ECEN 714 Lab 6 report
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1. Chenjie_module.v:

```
module chenjie_module (
clk    , // clock signal (positive edge triggered)
reset    , // reset signal (positive edge triggered)
throttle   ,
set    ,
accel    ,
coast   ,
cancel  ,
resume  ,
brake   ,
speed   ,   // output of spped
cruise_speed    ,  //output of cruise_speed
cruise_on   ////curise status
);

// Input declaration
input clk, reset, throttle, set, accel, coast, cancel, resume, brake ;
// Output declaration
output speed, cruise_speed, cruise_on;

// Output should be also declared as reg type
reg [7:0]   speed;
reg [7:0]   cruise_speed;
reg [7:0]   cached_speed;  //stored current speed to assign
reg cruise_on;  //cruise mode status

// Code starts here
always @(posedge clk)
begin
if (reset)
begin
   speed = 8'b0;
   cruise_speed = 8'b0;
   cruise_on = 1'b0;
end
if (throttle)
   speed = speed + 1'b1;
else
```

```
begin
   if (cruise_on)
   begin
      if (accel)     //When accel is high and cruise_on is true, cruise_speed will increment 1 mph.
         cruise_speed = cruise_speed + 1'b1;
      if (coast && cruise_speed > 45)  //Similarly, cruise_speed will decrease by 1 mph.
         cruise_speed = cruise_speed - 1'b1;
      if (speed < cruise_speed)    //If speed != cruise_speed, it should converge to cruise_speed.
         speed = speed + 1'b1;
      if (speed > cruise_speed)
         speed = speed -1'b1;
   end
   else
   begin
      if (!brake && speed > 0) //if throttle is off and cruise_on is low, the speed to decrease until 0
         speed = speed -1'b1;
   end
end
if (cancel)
   cruise_on = 1'b0;
if (set && speed >45)  //only if when speed > 45 mph, set pulse will trigger cruise mode on
begin
   cruise_on = 1'b1;
   cruise_speed = cached_speed;
end
if (resume && speed > 0 && cruise_speed >=45)
   cruise_on = 1'b1;
if (brake)         //if brake is on, speed will decrease 2 mph/clk_cycle and cruise_on turns false.
begin
   cruise_on = 1'b0;
   speed = speed - 2;
end
end

always @(posedge set) //when set pulse arrives and speed > 45, save current speed right
away.
begin
   if (speed > 45)
         cached_speed = speed;
end

endmodule // End
```

2. Chenjie_testbench.v:

```
module chenjie_testbench();

// Input signal declaration
reg clk, reset, throttle, set, accel, coast, cancel, resume, brake ;

// Output
wire[7:0] speed;
wire[7:0] cruise_speed;
wire cruise_on;

always
begin
   #5 clk = ~clk;
end

// Code starts here
initial begin
clk = 0;
reset = 0;
throttle = 0;
set = 0;
accel = 0;
coast = 0;
cancel = 0;
resume = 0;
brake = 0;

#2 reset = 1;   //initialize output

#5 reset = 0;
throttle = 1;   //accelerate starts now to 30mph, 30*5*2 = 300 will be needed

#300 set = 1;
throttle = 0;

#10 set = 0;
#90 throttle = 1; //at this point the speed should be 20mph

#300 set = 1;
#10 set = 0;
```

```
#90 throttle = 0;   //at this point the speed should be 60mph

#150  brake = 1; //from now on cruise mode is off and speed decreases 2 mph/clk_cycle
#100  brake = 0; //at this point speed is 30 mph.
resume = 1;

#10 resume = 0;

#240  accel = 1; //accel lasts 5 clk cycles
#50  accel = 0;

#50  coast = 1; //coast lasts 5 clk cycles
#50 coast = 0;

#50  cancel = 1; //cancel turns on, cruise mode is off and speed will decrease to 0

#10 cancel = 0;
end
chenjie_module module1(clk,reset,throttle,set,accel,coast,cancel, resume, brake, speed,
cruise_speed, cruise_on);
endmodule // End
```

