Embedded Systems Advanced Nanodegree Program

Embedded Software Design

Project: Automotive door control system design

Dynamic design analysis

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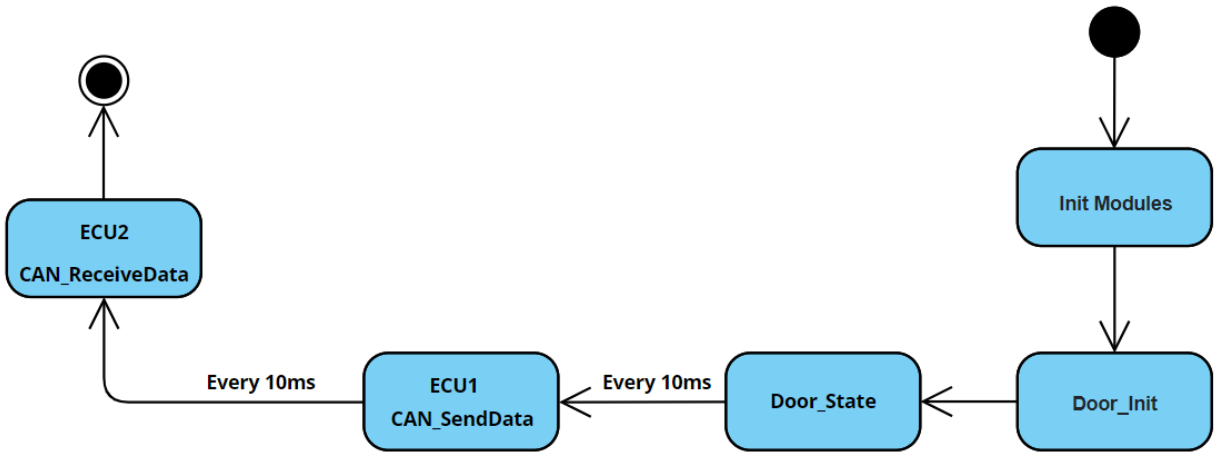
First ECU.

