CSE_411
Real-Time and Embedded Systems Design

POWER WINDOW CONTROL SYSTEM USING TIVA C RUNNING FREE RTOS

Team 11

GitHub: https://github.com/MarioRemon/Real-Time-Embedded-System-CarWindow-Project.git
Short Video:
https://drive.google.com/file/d/1n2miBNicCTzd_dc_X1njDECevYE3PqOu/view?usp=drivesdk

Role of each team member

Mario Remon Girguis
19p6892
Car Handler

Mai Hossam Hassan
19p6129
Jam

Team 11

Hardware was done by all of us

Nour Hany Abdallah
19p4089
Up/Down Automatic

Malak Mohammed Metwalli
19p7787
Up/Down Manual

Submitted to: Dr. Sheriff Hammad
Eng. Mohammed Tarek

Project Description

The objective of this project is to design and implement a power window system for the front passenger door of a car. The system should allow both the driver and passenger to control the window, with basic features including manual open/close, one-touch auto open/close, window lock, and jam protection. The system should also include two limit switches to prevent the window motor from exceeding the top and bottom limits of the window. The implementation of FreeRTOS is required to ensure real-time performance and reliable operation.

In our system, we implemented the four basic features:

1. **Manual open/close function**
   To implement the manual function, we used 4 push buttons. For both the driver and passenger, there is a push button to move the window up and another one to move it down. If the button is pressed, the window should be moving up or down depending on which button is pressed, stop only either if the limit switch is pressed (the window hit the limit), or when the button is not pressed, the window should stop.

2. **One touch auto open/close function**
   To implement the auto function, we used 4 push buttons and 2 limit switches similar to the manual function both the driver and passenger have one button to move the window up and the other button to move it down. Once the key is pressed, the window moves and stop only if the limit switch is pressed (the window hit the limit).

3. **Window lock function**
   The lock function is implemented with an ON/OFF switch. If the lock is set to OFF (locked/ pin reads 1), only the driver can move the window and the passenger can't. If it is set to ON (not locked/ pin reads 0), both the driver and the passenger can move the window.

4. **Jam protection function**
   In jam function, we implemented it using a push button. If this button is pressed at any time while the program is running, it should go immediately to the jam function as it has higher priority than all tasks. in the jam protection function, the direction of the motor is reversed for 500ms then it stops.