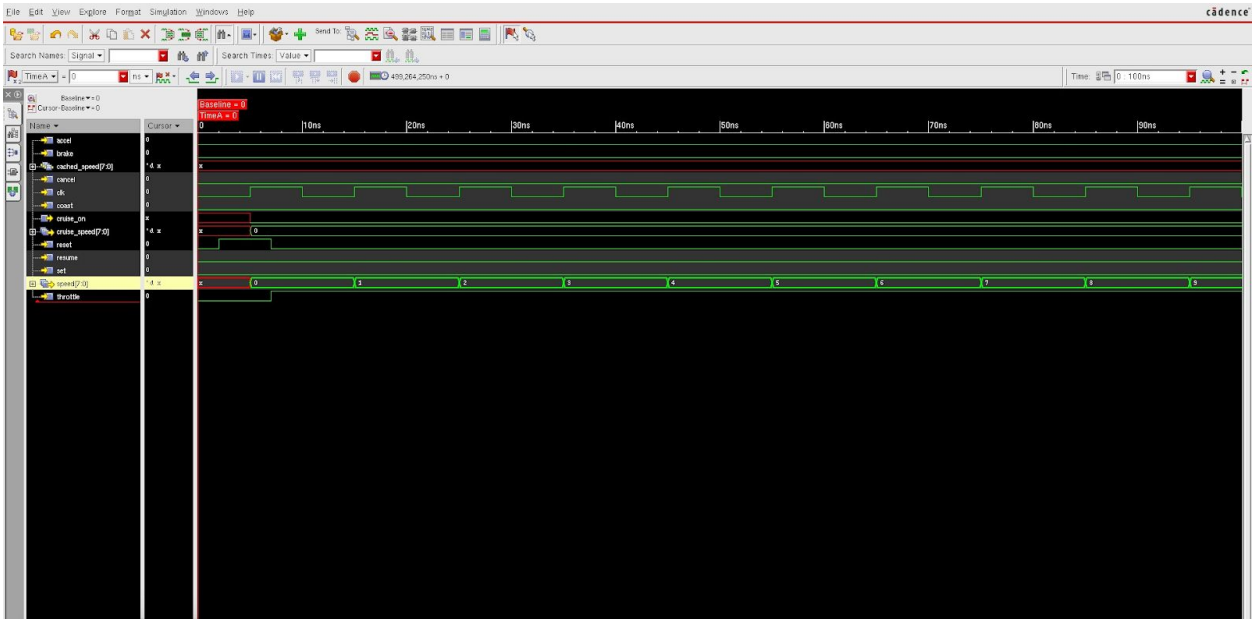

Fig. 1

When reset pulse arrives at #2, all three outputs: cruise_speed, speed and cruise_on will be reset to 0.

