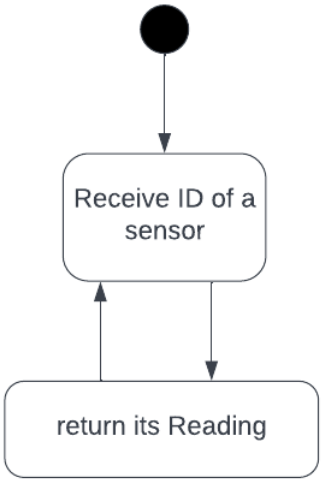
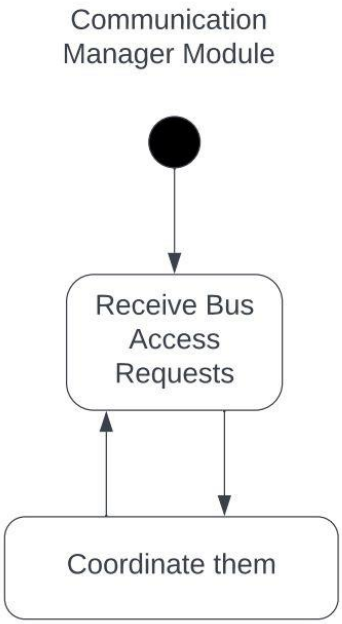
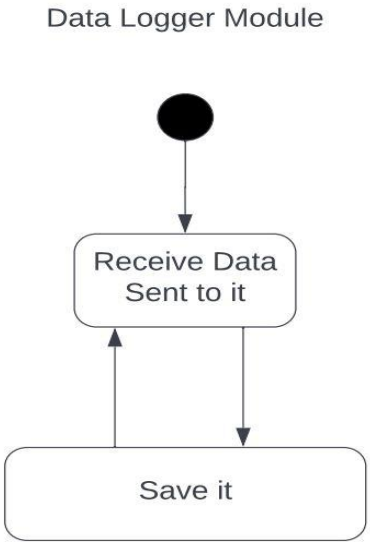
Dynamic Design Analysis

ECU 1

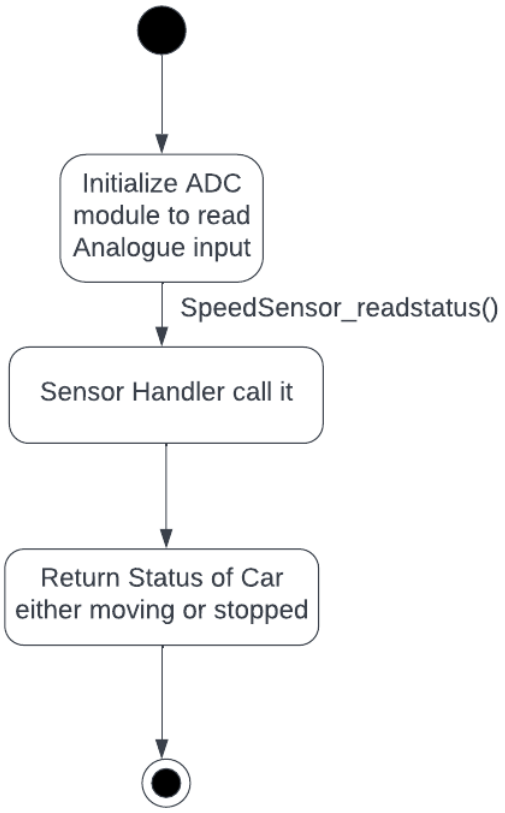
1. State Machine Diagram for each ECU component:



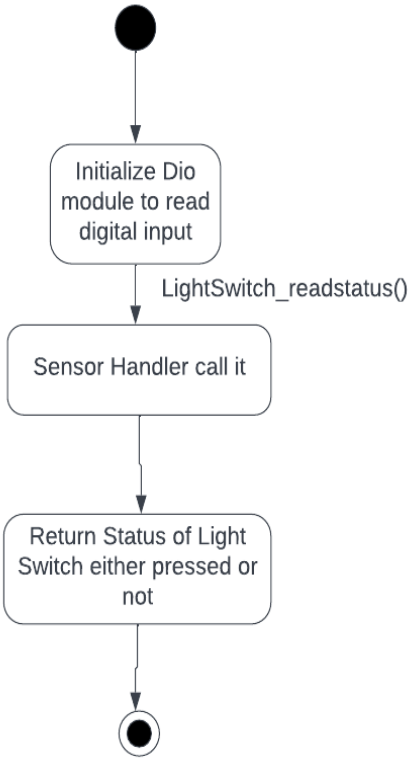




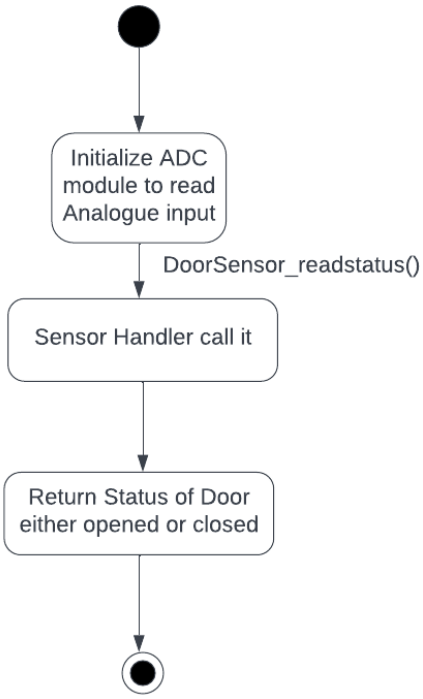
Speed Sensor Module