state machine diagram for ECU1 component

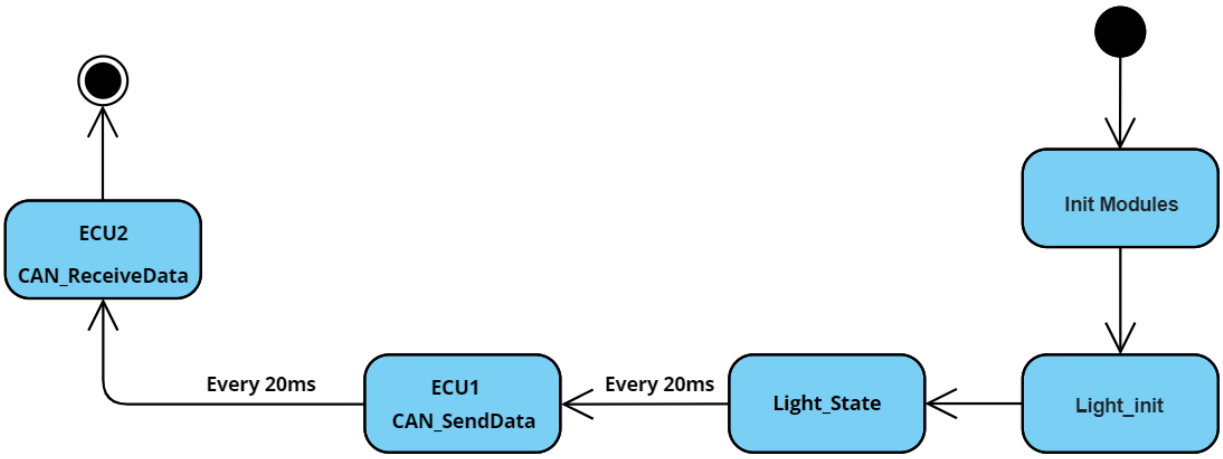
Door Sensor

1. Door state message will be sent every 10ms to ECU 2

