

Ford Thunderbird 1965 car tail light sequence control.

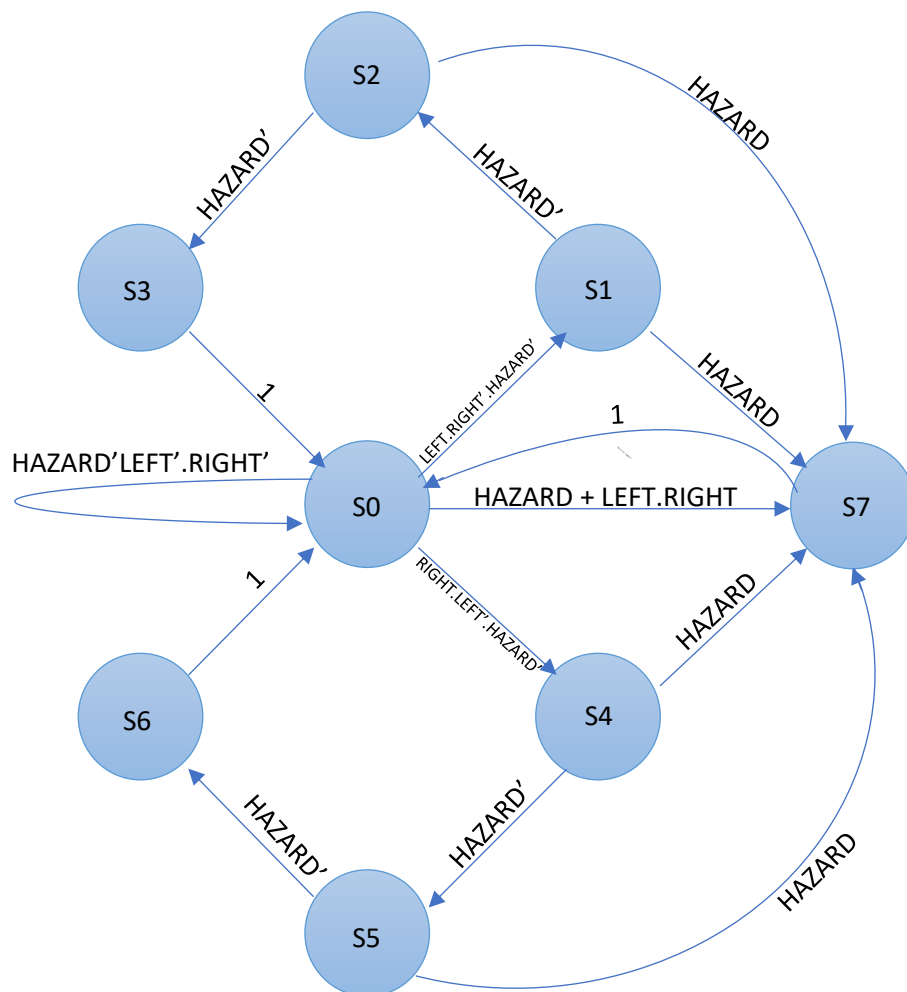
In thunderbird car, the user can give three inputs to indicate signal as LEFT, RIGHT and HAZARD indication. When LEFT input is given, the first left light (LA) turns ON, then first and second ($LA + LB$) then all the three ($LA+LB+LC$), and finally all lights are turn OFF($(LA+LB+LC)'$). The same case is for RIGHT input signal. For the HAZARD input signal, all the lights will turn ON and OFF continuously, until it becomes 0 again. The HAZARD signal is given highest priority over LEFT and RIGHT to avoid any delays in the emergency situation. If user gives HAZARD at any instant, it should leave the current state and jump quickly to HAZARD state.

The states can be defined in 3-bit wide format ranging from $S0(000)$ to $S7(111)$ defining the status of each lights (LA, LB, LC, RA, RB, RC).

For this, state diagram is designed based on the given parameters and conditions and then Verilog code is written for the same along with TESTBENCH.

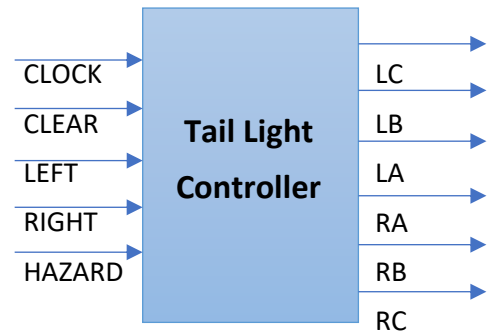
The code is written in the Verilog HDL by using MODELSIM (MENTOR GRAPHICS).

This problem is taken from *Digital Design by John F. Wakerly* but the Verilog program is written by myself own.



