KING MONGKUT'S INSTITUTE OF TECHNOLOGY LATKRABANG
SCHOOL OF ENGINEERING GROUP OF
ROBOTICS & AI

01416518
INDUSTRIAL AUTOMATION

FINAL PROJECT

INSTRUCTED BY:
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DATE OF SUB.:6/11/2024

Abstract

This project presents the development of an automated joining station designed to enhance precision and efficiency in industrial assembly processes. Inspired by Festo's automation systems, the station incorporates sensors, actuators, and intelligent control mechanisms to streamline the alignment and joining of components. By automating these tasks, the station reduces the need for manual intervention, improving safety and minimizing human error in industries such as automotive and electronics manufacturing. Initial tests indicate a substantial reduction in assembly time and error rates, with enhanced production consistency and overall product quality. This automated station demonstrates the potential for advanced automation to transform traditional manufacturing processes by increasing productivity, reducing costs, and improving workplace safety.

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Chapter 1- Introduction

In today's competitive industrial landscape, manufacturers face increasing pressure to optimize production efficiency, reduce costs, and enhance product quality. Automation has become a critical solution in achieving these goals, allowing industries to transition from labor-intensive manual processes to highly efficient, precise, and consistent production methods. This project explores the development of an automated joining station, inspired by the cutting-edge automation technology of Festo. The station is designed to perform complex joining tasks autonomously, eliminating the need for extensive manual labor and reducing the potential for human error.

The joining process is an essential stage in manufacturing, particularly in industries like automotive and electronics, where precision and reliability are paramount. Even slight misalignments in joining operations can lead to product defects, which may compromise safety or lead to costly rework. Traditional manual joining processes are also prone to variability, which can impact product quality and slow down production. The automated joining station developed in this project seeks to address these issues by combining sensors, actuators, and control systems to achieve high accuracy in aligning and joining parts, with minimal operator involvement.

The objectives of this project are twofold: to enhance production speed and consistency while also improving safety in the workplace. By delegating repetitive and physically demanding tasks to machines, the automated station reduces the risk of worker injuries, particularly in hazardous environments where manual joining can pose significant risks. Additionally, the station's intelligent control algorithms ensure that each joining operation is completed with precision, minimizing defects and increasing overall efficiency.

This document provides an overview of the design, implementation, and testing phases of the automated joining station. The following sections will detail the components and technologies used in the system, the methods employed to achieve optimal joining accuracy, and an evaluation of the system's performance. The findings of this project illustrate the benefits of integrating advanced automation into assembly lines, demonstrating how technology can enhance both productivity and safety in modern manufacturing environments.

Chapter 2

Components Table

Electrical & Pneumatic

#	RAI Serial	Mechanical Electrical Pneumatic	Type	Description / Component	MFG Name	MFG Part Number	Q'ty (per m/c)	Price / Unit (BAHT)	Total Price (BAHT)
1	RAI-GX-E-001	Pneumatic	COML	Air Slide Table	SMC	MXS6-75ASF	2	650	1300
2	RAI-GX-E-002	Pneumatic	COML	compact cylinder	SMC	CDQSB12-10S	2	250	500
3	RAI-GX-E-003	Electrical	COML	power supply	conder	GPC225-24	1	900	900
4	RAI-GX-E-004	Electrical	sensor	Reed switch	SMC	D-F8N	8	100	800
5	RAI-GX-E-005	Electrical	sensor	Photoelectronic Sensor	SMC	PZ-M31	2	550	1100
6	RAI-GX-E-006	Pneumatic	COML	Vacuum Ejector	SMC	ZK2B10R5NL 3-06-J	1	900	900
7	RAI-GX-E-007	Electrical	sensor	Pressure sensor	SMC	ZSE30AF-C6 H-N-M	1	500	500
8	RAI-GX-E-008	Electrical	Motor	Motor gear 24VDC 80RPM	Sangtawan	ZGA372	2	270	540
9	RAI-GX-E-009	Electrical	COML	Relay with Socket	Omron	MY4N	5	150	750
10	RAI-GX-E-010	Electrical	sensor	Photo Sensor	SUNX	SUNX EX-11EP	4	0	0
11	RAI-GX-E-011	Electrical	COML	Fuse	Shinohawa	RT14-20	1	0	0
12	RAI-GX-E-012	Electrical	HMI	HMI	samkoon	AK-070AW	1	0	0
13	RAI-GX-E-013	Electrical	Button	Automation and Safety Emergency Stop Switches	Omron	A22-01	1	0	0
14	RAI-GX-E-014	Electrical	COML	Magnetic Contactor	Mitsubishi	SD-Q11	1	0	0
15	RAI-GX-E-015	Electrical	PLC	PLC	Mitsubishi	fx3u-24mr-6A D2DA	1	0	0
16	RAI-GX-E-016	Electrical	Button	Push Button Switch	idec	yw-de	2	0	0
17	RAI-GX-E-017	Electrical	COML	Solenoid Valve	SMC	VQ1100-51	2	0	0
18	RAI-GX-E-018	Electrical	COML	Solenoid Valve	SMC	VQ1200-51	7	0	0
19	RAI-GX-E-019	Electrical	COML	Solenoid Valve	SMC	VQ1400-51	1	0	0
20	RAI-GX-E-020	Electrical	COML	Safety Relay Module	Schneider	0smc32n1d20	1	0	0
21	RAI-GX-E-021	Electrical	COML	Fuse Holder	Shinohawa	RT18-32A	1	0	0
22	RAI-GX-E-022	Electrical	COML	Light Curtain	Mirco-scree n	USDINT-1T2	1	0	0

Mechanical

#	RAI Serial	Mechanical Electrical Pneumatic	Type	Description / Component	MFG Name	MFG Part Number	Q'ty (per m/c)	Price / Unit (BAHT)	Total Price (BAHT)
1	RAI-GX-M-001	Mechanical	COML	vacuum pad	SMC	ZPR16 VN-06-B5	1	350	350
2	RAI-GX-M-008	Mechanical	COML	Conveyor belt	S2	-	1	492.2	492.2
3	RAI-GX-M-002	Mechanical	COML	Aluminum Profile 30x60mm, 245 mm Length	AIC	AAZ-36	1	94.33	94.33
4	RAI-GX-M-003	Mechanical	COML	Aluminum Profile 30x60mm, 350 mm Length	AIC	AAZ-36	2	134.75	269.5
5	RAI-GX-M-004	Mechanical	COML	Hard Bracket 30x60mm	AIC	BAC-36	1	95	95
6	RAI-GX-M-024	Mechanical	COML	Slide Nut 30mm M8	AIC	BBA-38		0	0
7	RAI-GX-M-025	Mechanical	COML	Slide Nut 30mm M6	AIC	BBA-36		0	0
8	RAI-GX-M-026	Mechanical	COML	Slide Nut 30mm M5	AIC	BBA-35		0	0
9	RAI-GX-M-005	Mechanical	COML	Timing Pulley 2GT 40 teeth width 10mm hole 8mm	AIC	-	2	75	150
10	RAI-GX-M-006	Mechanical	COML	Timing Pulley 2GT 40 teeths width 10mm hole 5mm	AIC	-	2	70	140
11	RAI-GX-M-007	Mechanical	COML	Timing Belt 2GT	AIC	-	2	35	70
12	RAI-GX-M-027	Mechanical	COML	T-Nut M4	AIC	-	15	3	45
13	RAI-GX-M-028	Mechanical	COML	T-Nut M5	AIC	-	15	3	45
14	RAI-GX-M-029	Mechanical	COML	T-Nut M6	AIC	-	15	3	45
15	RAI-GX-M-009	Mechanical	COML	Linear Shaft D8, 100mm	AIC	-	2	55	110
16	RAI-GX-M-010	Mechanical	COML	Wiring Duct H20*W20 mm	SCG	-	1	94.32	94.32
17	RAI-GX-M-011	Mechanical	COML	Wiring Duct H30*W30 mm	SCG	-	2	134.75	269.5

#	RAI Serial	Mechanical Electrical Pneumatic	Type	Description / Component	MFG Name	MFG Part Number	Q'ty (per m/c)	Price / Unit (BAHT)	Total Price (BAHT)
18	RAI-GX-M-012	Mechanical	COML	Spiral Wrapping Band 10 mm	ELEKTRA	-	1	79	79
19	RAI-GX-M-013	Mechanical	COML	M8x10	Mahatara	-		0	0
20	RAI-GX-M-014	Mechanical	COML	M8x15	Mahatara	-		0	0
21	RAI-GX-M-015	Mechanical	COML	M6 x 10	Mahatara	-		0	0
22	RAI-GX-M-016	Mechanical	COML	M6 x 15	Mahatara	-		0	0
23	RAI-GX-M-017	Mechanical	COML	M5 x 10	Mahatara	-		0	0
24	RAI-GX-M-018	Mechanical	COML	M5 x 15	Mahatara	-		0	0
25	RAI-GX-M-019	Mechanical	COML	M4 x 10	Mahatara	-		0	0
26	RAI-GX-M-020	Mechanical	COML	M4 x 15	Mahatara	-		0	0
27	RAI-GX-M-021	Mechanical	COML	M3 x 10	Mahatara	-		0	0
28	RAI-GX-M-022	Mechanical	COML	M3 x 15	Mahatara	-		0	0
29	RAI-GX-M-023	Mechanical	COML	M3 x 70	Mahatara	-		0	0

