BCIT SCHOOL OF ENERGY

Mechatronics and Robotics Engineering Technology

ROBT 4456:

PLC Applications

PROJECT REPORT:

ADVANCED FOUR-FLOOR ELEVATOR

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ABSTRACT

This PLC project demonstrates the application of various PLC programming techniques. This project programs the lab bench mock elevator to behave as real elevator. To accomplish this, the project utilizes a finite state machine to control the process. Additional unique features were implemented which required advanced PLC programming topics such as Add-On Instructions, Networking, and HMI design...

PREFACE

The assignment of this project was provided in 9 distinct parts. Each part asks for additional functionality and must be completed sequentially. All 9 parts are complete and documented...

CONTENTS

FIGURES

TABLES

DEFINITIONS

Table 0.1: List of Abbreviations

Abbreviation	Definition
PLC	Programmable Logic Controller

Table 0.2: List of Symbols

Symbol	Definition
V:	Virtual
!	Boolean operator: Logical NOT
D	Door
F	Floor

1 INTRODUCTION

This document discusses the design and implementation of an Advanced Four-Floor Elevator PLC controller. As a PLC programming project, the hardware is provided by BCIT Mechatronics and Robotics.

1.1 PROJECT DESCRIPTION

The elevator project is defined in nine parts. Each part demands additional features on top of the previous parts. This report reflects the most advanced implementation.

1.2 PROJECT HARDWARE

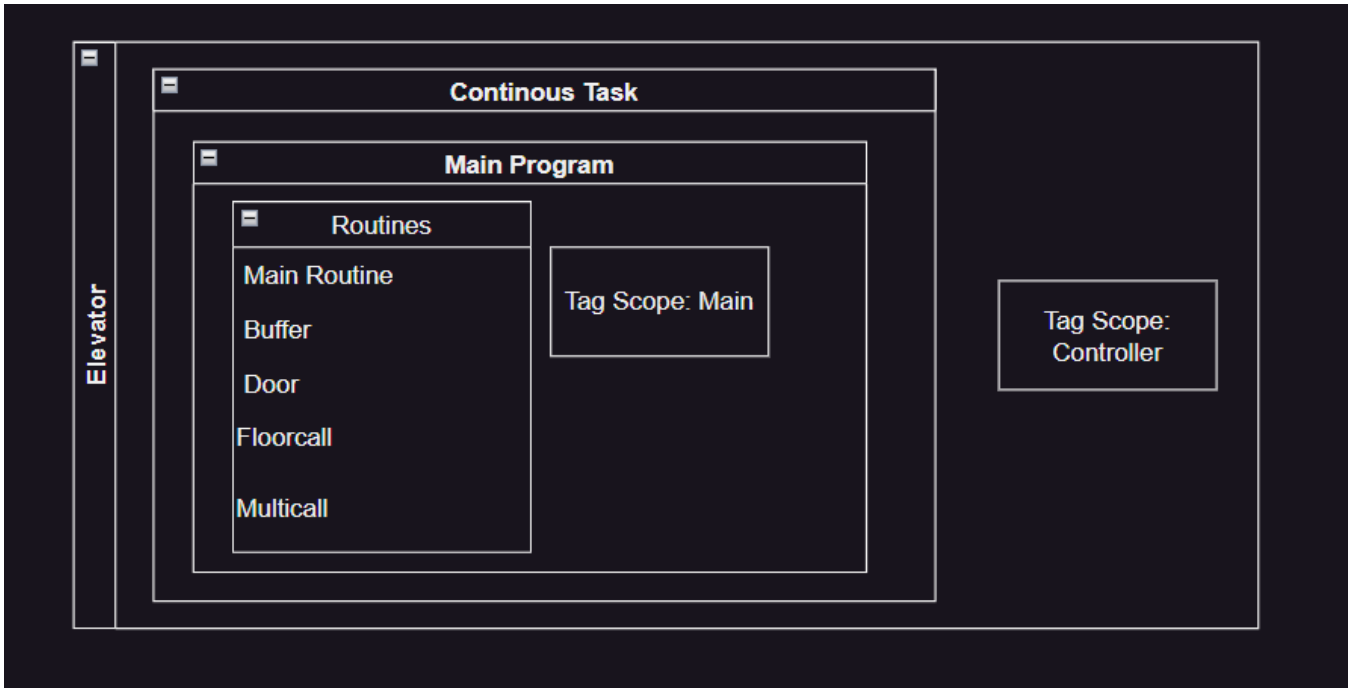
The hardware design and implementation is provided at the start of the project. The main PLC controller is an Allen-Bradley 1769 CompactLogix PLC. The I/O modules utilized are:

