Power Window Control System

Real-Time and Embedded Systems Design

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01 Team members

Specifying the role of each member

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02 Project Description

Describing project's main features

Project goal

The goal of this project is to develop a power window control system for a vehicle using a TM4C123GH6PM microcontroller and the FreeRTOS operating system. The system incorporates various features such as manual open/close function, one-touch auto open/close function, window lock function, and jam protection function.

Project Features

The system utilizes the microcontroller's GPIO ports to monitor the status of power window switches and implement the desired functionality. Next's a detailed description of each of the following features:

Features

- Manual Open/Close
- One-Touch Auto Open/Close
- Window Lock
- Jam Protection

Manual open/close function

- When the power window switch is pushed or pulled continuously, the window opens or closes until the switch is released.
- This feature provides manual control over the power window, allowing the user to precisely adjust the window position as desired.

One touch Auto open/close function

- When the power window switch is pushed or pulled shortly, the window fully opens or closes.
- This feature provides convenience to the user by allowing them to quickly open or close the window with a single press or pull of the switch.

Window Lock function

- When the window lock switch is turned on, only the driver can control the windows
- This feature ensures the safety and security of passengers by preventing unauthorized or accidental operation of windows by occupants other than the driver.

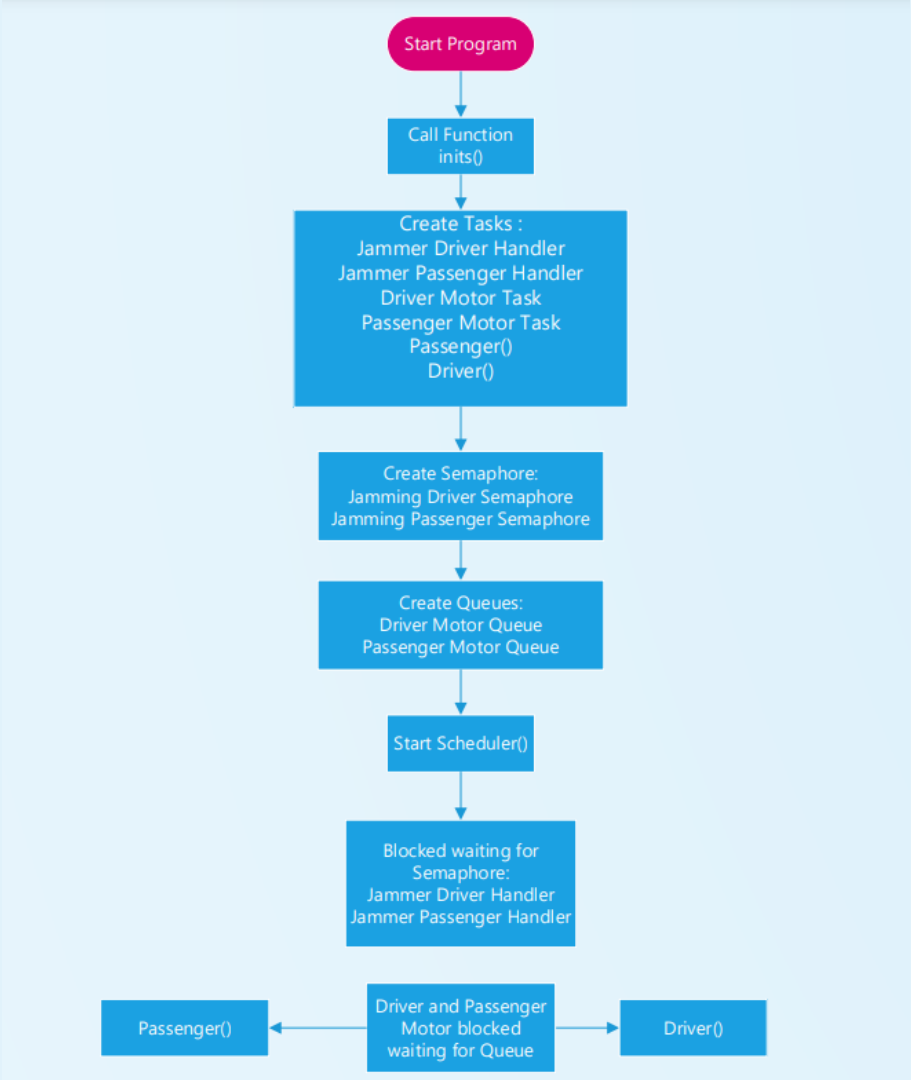
Jam protection function

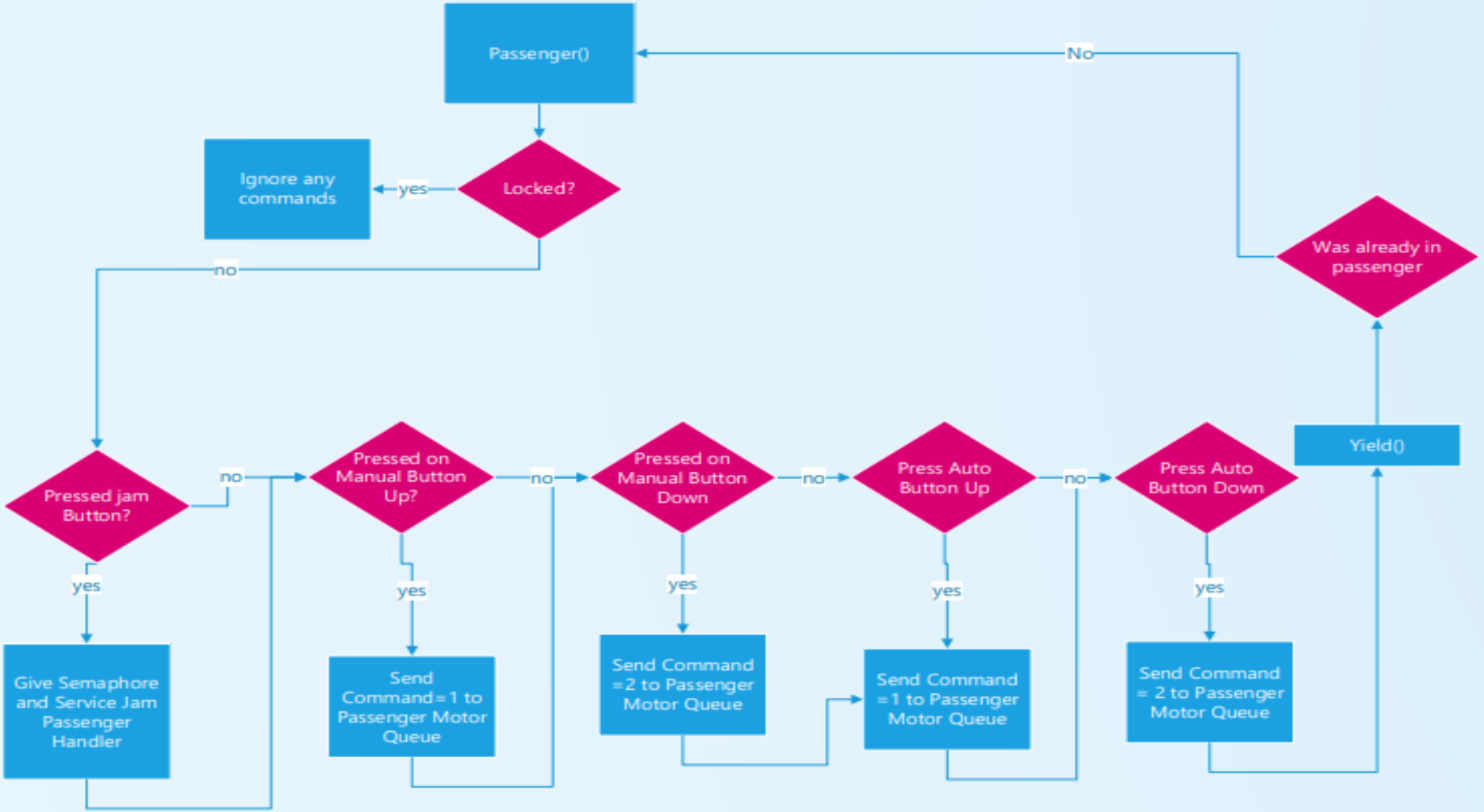
- This function automatically stops the power window and moves it downward about 0.5 seconds if foreign matter gets caught in the window during close operations.
- The system monitors the window position and detects any obstruction during any close operation.
- If an obstruction is detected, the power window reverses its direction and moves downward slightly to release the foreign matter and avoid any potential damage or injury.

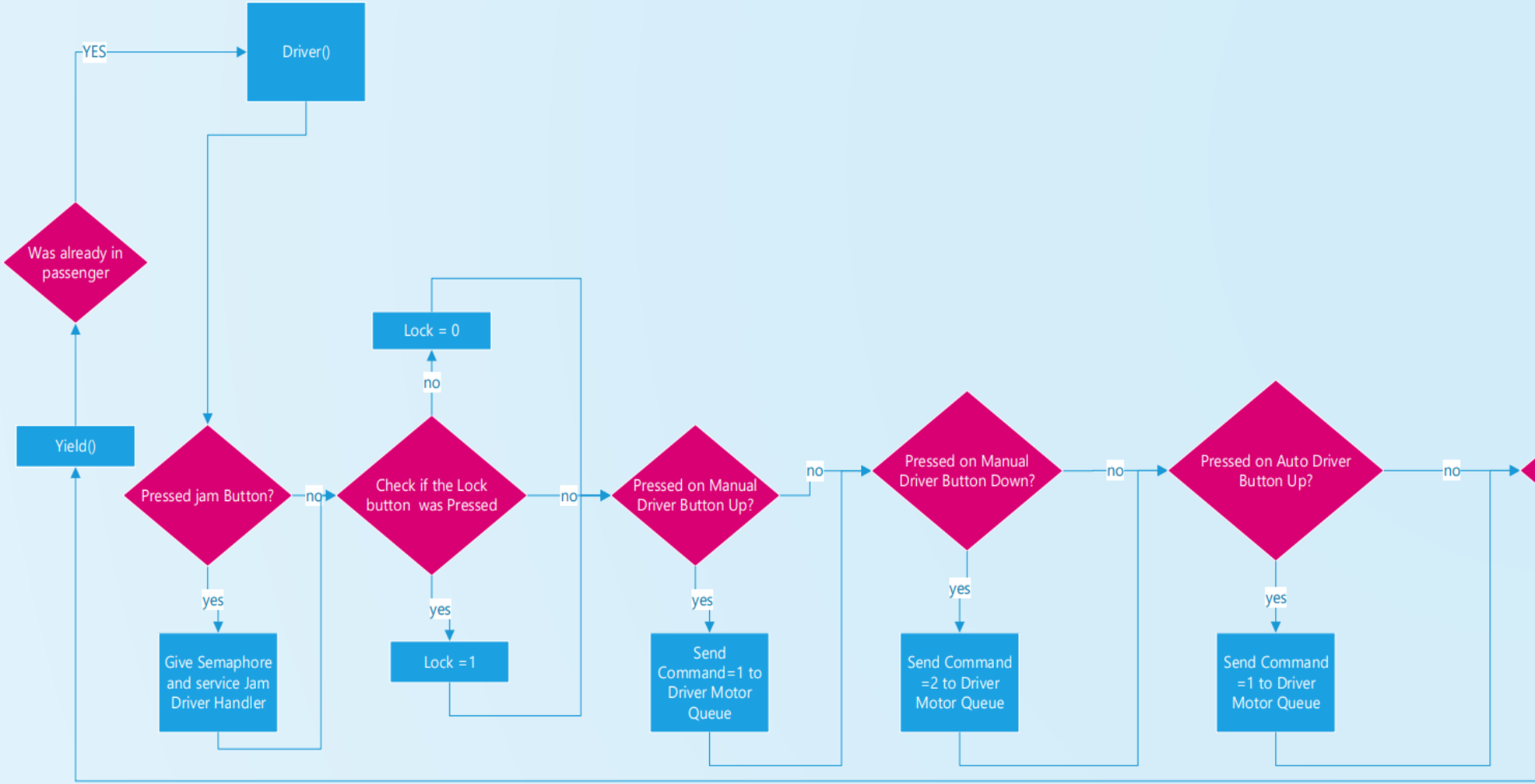
The project involves configuring the microcontroller's GPIO pins to read the status of power window switches and control the motor that operates the windows. polling is used to detect button press/release events and initiate the desired window movement.