Program Workflow

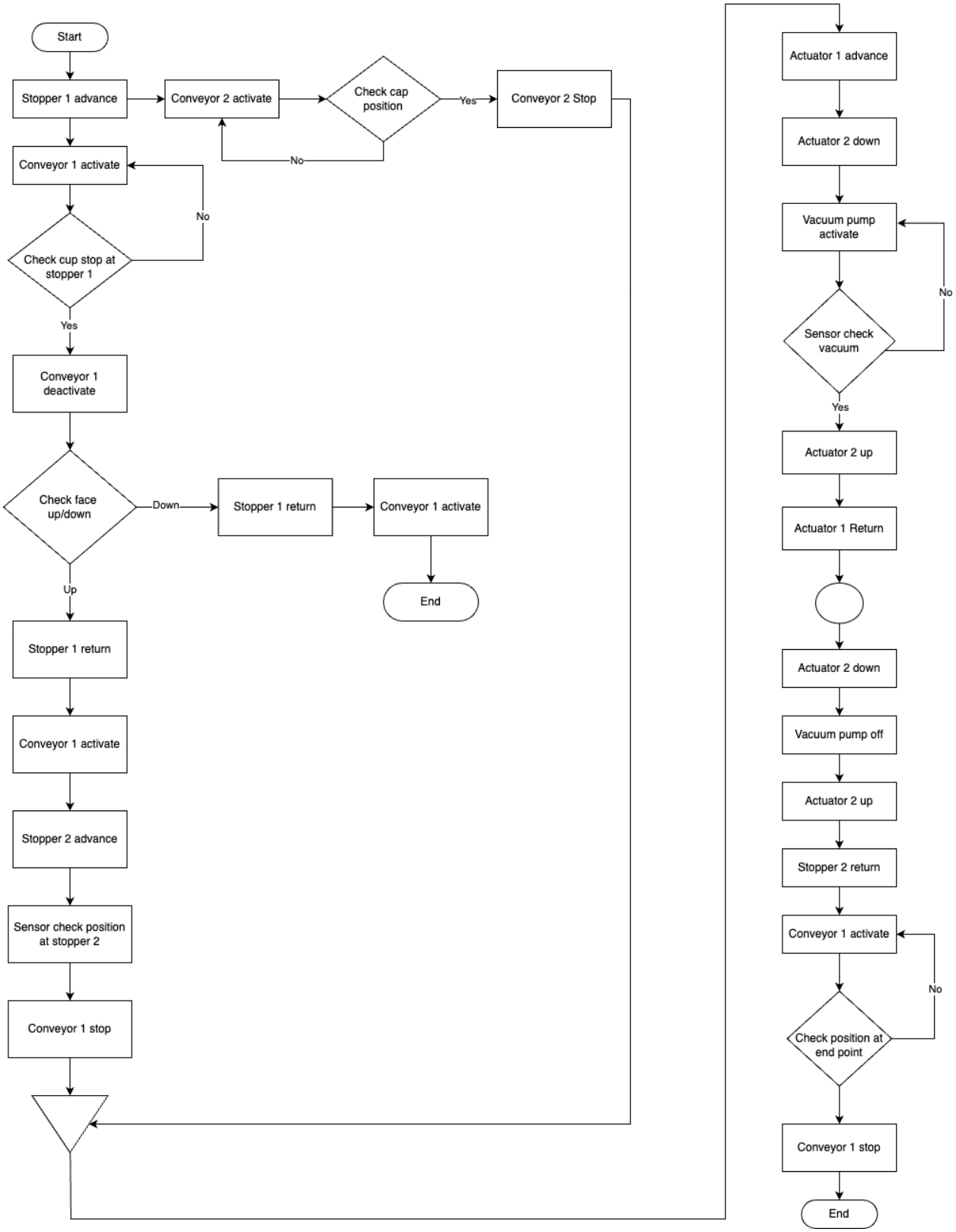
PLC - Inputs/Outputs Table

	ADDRESS	DESCRIPTION		ADDRESS	DESCRIPTION
	X0	RTN.SLIDE		Y0	BELT A
	X1	ADV.SLIDE		Y1	BELT B
	X2	RTN.UP		Y2	VACUUM -ON
	X3	ADV.DOWN		Y3	
	X4	RTN.STOPPER AT VACUUM		Y4	SOL STOPPER AT VACUUM
	X5	ADV.STOPPER AT VACUUM		Y5	SOL STOPPER AT CHECKER
INPUT	X6	RTN.STOPPER AT CHECKER	**OUTPUT**	Y6	SOL SLIDE RTN
	X7	ADV.STOPPER AT CHECKER		Y7	SOL SLIDE ADV
	X10	SUCTION CUPS FACING DOWN OR UP		Y10	SOL UP
	X11	SUCTION CUPS AT VACUUM		Y11	SOL DOWN
	X12	PRESSURE SENSOR			
	X13	CAP AT THE END			
	X14	CUP AT THE START			
	X15	CUP AT THE END			

HMI - Inputs/Outputs Table

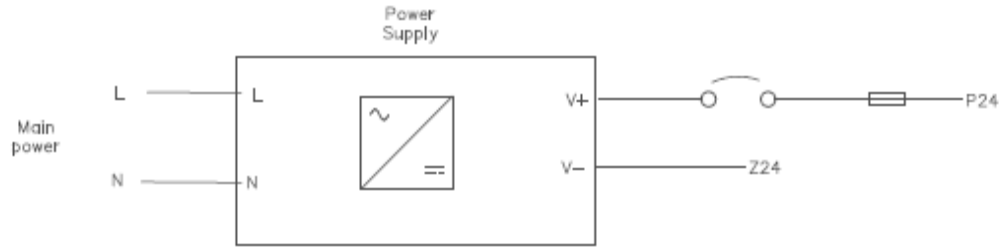
	ADDRESS	DESCRIPTION		ADDRESS	DESCRIPTION
INDICATOR	M2000	RTN.SLIDE	**MANUAL BUTTON**	M1001	BELT A
	M2001	ADV.SLIDE		M1002	BELT B
	M2002	RTN.UP		M1003	VACUUM -ON / OFF
	M2003	ADV.DOWN		M1004	SOL STOPPER AT VACUUM
	M2004	RTN.STOPPER AT VACUUM		M1005	SOL STOPPER AT CHECKER
	M2005	ADV.STOPPER AT VACUUM		M1006	SOL SLIDE ADV
	M2006	RTN.STOPPER AT CHECKER		M1007	SOL DOWN
	M2007	ADV.STOPPER AT CHECKER		M1000	ON / OFF
	M2008	SUCTION CUPS FACING DOWN OR UP			
	M2009	SUCTION CUPS AT VACUUM			
	M2010	PRESSURE SENSOR			
	M2011	CAP AT THE END			
	M2012	CUP AT THE START			
	M2013	CUP AT THE END			
AUTO BUTTON	M2020	ON			
	M2021	RESET			
	M2022	EM STOP			

Flowchart

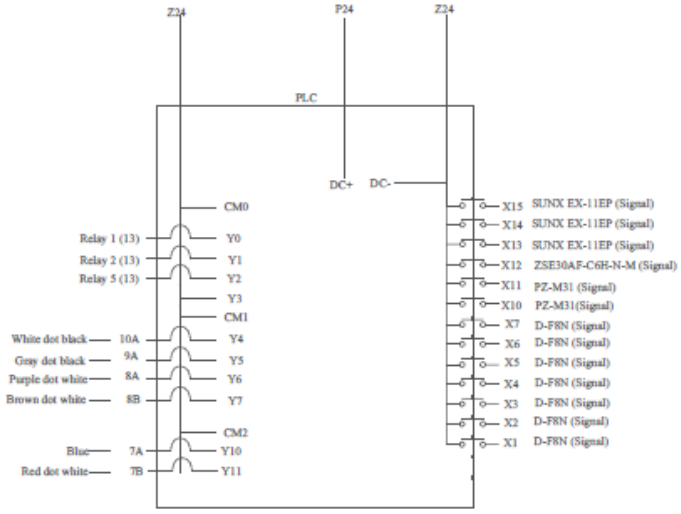

Start
Stopper 1 advance
Conveyor 2 activate
Check cap position
Yes
Conveyor 2 Stop
No
Conveyor 1 activate
No
Check cup stop at stopper 1
Yes
Conveyor 1 deactivate
Check face up/down
Down
Stopper 1 return
Conveyor 1 activate
End
Up
Stopper 1 return
Conveyor 1 activate
Stopper 2 advance
Sensor check position at stopper 2
Conveyor 1 stop
Actuator 1 advance
Actuator 2 down
Vacuum pump activate
No
Sensor check vacuum
Yes
Actuator 2 up
Actuator 1 Return
Actuator 2 down
Vacuum pump off
Actuator 2 up
Stopper 2 return
Conveyor 1 activate
No
Check position at end point
Conveyor 1 stop
End

