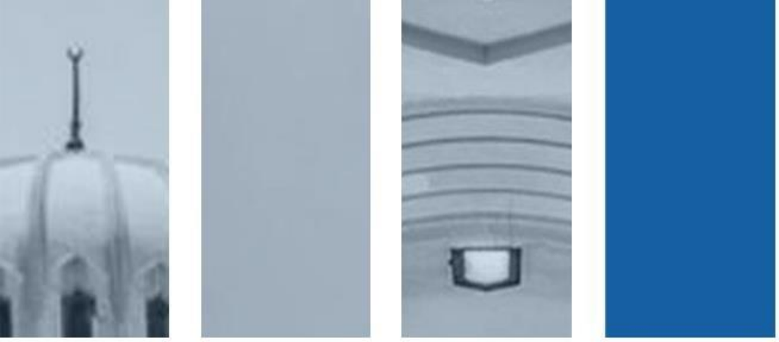

Automation Project #1 Documentation

Program:Senior-1 Mechatronics

Course Code: MCT332

Course Name: Industrial Automation

Examination Committee

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Fall Semester – 2021

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01

First Topic

Project Summary

We are practicing our knowledge in classic control . we will do this by designing our electrical control panel. Then, simulating our design for optimizing our results and pre-testing. After that, we will implement the final system .

We get more to know about classical control components and its characteristics (Rated and Instantaneous Conditions , optimal working parameters … etc.) such as :-

1. Circuit Breakers
2. Overload Relays
3. Electro-mechanical Relays
4. Contactors
5. Switches
6. Push buttons … etc.

It is about a conveyor

02

Second Topic

Contribution List

Name	Responsibility	
Ibrahim Nabil	-Design (50). -Purchase of components (25). Doc. Points 6 & 8	-Simulation (70). –Hardwired Diagram (70). -Docs preparation and Assembly.
Ahmed Abdelnaby Bakr	-Simulation (30). -Purchase of components (25). Doc. Points 1 & 4	–Implementation (50). –Hardwired Diagram (30). -Electrical wiring (50).
Kareem Elsayed	-Electrical wiring (25). -Purchase of components (25). Doc. Points 7	–Implementation (15). –Control panel planning (70). -Design (20).
Mahmoud Ashraf	-Design (30). -Purchase of components (25). Doc. Points 5 & 9	-Electrical wiring (25). -Implementation (35). -Control panel planning (30).

Topic (Percentage contributed)

03

Third Topic

List of Figures and Tables

List of Figures :-

Figure 1	**Dimensions of HIBD63-S Miniature Circuit Breaker**
Figure 2	Tripping B Curve
Figure 3	Relay Dimensions
Figure 4	Endurance Curve for relay
Figure 5	Switching Power for relay

List of tables :-

Table 1	**B & C curves Codes of HIBD63-S Miniature Circuit Breaker**
Table 2	Tripping Characteristics
Table 3	Temperature Derating
Table 4	Overall Characteristics for omron relays
Table 5	Coil Ratings for omron relays
Table 6	Contacts Ratings for omron relays
Table 7	Endurance ratings for omron relays

04

Fourth Topic

Acronym List

ABBREVIATION	DEFINITION
CR1	Coil relay and its contacts responsible for initializing the process
CR2	Coil relay &its contacts responsible for controlling conveyor
CR3	Coil relay &its contacts responsible for controlling Gate 2
CR4	Coil relay &its contacts responsible for controlling the closing conditions for CR2 & CR3
G1	The entry gate which allows the package to enter the conveyor
G2	The sterilization gate which allow the
LS1	Limit switch responsible for closing G1 & Starting Conveyor
LS2	Limit switch responsible for opening G2
LS3	Limit switch responsible for closing G2 & closing Conveyor

05

Fifth Topic

Introduction to Electrical Control Panels and Hardwired ladder diagrams

An electrical control panel is an enclosure, typically a *metal box* or *plastic molding* which contains important electrical components that control and monitor several mechanical processes. They are energized systems that require maintenance, with planned preventative maintenance and condition-based monitoring being the most effective methods. Electrical personnel will need to gain access within control panels for fault finding, adjustments, and electrical safety testing. Operators will interact with the controls of the panel to operate and control the plant and process. Components within the control panel will facilitate many tasks, for example, they may monitor pressure or flow within a pipe and signal to open or close a valve. They are commonplace and integral to most industries. Problems with them, including neglect, can cause havoc to any business operation and endanger employees. This makes the safe operation of panels a desirable skill for both electrical and non-electrical workers.

Different types of panels:-

Control panels come in many shapes and sizes. They range from a small box on a wall through to long rows of cabinets located in dedicated plant areas. Some controls are in a control room, under the supervision of a small team of production coordinators while others are placed close to machinery and are under the control of certain production operatives. Another form of control panel, common in the UK, is the Motor Control Centre or MCC, which includes all the motor starting and control equipment to drive heavy plant, and which may, in certain circumstances include high voltage supplies such as 3.3 kV and 11 kV.

06

Sixth Topic

Components used in Electrical Control Panel and their characteristics

Electrical control panel components:-

Some of the components of an electrical control panel include:

- Enclosures
- Incoming Protection and Switching
- Power and Energy Monitoring and Control
- Power Distribution Systems
- Circuit and Load Protection
- Thermal Management
- Motion and Drives
- Safety systems
- Programmers, timers and variable frequency drives
- Power Supplies and Transformers
- Power factor correction, surge protection and uninterruptable power supplies
- Relays and contactors

Enclosures:-

An enclosure is the body of an electrical control panel. It stores the components inside them and acts as a barrier between the hazards contained within and persons on the outside.

The size of an enclosure is also important. Smaller ones typically have higher device density, which pose a greater risk of overheating. With that said, companies don’t want to lose too much room space with a giant metal box either. When working with electrical control panels you should first understand what it is used for. This can then help you determine if there is inefficient wiring and wasted space.

Circuit breaker

In many cases the supply to a control panel will enter through a circuit breaker, although in some cases this may simply be a disconnecting device that offers no fault protection. The specific arrangements on your site will vary, but in many cases where this device is located within the control panel itself.