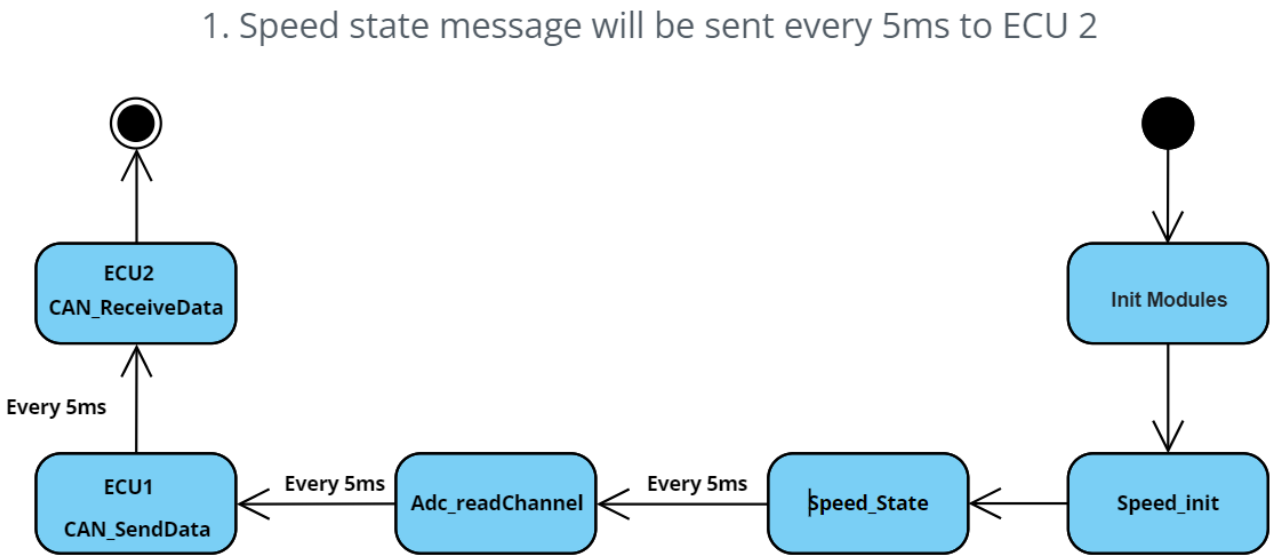


Light Switch Sensor

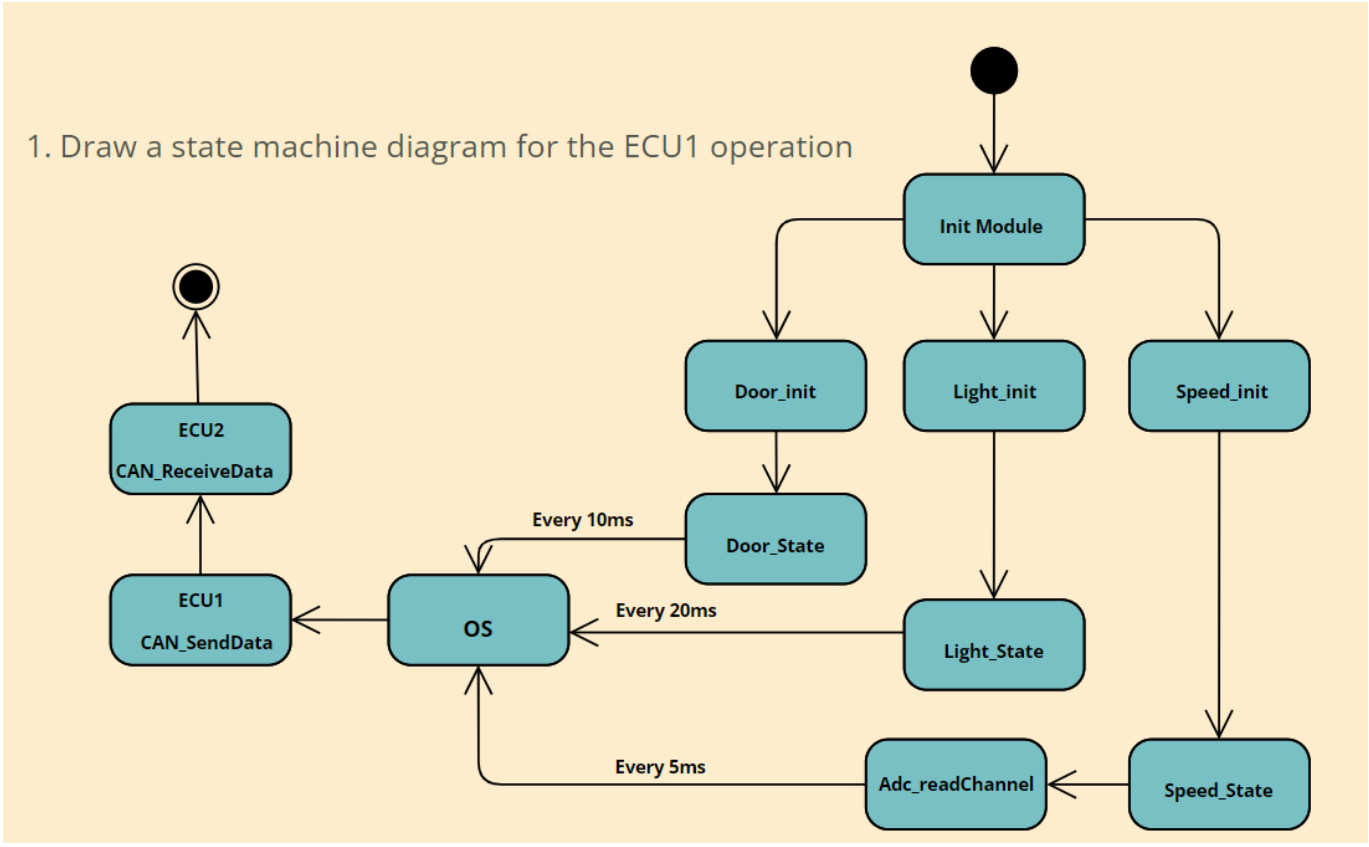
1. Light switch state message will be sent every 20ms to ECU 2