Electrical Design

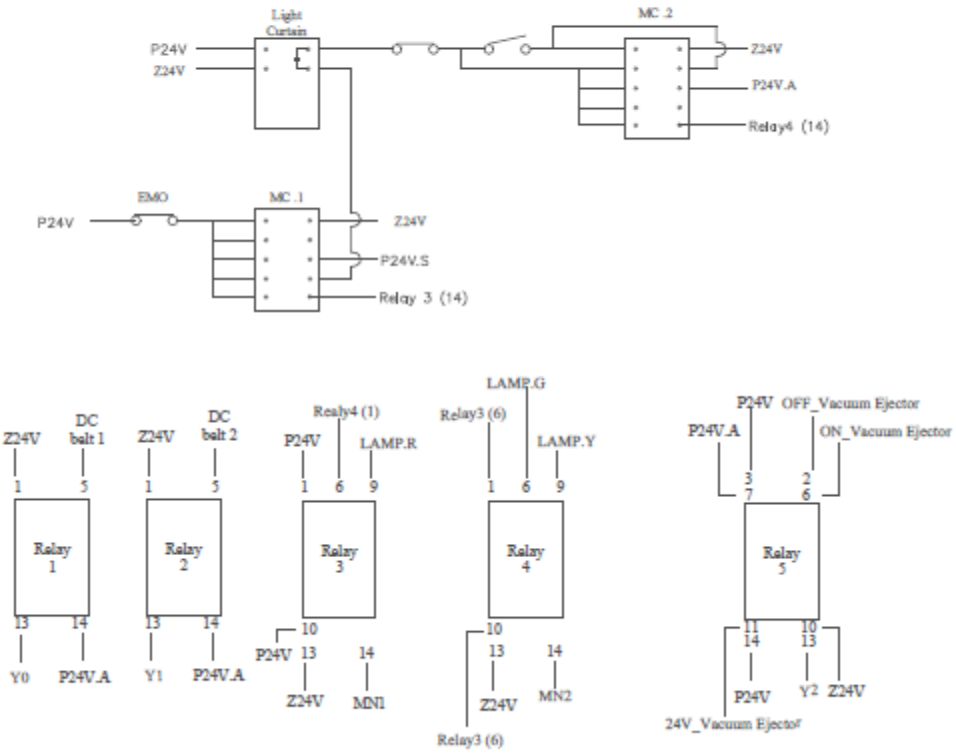
Wiring Diagram



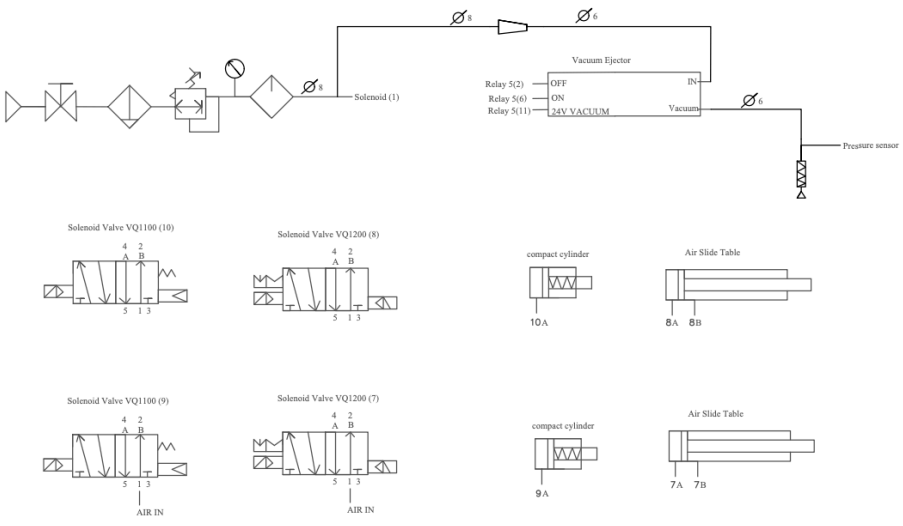
Main Power Diagram



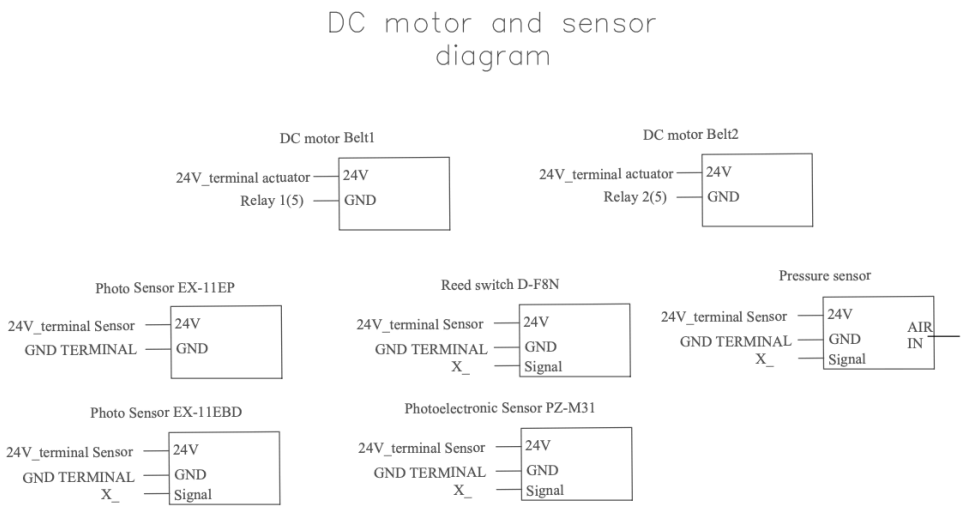
PLC Diagram



Relay, Magnetic Contactor, and Light Curtain Diagram



Pneumatic Diagram

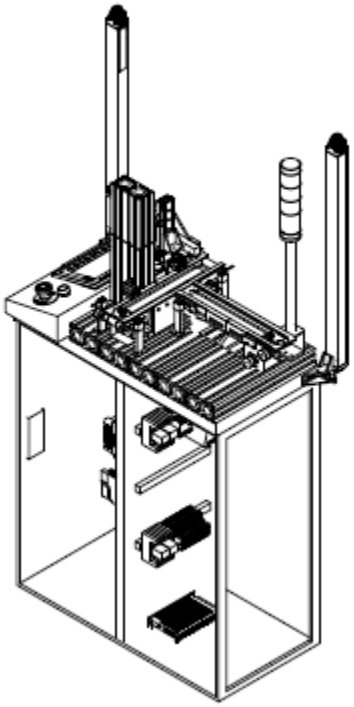


DC Motor and Sensor Diagram

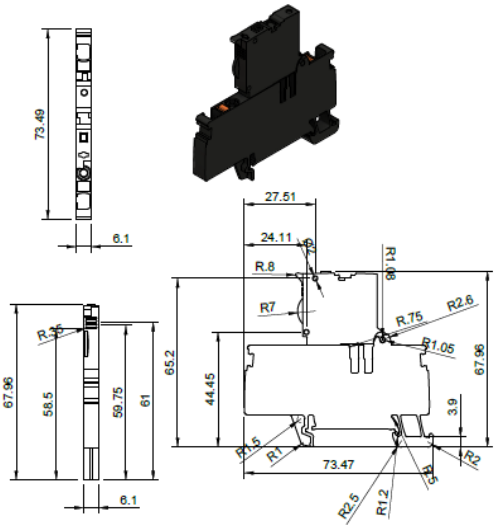
Load calculation

Component	MFG Name	Part Number	no.	Volt	Amp	With 25%	Watt
Reed switch	SMC	D-F8N	8	24V	0.00A	0.00A	0.03W
Photoelectric Sensor	SMC	PZ-M31	2	24V	0.00A	0.00A	0.09W
Pressure sensor	SMC	ZSE30AF-C6 H-N-M	1	24V	0.01A	0.01A	0.24W
Motor gear 24VDC 80RPM	Sangtawan	ZGA372	2	24V	0.06A	0.08A	1.88W
Relay with Socket	Omron	MY4N	5	24V	0.04A	0.05A	1.13W
Photo Sensor	SUNX	SUNX EX-11EP	4	24V	0.03A	0.04A	0.90W
HMI	samkoon	AK-070AW	1	24V	0.25A	0.31A	7.50W
Magnetic Contactor	Mitsubishi	SD-Q11	2	24V	1.10A	1.38A	33.00W
PLC	Mitsubishi	fx3u-24mr-6 AD2DA	1	24V	0.17A	0.21A	5.00W
Solenoid Valve	SMC	VQ1100-51	2	24V	0.04A	0.05A	1.25W
Solenoid Valve	SMC	VQ1200-51	2	24V	0.04A	0.05A	1.25W
Light Curtain	Mirco-scree n	USDINT-1T2	1	24v	1.50A	1.88A	45.00W
Tower Lamp	Patlite	LE-FB	1	24v	0.03A	0.03A	0.75W
SUM					3.27A	4.08A	98.02W

Mechanical Design



Complete Automation



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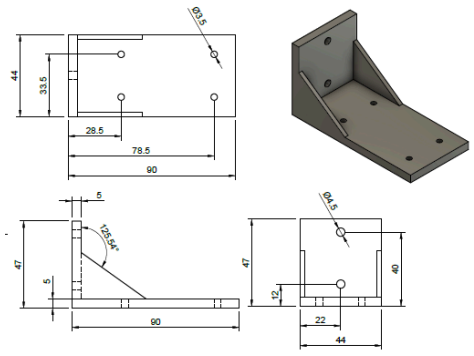
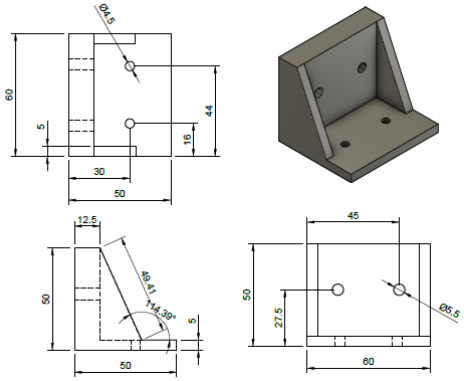
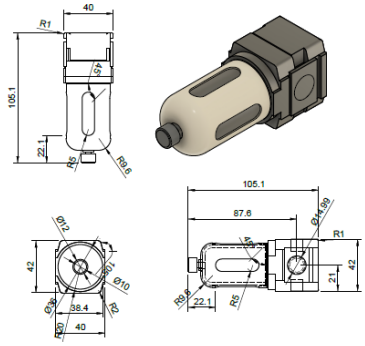


Actuator - Actuator Holder



Actuator - Profile Holder



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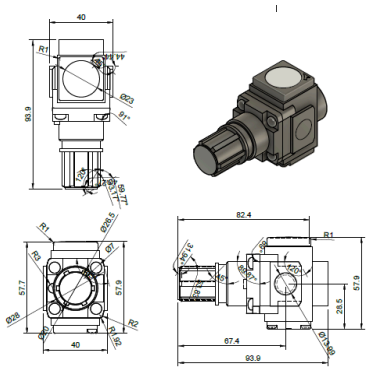