Ports Used

Input Buttons

Port D – pin 0: passenger window up automatic

pin 1: passenger window down automatic

pin 2: passenger window up automatic at Driver Side

pin 3: passenger window down automatic at Driver Side

pin 6: Jam Button

pin 7: ON/OFF Switch

Port A – pin 2: passenger window up manual

pin 3: passenger window down manual

pin 4: passenger window up manual at Driver Side

pin 5: passenger window down manual at Driver Side

Motor & Limit switches

Port B – pin 0: motor direction up

pin 1: motor direction down

pin 3: limit switch top

pin 4: limit switch bottom

Queues

Binary Semaphore

Passenger Auto Up

P Manual Up

P Auto Down

P Manual Down

Driver Auto Up

D Manual Up

D Auto Down

D Manual Down

Tasks

Car Handler – priority 1

Passenger Auto Up – priority 2

P Manual Up – priority 2

P Auto Down – priority 2

P Manual Down – priority 2

Jam Protection – priority 3

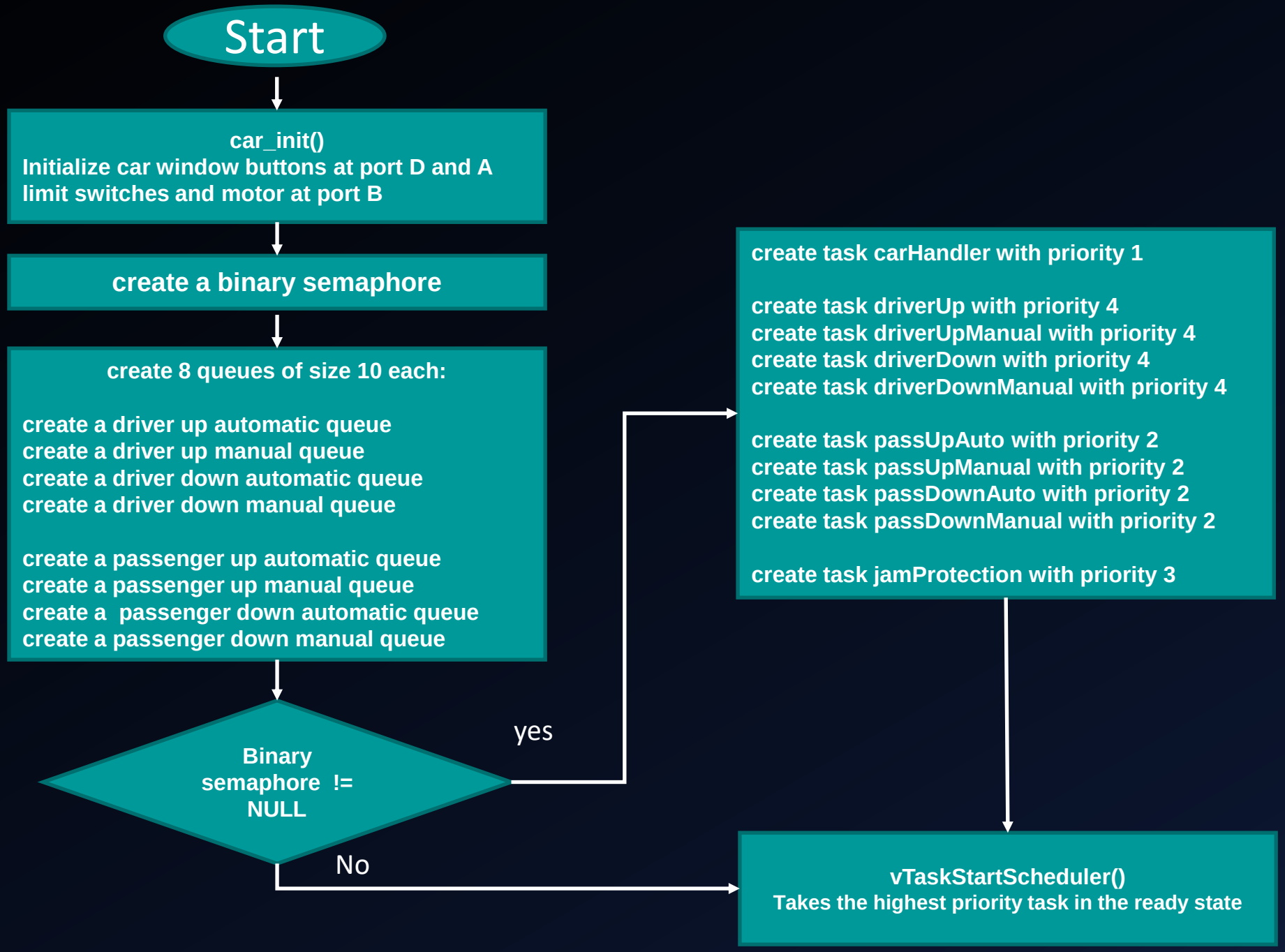
Driver Auto Up – priority 4

D Manual Up – priority 4

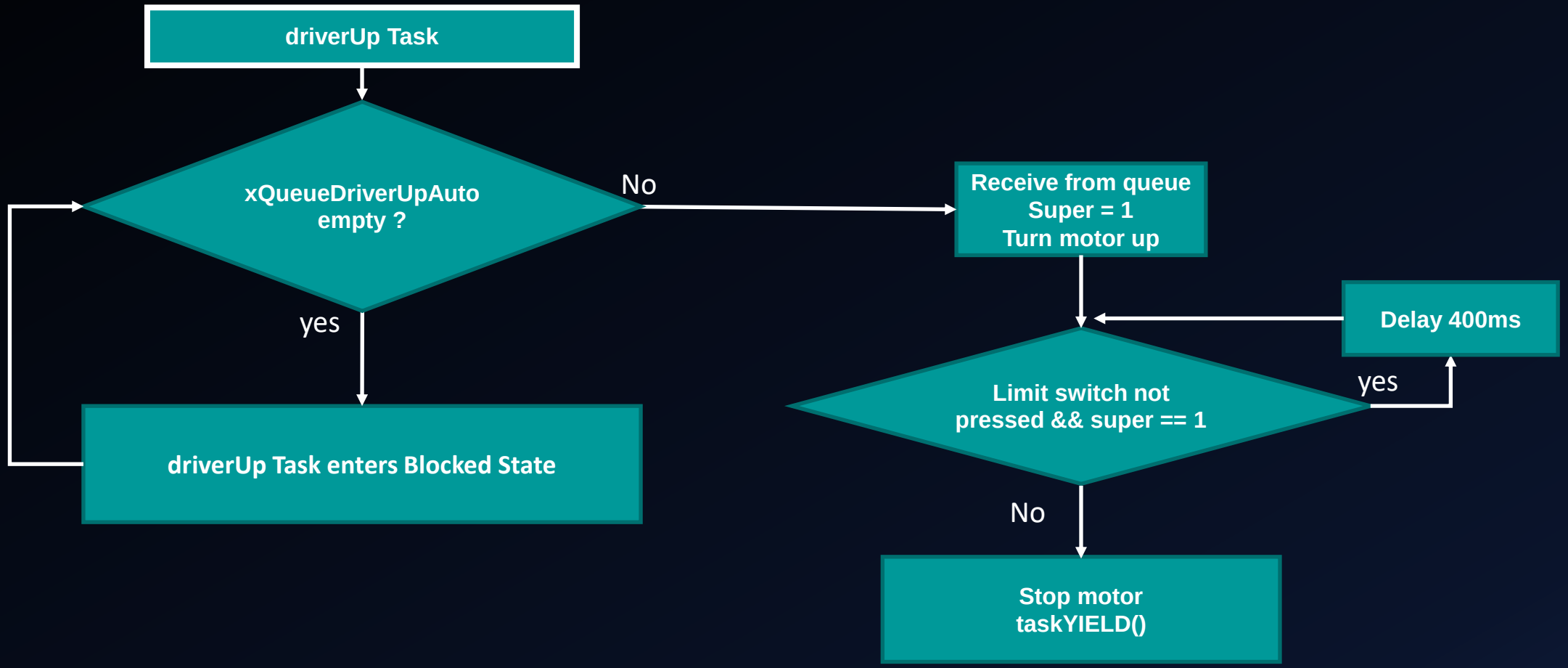
D Auto Down – priority 4

D Manual Down – priority 4

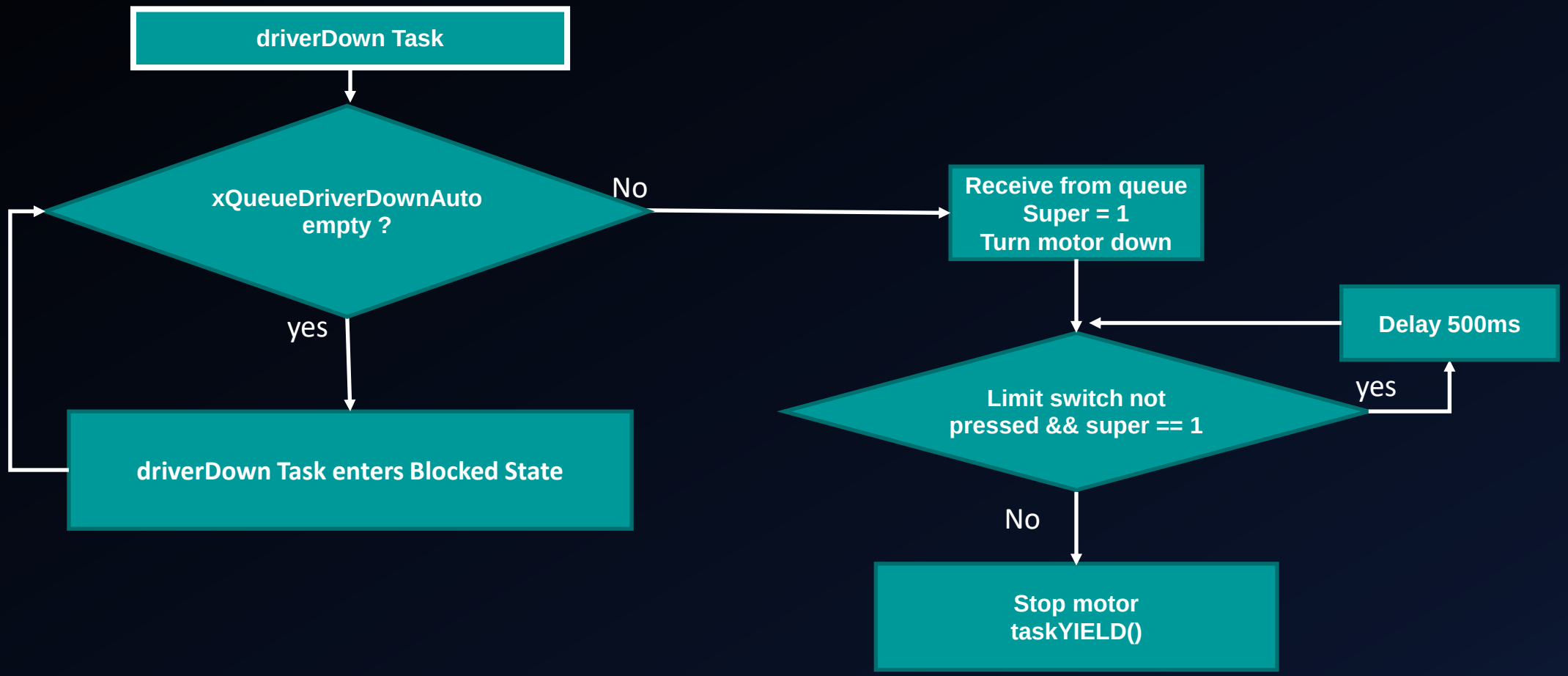
main()