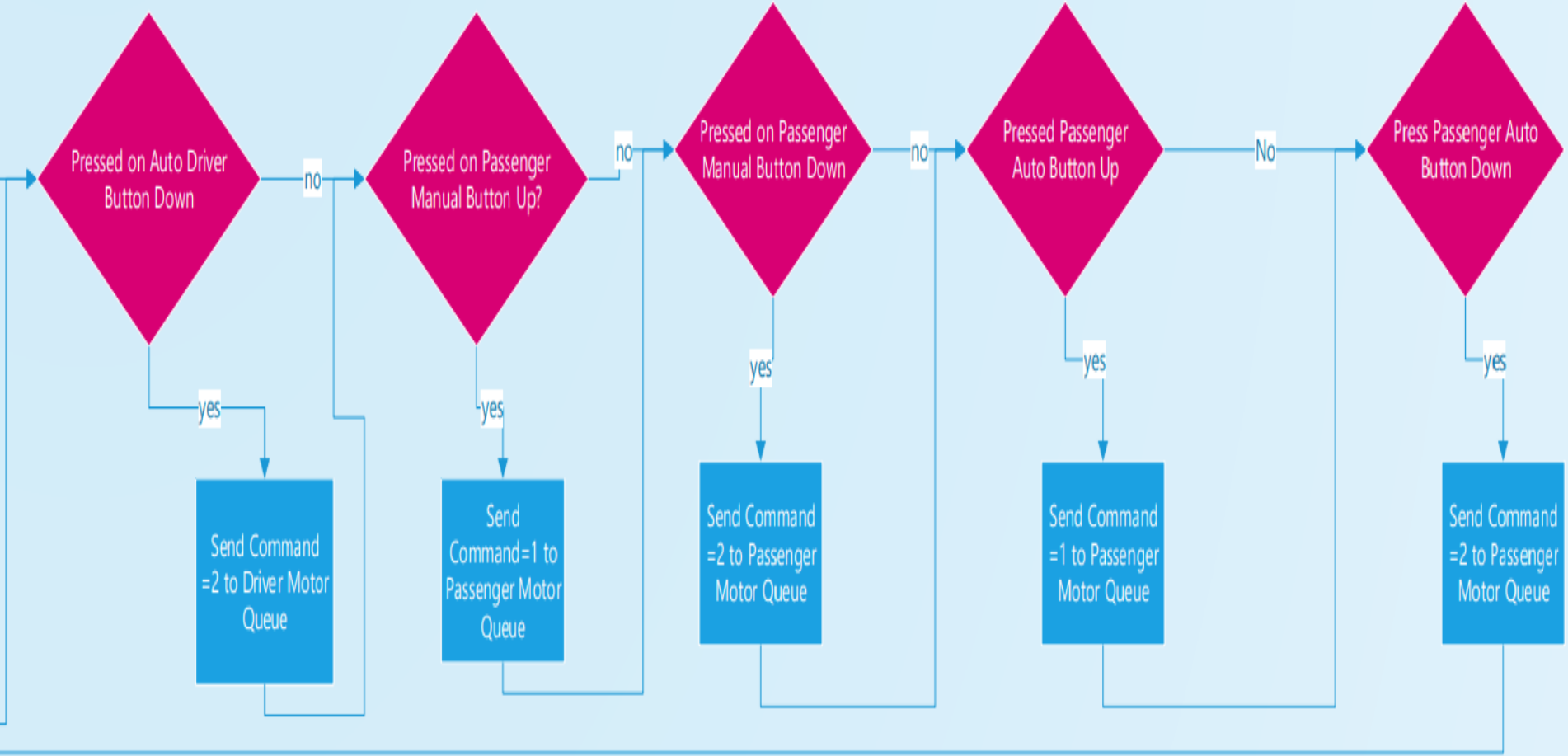
Tasks ,queues and semaphores are implemented to handle different functions concurrently within the FreeRTOS framework.