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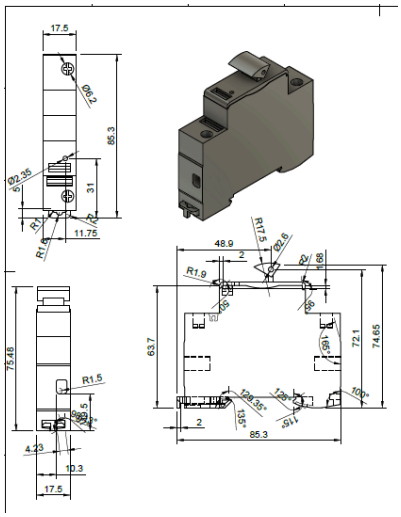
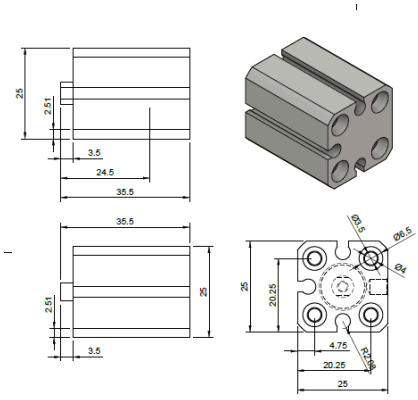


Breaker



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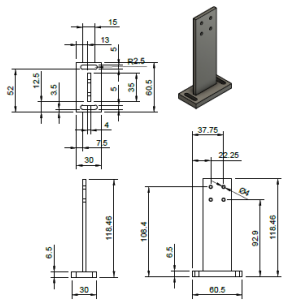
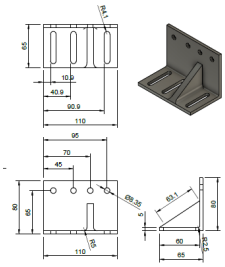
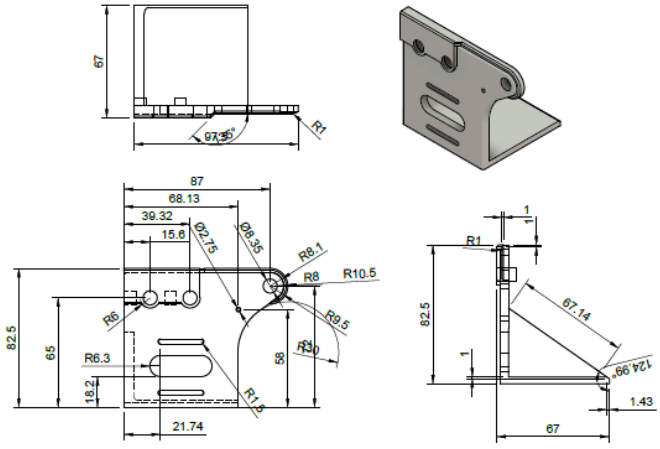


Compact Cylinder Holder



Conveyor Part



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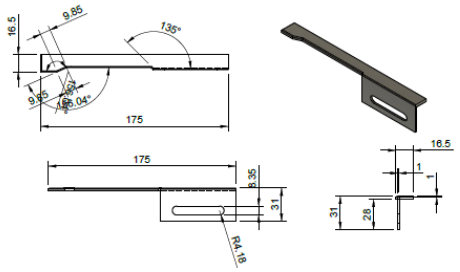

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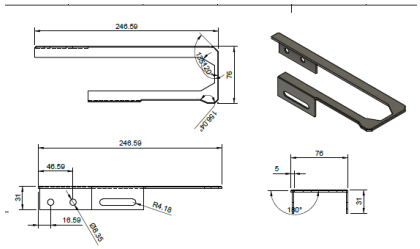

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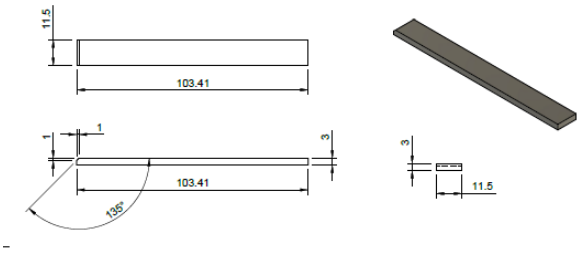

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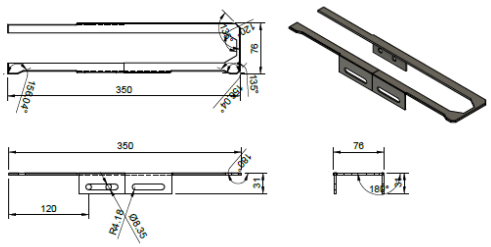

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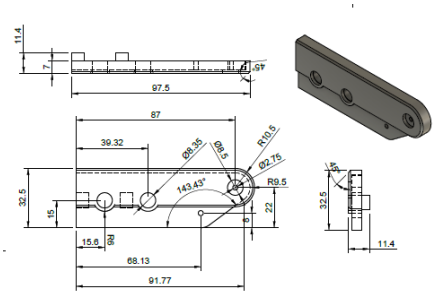

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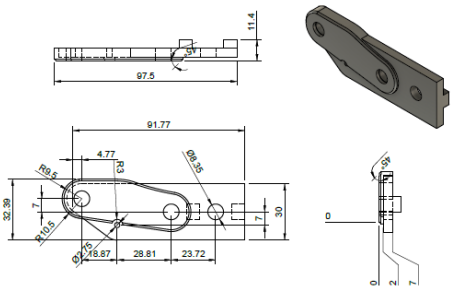

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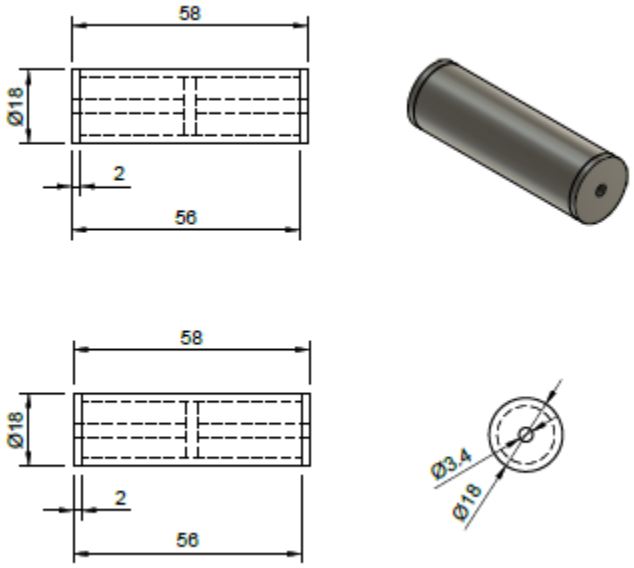

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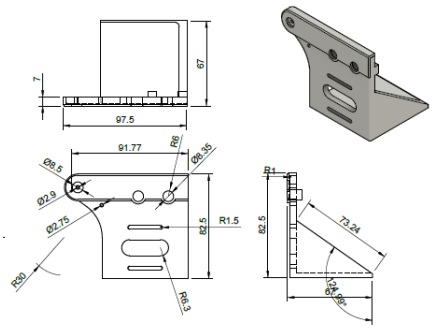

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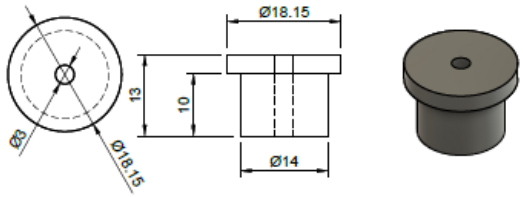

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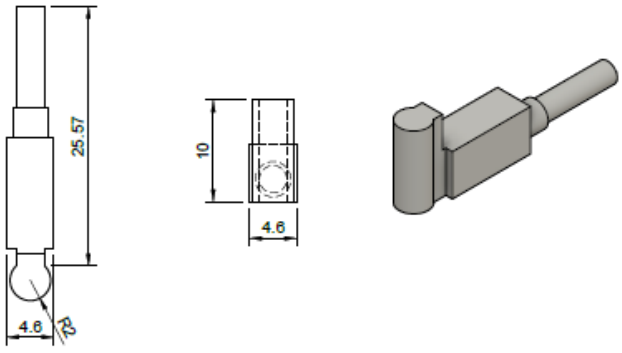

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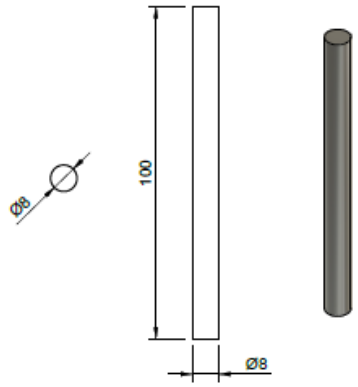
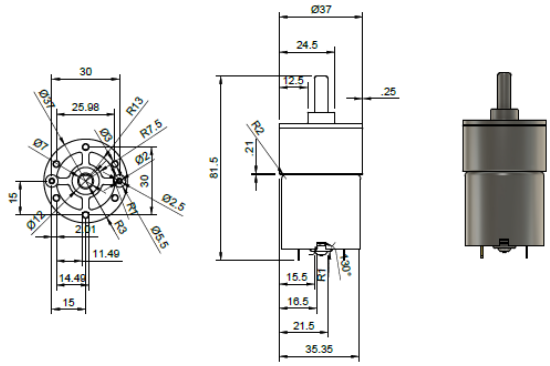
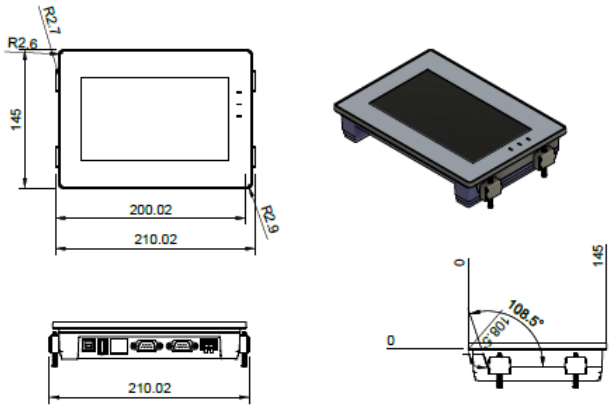