Start
car_init()
Initialize car window buttons at port D and A
limit switches and motor at port B
create a binary semaphore
create 8 queues of size 10 each:
create a driver up automatic queue
create a driver up manual queue
create a driver down automatic queue
create a driver down manual queue
create a passenger up automatic queue
create a passenger up manual queue
create a passenger down automatic queue
create a passenger down manual queue
Binary semaphore != NULL
yes
No
create task carHandler with priority 1
create task driverUp with priority 4
create task driverUpManual with priority 4
create task driverDown with priority 4
create task driverDownManual with priority 4
create task passUpAuto with priority 2
create task passUpManual with priority 2
create task passDownAuto with priority 2
create task passDownManual with priority 2
create task jamProtection with priority 3
vTaskStartScheduler()
Takes the highest priority task in the ready state

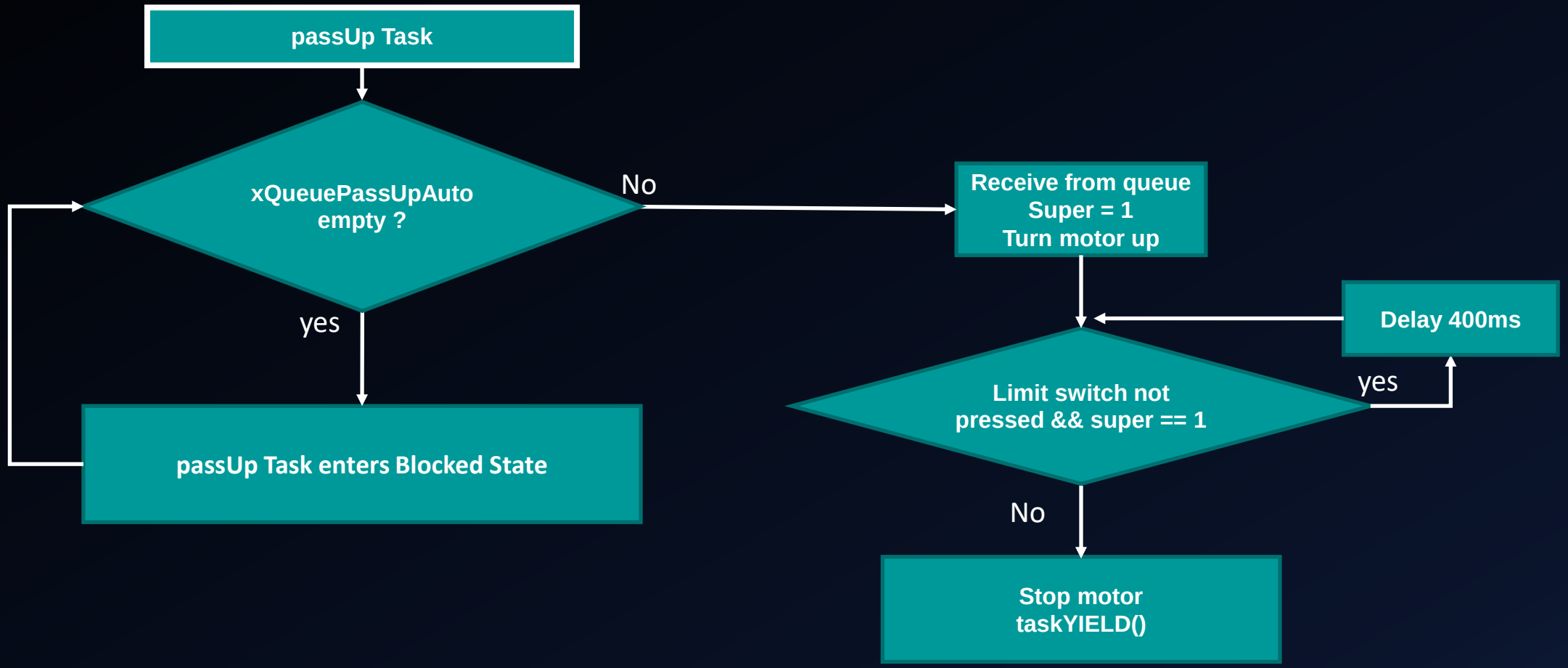
Driver Up Auto



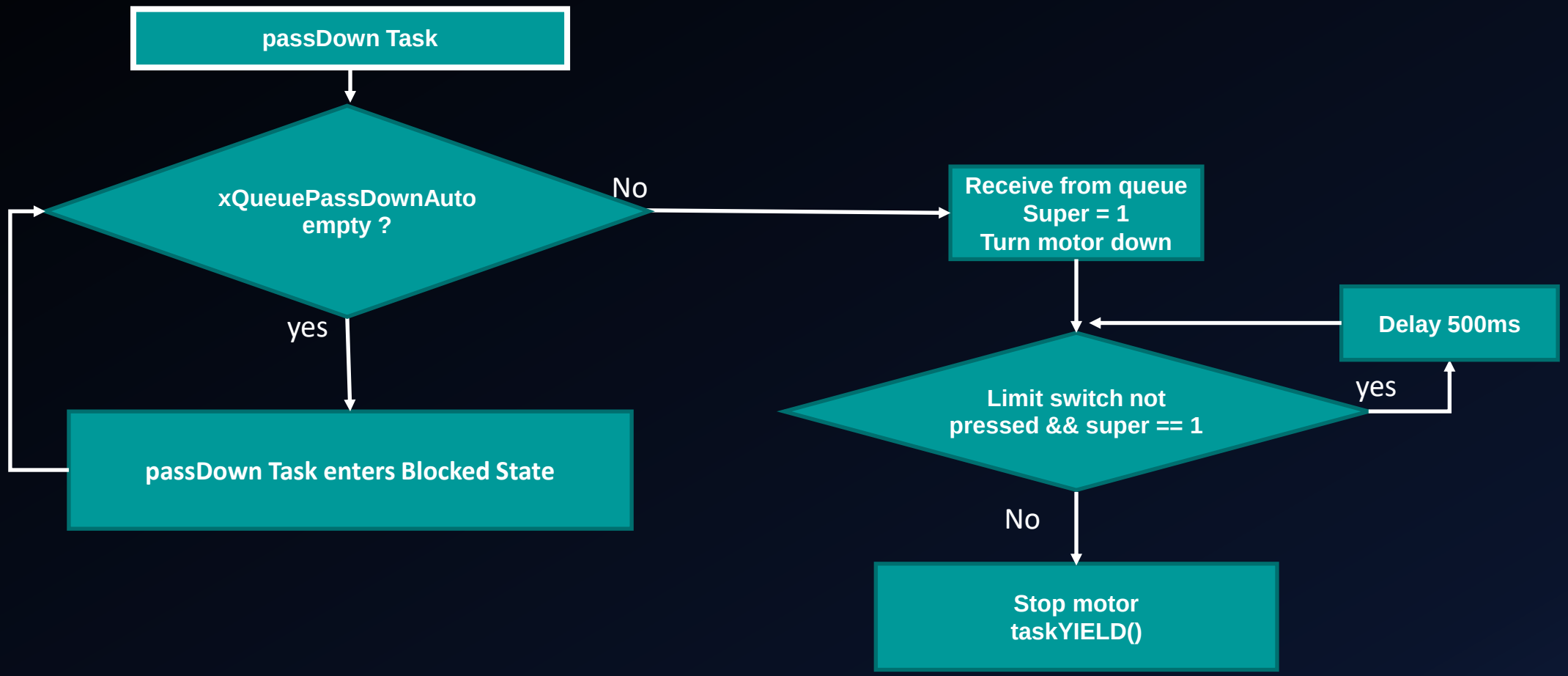
Driver Down Auto



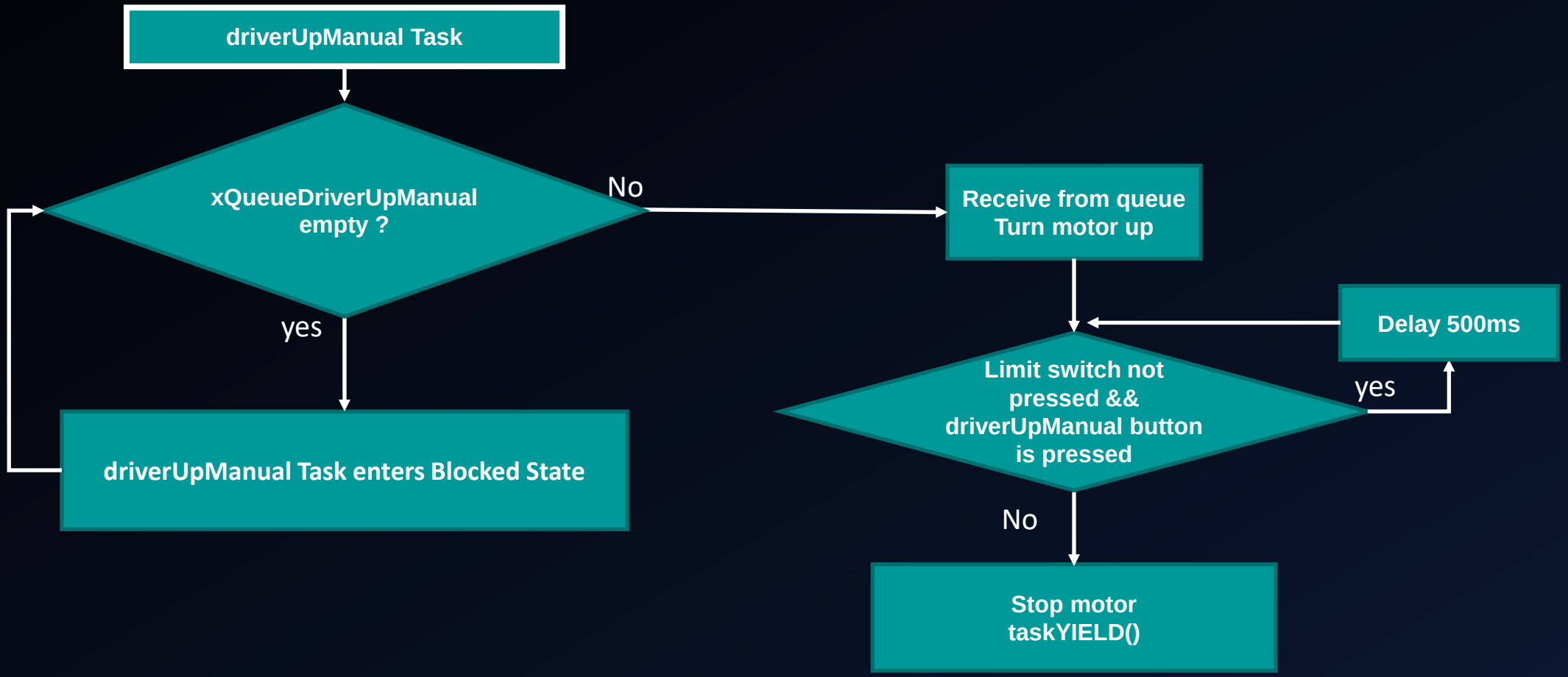
Passenger Up Auto



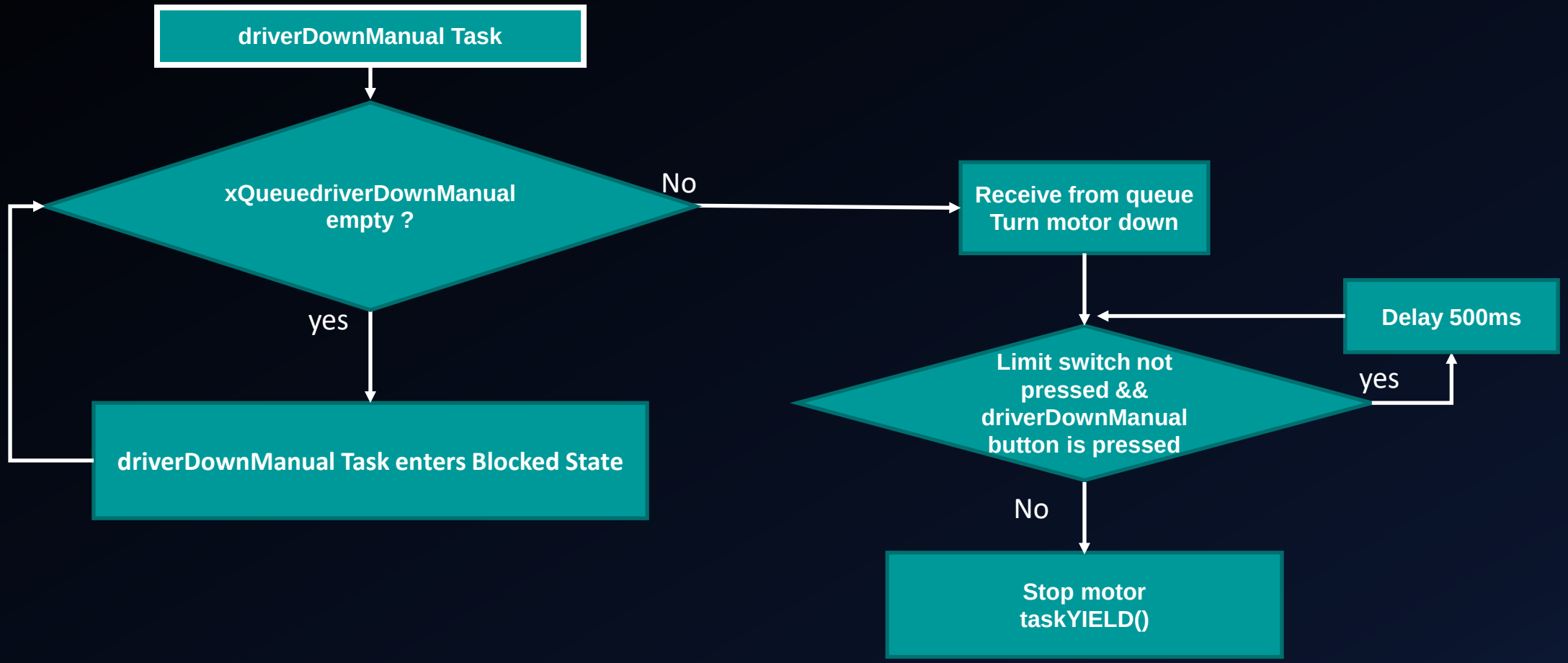
Passenger Down Auto



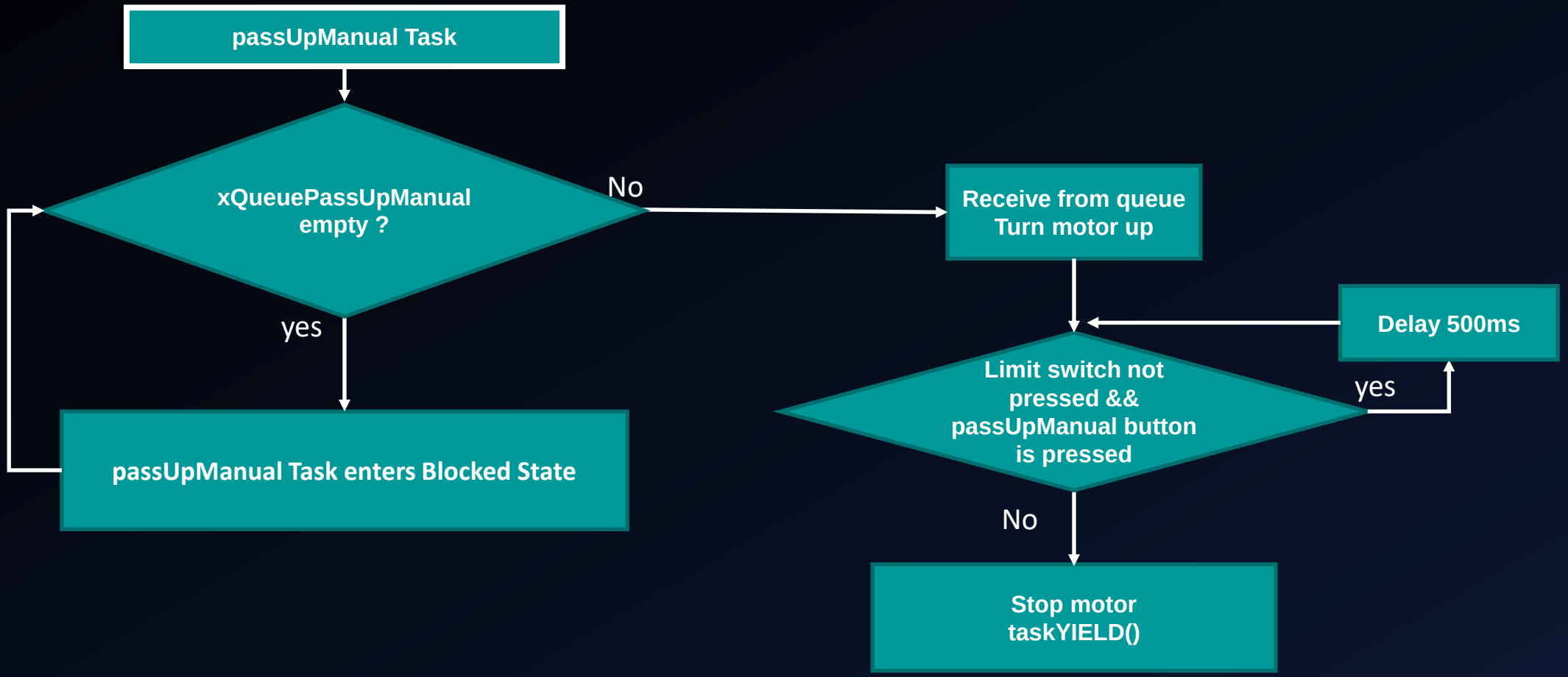
Driver Up Manual



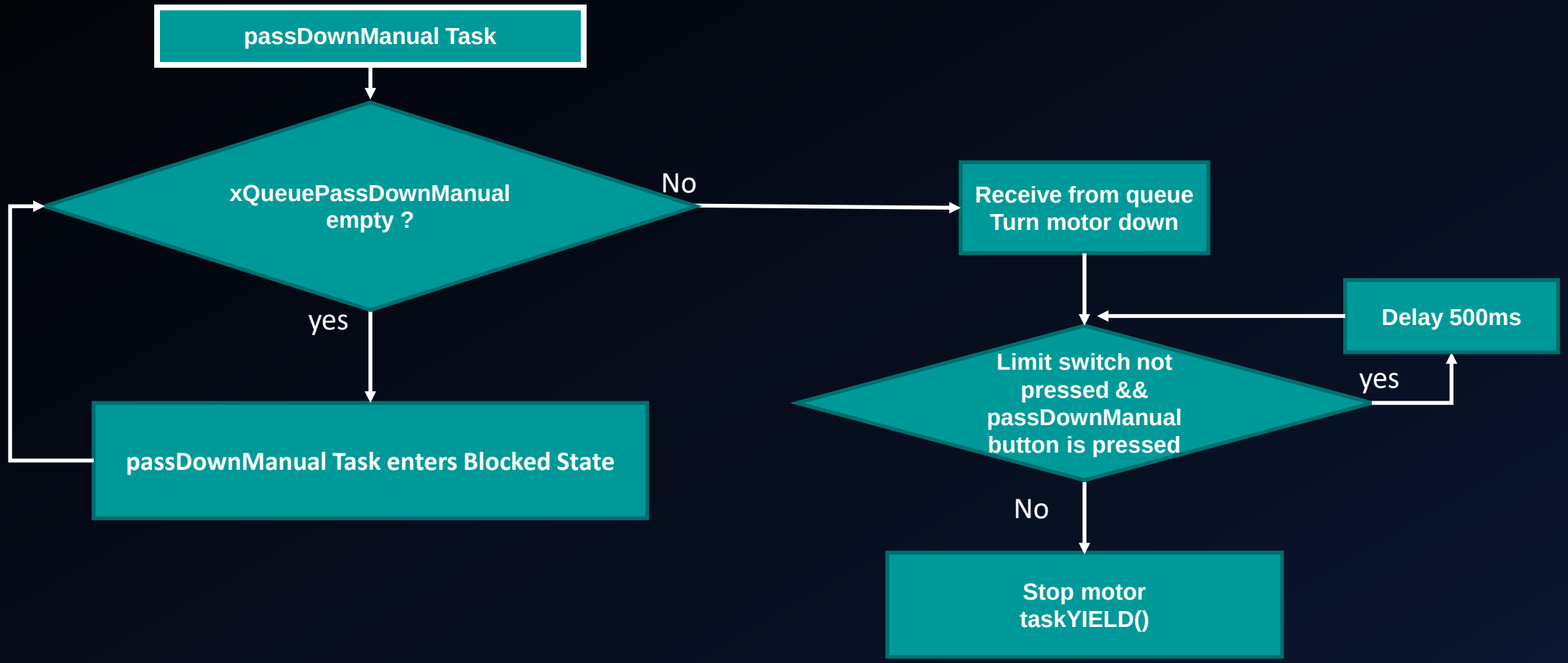
Driver Down Manual



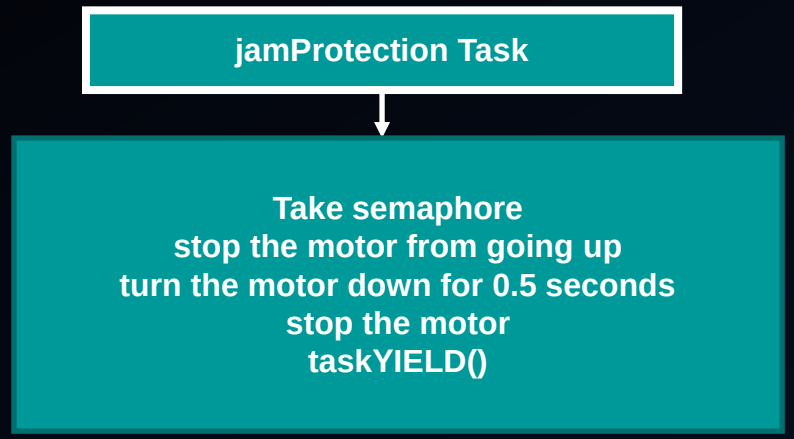
Passenger Up Manual



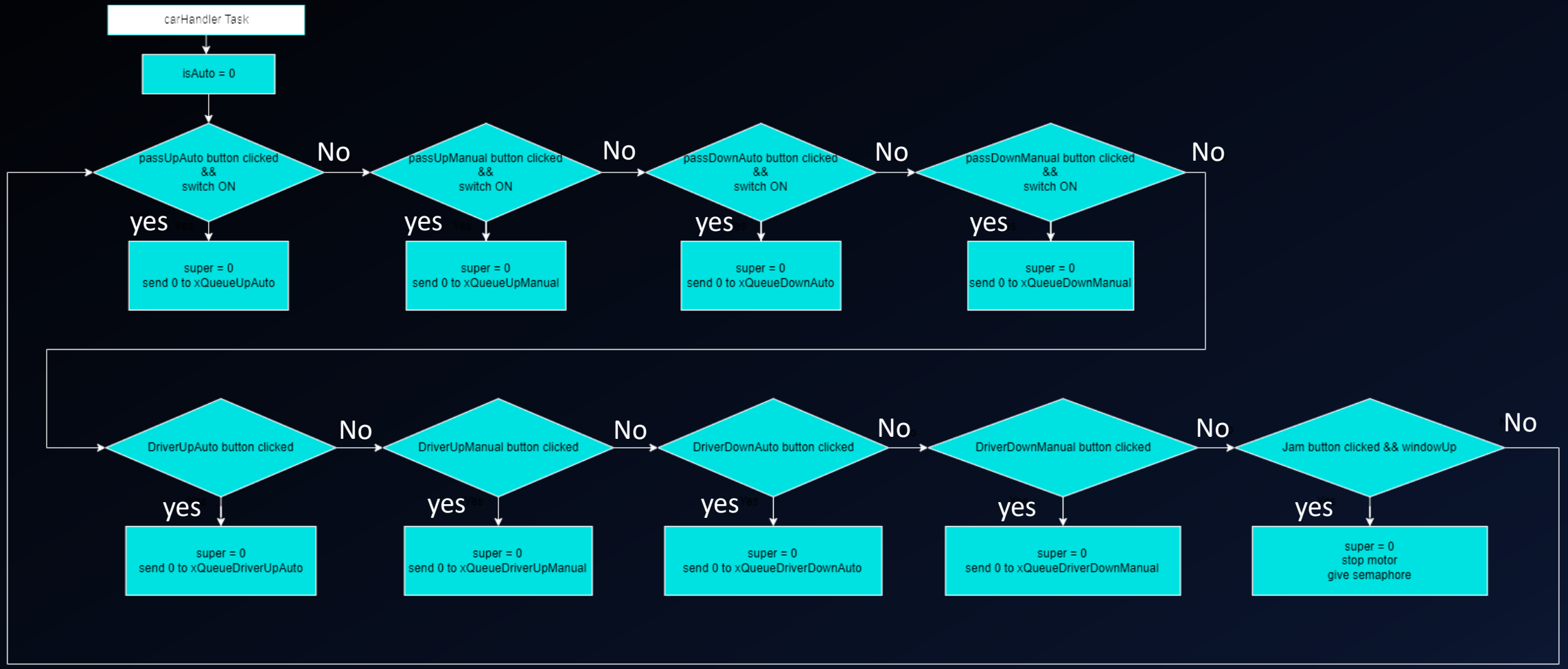
Passenger Down Manual



Jam Protection



Car Handler


carHandler Task