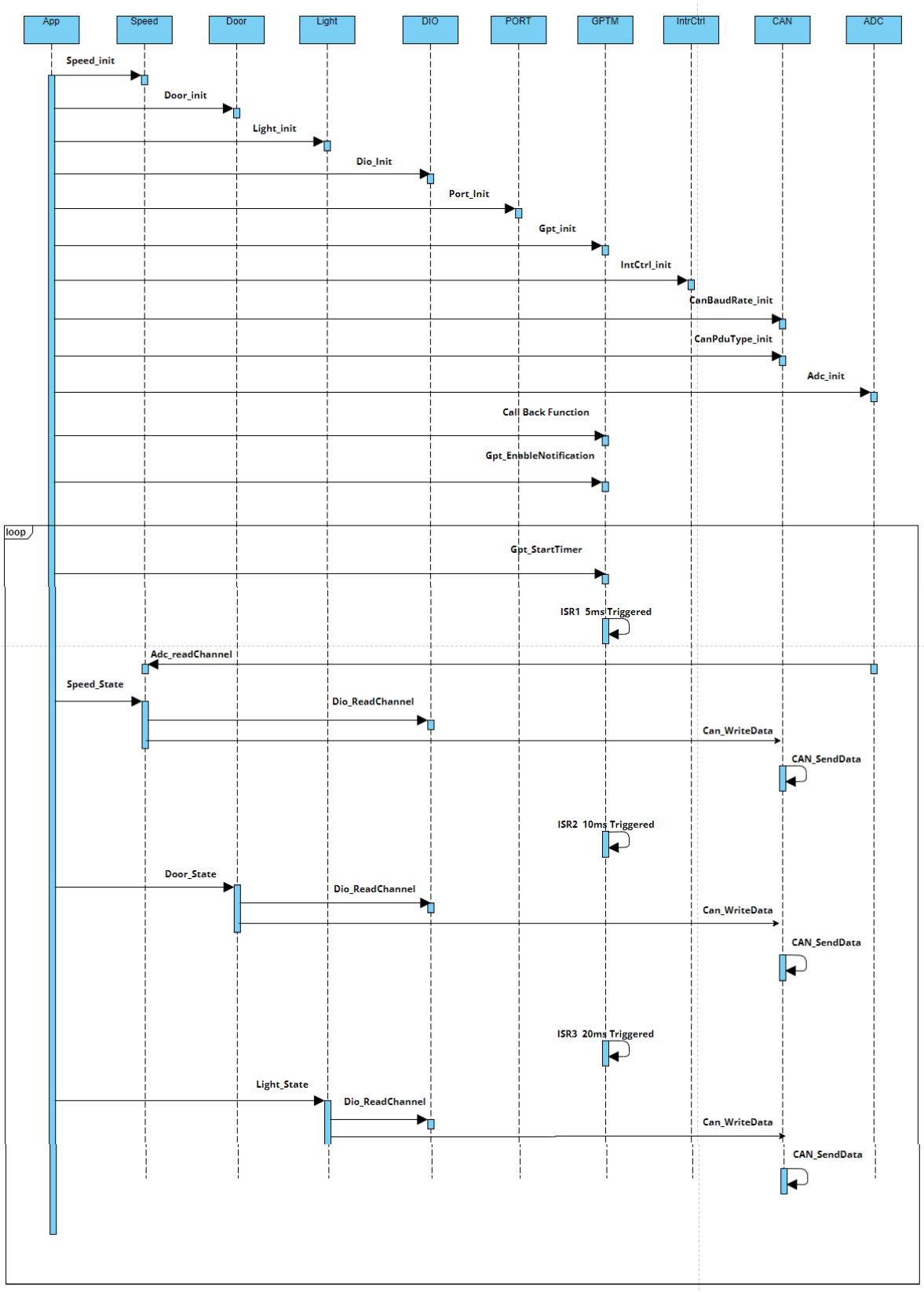
Speed Sensor



state machine diagram for the ECU1 operation