2 PROJECT OVERVIEW

Discuss the organization of the project.

2.1 STUDIO 5000 PROJECT ORGANIZATION

The PLC program is organized to be modular.



2.2 CONTROLLER TAGS

Table 2.1: Controller Tags

Tag	Type	Task
Local:2:I.Data	DINT	InputBuffer
Local:3:I.Data	DINT	InputBuffer
Local:4:O.Data	DINT	OutputBuffer
Local:5:O.Data	DINT	OutputBuffer

2.3 Ladder Logic Structure

Each program adheres to an Buffer, Logic structure. The buffer routine of a program ensures logical inputs and outputs are not change during a single scan.

Each subroutine is responsible for a dedicated set of tags which may not be written to in other subroutines.

3 MAIN PROGRAM

The elevator operation is managed by a state machine. This state machine determines logical movement of the elevator by driving the motor and its direction.

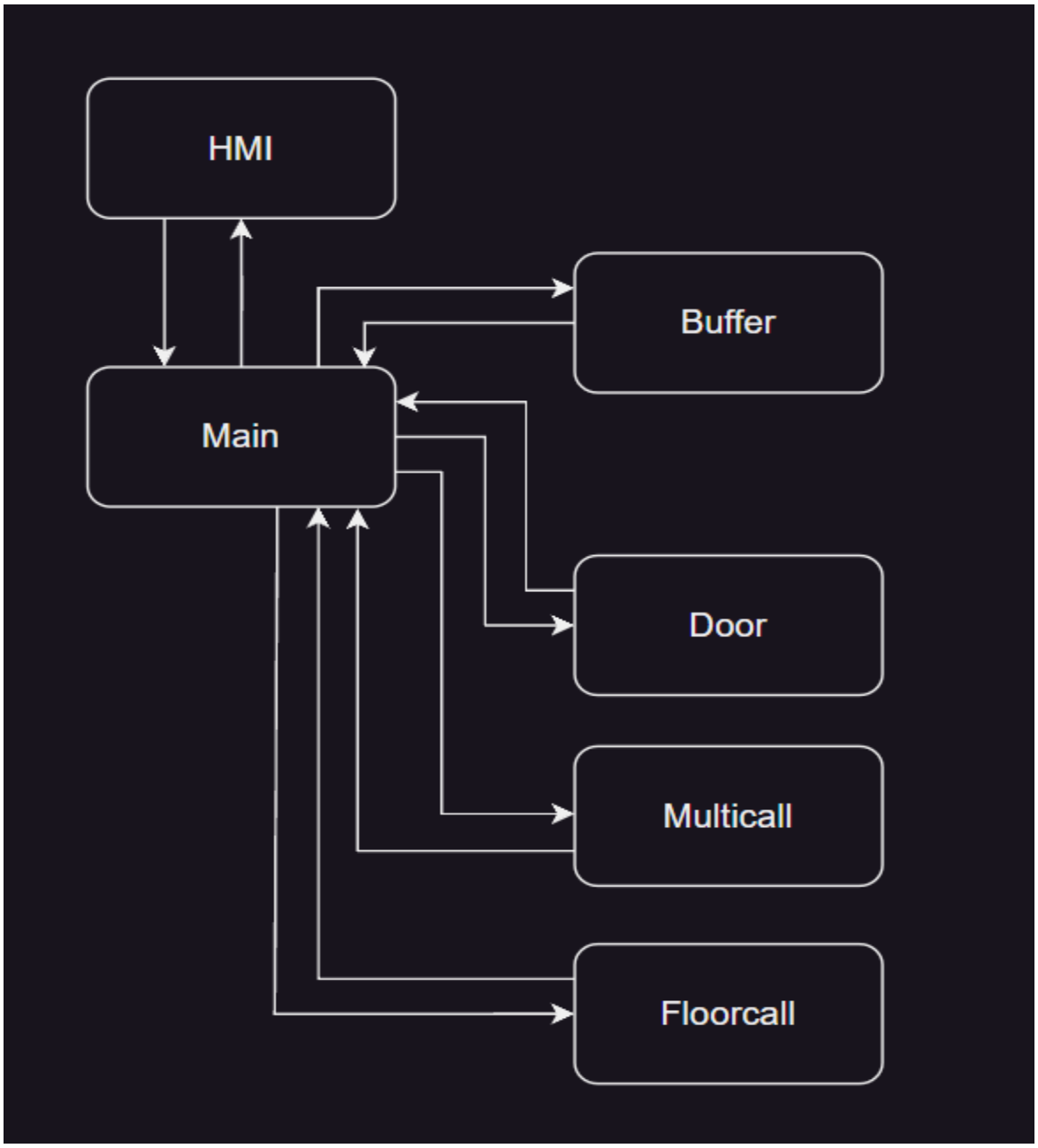


Figure 3.1: This diagram shows where each subroutine is called.

3.1 Program Tags