4.5kA, 2P	1A	HIBD63-S 2PMBS0000C 00001	HIBD63-S 2PMCS0000C 00001	60	MCB	M7
	2A	HIBD63-S 2PMBS0000C 00002	HIBD63-S 2PMCS0000C 00002			
	3A	HIBD63-S 2PMBS0000C 00003	HIBD63-S 2PMCS0000C 00003			
	4A	HIBD63-S 2PMBS0000C 00004	HIBD63-S 2PMCS0000C 00004			
	5A	HIBD63-S 2PMBS0000C 00005	HIBD63-S 2PMCS0000C 00005			
	6A	HIBD63-S 2PMBS0000C 00006	HIBD63-S 2PMCS0000C 00006			
	10A	HIBD63-S 2PMBS0000C 00010	HIBD63-S 2PMCS0000C 00010			
	13A	HIBD63-S 2PMBS0000C 00013	HIBD63-S 2PMCS0000C 00013			
	15A	HIBD63-S 2PMBS0000C 00015	HIBD63-S 2PMCS0000C 00015			
	16A	HIBD63-S 2PMBS0000C 00016	HIBD63-S 2PMCS0000C 00016			
	20A	HIBD63-S 2PMBS0000C 00020	HIBD63-S 2PMCS0000C 00020			
	25A	HIBD63-S 2PMBS0000C 00025	HIBD63-S 2PMCS0000C 00025			
	32A	HIBD63-S 2PMBS0000C 00032	HIBD63-S 2PMCS0000C 00032			
	40A	HIBD63-S 2PMBS0000C 00040	HIBD63-S 2PMCS0000C 00040			
	50A	HIBD63-S 2PMBS0000C 00050	HIBD63-S 2PMCS0000C 00050			
	63A	HIBD63-S 2PMBS0000C 00063	HIBD63-S 2PMCS0000C 00063			

Table 1

Curve	Rated current	Condition					
		Thermal release			Thermal release		
		Conventional		Tripping time	Holding current	Tripping current	Tripping time
		Non-tripping	Tripping				
B	6-63A	1.13×In		>1h	3×In		>0.1sec.
			1.45×In	<1h		5×In	<0.1sec.
C	0.5-63A	1.13×In		>1h	5×In		>0.1sec.
			1.45×In	<1h		10×In	<0.1sec.
D	0.5-63A	1.13×In		>1h	10×In		>0.1sec.
			1.45×In	<1h		20×In	<0.1sec.

Table 2

Rated current (A)	Correction factor for ambient temperature											
	-40℃	-30℃	-20℃	-10℃	0℃	10℃	20℃	30℃	40℃	50℃	60℃	70℃
1	1.33	1.29	1.25	1.2	1.15	1.11	1,05	1	0.94	0.88	0.82	0.75
2	2.67	2.58	2.49	2.4	2.31	2.21	2.11	2	1.89	1.76	1.63	1.49
3	4	3.9	3.7	3.6	3.5	3.3	3.2	3	2.8	2.6	2.4	2.2
4	5.3	5.2	5	4.8	4.6	4.4	4.2	4	3.8	3.5	3.3	3
5	6.7	6.5	6.31	6.1	5.8	5.5	5.25	5	4.7	4.3	4	3.7
6	8	7.7	7.5	7.2	6.9	6.6	6.3	6	5.7	5.3	4.9	4.5
10	13.3	12.9	12.5	12	11.5	11.1	10.5	10	9.4	8.8	8.2	7.5
13	17.3	16.8	16.2	15.6	15	14.4	13.7	13	12.3	11.5	10.6	9.7
15	19.5	18.7	18	17.4	16.7	16.1	15.6	15	14.2	13.1	12	11
16	21.3	20.7	20	19.2	18.5	17.7	16.9	16	15.1	14.1	13.1	11.9
20	26.7	25.8	24.9	24	23.1	22.1	21.1	20	18.9	17.6	16.3	14.9
25	33.3	32.3	31.2	30	28.9	27.6	26.4	25	23.6	22	20.4	18.6
32	42.7	41.3	39.9	38.5	37	35.4	33.7	32	30.2	28.2	26.1	23.9
40	53.3	51.6	49.9	48.1	46.2	44.2	42.2	40	37.7	35.3	32.7	29.8
50	66.7	64.5	62.4	60.1	57.7	55.3	52.7	50	47.1	44.1	40.8	37.3
63	84	81.3	78.6	75.7	72.7	69.6	66.4	63	59.4	55.6	51.4	47