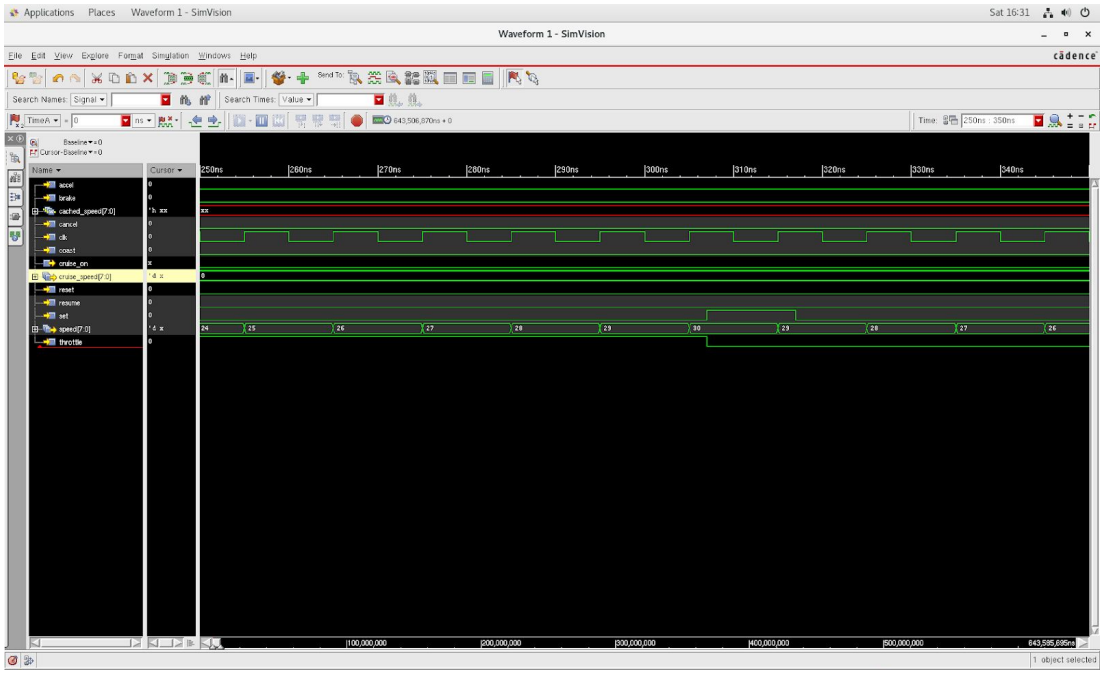

Fig. 2

When the speed increases to 30 mph, throttle will switched low, and from now on the speed will decrease 1mph / clock_cycle to 20 mph. Meanwhile, a set pulse will arrive but there is no response since the current speed is less than 45 mph.

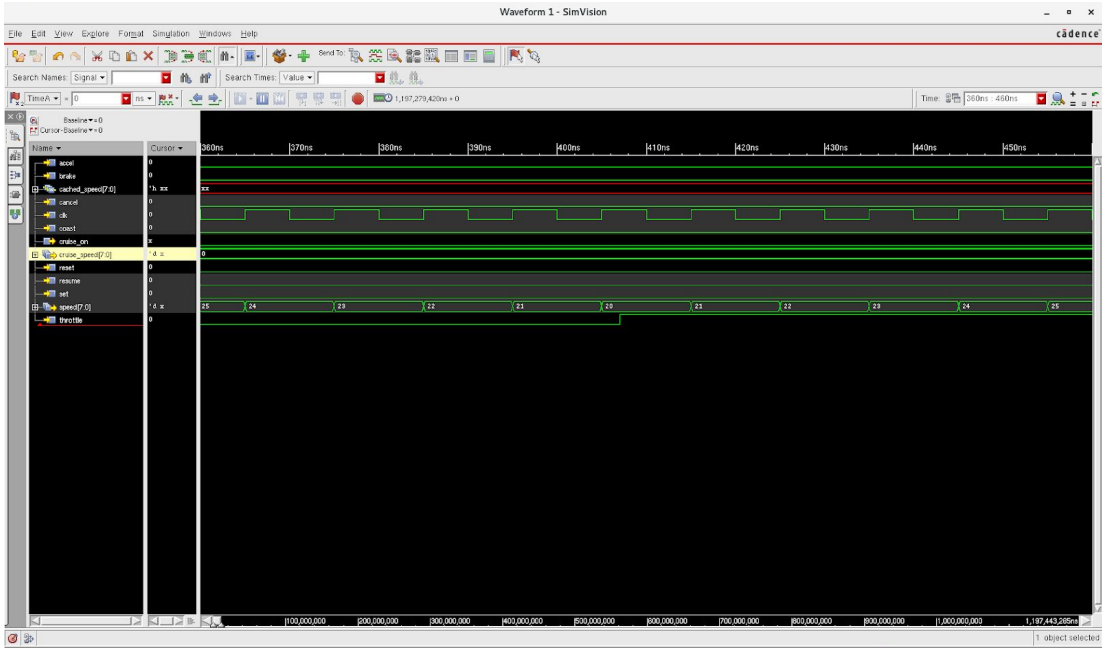

Fig. 3

When the speed reaches 20 mph, throttle will switch high again and the speed starts to increase.