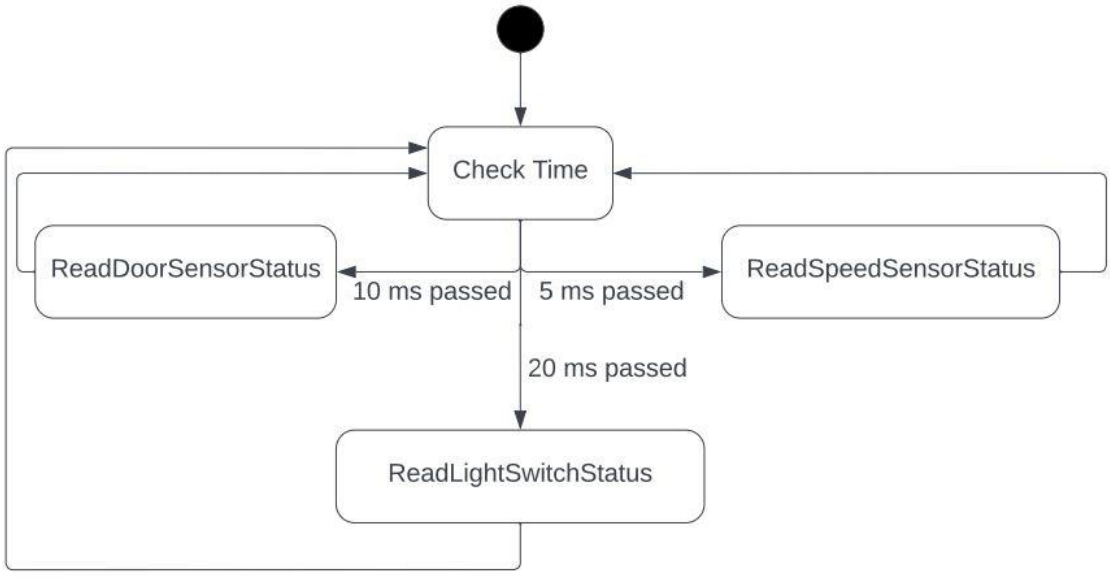
Light Switch Module

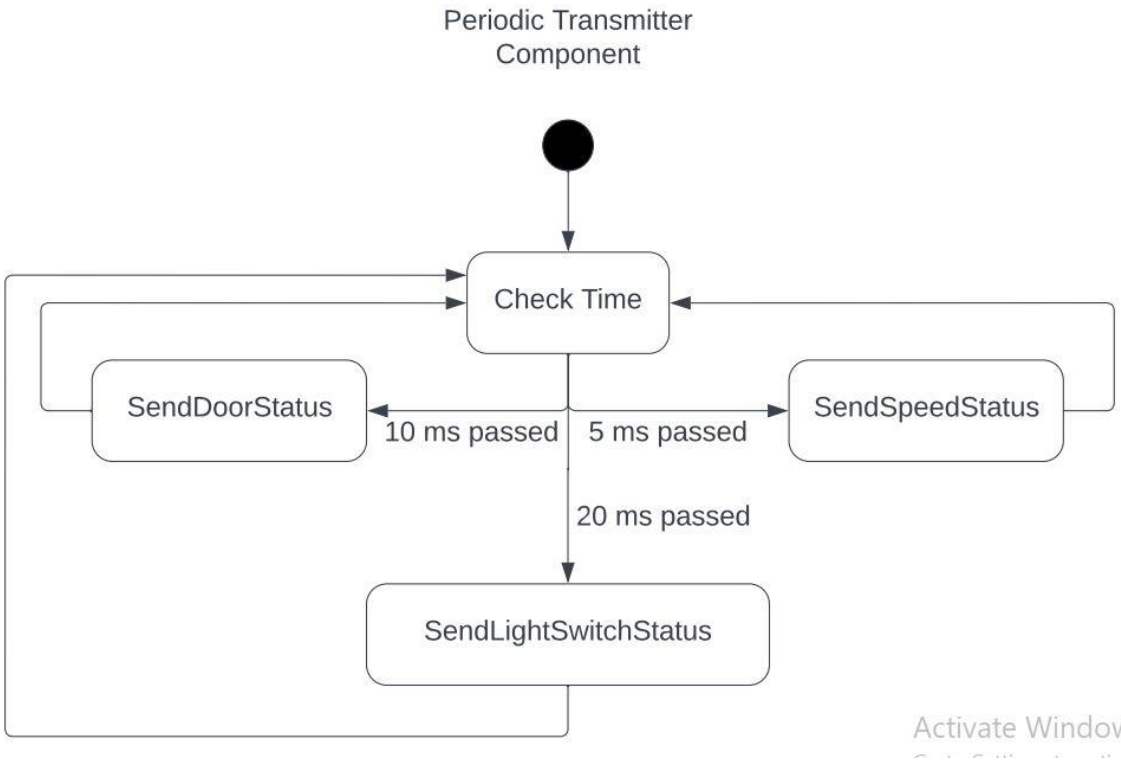


Door Sensor Module