isAuto = 0
passUpAuto button clicked && switch ON
No
yes
super = 0
send 0 to xQueueUpAuto
passUpManual button clicked && switch ON
No
yes
super = 0
send 0 to xQueueUpManual
passDownAuto button clicked && switch ON
No
yes
super = 0
send 0 to xQueueDownAuto
passDownManual button clicked && switch ON
No
yes
super = 0
send 0 to xQueueDownManual
DriverUpAuto button clicked
No
yes
super = 0
send 0 to xQueueDriverUpAuto
DriverUpManual button clicked
No
yes
super = 0
send 0 to xQueueDriverUpManual
DriverDownAuto button clicked
No
yes
super = 0
send 0 to xQueueDriverDownAuto
DriverDownManual button clicked
No
yes
super = 0
send 0 to xQueueDriverDownManual
Jam button clicked && windowUp
No
yes
super = 0
stop motor
give semaphore

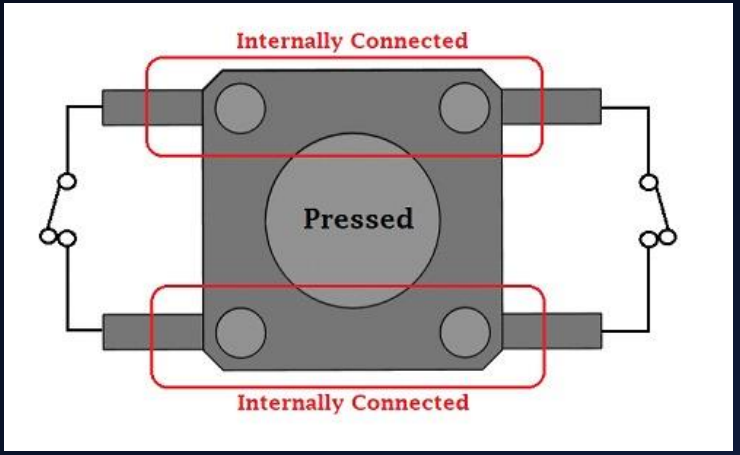