These tags are external to the Main program. Access to these tags is managed by the input and output buffer subroutines.

Table 3.1: Controller Tag Buffering

Tag	Mapping	Type	Subroutine
V_2I_Data	Local:2:I.Data	DINT	InputBuffer
V_3I_Data	Local:3:I.Data	DINT	InputBuffer
V_4O_Data	Local:4:O.Data	DINT	OutputBuffer
V_5O_Data	Local:5:O.Data	DINT	OutputBuffer

Table 3.2: Input Module 2 – InputBuffer Tags

Tag	Alias	Type	Description
V_PB4	V_2I_Data.0	BOOL	V: Pushbutton 4
V_PB3	V_2I_Data.1	BOOL	V: Pushbutton 3
V_PB2	V_2I_Data.2	BOOL	V: Pushbutton 2
V_PB1	V_2I_Data.3	BOOL	V: Pushbutton 1
V_PBO	V_2I_Data.4	BOOL	V: Pushbutton Open
V_PBC	V_2I_Data.5	BOOL	V: Pushbutton Close
V_PBE5	V_2I_Data.6	BOOL	V: Pushbutton Emergency 5
V_FPB4	V_2I_Data.8	BOOL	V: Floor Pushbutton 4
V_FPB3	V_2I_Data.9	BOOL	V: Floor Pushbutton 3
V_FPB2	V_2I_Data.10	BOOL	V: Floor Pushbutton 2
V_FPB1	V_2I_Data.11	BOOL	V: Floor Pushbutton 1
V_START	V_2I_Data.14	BOOL	V: START (N.O.)
V_STOP	V_2I_Data.15	BOOL	V: STOP (N.C.)