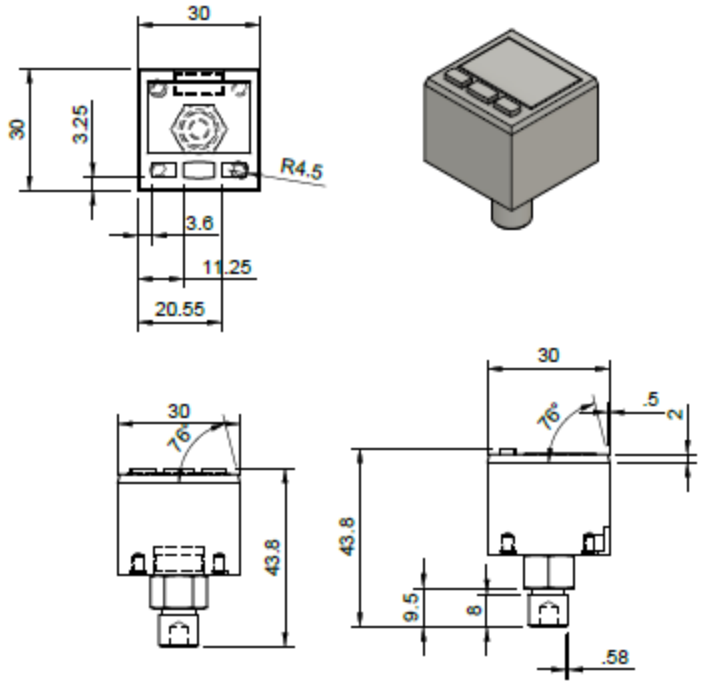
D8 Shaft 100mm



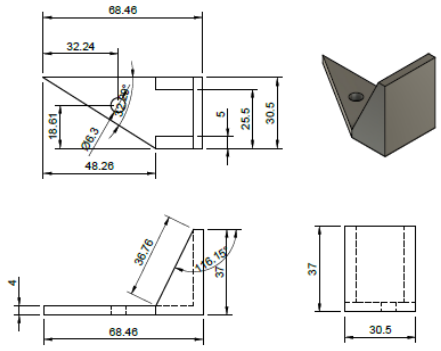
DC_Motor



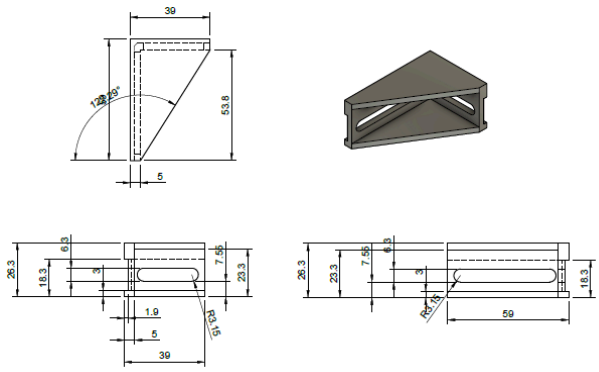
HMI



ISE30A-01-N-M(0)



Light Curtain Holder



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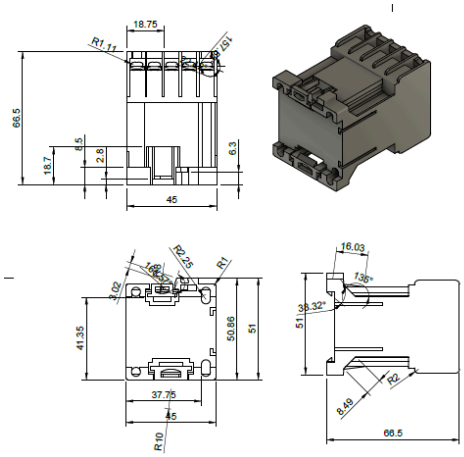
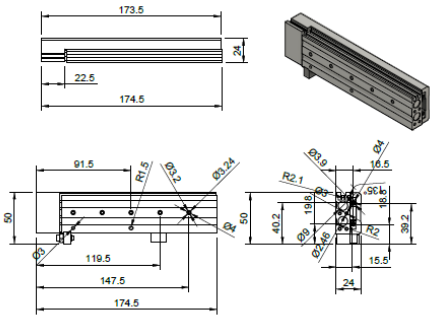


Magnetic contactor



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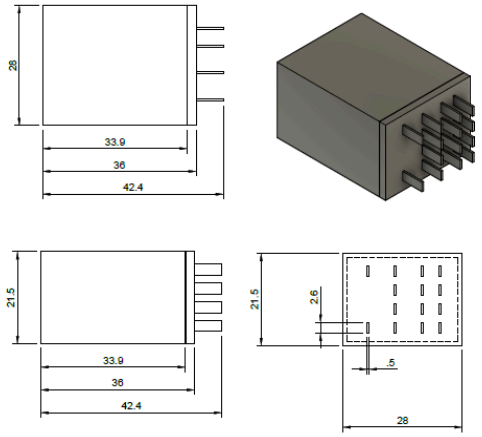


MY4N

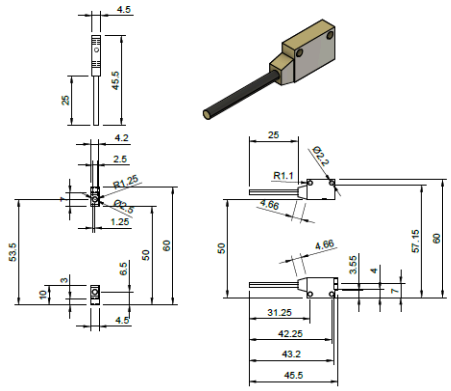
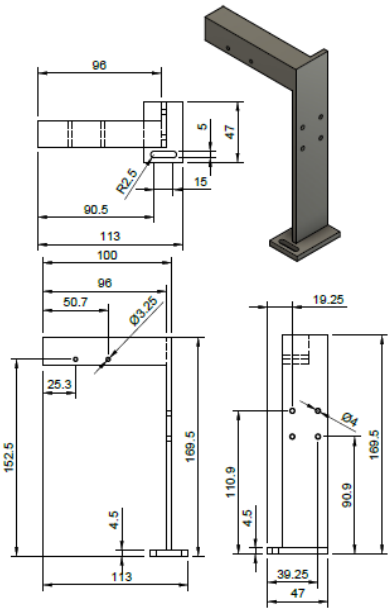
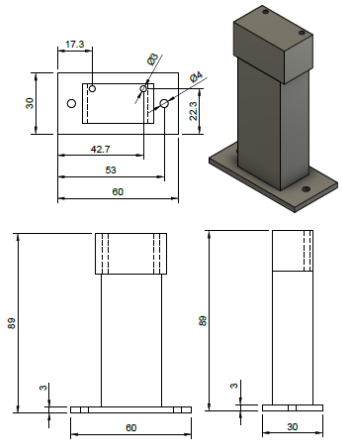


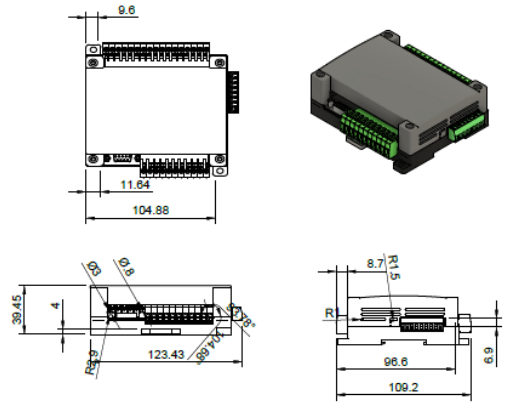
Photo Sensor



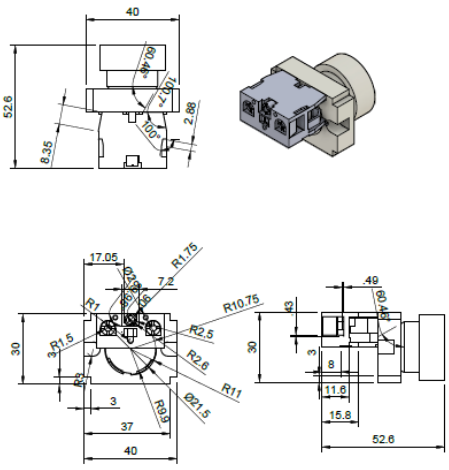
Photoelectric Sensor + Compact Cylinder Holder