Circuit Topology:

1. Push Button:

One side for VCC and the other side is for the output which is connected to a pin in the Tiva-c

Automatic – Port D

- (Passenger side) Passenger window up automatic – pin D0
- (Passenger side) Passenger window down automatic – pin D1
- (Driver side) Passenger window up automatic – pin D2
- (Driver side) Passenger window down automatic – pin D3
- The jam flag, if the window finds an obstacle while it is going up. – pin D6



Manual – Port A

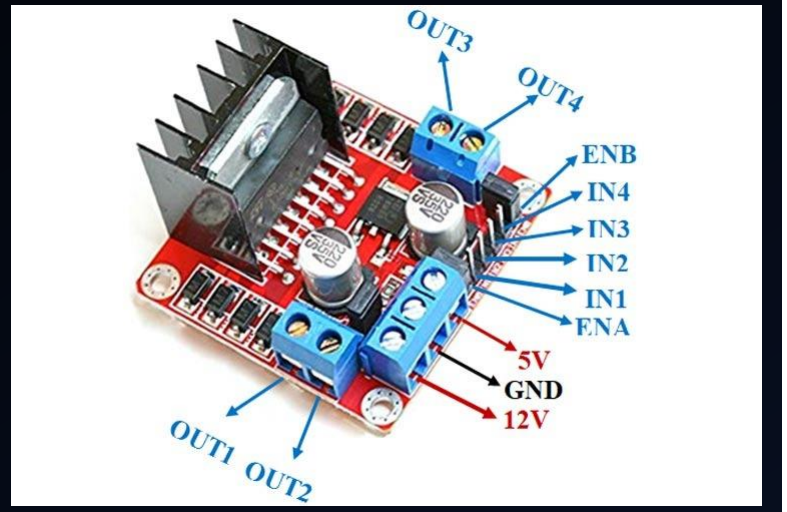
- (Passenger side) Passenger window up Manual – pin A2
- (Passenger side) Passenger window down Manual – pin A3
- (Driver side) Passenger window up Manual – pin A4
- (Driver side) Passenger window down Manual – pin A5