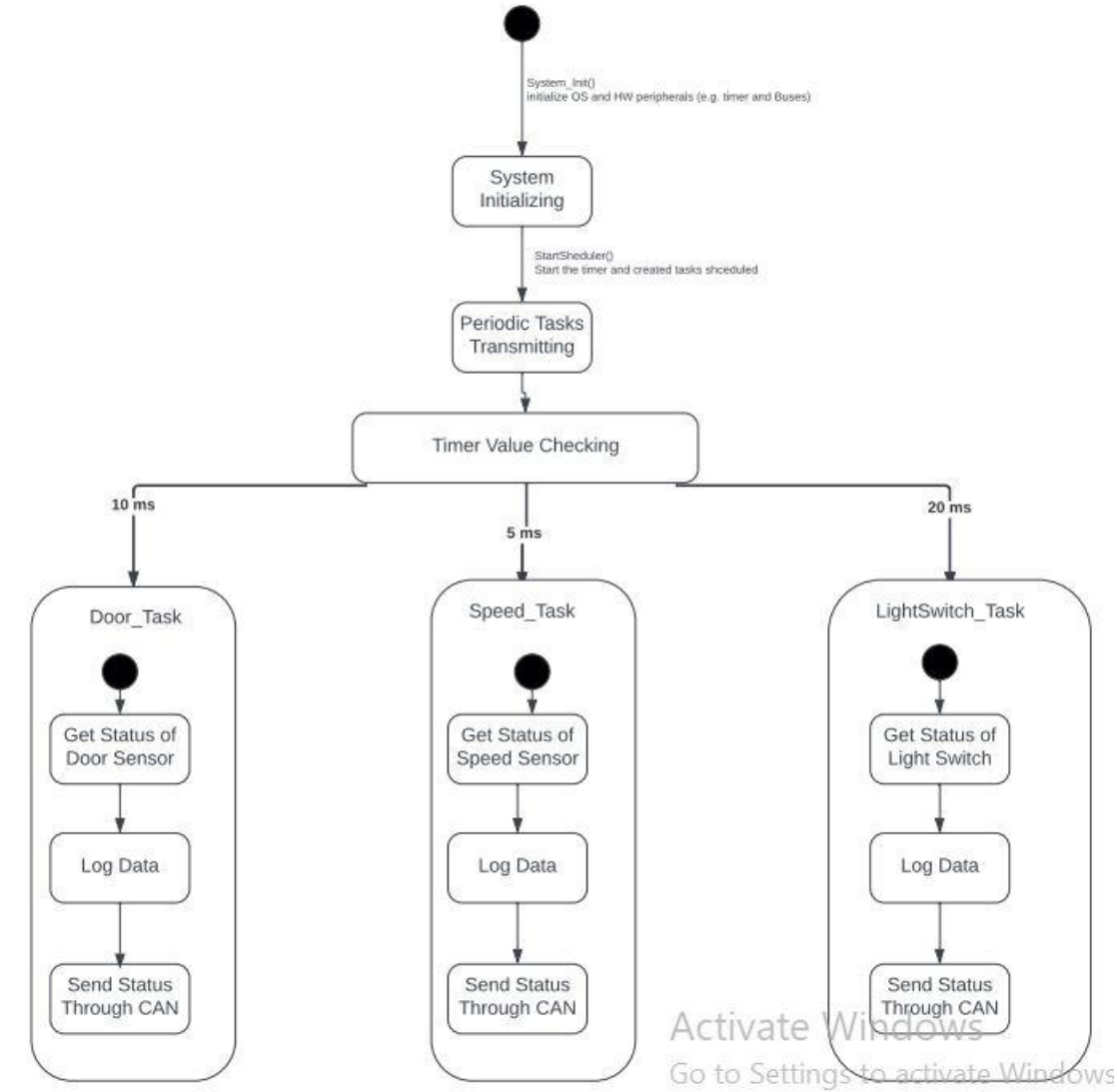


Monitoring Sensors Module

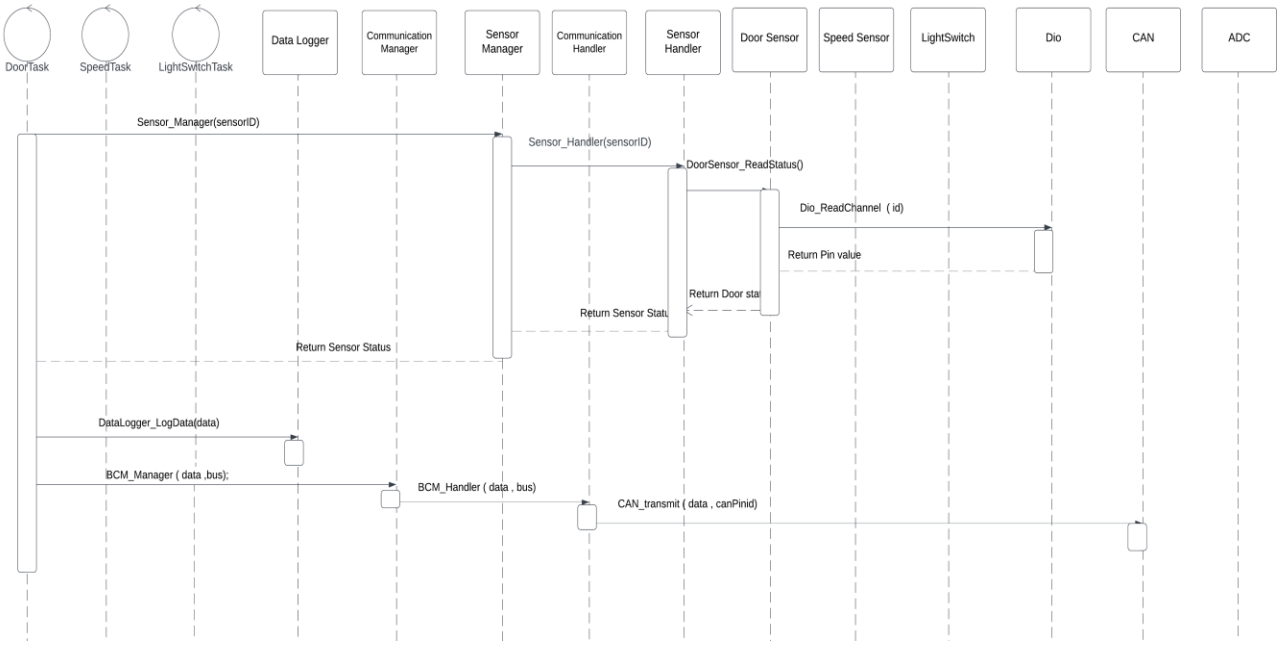