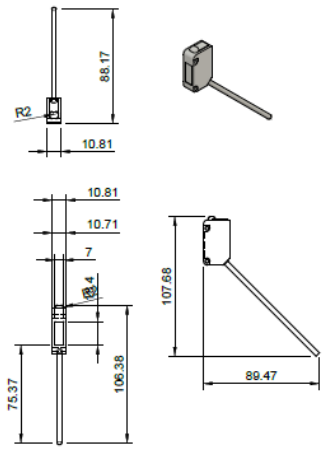
Photoelectric Sensor Holder



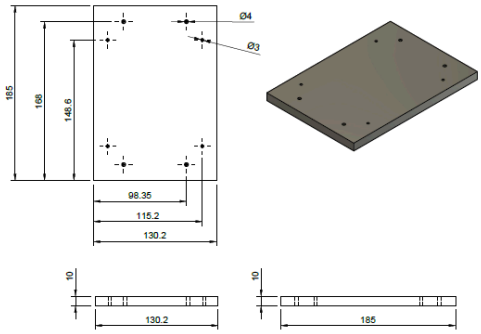
PLC



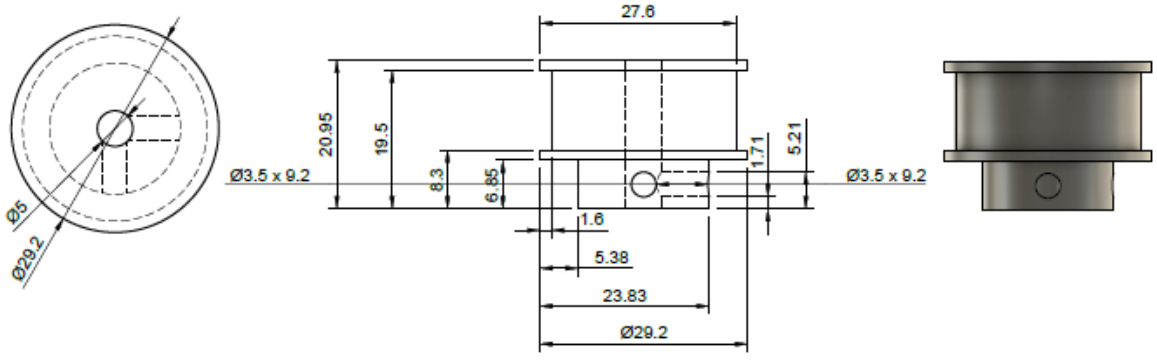
Push Button



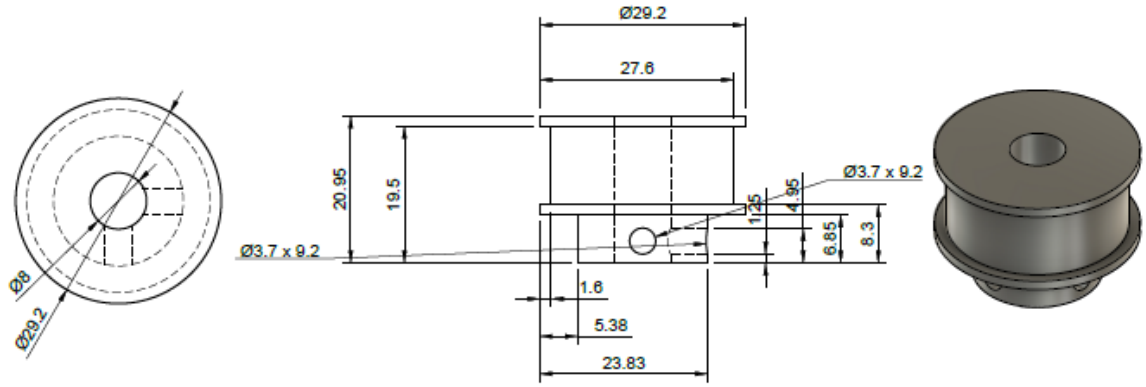
PZ-M11(P)_31(P)



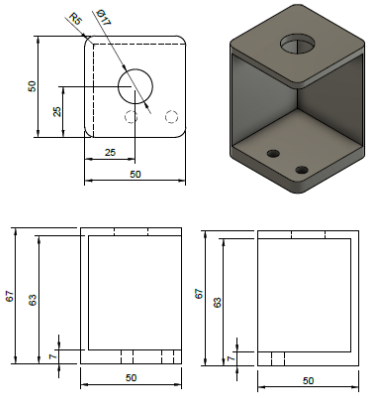
Solenoid Holder



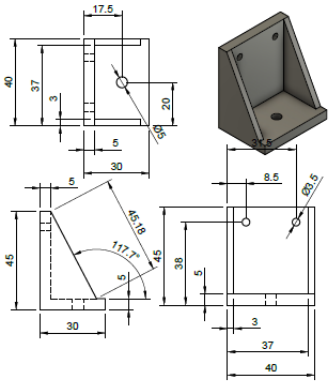
Timing Pulley 2GT 5mm Hole



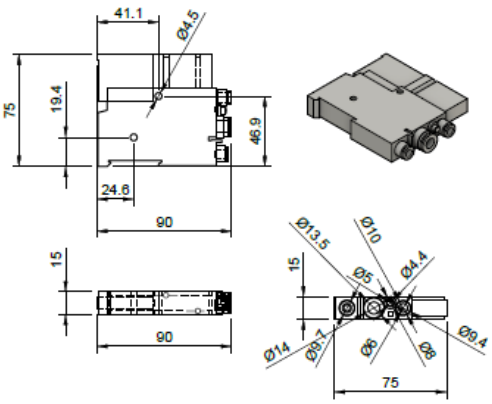
Timing Pulley 2GT 8mm Hole



Tower Lamp Holder



Vacuum Pad Holder



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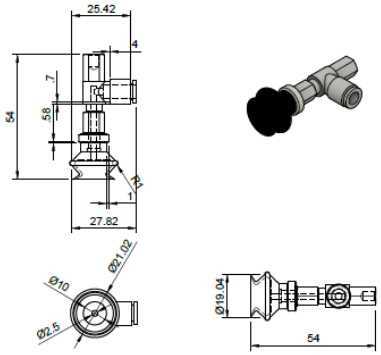