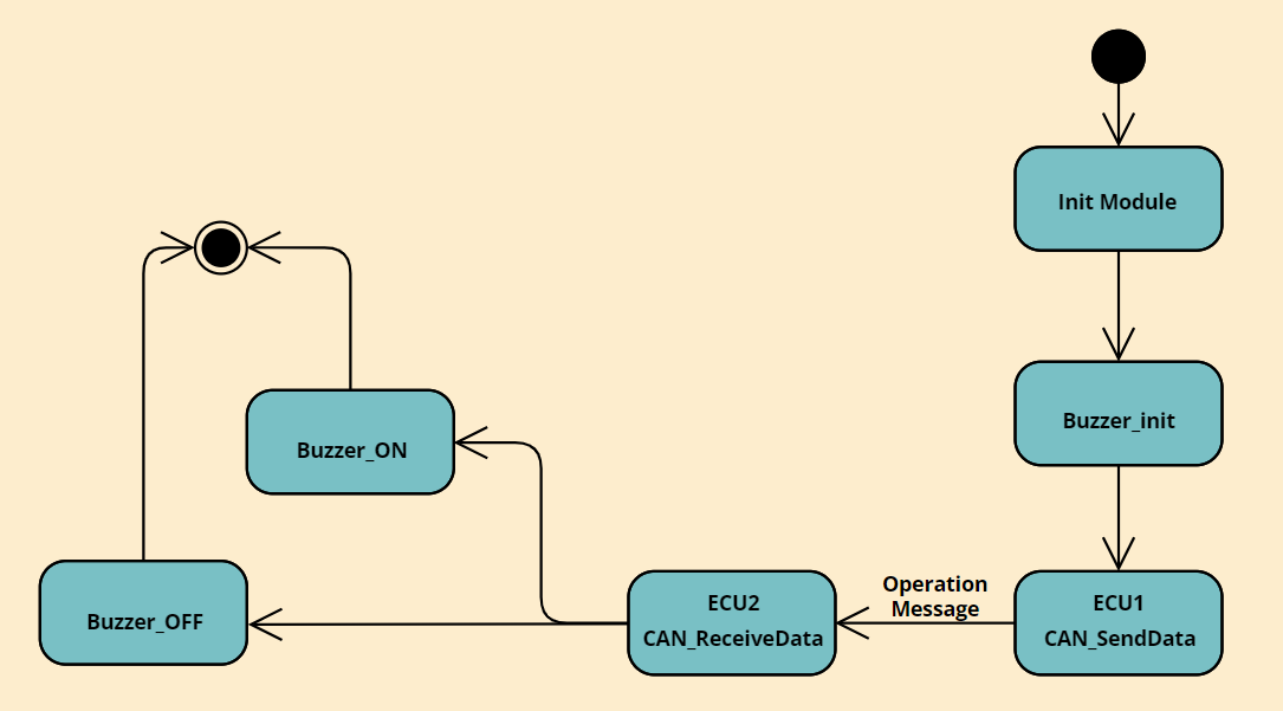
Draw the sequence diagram for the ECU1



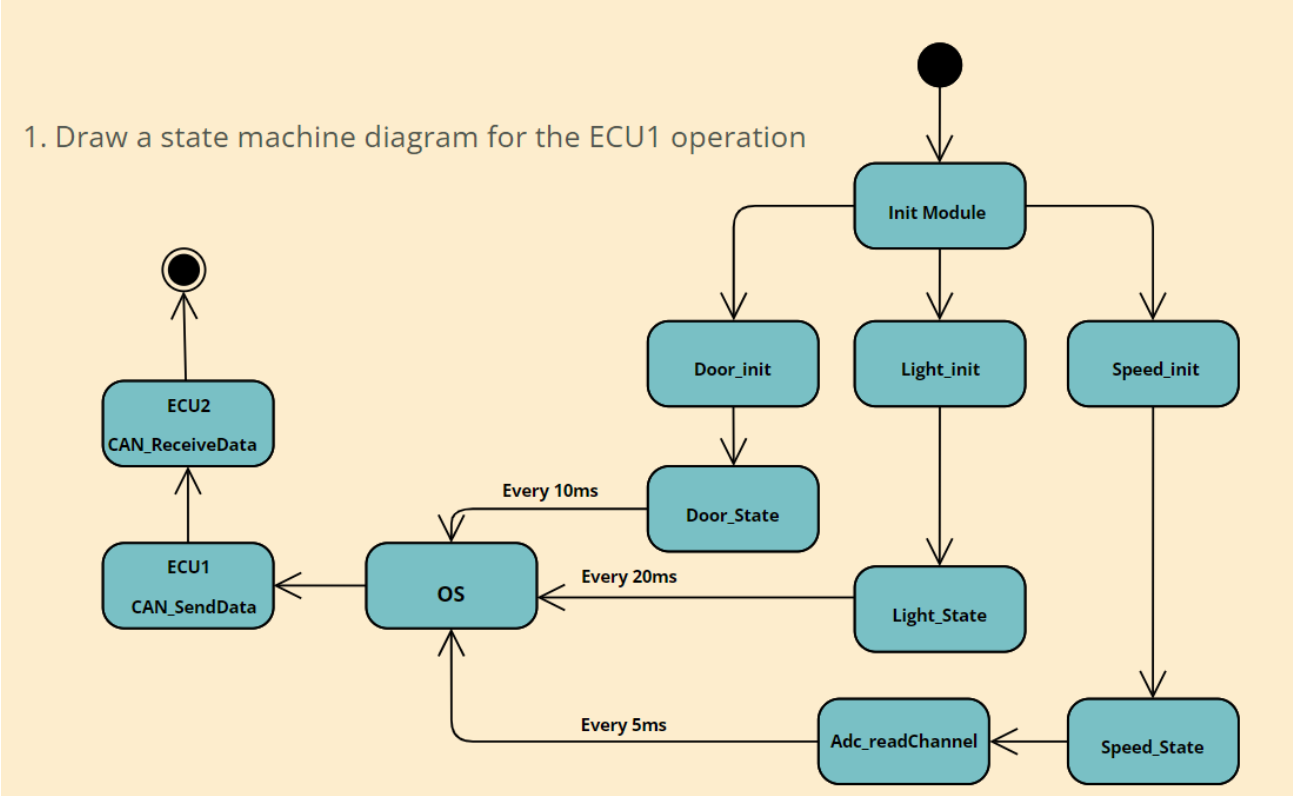
Second ECU.