Table 3

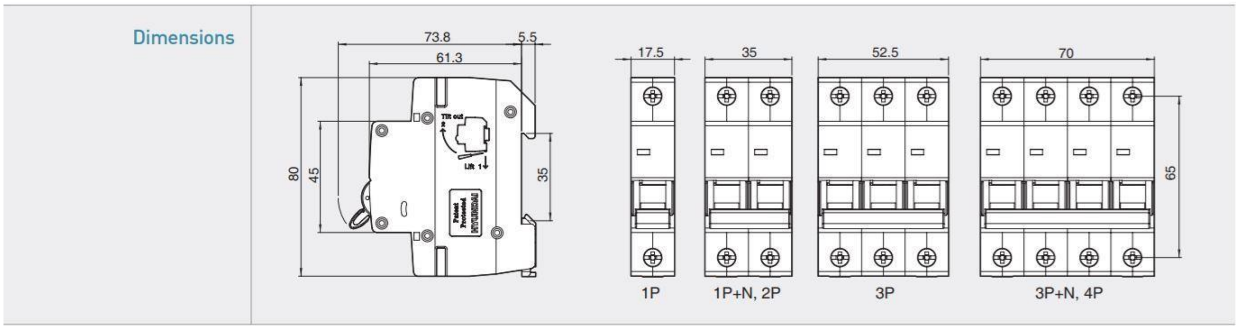


Figure 1

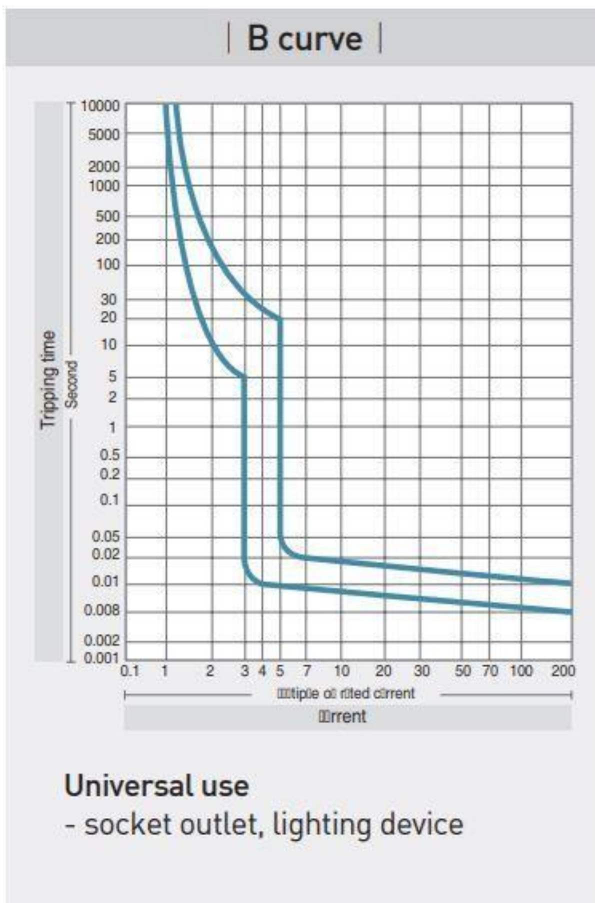


Figure 2

Electro-mechanical Relays :-

An electromechanical relay uses a physical moving part to connect contacts within the output component of the relay. The movement of this contact is generated using electromagnetic forces from the low-power input signal, allowing the completion of the circuit that contains the high-power signal. The physical component within the electromechanical relay commonly makes a “click” sound, which can actually be useful in some situations, though it can lead to internal arcing and takes a relatively large amount of time to move.

4-Pole Models

MY4N

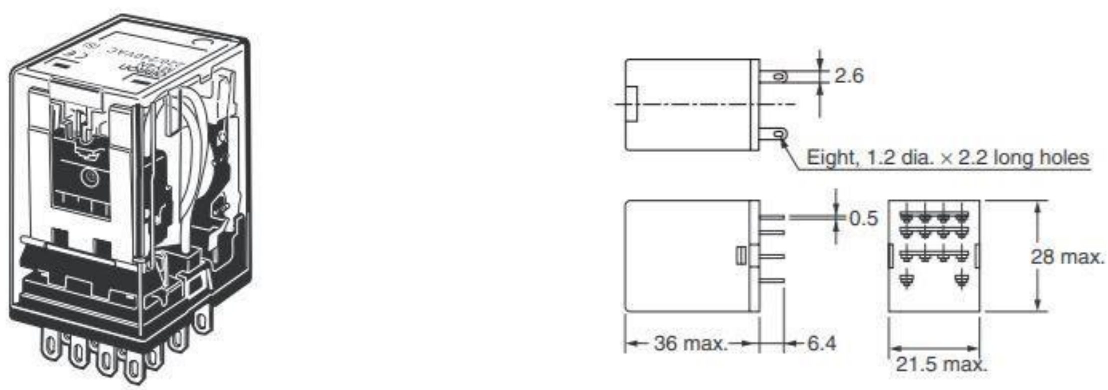


Figure 3

■ Characteristics

Item	All Relays
Contact resistance	100 mΩ max.
Operate time	20 ms max.
Release time	20 ms max.
Max. operating frequency	Mechanical: 18,000 operations/hr Electrical: 1,800 operations/hr (under rated load)
Insulation resistance	1,000 MΩ min. (at 500 VDC)
Dielectric strength	2,000 VAC, 50/60 Hz for 1.0 min (1,000 VAC between contacts of same polarity)
Vibration resistance	Destruction: 10 to 55 to 10 Hz, 0.5 mm single amplitude (1.0 mm double amplitude) Malfunction: 10 to 55 to 10 Hz, 0.5 mm single amplitude (1.0 mm double amplitude)
Shock resistance	Destruction: 1,000 m/s^2 Malfunction: 200 m/s^2
Endurance	See the following table.
Ambient temperature	Operating: –55°C to 70°C (with no icing)
Ambient humidity	Operating: 5% to 85%
Weight	Approx. 35 g

Table 4

■ Coil Ratings

Rated voltage		Rated current		Coil resistance	Coil inductance (reference value)		Must operate voltage	Must release voltage	Max. voltage	Power consumption (approx.)
		50 Hz	60 Hz		Arm. OFF	Arm. ON	% of rated voltage			
AC	6 V*	214.1 mA	183 mA	12.2 Ω	0.04 H	0.08 H	80% max.	30% min.	110%	1.0 to 1.2 VA (60 Hz)
	12 V	106.5 mA	91 mA	46 Ω	0.17 H	0.33 H				
	24 V	53.8 mA	46 mA	180 Ω	0.69 H	1.30 H				
	48/50 V*	24.7/ 25.7 mA	21.1/ 22.0 mA	788 Ω	3.22 H	5.66 H				
	110/120 V	9.9/10.8 mA	8.4/9.2 mA	4,430 Ω	19.20 H	32.1 H				0.9 to 1.1 VA (60 Hz)
	220/240 V	4.8/5.3 mA	4.2/4.6 mA	18,790 Ω	83.50 H	136.4 H				
DC	6 V*	151 mA		39.8 Ω	0.17 H	0.33 H		10% min.		0.9 W
	12 V	75 mA		160 Ω	0.73 H	1.37 H				
	24 V	37.7 mA		636 Ω	3.20 H	5.72 H				
	48 V*	18.8 mA		2,560 Ω	10.60 H	21.0 H				
	100/110 V	9.0/9.9 mA		11,100 Ω	45.60 H	86.2 H				

Table 5

■ Contact Ratings

Item	2-pole		4-pole		4-pole (bifurcated)	
	Resistive load (cosϕ = 1)	Inductive load (cosϕ = 0.4, L/R = 7 ms)	Resistive load (cosϕ = 1)	Inductive load (cosϕ = 0.4, L/R = 7 ms)	Resistive load (cosϕ = 1)	Inductive load (cosϕ = 0.4, L/R = 7 ms)
Rated load	5A, 250 VAC 5A, 30 VDC	2A, 250 VAC 2 A, 30 VDC	3 A, 250 VAC 3 A, 30 VDC	0.8 A, 250 VAC 1.5 A, 30 VDC	3 A, 250 VAC 3 A, 30 VDC	0.8 A, 250 VAC 1.5 A, 30 VDC
Carry current	10 A (see note)		5 A (see note)			
Max. switching voltage	250 VAC 125 VDC		250 VAC 125 VDC			
Max. switching current	10 A		5 A			
Max. switching power	2,500 VA 300 W	1,250 VA 300 W	1,250 VA 150 W	500 VA 150 W	1,250 VA 150 W	500 VA 150 W
Failure rate (reference value)	5 VDC, 1 mA		1 VDC, 1 mA		1 VDC, 100 μA	

Table 6

■ Endurance Characteristics

Pole	Mechanical life (at 18,000 operations/hr)	Electrical life (at 1,800 operations/hr under rated load)
2-pole	AC:50,000,000 operations min. DC:100,000,000 operations min.	500,000 operations min.
4-pole		200,000 operations min.
4-pole (bifurcated)	20,000,000 operations min.	100,000 operations min.