Finite State Machine for Thunderbird tail Light Sequence

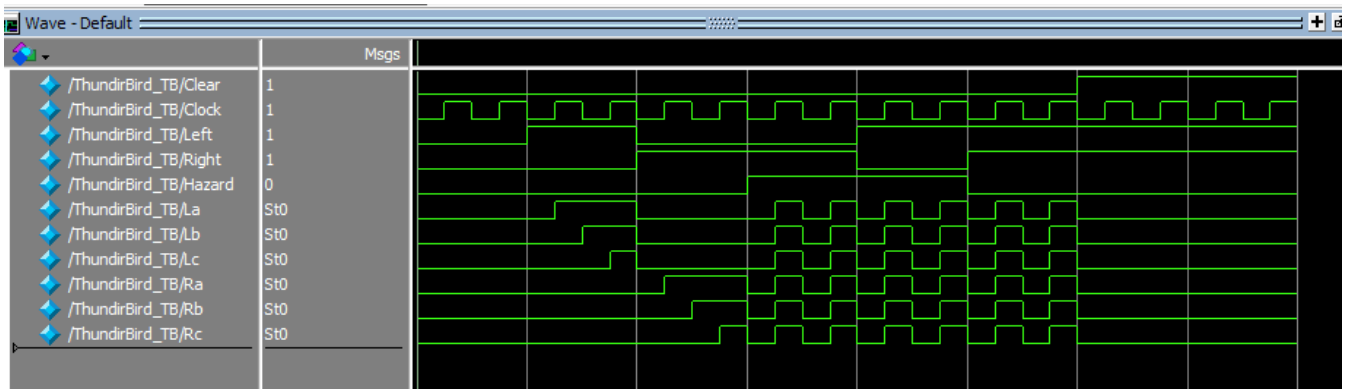
| State | | LC | LB | LA | RA | RB | RC |
|-------|-----|----|----|----|----|----|----|
| S0 | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| S1 | 001 | 1 | 0 | 0 | 0 | 0 | 0 |
| S2 | 010 | 1 | 1 | 0 | 0 | 0 | 0 |
| S3 | 011 | 1 | 1 | 1 | 0 | 0 | 0 |
| S4 | 100 | 0 | 0 | 0 | 1 | 0 | 0 |
| S5 | 101 | 0 | 0 | 0 | 1 | 1 | 0 |
| S6 | 110 | 0 | 0 | 0 | 1 | 1 | 1 |
| S7 | 111 | 1 | 1 | 1 | 1 | 1 | 1 |



Black Box Diagram of Light Controller

State Table of tail light

Output of The RTL description



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0 Clear = 0, Clock = 0, Left = 0, Right = 0, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
50 Clear = 0, Clock = 1, Left = 0, Right = 0, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
100 Clear = 0, Clock = 0, Left = 0, Right = 0, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
150 Clear = 0, Clock = 1, Left = 0, Right = 0, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
200 Clear = 0, Clock = 0, Left = 1, Right = 0, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
250 Clear = 0, Clock = 1, Left = 1, Right = 0, Hazard = 0, <---> La = 1, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
300 Clear = 0, Clock = 0, Left = 1, Right = 0, Hazard = 0, <---> La = 1, Lb = 1, Lc = 0, Ra = 0, Rb = 0, Rc = 0
350 Clear = 0, Clock = 1, Left = 1, Right = 0, Hazard = 0, <---> La = 1, Lb = 1, Lc = 1, Ra = 0, Rb = 0, Rc = 0
400 Clear = 0, Clock = 0, Left = 0, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
450 Clear = 0, Clock = 1, Left = 0, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 1, Rb = 0, Rc = 0
500 Clear = 0, Clock = 0, Left = 0, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 1, Rb = 1, Rc = 0
550 Clear = 0, Clock = 1, Left = 0, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 1, Rb = 1, Rc = 1
600 Clear = 0, Clock = 0, Left = 0, Right = 1, Hazard = 1, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
650 Clear = 0, Clock = 1, Left = 0, Right = 1, Hazard = 1, <---> La = 1, Lb = 1, Lc = 1, Ra = 1, Rb = 1, Rc = 1
700 Clear = 0, Clock = 0, Left = 0, Right = 1, Hazard = 1, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
750 Clear = 0, Clock = 1, Left = 0, Right = 1, Hazard = 1, <---> La = 1, Lb = 1, Lc = 1, Ra = 1, Rb = 1, Rc = 1
800 Clear = 0, Clock = 0, Left = 1, Right = 0, Hazard = 1, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
850 Clear = 0, Clock = 1, Left = 1, Right = 0, Hazard = 1, <---> La = 1, Lb = 1, Lc = 1, Ra = 1, Rb = 1, Rc = 1
900 Clear = 0, Clock = 0, Left = 1, Right = 0, Hazard = 1, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
950 Clear = 0, Clock = 1, Left = 1, Right = 0, Hazard = 1, <---> La = 1, Lb = 1, Lc = 1, Ra = 1, Rb = 1, Rc = 1
1000 Clear = 0, Clock = 0, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1050 Clear = 0, Clock = 1, Left = 1, Right = 1, Hazard = 0, <---> La = 1, Lb = 1, Lc = 1, Ra = 1, Rb = 1, Rc = 1
1100 Clear = 0, Clock = 0, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1150 Clear = 0, Clock = 1, Left = 1, Right = 1, Hazard = 0, <---> La = 1, Lb = 1, Lc = 1, Ra = 1, Rb = 1, Rc = 1
1200 Clear = 1, Clock = 0, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1250 Clear = 1, Clock = 1, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1300 Clear = 1, Clock = 0, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1350 Clear = 1, Clock = 1, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1400 Clear = 1, Clock = 0, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0
1450 Clear = 1, Clock = 1, Left = 1, Right = 1, Hazard = 0, <---> La = 0, Lb = 0, Lc = 0, Ra = 0, Rb = 0, Rc = 0

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