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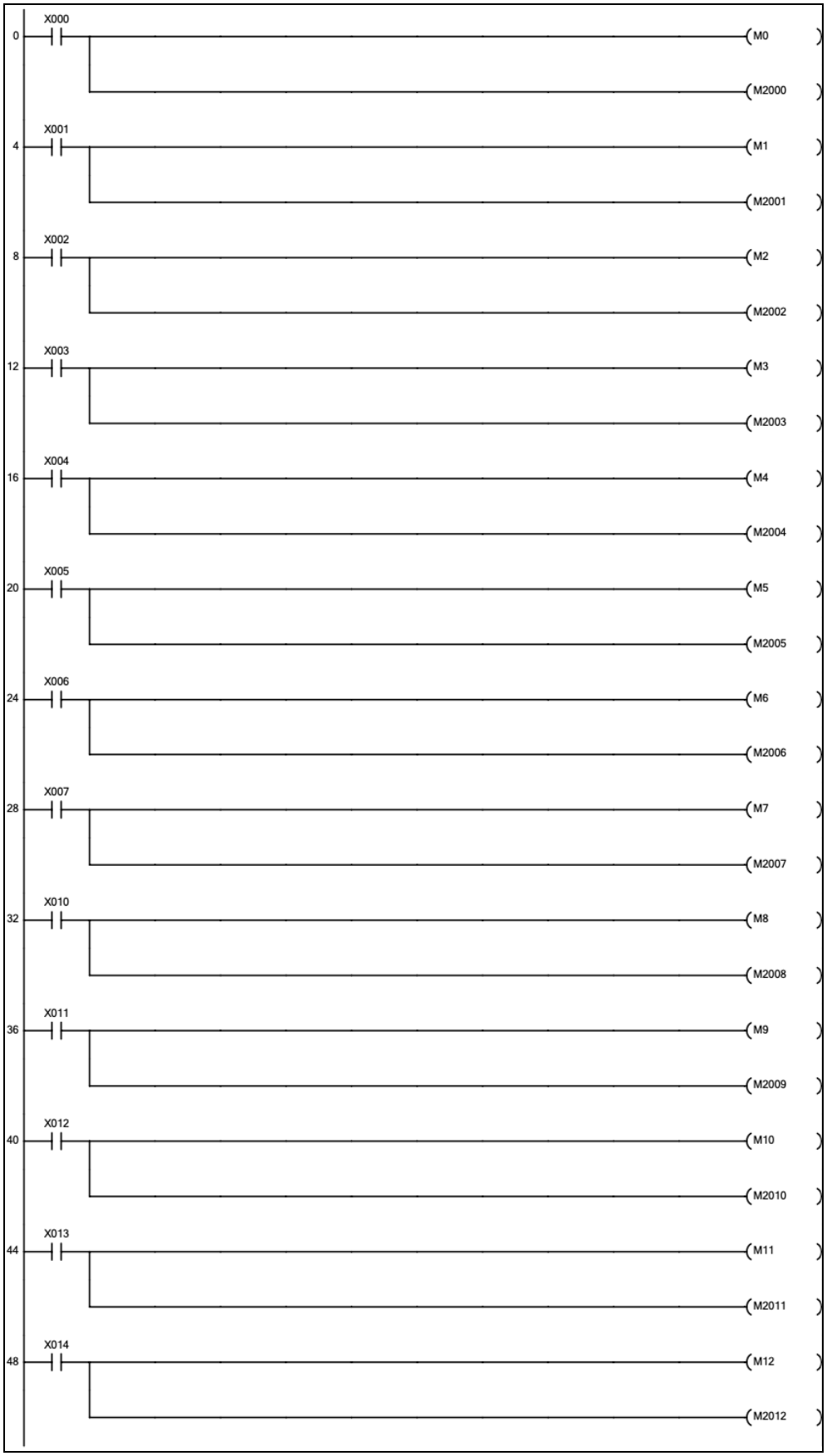
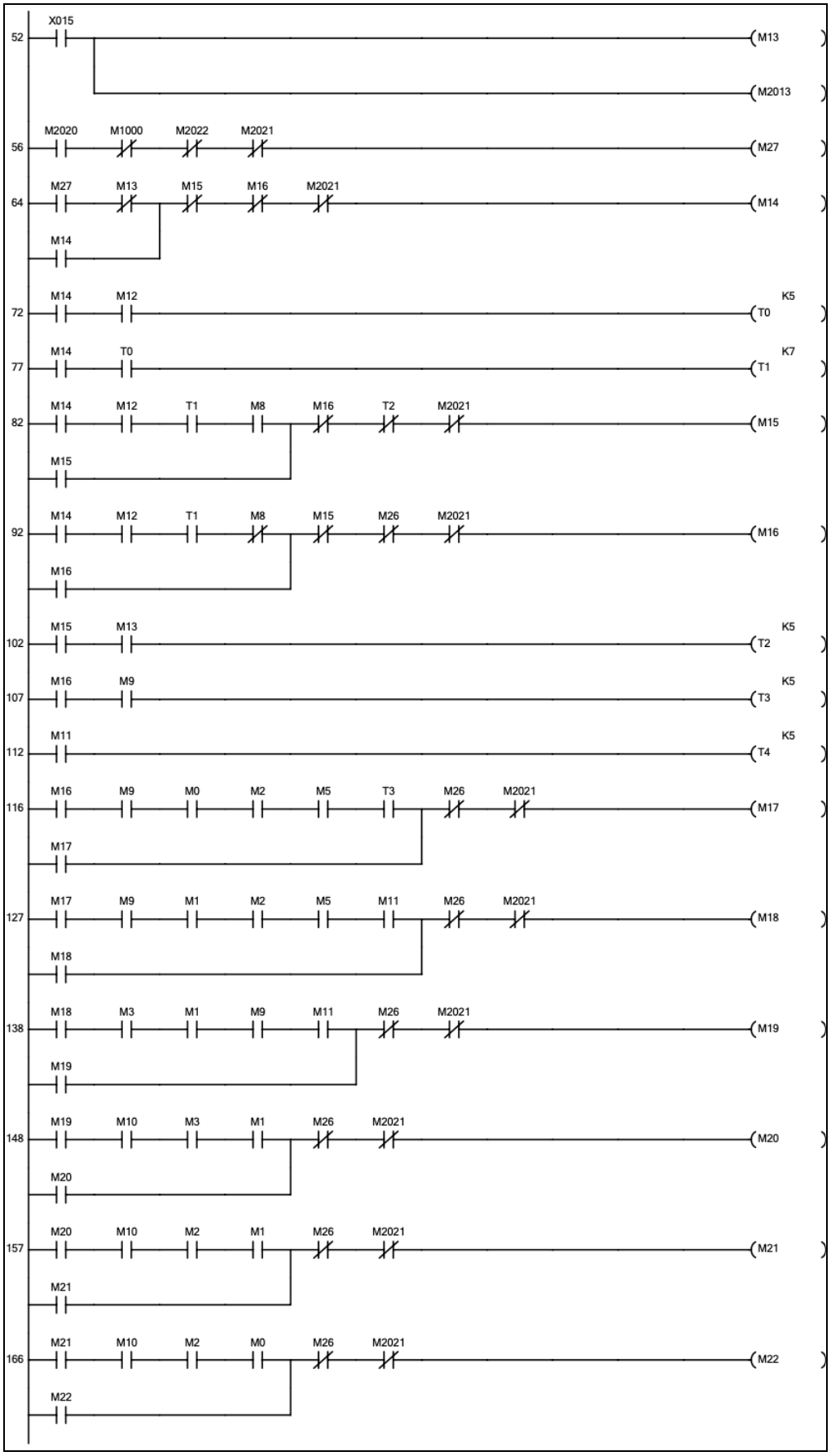
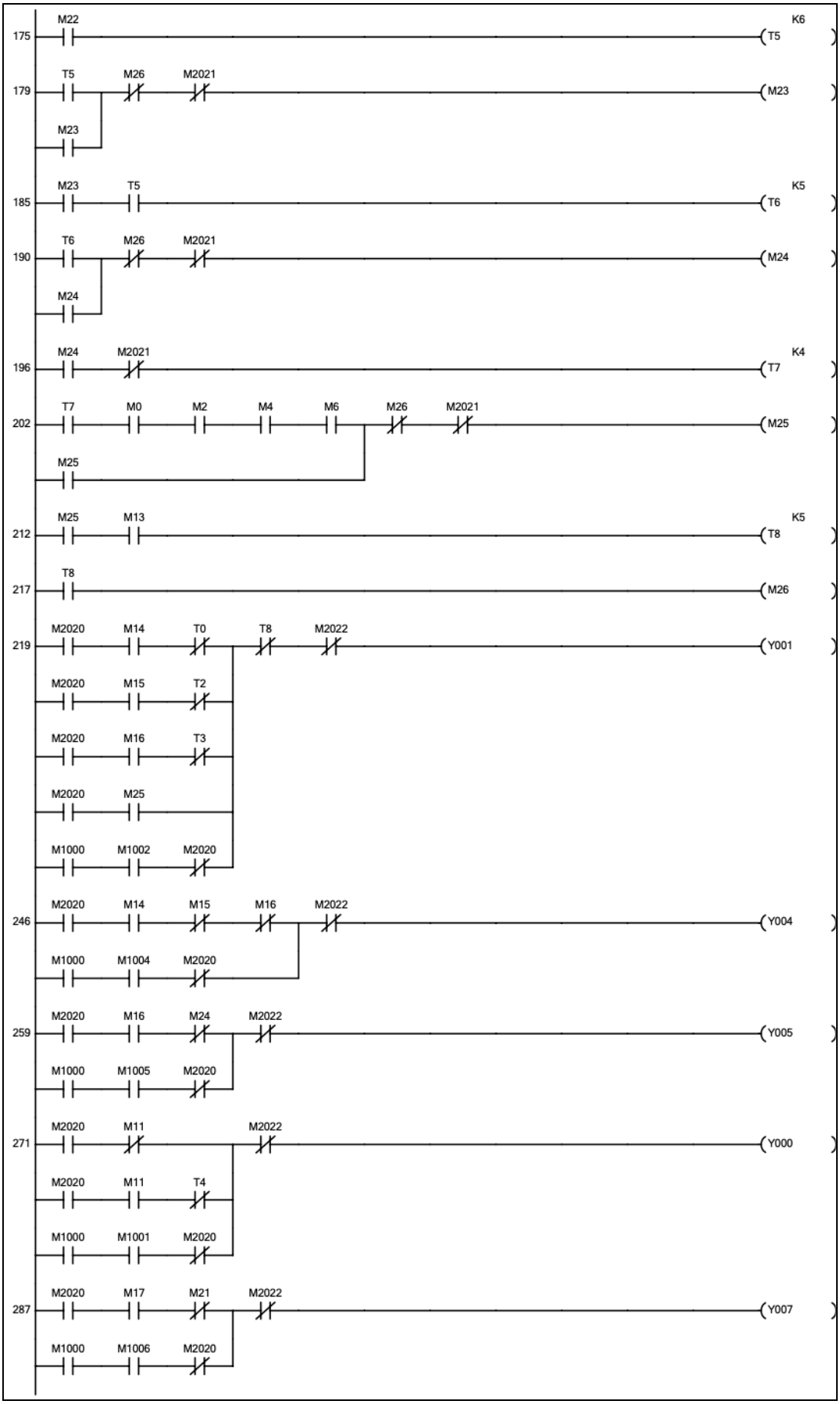
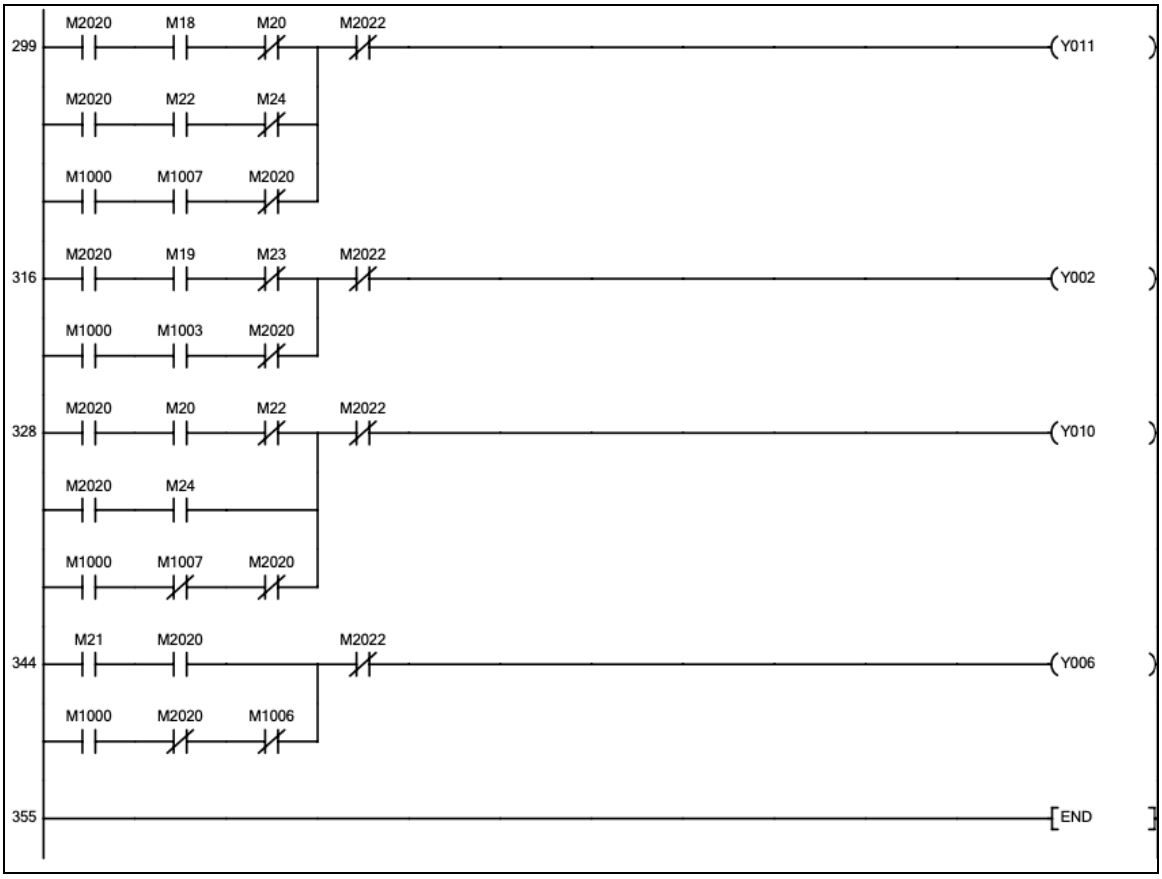
PLC ladder diagram