Table 7

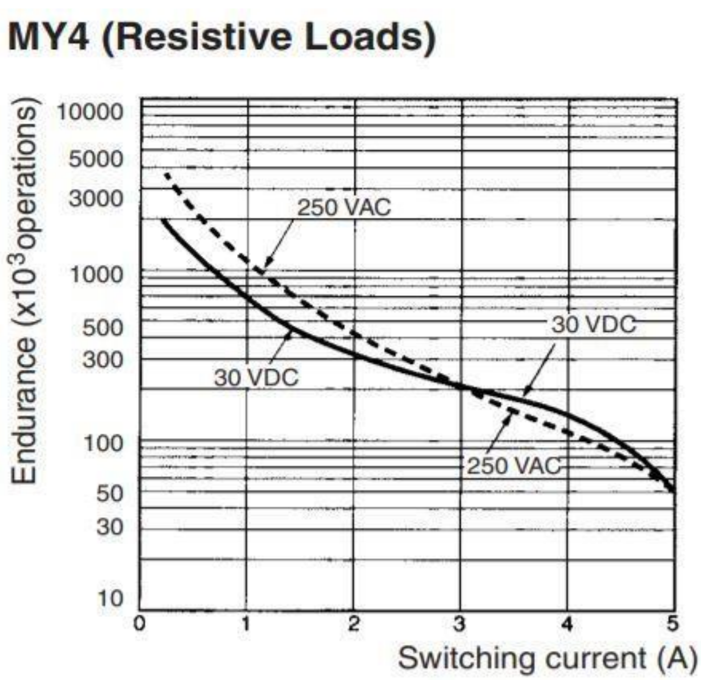


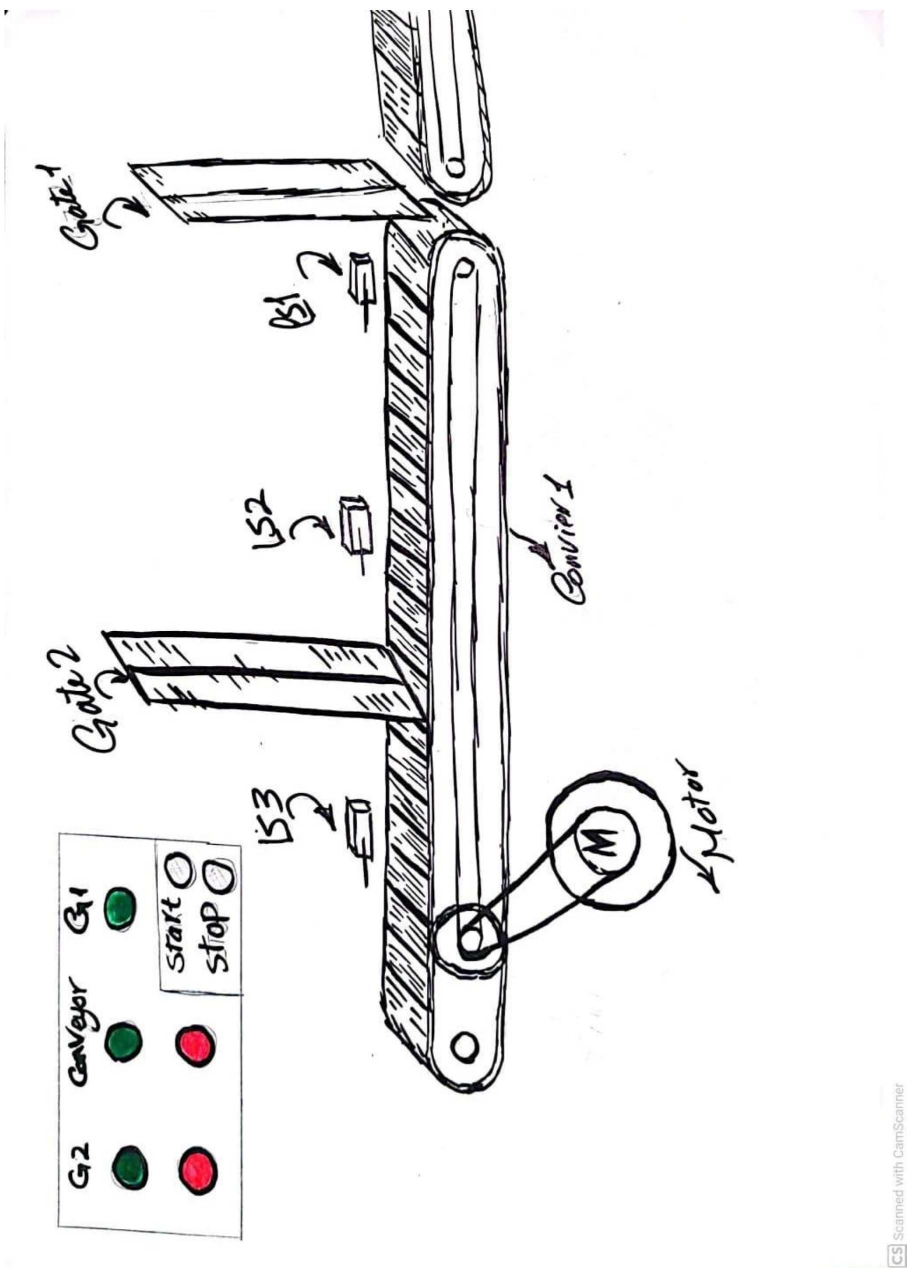
Figure 4

07

Seventh Topic

Proposed system Scenario Layout, description, and requirements

Layout



Description

When I press start PB, I get: -

- Open gate 1 to receive packages, green lamp O:2/0 glows.
- Conveyor is still stop, so the red lamp O:2/3 glows.
- Gate 2 is still closed, so the red lamp O:2/5 glows.

After that, the packages will transmit to the conveyor and closes LS1.

When I press LS1 instantaneously: -

- Gate 1 Closed, so the green lamp O:2/0 won't glow.
- Conveyor will run, so the green lamp O:2/2 glows.
- Gate 2 is still close, so the red lamp O:2/5 glows.

After that, the conveyor is still running and packages will travel to the close LS2.

When I press LS2 instantaneously: -

- Gate 1 is still closed, so the green lamp O:2/0 won't glow.
- Conveyor is still running, green lamp O:2/2 still glows.
- Gate 2 will open, so the green lamp O:2/4 glows.

Then the Package will travel by conveyor to go throw gate 2 and close LS3.

