT

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Set-point	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

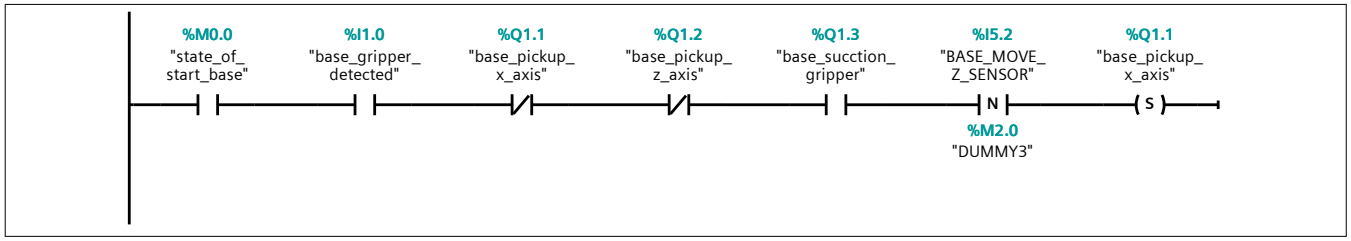
Network 1: BASE_PICKUP_ROBOT_LOWEING_Z_AXIS



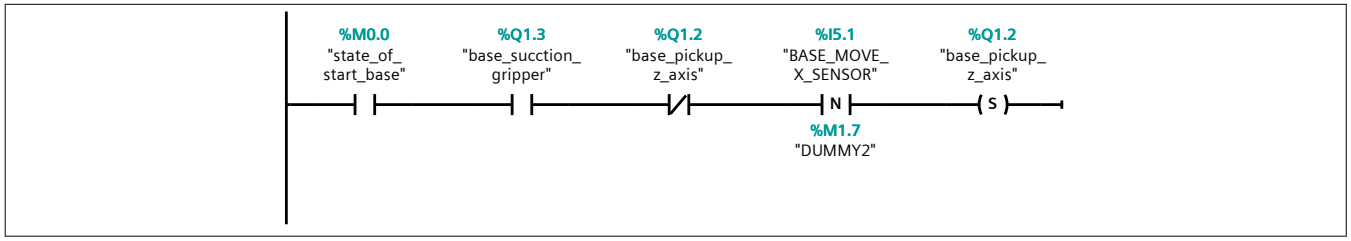
Network 2: BASE_PICKUP_OPERATE_SUCTION



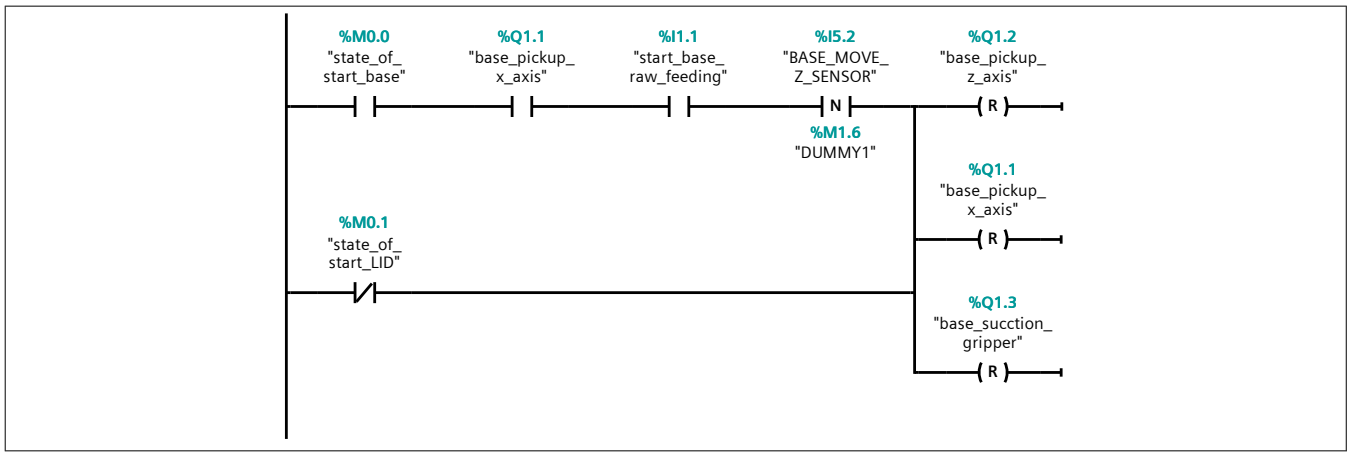
Network 3: PICK_UP_BASE_GO_TO_FEEDING



Network 4: LID_PICK_UP_LOWERING_Z_AXIS_IN_FEEDING



Network 5: LID_RETURN_TO_ORIGIN_PICKUP



full production line / PLC_1 [CPU 1511-1 PN] / Program blocks

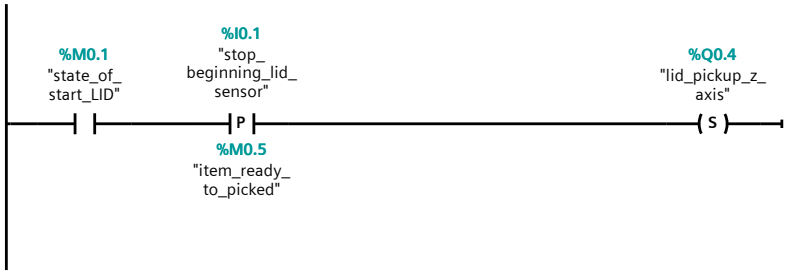
PICK_UP_LID_ROBOT [FB2]

PICK_UP_LID_ROBOT Properties					
General					
Name	PICK_UP_LID_ROBOT	**Number**	2	**Type**	FB
Language	LAD	**Numbering**	Automatic		
Information					
Title		**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