52 X015 M13 M2013
56 M2020 M1000 M2022 M2021 M27
64 M27 M13 M15 M16 M2021 M14 M14
72 M14 M12 K5 T0
77 M14 T0 K7 T1
82 M14 M12 T1 M8 M16 T2 M2021 M15 M15
92 M14 M12 T1 M8 M15 M26 M2021 M16 M16
102 M15 M13 K5 T2
107 M16 M9 K5 T3
112 M11 K5 T4
116 M16 M9 M0 M2 M5 T3 M26 M2021 M17 M17
127 M17 M9 M1 M2 M5 M11 M26 M2021 M18 M18
138 M18 M3 M1 M9 M11 M26 M2021 M19 M19
148 M19 M10 M3 M1 M26 M2021 M20 M20
157 M20 M10 M2 M1 M26 M2021 M21 M21
166 M21 M10 M2 M0 M26 M2021 M22 M22


175
M22
K6
T5
179
T5
M26
M2021
M23
M23
185
M23
T5
K5
T6
190
T6
M26
M2021
M24
M24
196
M24
M2021
K4
T7
202
T7
M0
M2
M4
M6
M26
M2021
M25
M25
212
M25
M13
K5
T8
217
T8
M26
219
M2020
M14
T0
T8
M2022
Y001
M2020
M15
T2
M2020
M16
T3
M2020
M25
M1000
M1002
M2020
246
M2020
M14
M15
M16
M2022
Y004
M1000
M1004
M2020
259
M2020
M16
M24
M2022
Y005
M1000
M1005
M2020
271
M2020
M11
M2022
Y000
M2020
M11
T4
M1000
M1001
M2020
287
M2020
M17
M21
M2022
Y007
M1000
M1006
M2020


299
M2020
M18
M20
M2022
Y011
M2020
M22
M24
M1000
M1007
M2020
316
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M19
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M2022
Y002
M1000
M1003
M2020
328
M2020
M20
M22
M2022
Y010
M2020
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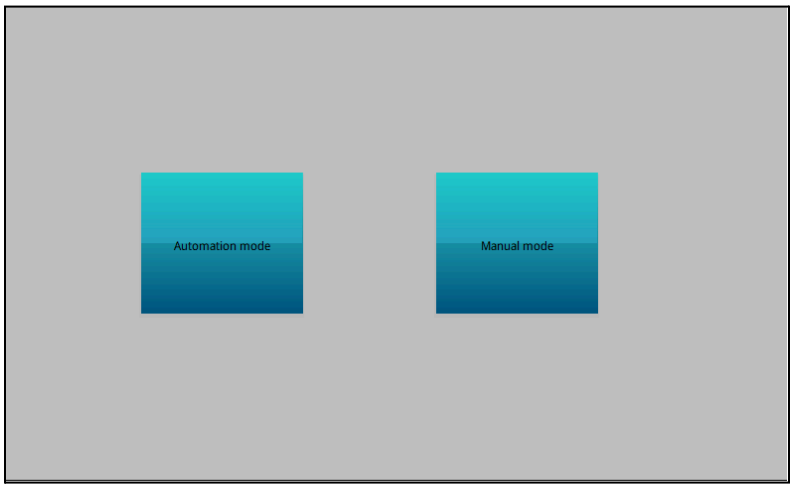
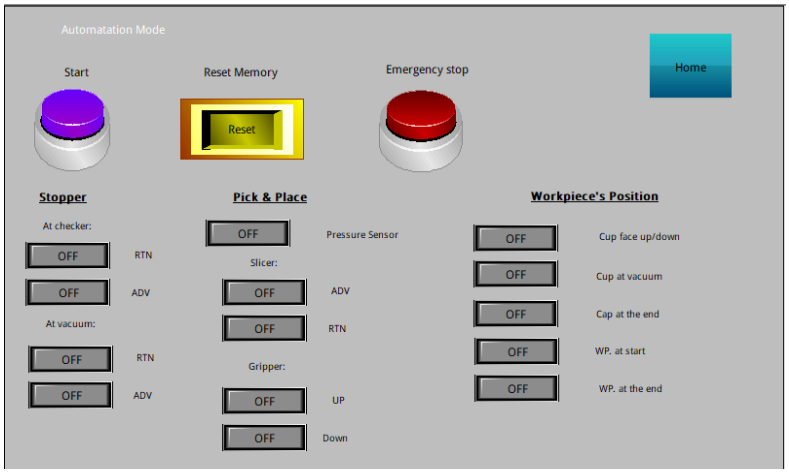
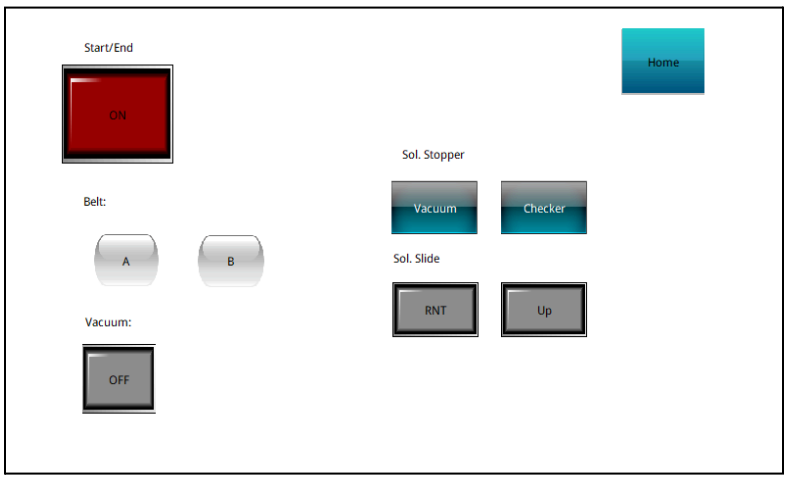
M2020
M2022
Y006
M1000
M2020
M1006
355
END

HMI Design


Automation mode
Manual mode


Automatation Mode
Start
Reset Memory
Reset
Emergency stop
Home
Stopper
At checker:
OFF
RTN
OFF
ADV
At vacuum:
OFF
RTN
OFF
ADV
Pick & Place
OFF
Pressure Sensor
Slicer:
OFF
ADV
OFF
RTN
Gripper:
OFF
UP
OFF
Down
Workpiece's Position
OFF
Cup face up/down
OFF
Cup at vacuum
OFF
Cap at the end
OFF
WP. at start
OFF
WP. at the end


Start/End
ON
Home
Sol. Stopper
Vacuum
Checker
Belt:
A
B
Sol. Slide
RNT
Up
Vacuum:
OFF

Chapter 3 - Experimental results

The design of the automated joining station posed a number of design problems. Accurate orientating and integration of parts necessitated precise calibration and testing because even the slightest variation from the standard could reduce the quality of assembly. It was also a concern to find the right sensors and actuators that would give the desired performance, while not breaking the bank. Furthermore, including mechanisms for real-time observation and troubleshooting added to the scope of complexity in the control mechanism. Another imposing task was being able to design control systems that would be both effective, efficient and able to cope with safety considerations, even in designs that allowed for very rapid transitions. It was comfortable addressing these aspects that it became possible to come up with a solution which was effective and reliable without variances.

Chapter 4 - Conclusion

The development of an automated joining station presented in this project demonstrates the potential of automation to transform traditional assembly processes. By leveraging advanced sensors, actuators, and control mechanisms, the system successfully automates the alignment and joining tasks that are critical in industries requiring high precision, such as automotive and electronics manufacturing. The integration of these technologies not only reduced assembly time and error rates but also enhanced product consistency and overall quality.

The project faced challenges, particularly in selecting components and calibrating the system to ensure precise operation. However, through careful design and iterative testing, the automated station achieved its objectives of increased productivity, reduced manual intervention, and improved workplace safety. The station's performance underscores the importance of automation in modern manufacturing, especially in environments where efficiency and reliability are paramount.

In conclusion, this automated joining station exemplifies the benefits of integrating intelligent automation into assembly lines. It supports a safer, faster, and more consistent production process, demonstrating the value of automation in meeting the demands of today’s industrial landscape. Future enhancements could focus on further improving the adaptability of the station, allowing it to be applied across a broader range of applications in various manufacturing sectors.

Chapter 5 - Team management

Name	Student ID	Work %	Workload	Signature
Varis	**65011619**	**95**	**All**	**Varis**
Akesit	**65110131**	**100**	**All**	**Akesit**
Kunlanith	**65110141**	**95**	**All**	**Kunlanith**
Rattapol	**65110149**	**95**	**All**	**Rattapol**
Saranya	**65110150**	**95**	**All**	**Saranya**

*Remark, All = Hardware, Software, Report, Slide presentation, 3d, Poster, Video
*Remark 2 special thank Noranont Surabote (Mahidol Salaya student) for take a video and entertain for us