Table 3.3: Input Module 3 – InputBuffer Tags

Tag	Alias	Type	Description

V_FLS1	V_3I_Data.0	BOOL	V: Floor Limit Switch 1
V_FLS2	V_3I_Data.1	BOOL	V: Floor Limit Switch 2
V_FLS3	V_3I_Data.2	BOOL	V: Floor Limit Switch 3
V_FLS4	V_3I_Data.3	BOOL	V: Floor Limit Switch 4
V_DCLS	V_3I_Data.8	BOOL	V: Door Close Limit Switch
V_DOLS	V_3I_Data.9	BOOL	V: Door Open Limit Switch
V_TS2	V_3I_Data.10	BOOL	V: Toggle Switch 2
V_TS1	V_3I_Data.11	BOOL	V: Toggle Switch 1
V_TS0	V_3I_Data.12	BOOL	V: Toggle Switch 0

Table 3.4: Output Module 4 – OutputBuffer Tags

Tag	Alias	Type	Description
V_IL4	V_4O_Data.0	BOOL	V: Indicator Light 4
V_IL3	V_4O_Data.1	BOOL	V: Indicator Light 3
V_IL2	V_4O_Data.2	BOOL	V: Indicator Light 2
V_IL1	V_4O_Data.3	BOOL	V: Indicator Light 1
V_ILO	V_4O_Data.4	BOOL	V: Indicator Light Open
V_ILC	V_4O_Data.5	BOOL	V: Indicator Light Close
V_ILE5	V_4O_Data.6	BOOL	V: Indicator Light Emergency 5
V_FIL4	V_4O_Data.8	BOOL	V: Floor Indicator Light 4
V_FIL3	V_4O_Data.9	BOOL	V: Floor Indicator Light 3
V_FIL2	V_4O_Data.10	BOOL	V: Floor Indicator Light 2
V_FIL1	V_4O_Data.11	BOOL	V: Floor Indicator

3.2 MAINROUTINE

This Main routine is responsible for the main elevator operation. The elevator actuators are only controlled by the logic within this subroutine and is also the only routine which may call the door state machine subroutine. The logic within this subroutine implements a finite state machine.

All the tags are listed in pdf file named Tags.pdf.