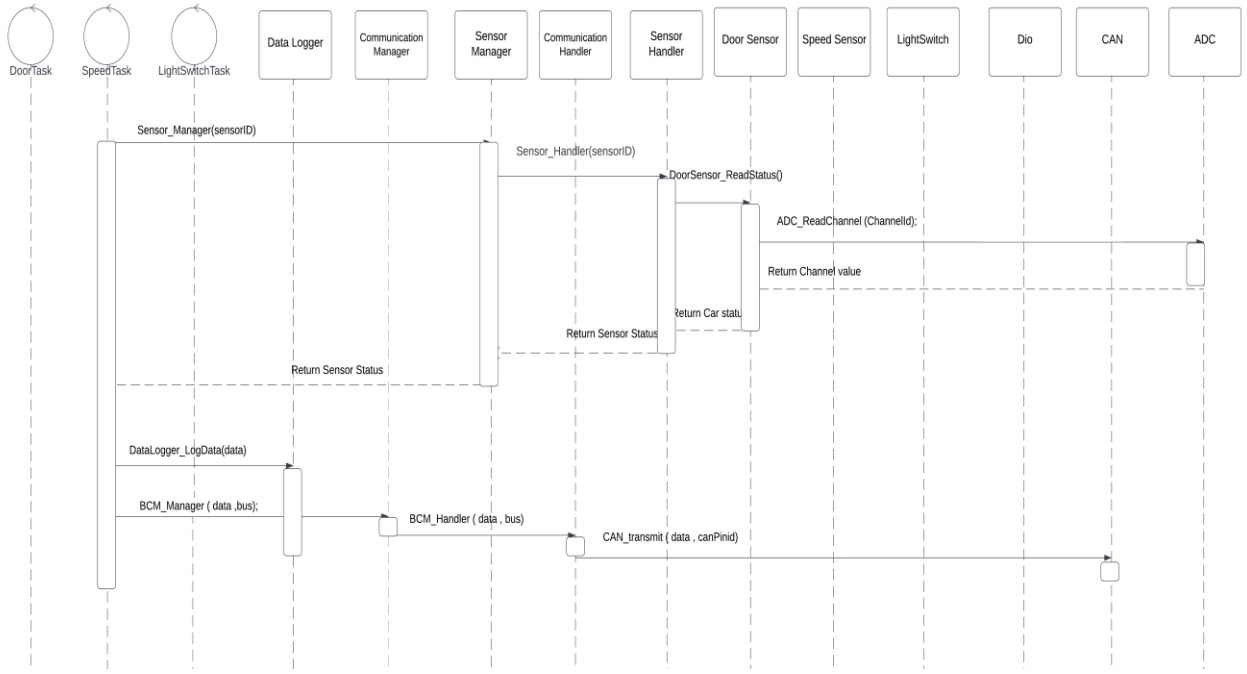


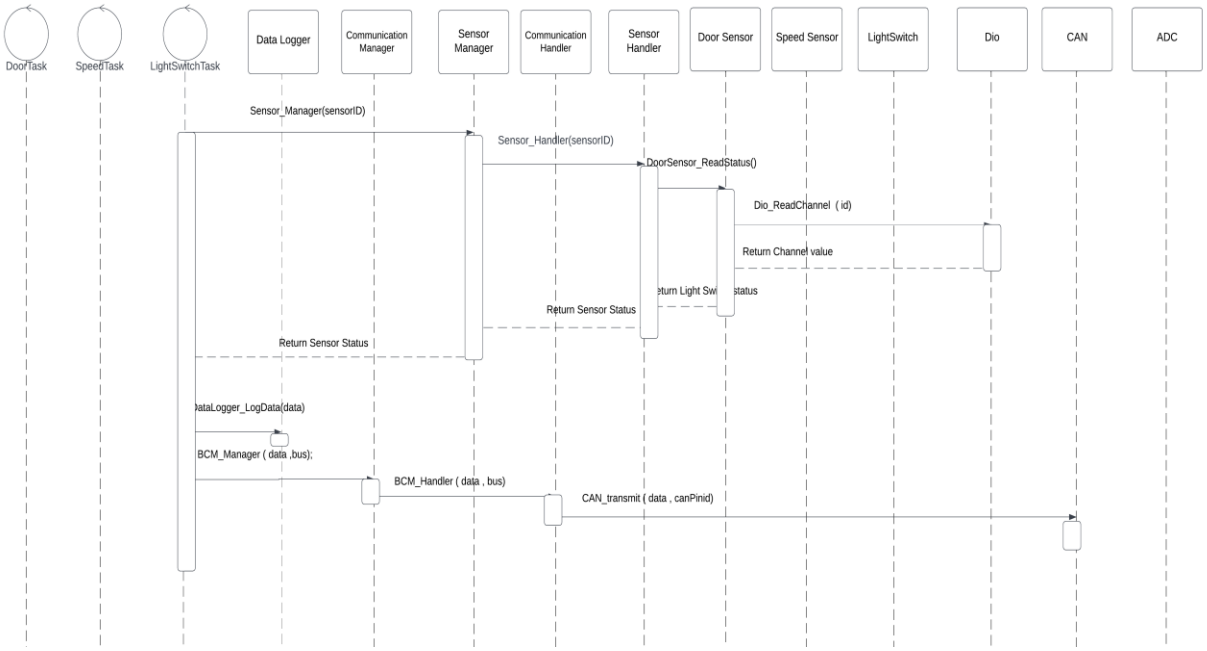
2. State Machine Diagram for ECU Operation:



3. Sequence Diagram for ECU:





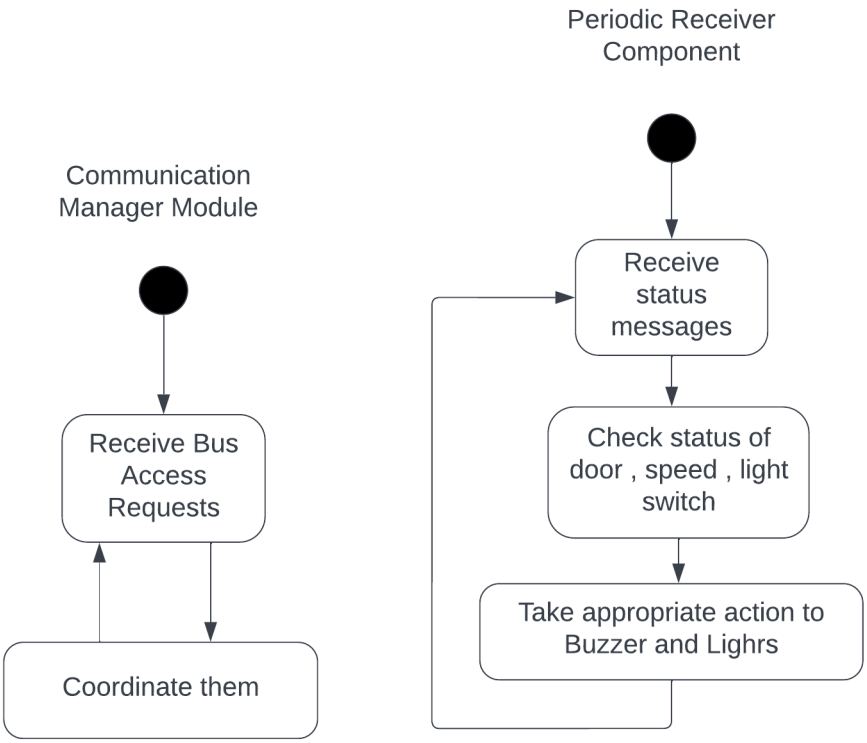


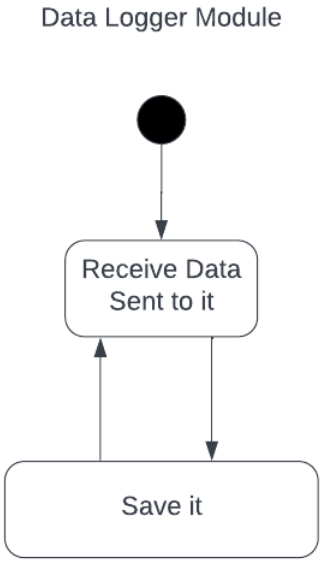
4. <u>CPU Load for ECU:</u>

We have three tasks: (Assuming Execution time)
T1: {Periodicity: 10 ms , Execution Time : 1 ms }
T2: {Periodicity: 5 ms , Execution Time : 1 ms }
T3: {Periodicity: 20 ms , Execution Time : 1 ms }
H (HyperPeriod) = LCM(Pi) = 20 ms
CPU Load = $\sum$ E / H = (1*2 + 1*4 + 1*1) /20 * 100 = 35%