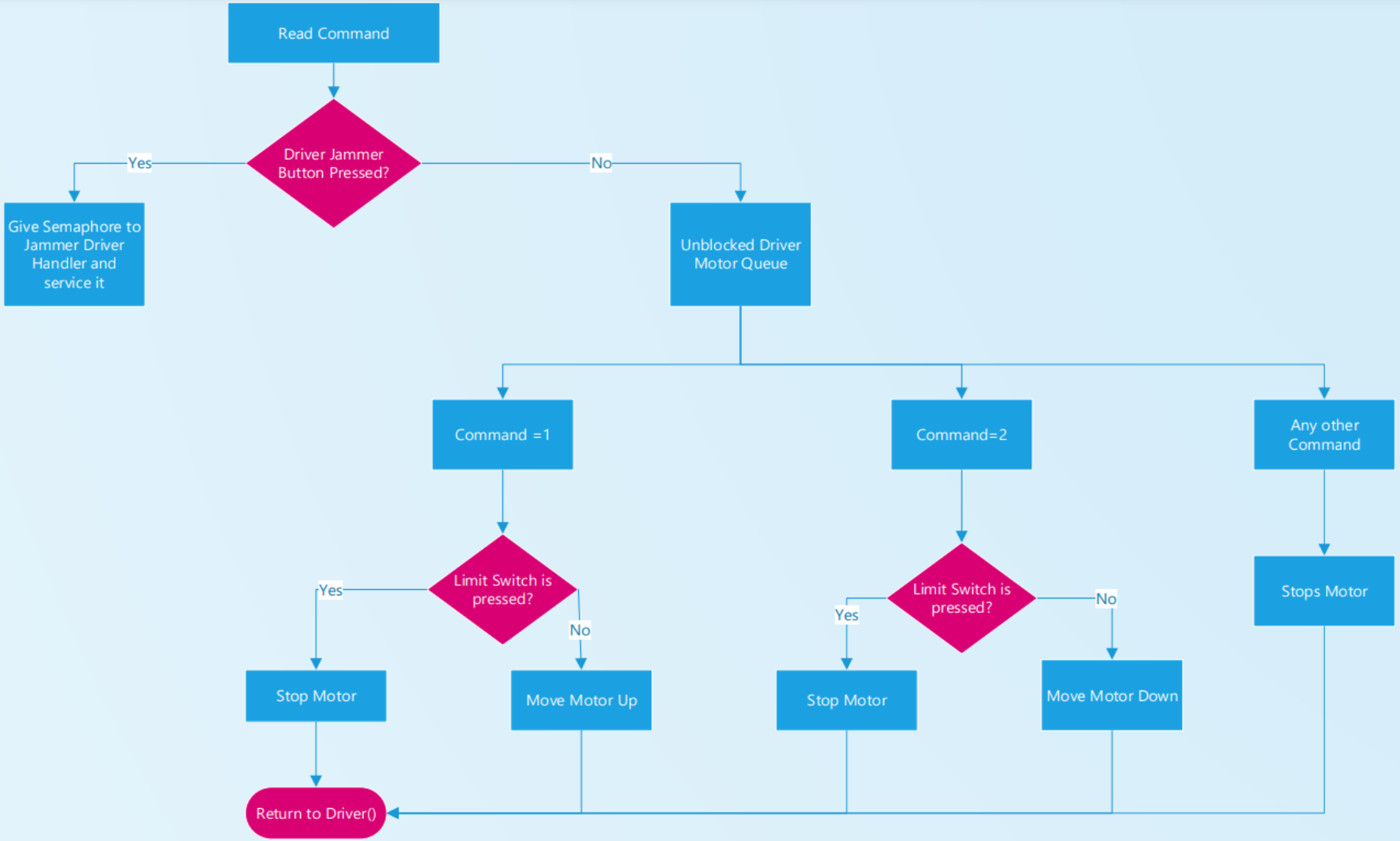
03 System flowcharts

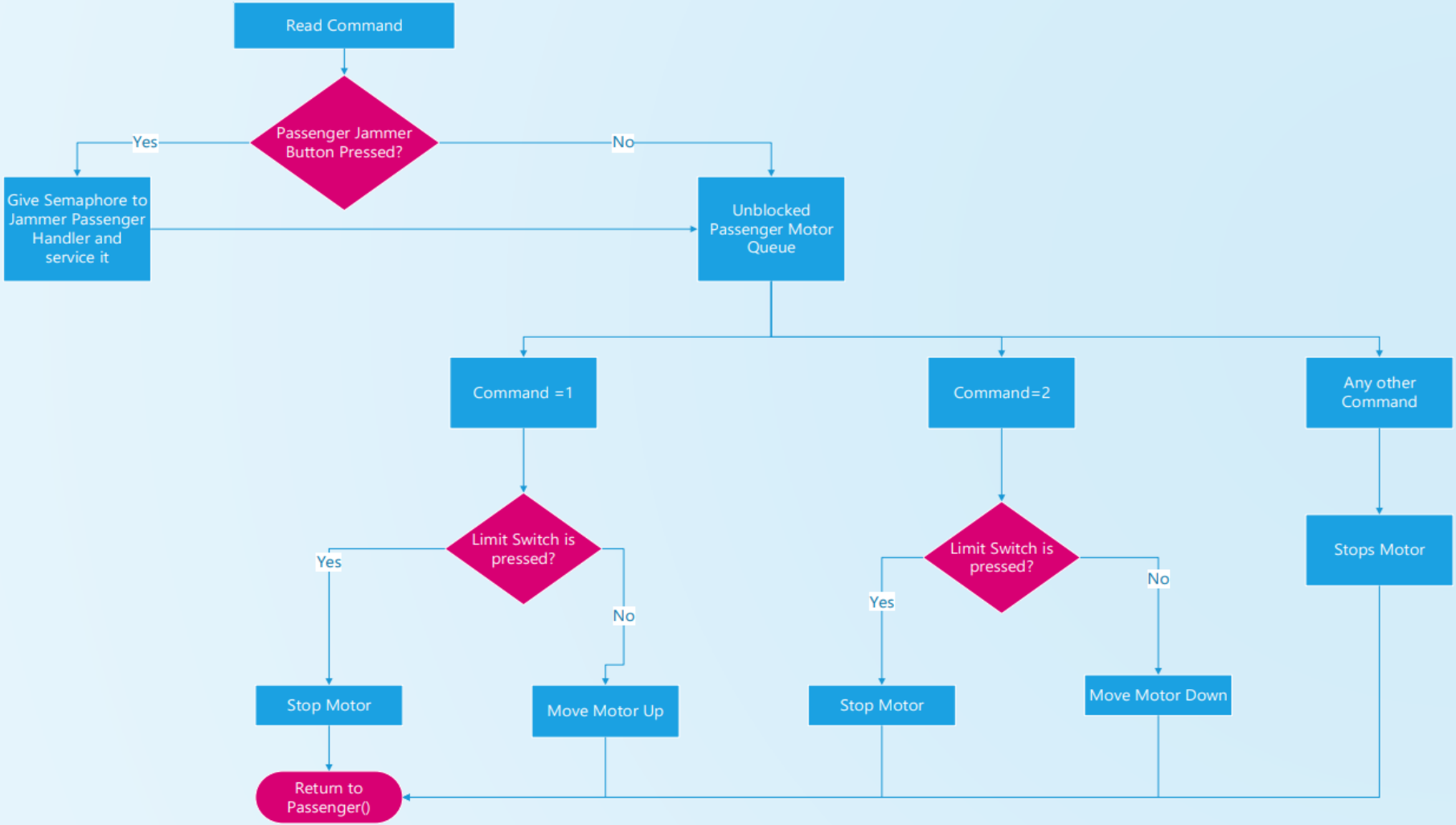

Start Program
Call Function
inits()
Create Tasks :
Jammer Driver Handler
Jammer Passenger Handler
Driver Motor Task
Passenger Motor Task
Passenger()
Driver()
Create Semaphore:
Jamming Driver Semaphore
Jamming Passenger Semaphore
Create Queues:
Driver Motor Queue
Passenger Motor Queue
Start Scheduler()
Blocked waiting for
Semaphore:
Jammer Driver Handler
Jammer Passenger Handler
Passenger()
Driver and Passenger
Motor blocked
waiting for Queue
Driver()