When I press LS3 for a specific period: -

- Gate 1 still close (the green lamp O:2/0 won't glow).
- Conveyor will stop (The red lamp O:2/3 will glow).
- Gate 2 will close (The red lump O:2/5 will glow).

As carrying the package up, the process is being repeated: -

- Gate 1 will open to receive packages, green lamp O:2/0 glows.
- Conveyor is still stop, so the red lamp O:2/3 glows.
- Gate 2 is still closed, so the red lamp O:2/5 glows.

Requirements

A Human to push the *START* push buttons, 3 limit switches in a certain order then press the *STOP* push button .

Requirements	Quantity
Hyundai double port miniature Circuit Breaker 16A "HIBD63-S"	2
Omron Relay 240VAC/28VDC	4
Control Panel	1
AC indicator Light	5
Terminal Block	2
Start Push Button	1
Stop Push Button	1
Wires	-

Limitation

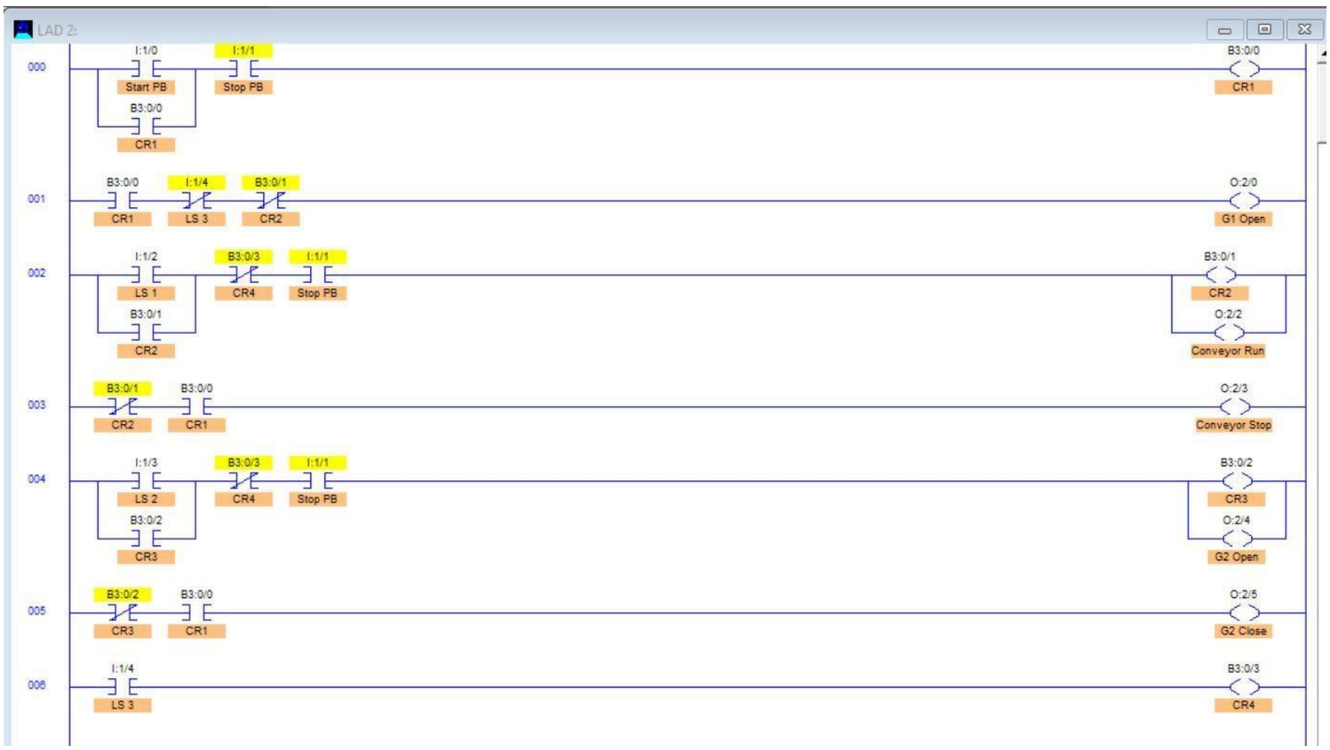
START PB must be Pushed first before Limit switches , after that the three limit switches should be pressed in their certain order (LS1 >> LS2 >> LS3).