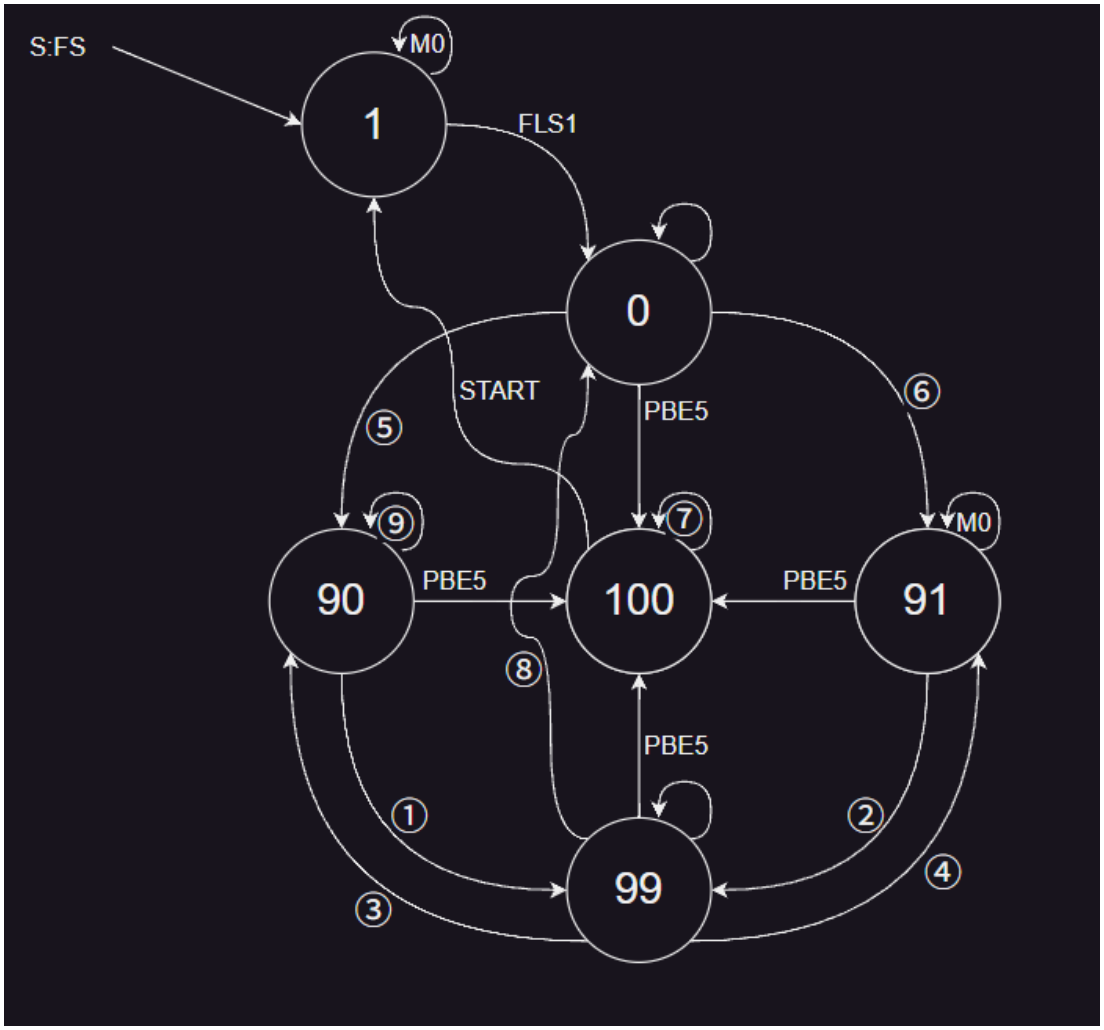


Figure 3.2: A Mainroutine State Machine

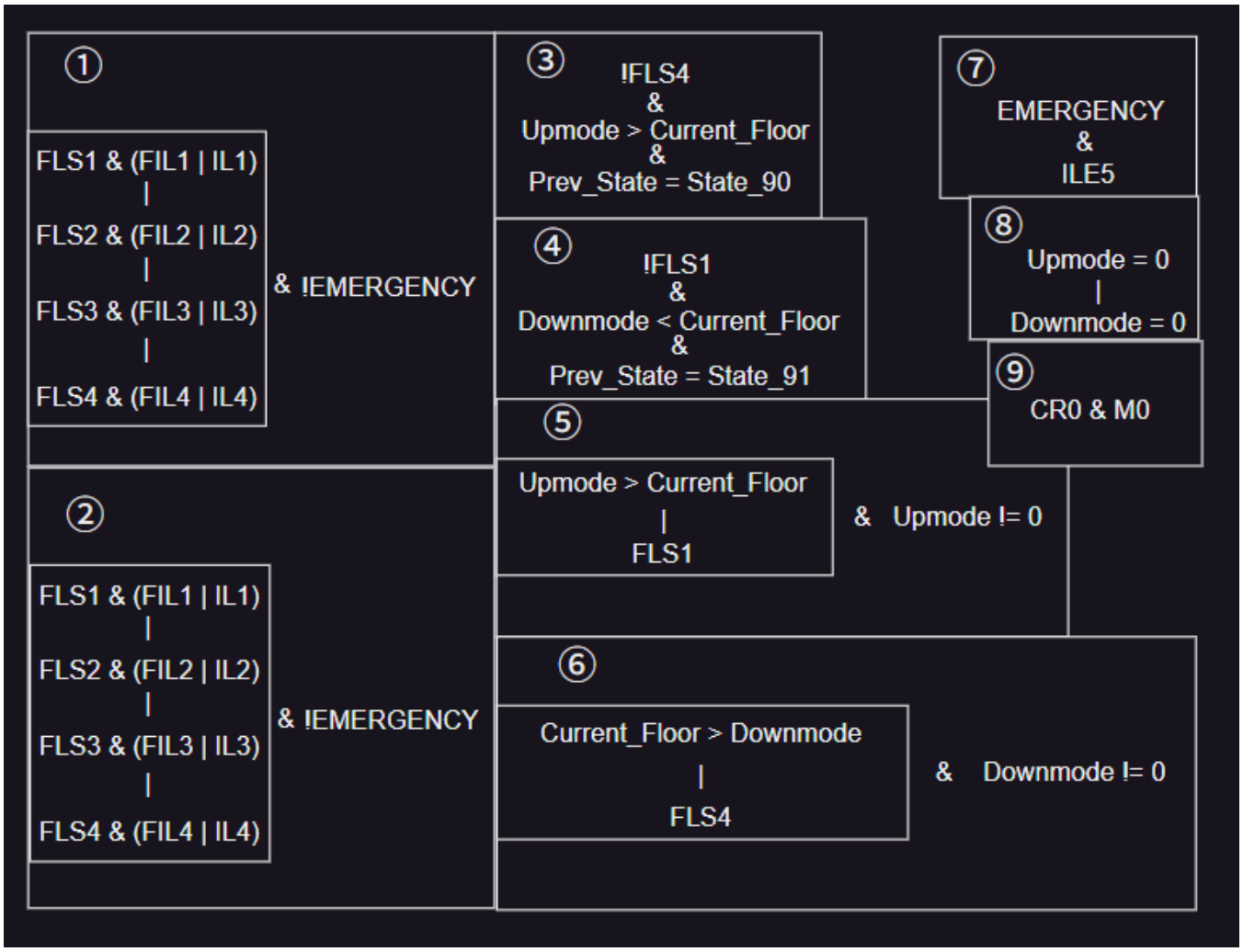


Figure 3.3: State Change Conditions

The state machine forces the elevator to behave a specific way. Modifying the transitions can modify the overall behaviour of the system.

Table 3.5: State Descriptions

State	Entry Points	Exit Points	Actions
0: Idle	1: FLS1 99: ⑧	90: ⑤ 91: ⑥ 99: 100: PBE5	No actions.
1: F1	First Scan 100: START	0: FLS1	Run M0 until the elevator at 1st floor
90: UPmode	0: ⑤ 99: ③	99: ①	Run M0 to move the Elevator upward
91: DOWNmode	0: ⑥ 99: ④	99: ②	Run M0 to move the Elevator downward
99: Service	90: ① 91: ②	0: ⑧ 90: ③ 91: ④	No actions.
100: Emergency	0: PBE5 90: PBE5 91: PBE5 99: PBE5	1: START	Stop the operation of the elevator

3.3 Door Routine

This routine manages the door controls and opens and closes while the elevator is servicing floors.

See Door.pdf for ladder diagram.