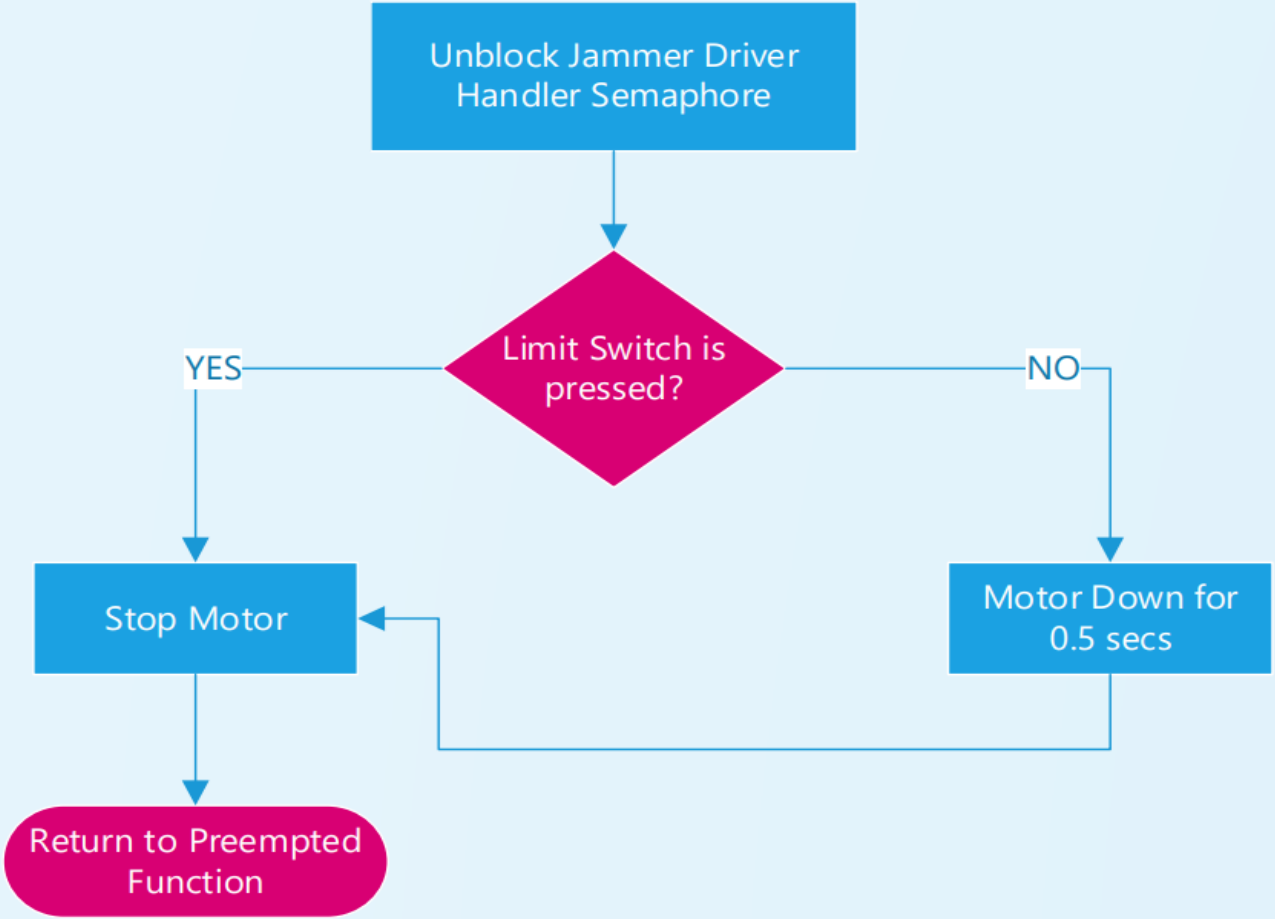

Passenger()
No
Was already in passenger
Locked?
yes
Ignore any commands
no
Yield()
Pressed jam Button?
no
Pressed on Manual Button Up?
no
Pressed on Manual Button Down
no
Press Auto Button Up
no
Press Auto Button Down
yes
Give Semaphore and Service Jam Passenger Handler
yes
Send Command=1 to Passenger Motor Queue
yes
Send Command =2 to Passenger Motor Queue
yes
Send Command =1 to Passenger Motor Queue
yes
Send Command = 2 to Passenger Motor Queue