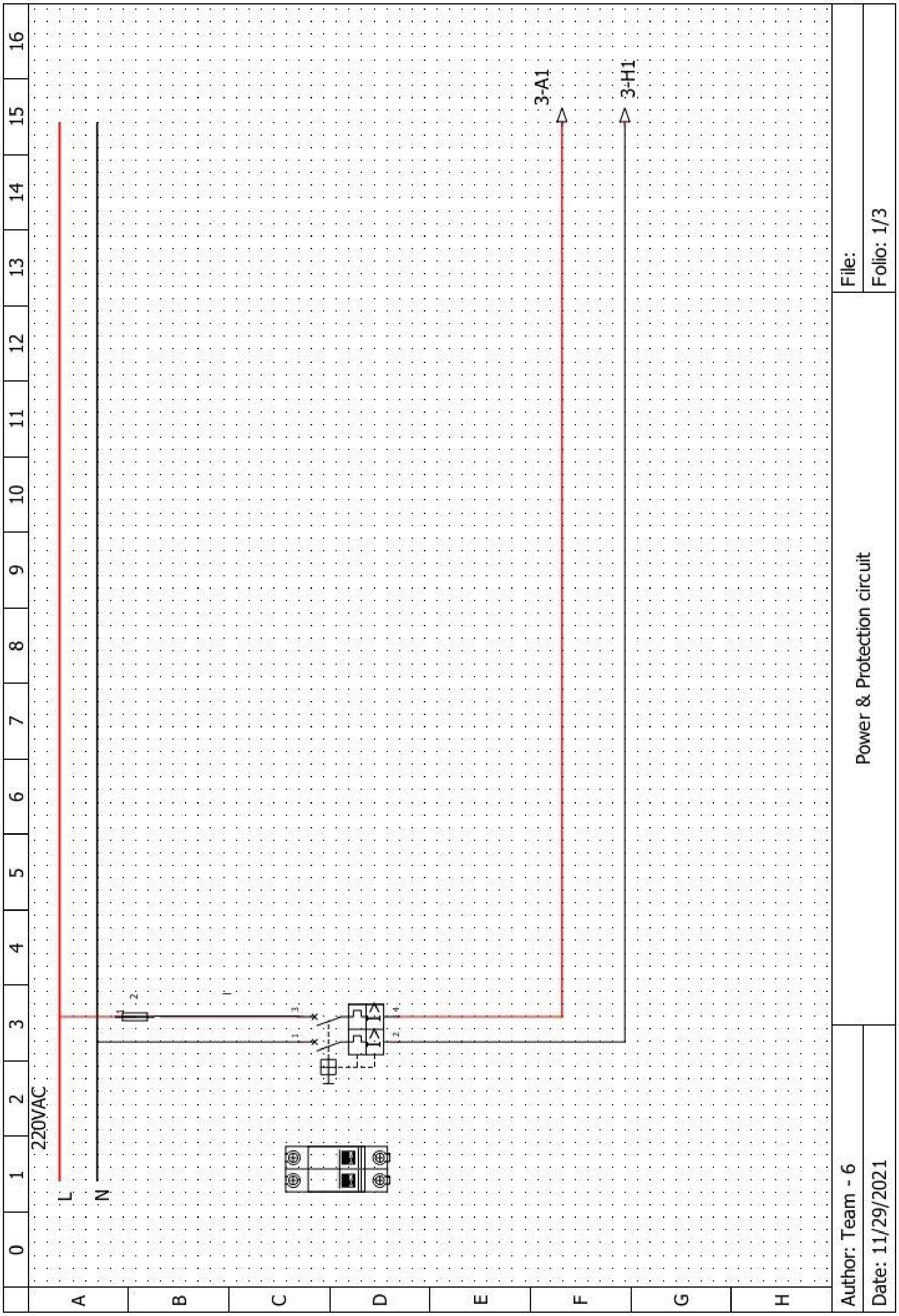
08

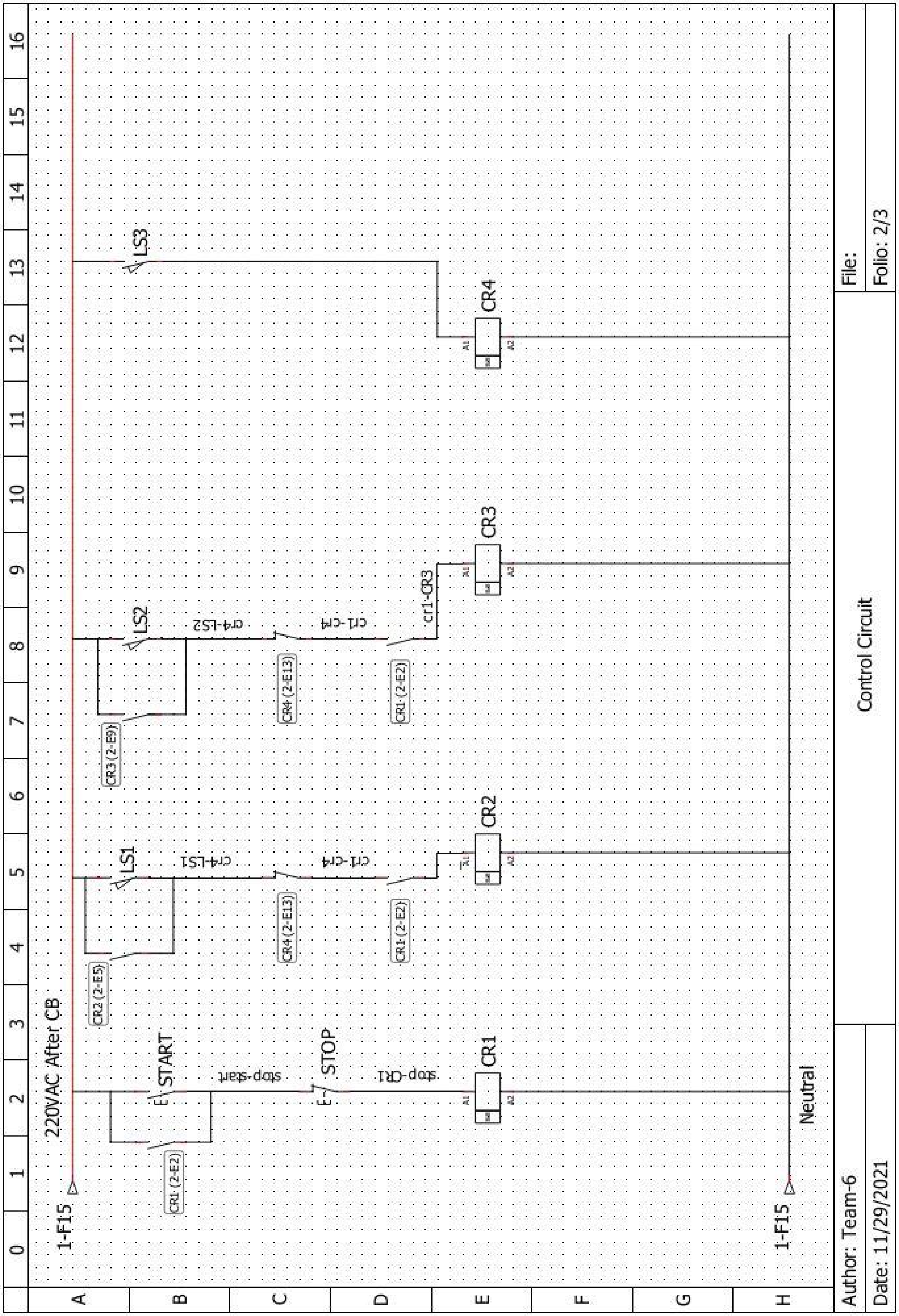
eighth Topic

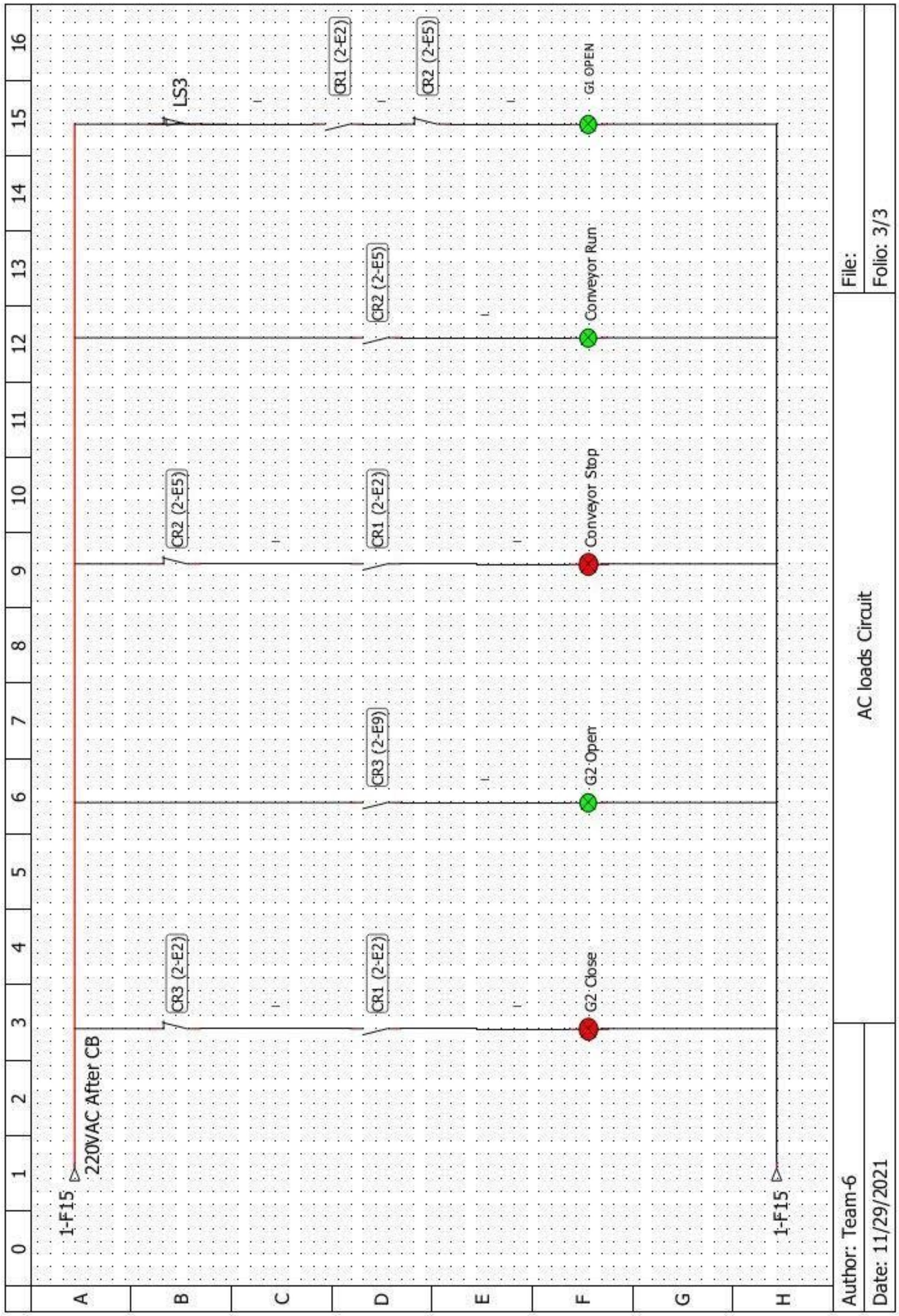
Design, Simulation, and Implementation

Design



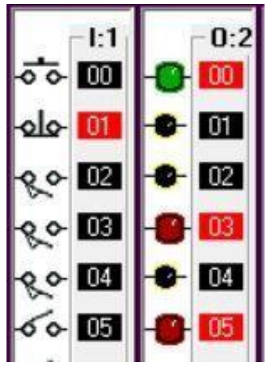

220VAC
L
N
3-A1
3-H1
Power & Protection circuit
Author: Team - 6
Date: 11/29/2021
File:
Folio: 1/3


220VAC After CB
1-F15
START
STOP
stop-start
stop-CR1
CR1
CR2
CR3
CR4
LS1
LS2
LS3
cr4-LS1
cr1-cr4
cr4-LS2
cr1-CR3
CR1 (2-E2)
CR2 (2-E5)
CR3 (2-E9)
CR4 (2-E13)
Neutral
Control Circuit