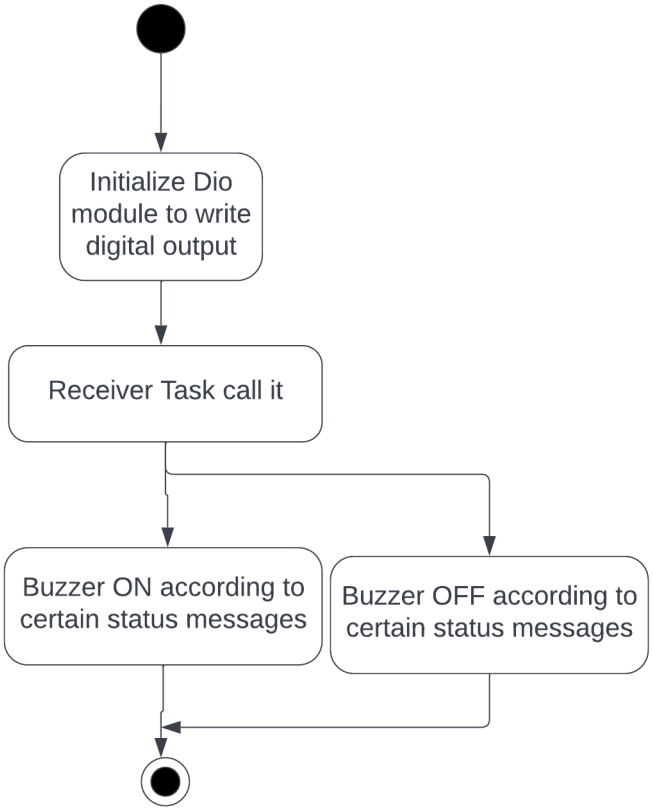
ECU 2

1. State Machine Diagram for each ECU component:

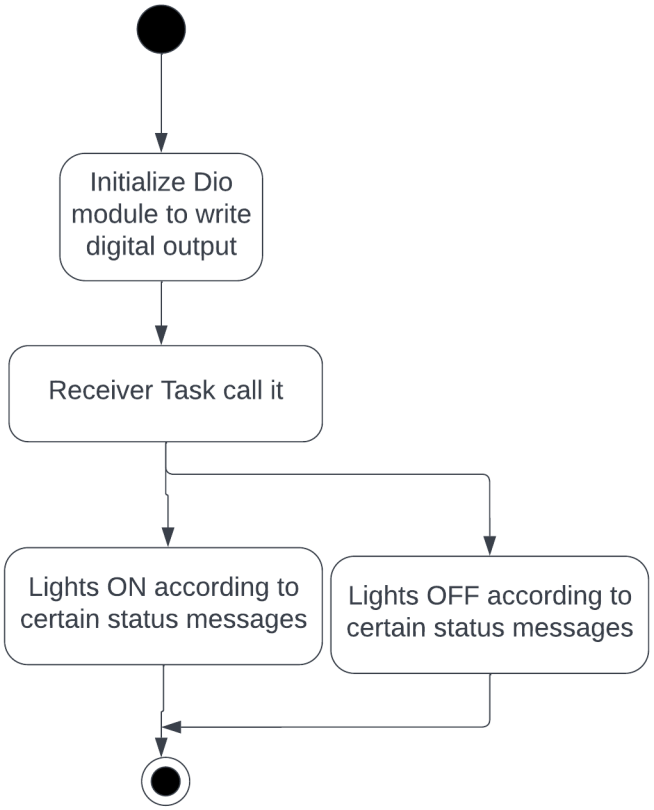




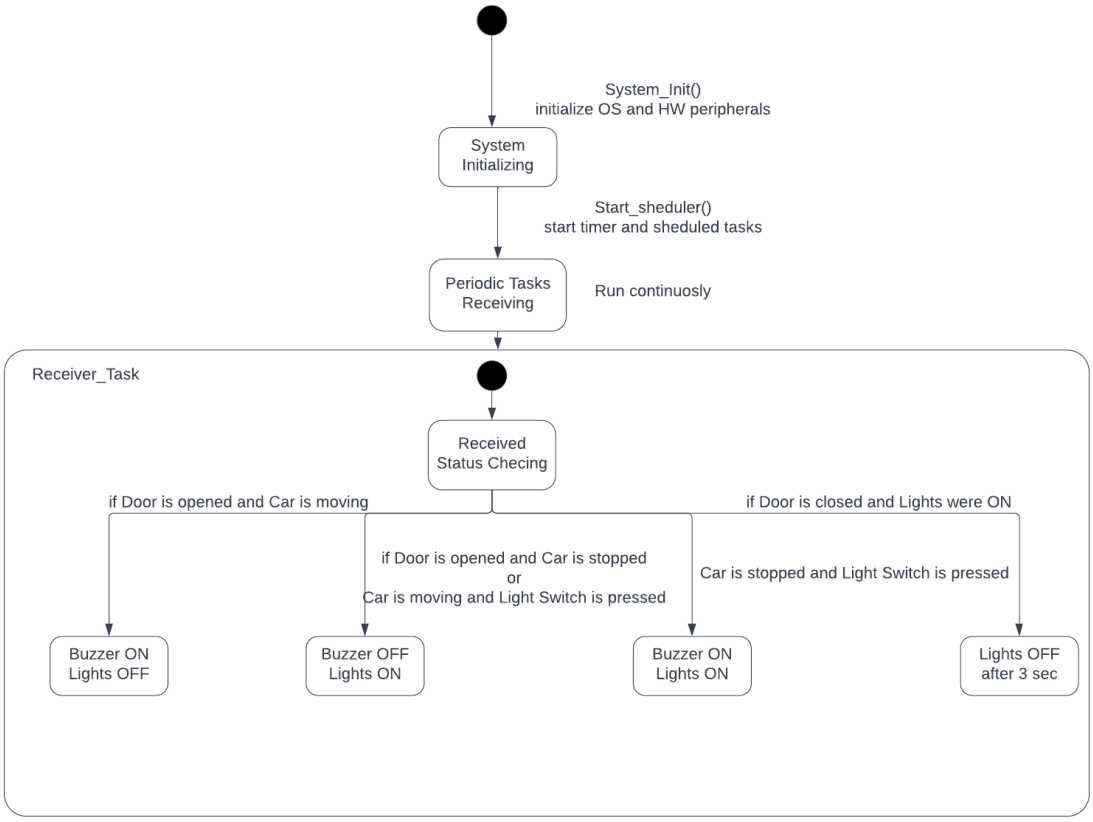
Buzzer Module



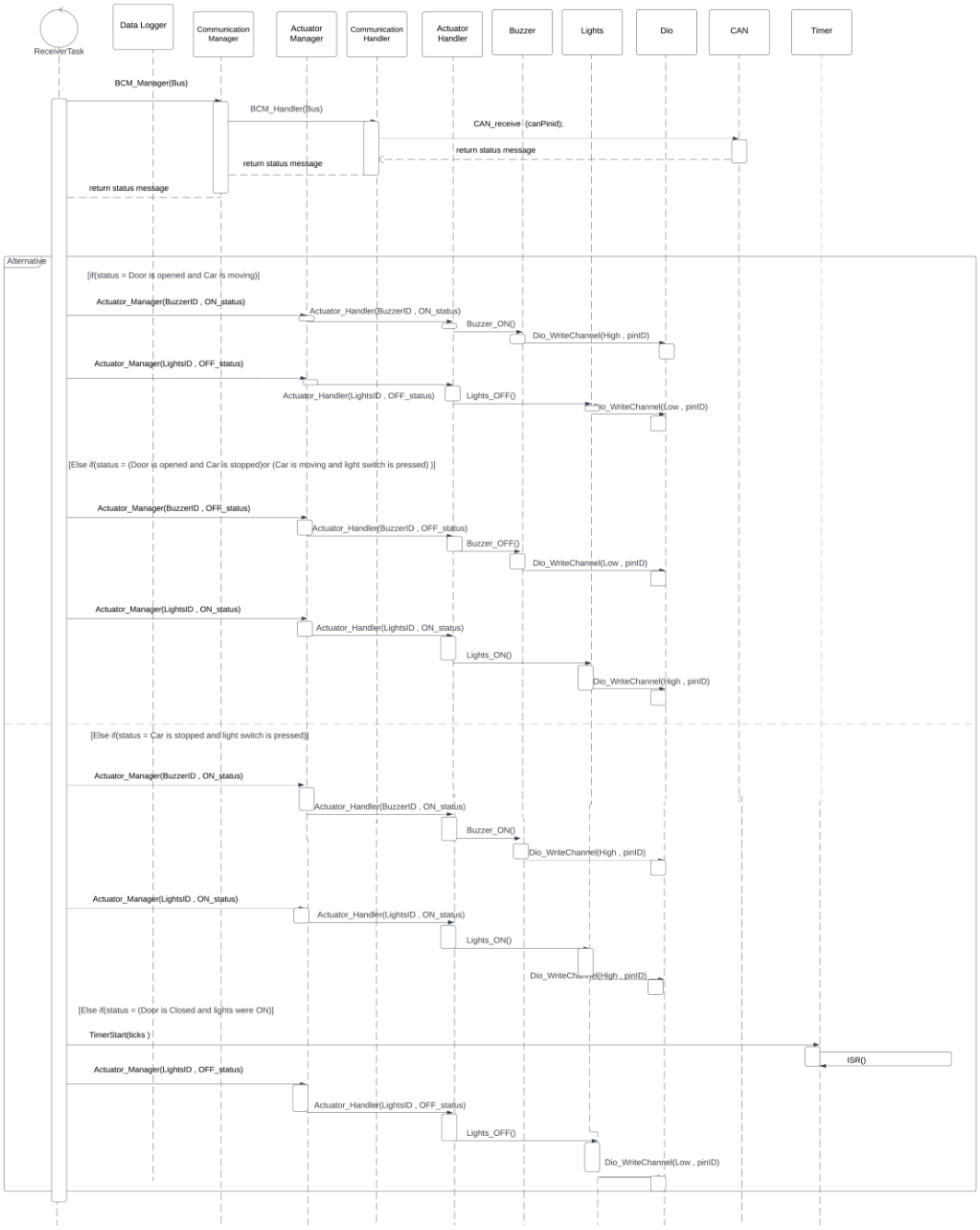
Lights Module



2. State Machine Diagram for ECU Operation:



5. Sequence Diagram for ECU:



6. CPU Load for ECU:

   We have one task: (Assuming Execution time and periodicity)
   T: {Periodicity: 5 ms , Execution Time : 2 ms }
   H (HyperPeriod) = LCM(Pi) = 5 ms
   CPU Load = $\sum$ E / H = (2) /5 * 100 = 40%

CAN Bus Load in System: (% of time the CAN bus loaded with data)

1 CAN frame contains approximately 125 bits.

Given we are using a 500 kBit/s bit rate:

bit time = 1 / bit rate = 1 / (500 * 1000) s = 2 * 10^{-6} s = 2 µs

This means 1 bit will take 2 µs to transfer on the bus when using 500 kBit/s.

So the approximate time to transfer 1 frame is (2 µs/bit * 125 bit) = 250 µs. (time for 125 bits)

We have multiple sending intervals on the bus:

1 frame every 10 ms = 100 frames every 1000 ms

1 frame every 20 ms = 50 frames every 1000 ms

1 frame every 5 ms = 200 frames every 1000 ms

This is in total = 350 frames every 1000 ms

Total time on bus = 350 (total number of frames)* 250 µs (time of 1 frame)

Bus load is = ((350 * 250) / (1000 * 1000)) * 100 % = 8.75 %