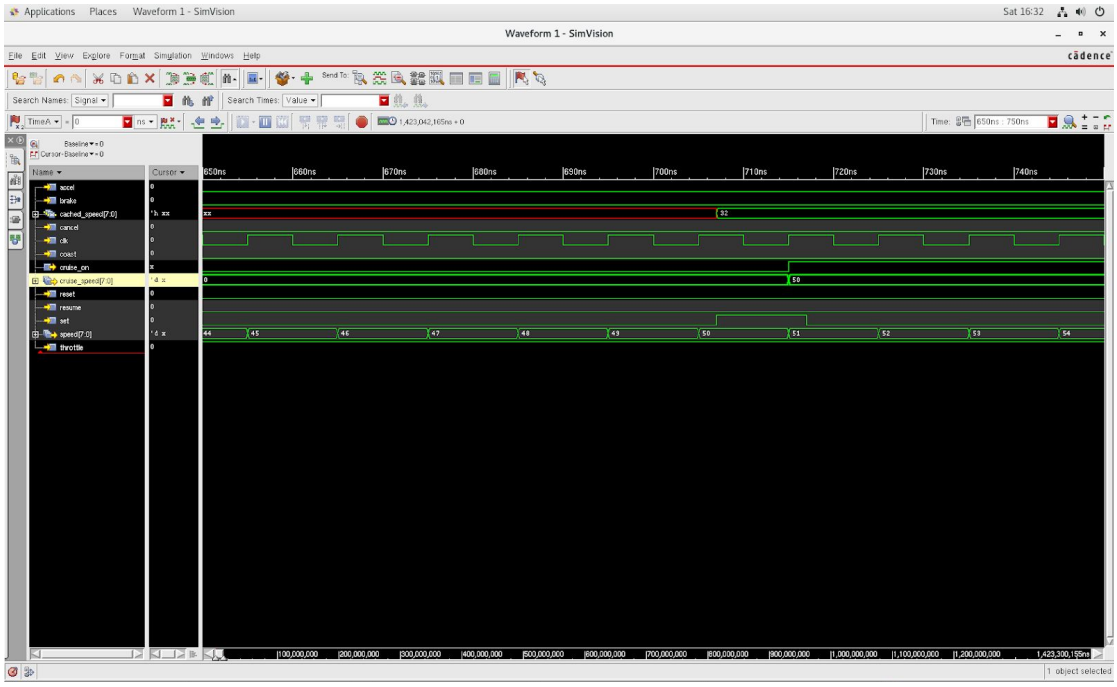

Fig. 4

When speed reaches 50 mph, a set pulse will arrive. This time cruise_speed will be assigned by speed when the positive edge of set pulse. I used a register here to save current speed which is 50 mph and assign this value to cruise_speed. Otherwise cruise _speed will be assigned to 51 mph since cruise_speed will synchronize updated speed which is 51 mph.