Author: Team-6
Date: 11/29/2021
File:
Folio: 2/3

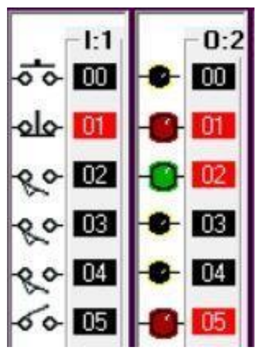

1-F15
220VAC After CB
LS3
CR3 (2-E2)
CR1 (2-E2)
G2 Close
CR3 (2-E9)
G2 Open
CR2 (2-E5)
CR1 (2-E2)
Conveyor Stop
CR2 (2-E5)
Conveyor Run
CR1 (2-E2)
CR2 (2-E5)
G1 OPEN
1-F15
Author: Team-6
Date: 11/29/2021
AC loads Circuit
File:
Folio: 3/3

Simulation

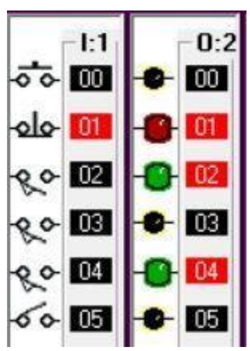
1) After START PB.



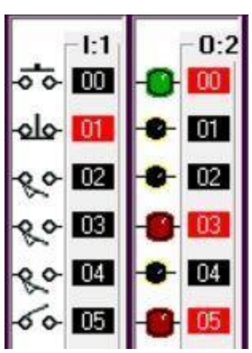
2) After LS1.

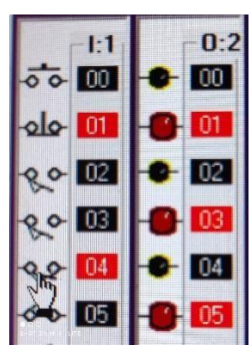


3) After LS2.