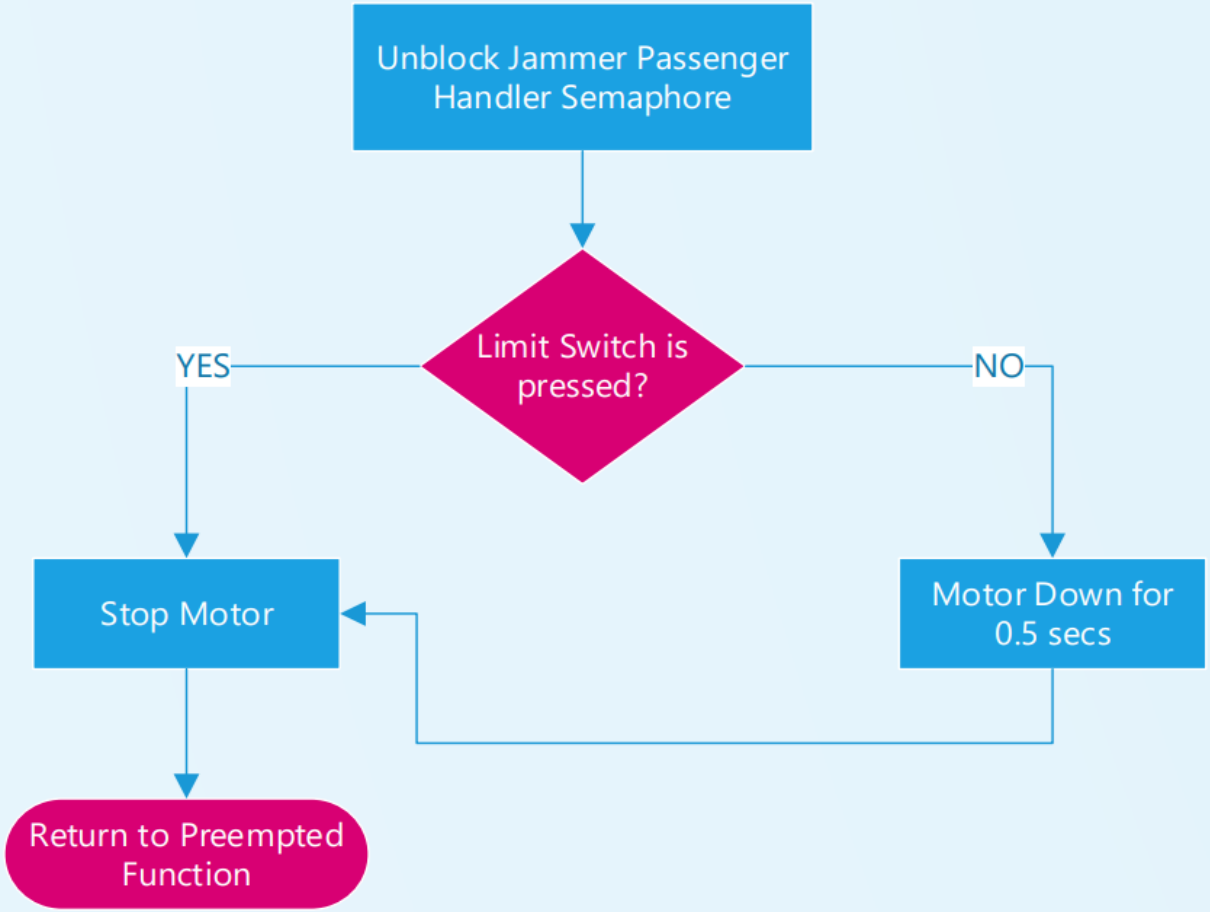

YES
Driver()
Was already in passenger
Yield()
Pressed jam Button?
no
yes
Give Semaphore and service Jam Driver Handler
Check if the Lock button was Pressed
no
yes
Lock =1
no
Lock = 0
Pressed on Manual Driver Button Up?
no
yes
Send Command=1 to Driver Motor Queue
Pressed on Manual Driver Button Down?
no
yes
Send Command =2 to Driver Motor Queue
Pressed on Auto Driver Button Up?
no
yes
Send Command =1 to Driver Motor Queue
no


Pressed on Auto Driver Button Down
no
yes
Send Command =2 to Driver Motor Queue
Pressed on Passenger Manual Button Up?
yes
Send Command=1 to Passenger Motor Queue
no
Pressed on Passenger Manual Button Down
yes
Send Command =2 to Passenger Motor Queue
no
Pressed Passenger Auto Button Up
yes
Send Command =1 to Passenger Motor Queue
No
Press Passenger Auto Button Down
yes
Send Command =2 to Passenger Motor Queue


Read Command
Driver Jammer Button Pressed?
Yes
No
Give Semaphore to Jammer Driver Handler and service it
Unblocked Driver Motor Queue
Command =1
Command=2
Any other Command
Limit Switch is pressed?
Yes
No
Stop Motor
Move Motor Up
Limit Switch is pressed?
Yes
No
Stop Motor
Move Motor Down
Stops Motor
Return to Driver()


Read Command
Passenger Jammer Button Pressed?
Yes
No
Give Semaphore to Jammer Passenger Handler and service it
Unblocked Passenger Motor Queue
Command =1
Command=2
Any other Command
Limit Switch is pressed?
Yes
No
Stop Motor
Move Motor Up
Limit Switch is pressed?
Yes
No
Stop Motor
Move Motor Down
Stops Motor
Return to Passenger()


Unblock Jammer Driver Handler Semaphore
Limit Switch is pressed?
YES
NO
Stop Motor
Motor Down for 0.5 secs
Return to Preempted Function


Unblock Jammer Passenger Handler Semaphore
Limit Switch is pressed?
YES
NO
Stop Motor
Motor Down for 0.5 secs
Return to Preempted Function

04 Circuit Topologies

Port	Pin	Task
Port D	Pin 0	Driver **automatic** up
	Pin 1	Driver **automatic** down
	Pin 2	Passenger **automatic** up at ***driver***
	Pin 3	Passenger **automatic** down at ***driver***
	Pin 6	Passenger **automatic** up
	Pin 7	Passenger **automatic** down
Port B	Pin 0	Driver **manual** up
	Pin 1	Driver **manual** down
	Pin 2	Passenger **manual** up at ***driver***
	Pin 3	Passenger **manual** down at ***driver***
	Pin 4	Passenger **manual** up
	Pin 5	Passenger **manual** down
Port E	Pin 0	Driver Jammer
	Pin 1	Passenger Jammer
	Pin 2	Lock switch
	Pin 3	driver motor control
	Pin 4	
Port A	Pin 2	Passenger motor control
	Pin 3	
	Pin 6	Passenger up Limit switch
	Pin 7	Passenger down Limit switch
	Pin 5	Driver up Limit switch
Port C	Pin 5	Driver down Limit switch

05 Test Cases

Handling of all test and corner cases

Pressing Manual and Automatic buttons at the same time test cases:

Test case 1

Pressing driver manual up button and driver manual down button at the same time:

The driver motor keeps on toggling between up and down a will neither move up nor down.

Test case 2

Pressing passenger manual up button and passenger manual down button of the at the same time:

The passenger motor keeps on toggling between up and down a will neither move up nor down.

Pressing Manual and Automatic buttons at the same time test cases:

Test case 3

Pressing driver automatic up button and driver manual down button at the same time:
The driver motor will not continue the automatically up.

Test case 4

Pressing automatic button down and manual button up of the passenger's motor at the same time from the driver seat: The passenger motor keeps on toggling between up and down a will neither move up nor down.

Pressing Manual and Automatic buttons at the same time test cases:

Test case 5

Pressing automatic button down and manual button up of the passenger's motor at the same time from the passenger seat: When we press automatic passenger down from the driver seat and manual passenger up the motor keeps on toggling.

Test case 6

Pressing automatic up and manual button down of the passenger's motor at the same time from the passenger seat: When we press automatic passenger up from the passenger seat and manual passenger up the motor keeps on toggling.

Pressing Manual and Automatic buttons at the same time test cases:

Test case 7

Pressing driver's manual up button from driver seat and passenger's manual up button from passenger seat at the same time: The two commands will work at the same time because the operations is on different motors : driver manual up will rotate the driver motor and passenger manual up will rotate the passenger motor.