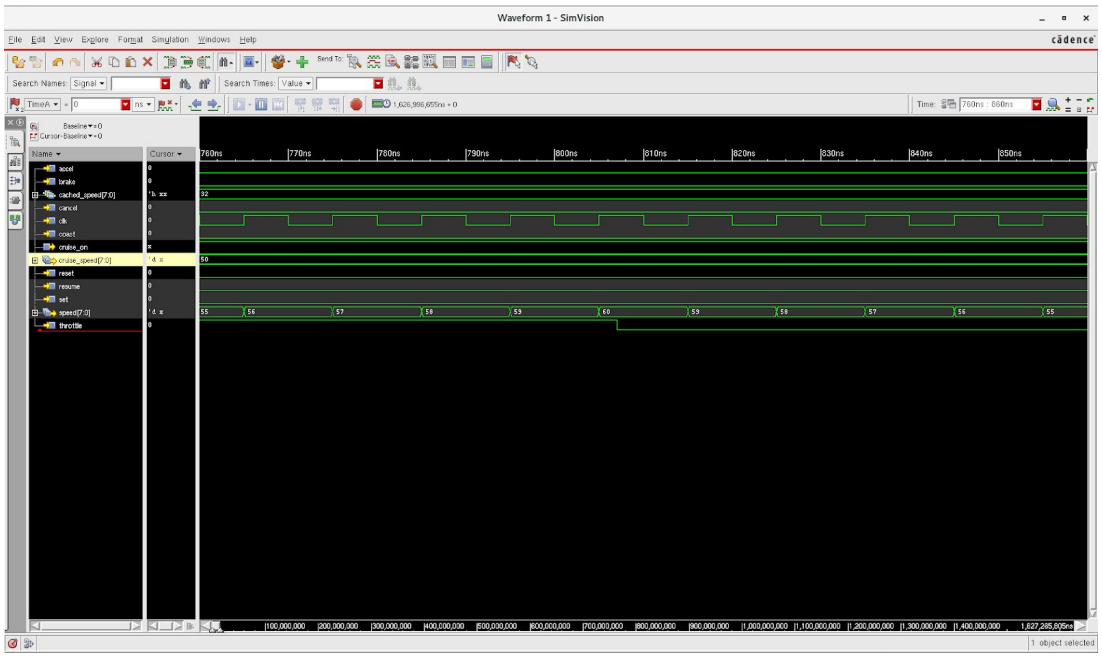

Fig. 5

When the speed reaches 60 mph, throttle switches low and the speed is supposed to converge to cruise_speed which is 50 mph.

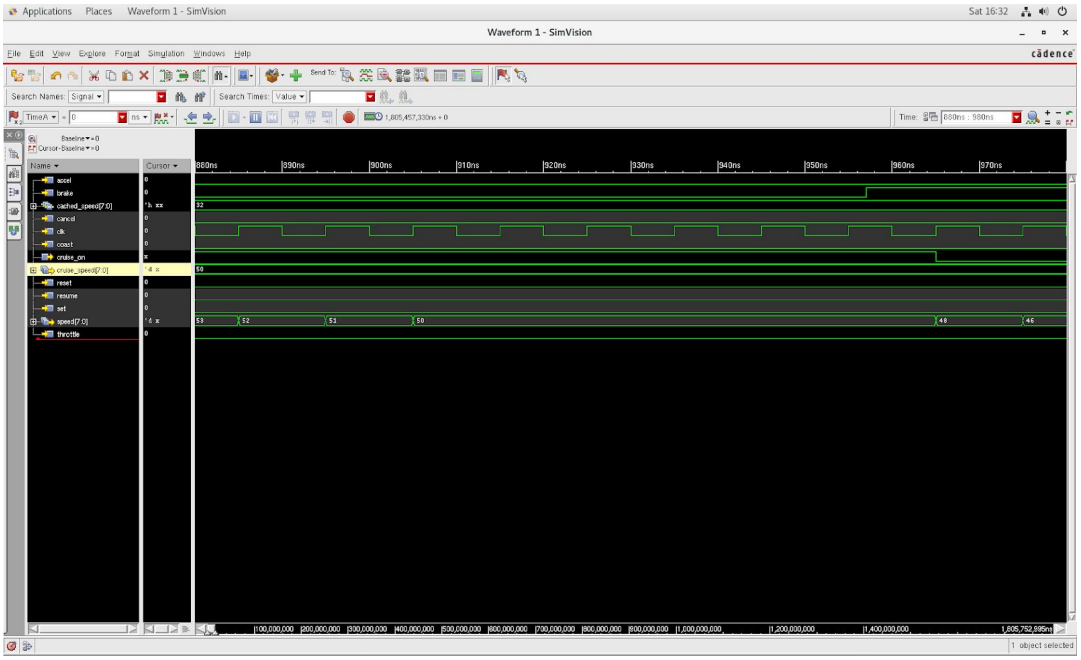

Fig. 6

When speed decreases to 50 mph, there is no external signal in the next 5 clk cycles. Thus, the speed should stay at 50 mph.