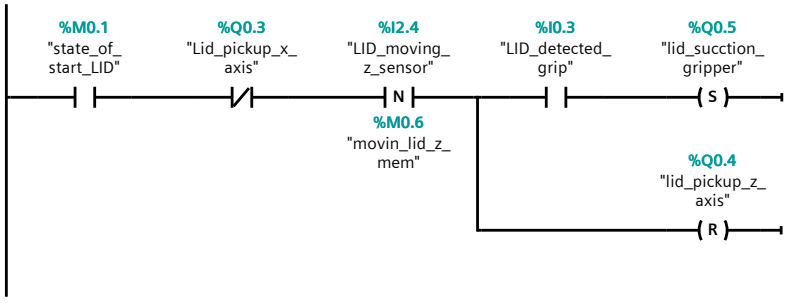
PICK_UP_LID_ROBOT

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA	Writable from HMI/OPC UA	Visible in HMI engineering	Set-point	Supervision	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

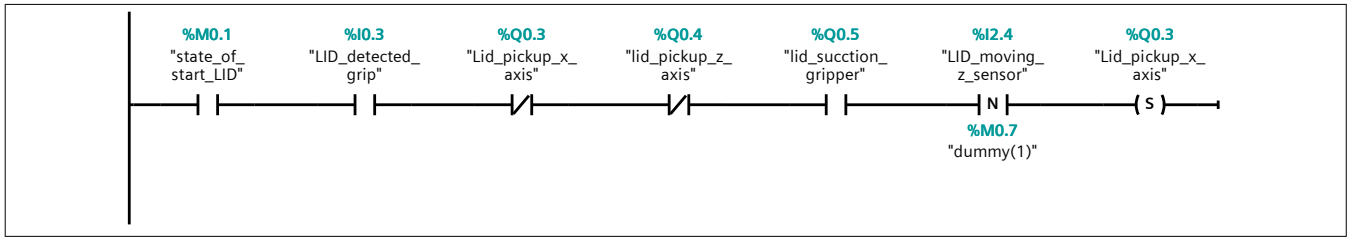
Network 1:



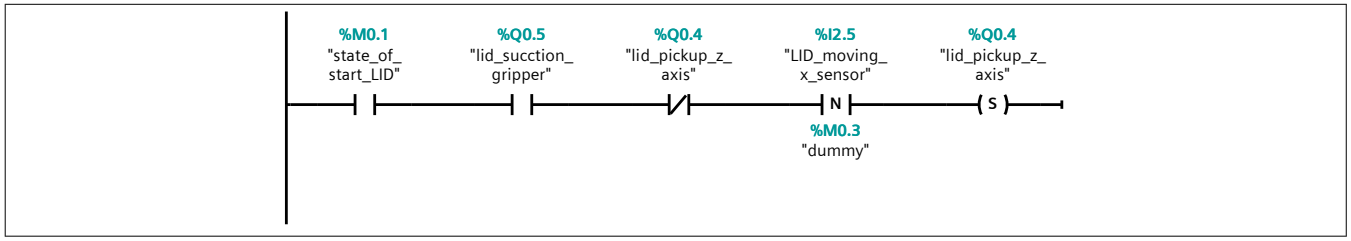
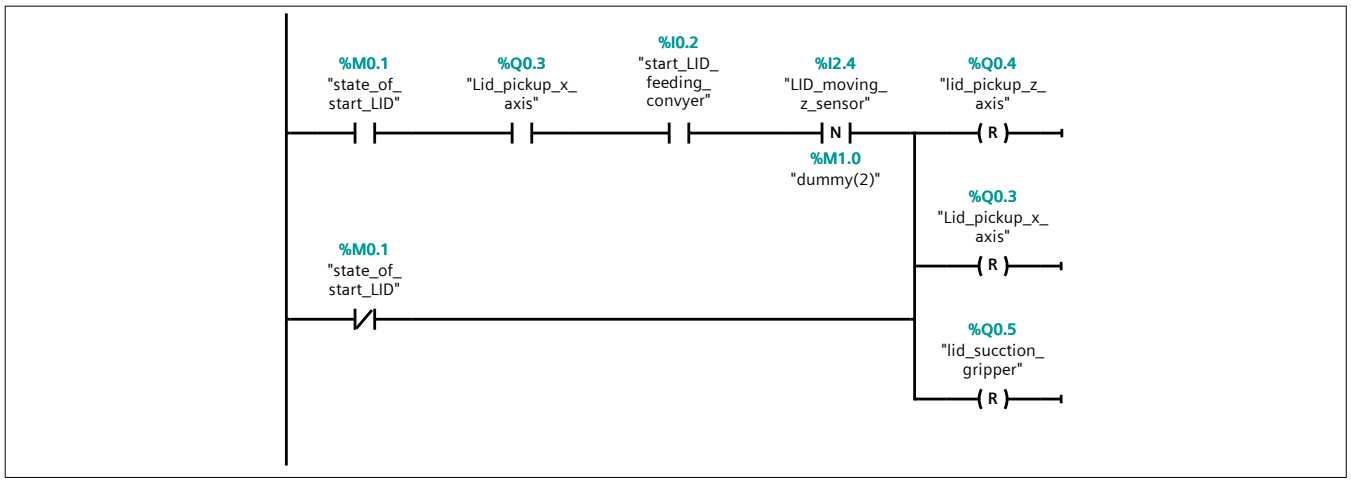
Network 2:



Network 3: PICK_UP_LID_GO_TO_FEEDING



Network 4: LID_PICK_UP_LOWERING_Z_AXIS_IN_FEEDING



Network 5: LID_RETURN_TO_ORIGIN_PICKUP