Test case 8

Pressing driver's manual up button from driver seat and passenger's manual up button from driver seat at the same time: The two commands will work at the same time because the operation is on different motors : driver manual up will rotate the driver motor and passenger manual up will rotate the passenger motor.

Lock switch test cases:

Test case 9

Pressing the driver manual up/down button and then press lock switch:

The driver motor will keep moving although the lock switch is pressed.

Test case 10

Pressing the driver automatic up/down button and then press lock switch:

The driver motor will keep moving although the lock switch is pressed.

Pressing Manual and Automatic buttons at the same time test cases:

Test case 11

Pressing the passenger manual up/down button from driver seat and then press lock switch:

The passenger motor will keep moving although the lock switch is pressed.

Test case 12

Pressing the passenger manual up/down button from passenger seat and then press lock switch:

The passenger motor will stop suddenly once the lock switch is pressed.

Pressing Manual and Automatic buttons at the same time test cases:

Test case 13

Pressing the passenger automatic up/down button from driver seat and then press lock switch:

The passenger motor will keep moving although the lock switch is pressed.

Test case 14

Pressing the passenger automatic up/down button from passenger seat and then press lock switch:

The passenger motor will stop suddenly once the lock switch is pressed.

Pressing Manual and Automatic buttons at the same time test cases:

Test case 15

Pressing driver manual up/down button then press on the limit switch:

The driver motor stops immediately.

Pressing driver automatic up/down button then press on the limit switch :

The driver motor stops immediately.

Test case 16

Pressing Manual and Automatic buttons at the same time test cases:

Test case

Pressing passenger manual up/down button then press on the limit switch :

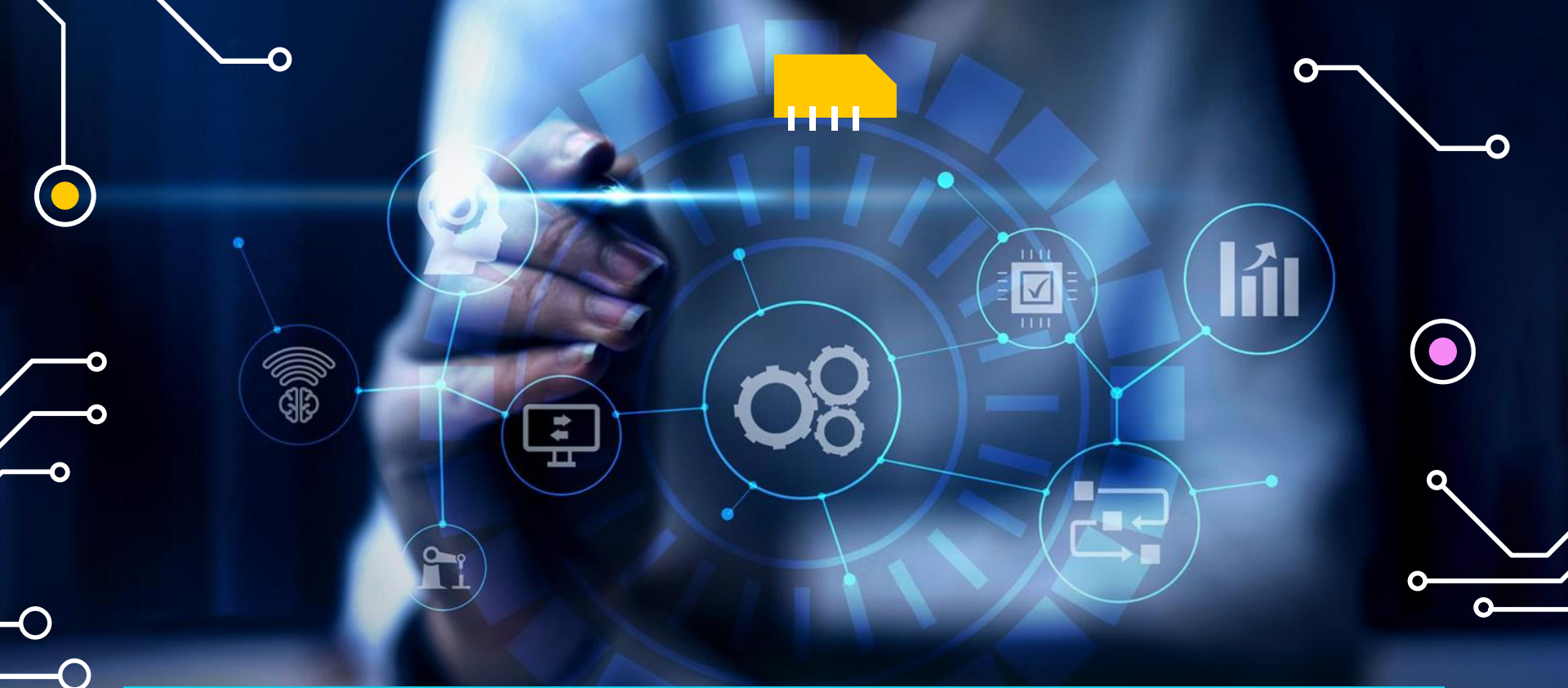
The passenger motor passenger motor stops immediately.

Pressing passenger automatic up/down button then press on the limit switch :

The passenger motor passenger motor stops immediately.

Test case

Thank you!



Video link: https://drive.google.com/drive/folders/1dKJS2xDelPNm4Ivim2-D1Eu2wW9jiyvp?usp=share_link