state machine diagram for ECU2 component

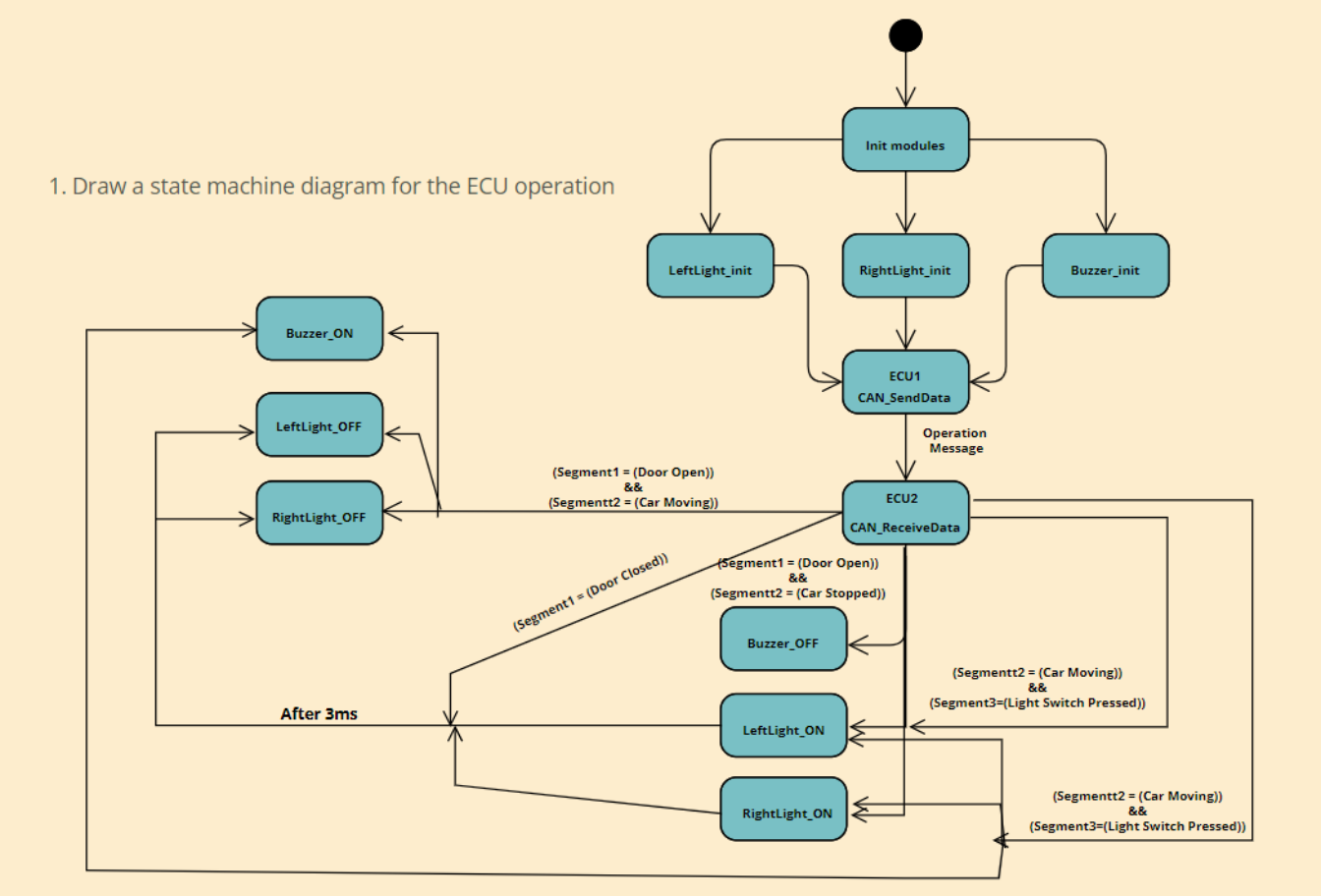
Buzzer Sensor



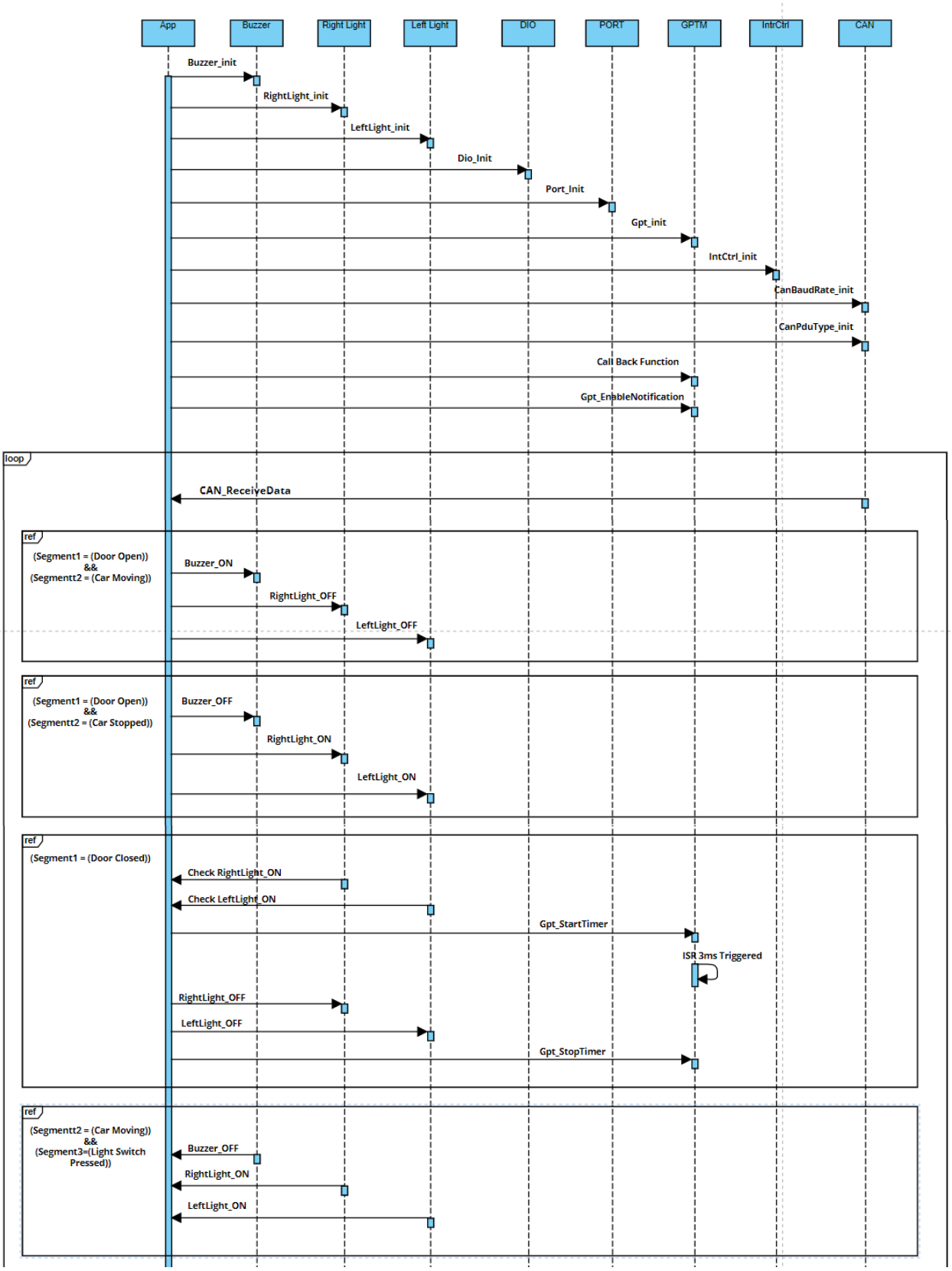
Two lights, right and left

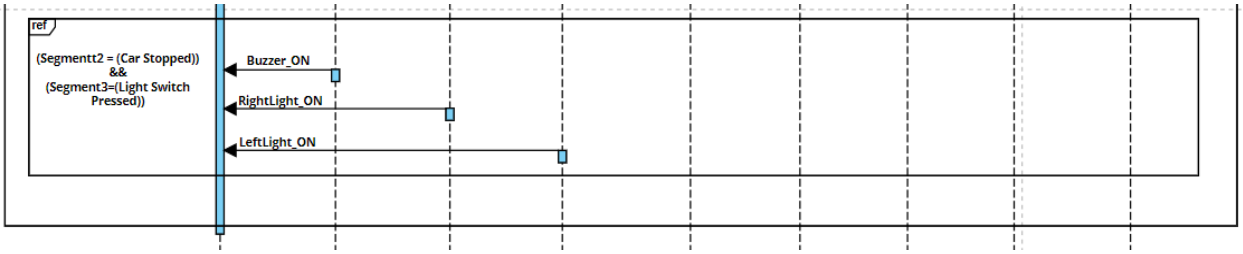


state machine diagram for the ECU2 operation



Draw the sequence diagram for the ECU2




ref
(Segmentt2 = (Car Stopped))
&&
(Segment3=(Light Switch Pressed))
Buzzer_ON
RightLight_ON
LeftLight_ON

CAN bus load calculation:

assuming standard identifier (11-bit identifier)

CAN frame:

- 1 bit start bit
- 11-bit identifier
- 1-bit RTR
- 6-bit control field
- 0-to-64-bit data field
- 15-bit CRC