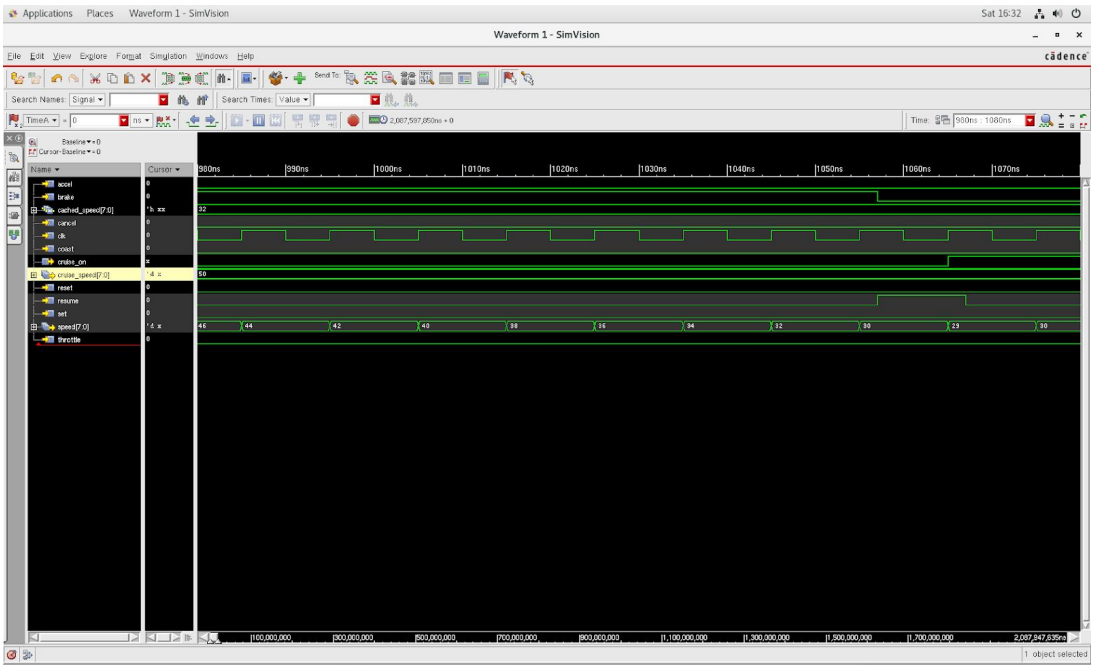

Fig. 7

Then the brake pulse arrives. Brake signal will be high until speed decreases to 30 mph. Since brake pulse is on, the acceleration is -2 mph/clk_cycle. When speed reaches 30 mph, a resume pulse arrives.