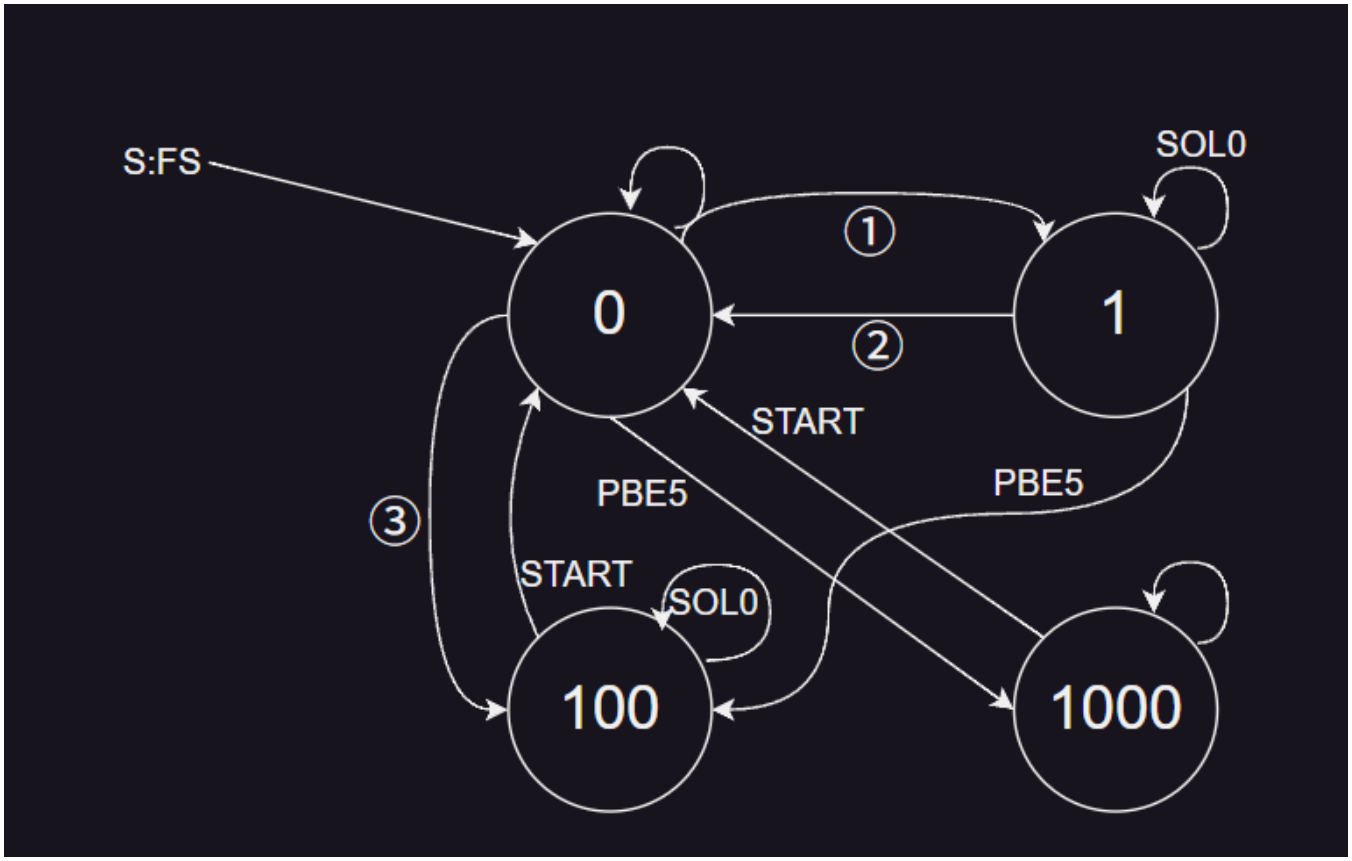


Figure 3.4: Door State Machine

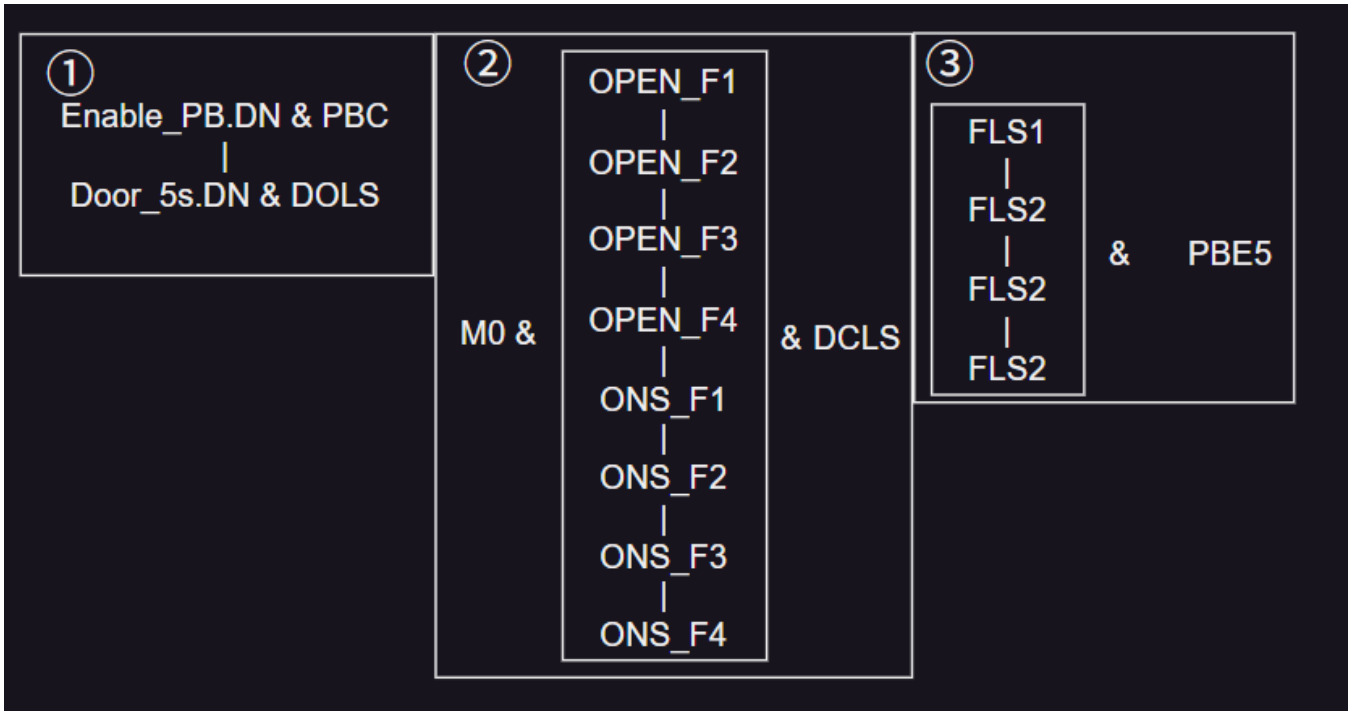


Figure 3.5: State Change Conditions

Table 3.6: State Descriptions

State	Entry Points	Exit Points	Actions
0: DC (Door Closed)	1: ② 100: START 1000: START	1: ① 100: ③ 1000: PBE5	No actions.
1: DO (Door Open)	0: ①	0: ② 100: PBE5	SOL0 On Turn on timer Door_5s and Enable_PB when DOLS is true
100: atFloor	0: ③ 1: PBE5	0: START	SOL0 On
1000: btwFloor	0: PBE5	0: START	No actions.

3.4 Emergency Stop

When PBE5 is pressed the Emergency Stop happens. This will set the Elevator state to be State_100_Emergency which stops the operation of the elevator immediately. Also set the Door state to be State_100_atFloor which opens the door if the elevator is stopped at floor or State_1000_btwFloor which does not allow the door to be opened.

See Mainroutine.pdf rung 4-8 & Door.pdf rung 4-6,10

3.5 Floorcall and multicall

Floorcall subroutine reads that passengers press buttons at a floor to call the elevator to that floor. Once inside the elevator, the passenger may request a floor to be dropped off at.

Multicall subroutine accepts the calls and requests and generates the next floor the elevator will go to.

See Floorcall.pdf and Multicall.pdf for ladder diagram.

4 Conclusion

This project successfully completed task 1 to 6 and some of HMI features. Comparing the previous motion state to next motion state was fully working. However, there is an issue with State_0 and State_99 ; both have no actions. To fix this problem, these two states might need to be combined.

5 Ladder Logic PDF

List the program PDFs and where to find relevant ladder logic.

Main Routine	- Mainroutine.pdf
Door	- Door.pdf
Buffer	- Buffer.pdf
Floorcall	- Floorcall.pdf
Multicall	- Multicall.pdf
Tags	- Tags.pdf
Emergency	- Mainroutine.pdf[page1,2], Door.pdf[page 2,3]