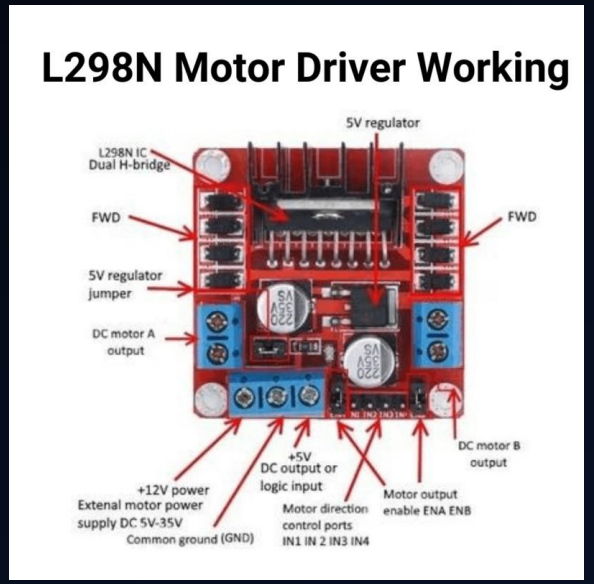
2. Limit Switch

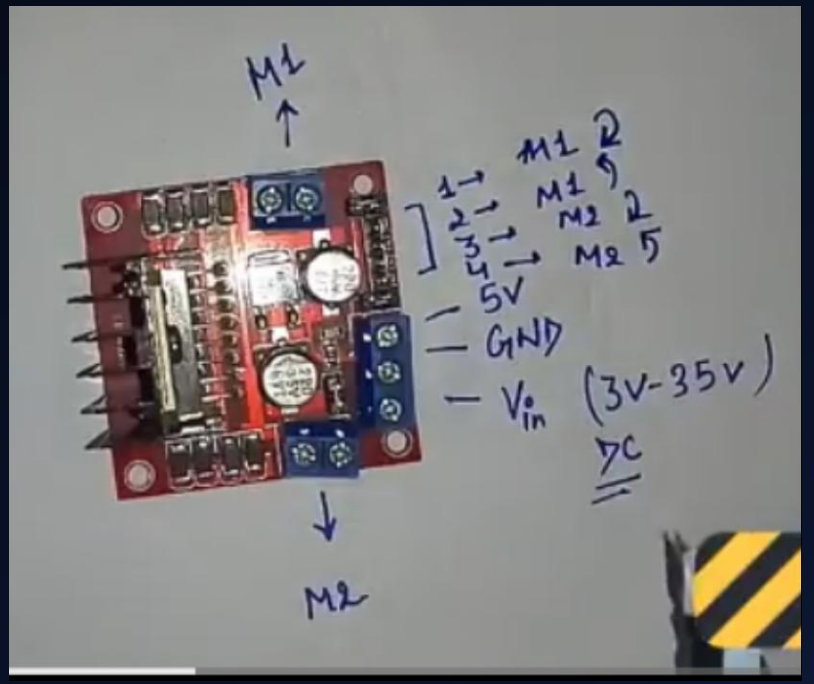
- The small pin down is connected to VCC
- The upper pin, output (when pressed, it sends 1)
- The most upper pin, output (when pressed, it sends 0)
- Limit switch at the top the window – pin B3
- Limit switch at the bottom of the window – pin B4

3. Motor Driver:

- We connected the Motor Driver to a 12-v adapter in (Vin) and ground
- We put 5v regulator jumper
- Enable
- M1(output) and connected M1(3,4) to B0,B4







4. Motor

- If we want to motor to go up, we send zero to B1, and we send one to B0
- If we want to motor to go down, we send zero to B0, and we send one to B1

5. ON/OFF Switch

- The middle pin – VCC
- The left one – output
- ON/OFF switch, if it is closed the passenger side doesn't work, while the driver is not affected by this button – Pin D7

TEST CASES:

When ON/OFF switch is off:

1- press passenger automatic up ....wait....press limit switch up>>>>> **Motor stops**

2- press passenger automatic down ....wait....press limit switch down>>>>> **Motor stops**

3- press driver automatic up ....wait....press limit switch up>>>>> **Motor stops**

4- press driver automatic up ....wait....press limit switch up>>>>> **Motor stops**

5- press passenger manual up, **Motor stops** when press limit switch up

6- press passenger manual down, **Motor stops** when press limit switch down

7- press driver manual up, **Motor stops** when press limit switch up

8- press driver manual up, **Motor stops** when press limit switch up

When ON/OFF switch is on

9- press passenger automatic up >>>>> **Nothing changes, Motor stay still**

10- press passenger automatic down>>>>> **Nothing changes, Motor stay still**

11- press passenger manual up >>>>> **Nothing changes, Motor stay still**

12- press passenger manual down >>>>> **Nothing changes, Motor stay still**

13- press driver automatic up ....wait....press limit switch up>>>>> **Motor stops**

14- press driver automatic up ....wait....press limit switch up>>>>> **Motor stops**

15-press driver manual up, **Motor stops** when press limit switch up

16- press driver manual up, **Motor stops** when press limit switch up

When Limit switch is pressed:

17- press passenger automatic up >>>>> **Nothing changes, Motor stay still**

18- press passenger automatic down>>>>> **Nothing changes, Motor stay still**

19- press passenger manual up >>>>> **Nothing changes, Motor stay still**

20- press passenger manual down >>>>> **Nothing changes, Motor stay still**

21- press driver automatic up >>>>> **Nothing changes, Motor stay still**

22- press driver automatic up >>>>> **Nothing changes, Motor stay still**

23-press driver manual up >>>>> **Nothing changes, Motor stay still**

24- press driver manual up >>>>> **Nothing changes, Motor stay still**

Priority list

- Passenger up auto
- Passenger up manual
- Passenger down auto
- Passenger down manual
- Driver up auto
- Driver up manual
- Driver down auto
- Driver down manual
- Jam

Corner Cases

25- Press Passenger up auto, **motor will go up**, then press Passenger down auto, **wait**, **motor will go down**

26- Press Passenger down auto**, motor will go down,** then press Passenger up auto, **wait**, **motor will go up**

27- Press Passenger up manual, **motor will go up**, then press Passenger down manual, motor will go down

28- Press Passenger down manual, **motor will go down**, then press Passenger up manual, **motor will go up**

29- Press Passenger up auto, **motor will go up**, then press Driver down auto**, wait**, **motor will go down**

30- Press Passenger down auto, **motor will go down**, then press Driver up auto**, wait**, **motor will go up**

Corner Cases

31- Press Passenger up manual, **motor will go up**, then press Driver down manual**, motor will go down**

32- Press Passenger down manual, **motor will go down**, then press Driver up manual**, motor will go up**

33- Press Driver up auto, **motor will go up**, then press Driver down auto, **wait**, **motor will go down**

35- Press Driver down auto**, motor will go down,** then press Driver up auto, **wait**, **motor will go up**

36- Press Driver up manual, **motor will go up**, then press Driver down manual, motor will go down

37- Press Driver down manual, **motor will go down**, then press Driver up manual, **motor will go up**

Thank you