- Bit stuffing is possible in the above, for every sequence of 5 consecutive bits of same level. Somewhere around 18 bits in the worst case.
- 3-bit delimiter, ack etc.
- 7-bit end of frame
- 3-bit intermission field after frame

So, CAN frame contains approximately 125 bits.

(High Speed From 40k bits/s to 1M bits/s (ISO 11898-2, SAE J2284))
Specifies the baud rate of the controller in kbps from 0 to 2000

Assume Baud rate = 500 Kbit/s

Given we are using 500 Kbit/s bit rate:

bit time = 1 / bit rate = 1 / (500 * 1000) S = 2 µs

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

The bus load for 1 message every 20ms with 500 Kbit/s can be calculated as below:
Given that every 20ms one (1) message will be sent
In 20ms the bus will be occupied for 250 µs.

So, the bus load from these cyclic messages is
250 µs / 20ms = (250 / (20*1000)) * 100 % = 25000 / 20000 % = 1.25 %

Let assume you have below multiple sending intervals on the bus as:

1 frame every 5ms = 4 frame every 20ms
1 frame every 10ms = 2 frame every 20ms
1 frame every 20ms = 1 frame every 20ms

This is in total 7 frames every 20ms

Total time on bus is = 7 * 250 µs

Total time is equal 20ms = 20 * 1000 µs

CAN Bus load is = ((7 * 250) / (20 * 1000)) * 100 % = 8.75 %