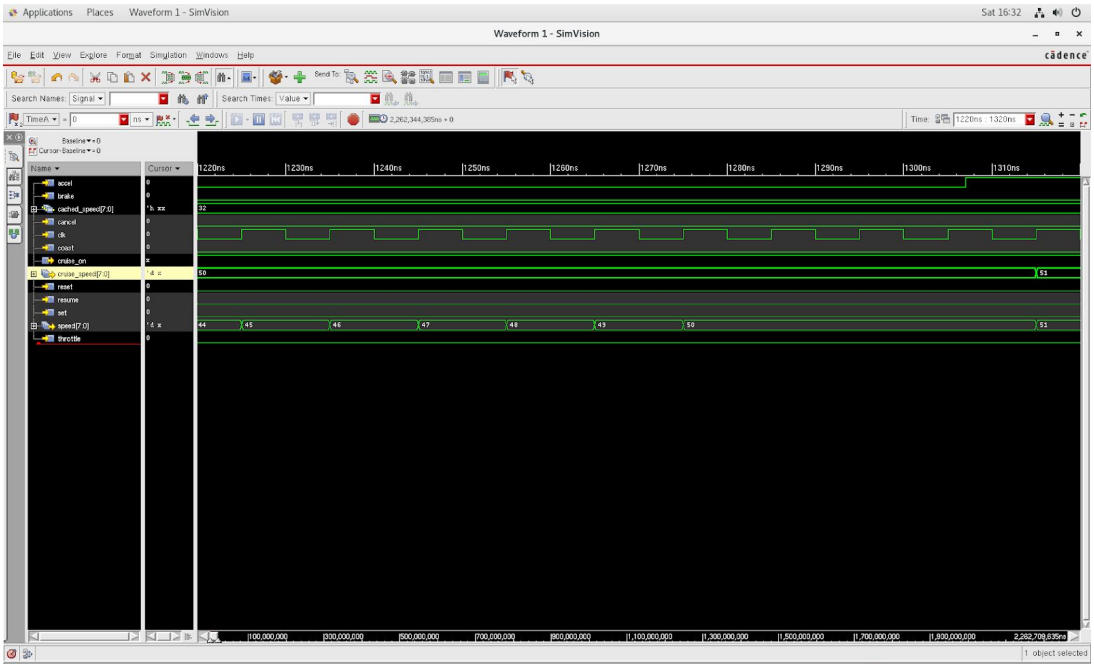

Fig.8

The speed will increase back to setted cruise_speed, which is 50 mph. After that, the car will cruise for 5 clk cycles at 50 mph.