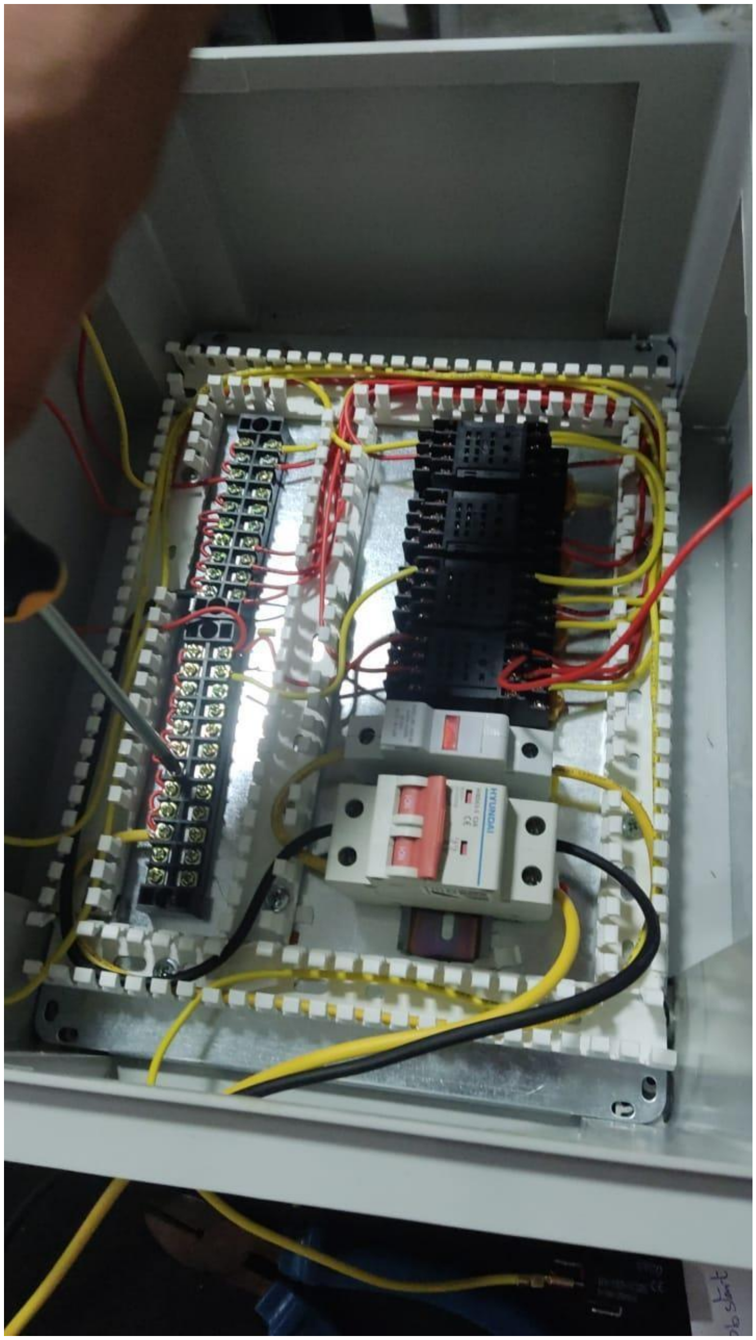


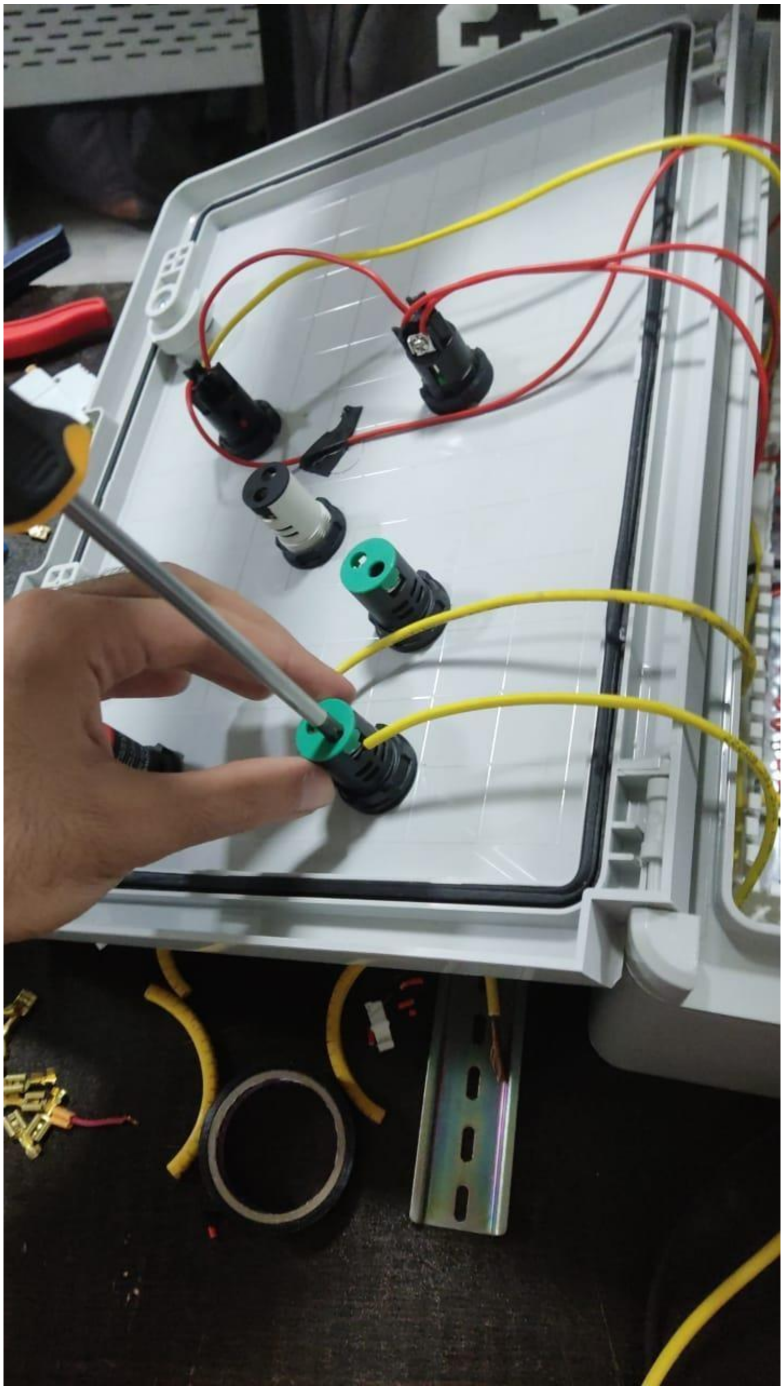
4) After LS3.





Implementation





09

nineth Topic

Testing & Results

Design Stage

*For testing the logic and criteria of the system we used a simulation program and checked every condition if it's valid and accomplished or not, then modified the system every time we find an error to solve it.

Implementation

*In purchasing and implementation processes the components used are examined individually and got tested with the avo-meter and through direct connection with the planned inputs for it.

-The results of testing process is discussed and the replacement or fixing is done.

-After implementation the control panel are tested over all as wiring connections and trouble shooting every found problem.

Turning On

-We made sure that the control panel is well isolated and plugged in the cable then turned on the circuit breaker to test the wiring and the system working.

10

tenth Topic

References

1) https://elecsafety.co.uk/electrical-control-panels/

2) http://hyundai-electric.es/media/images/Catalogos/Aparamenta-modular-eng.pdf

3) https://dtsheet.com/doc/423274/omron-my4n

4) https://www.arrow.com/en/research-and-events/articles/crydom-solid-state-relays-vs-electromechanical-relays