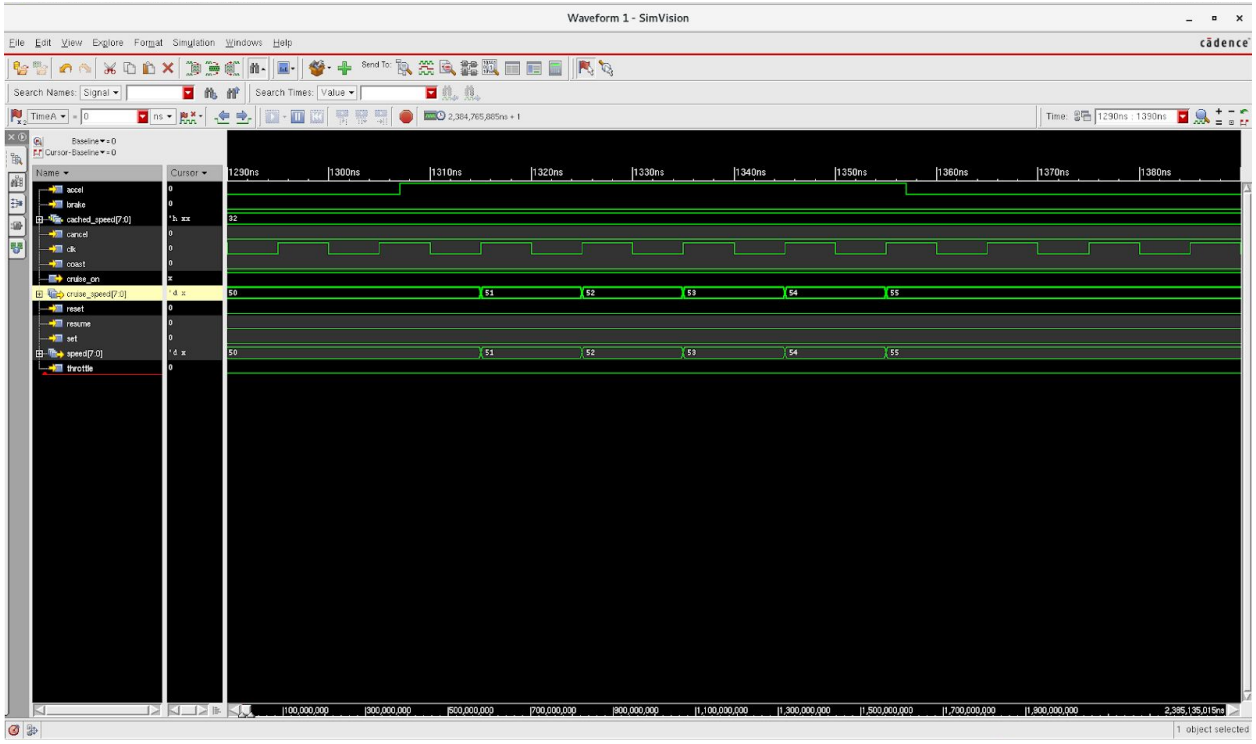

Fig. 9

Then we give 5 accel pulses consecutively, the speed and cruise_speed will then both be 55 mph. Then car will cruise at 55 mph.

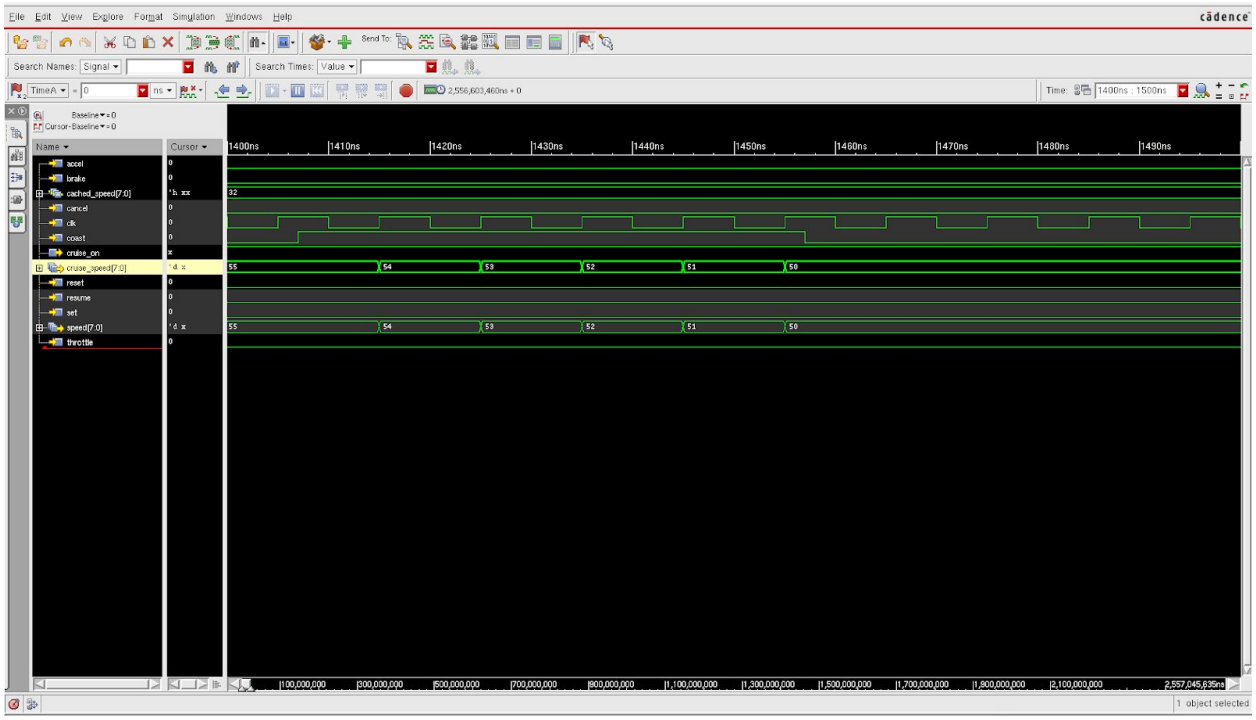

Fig. 10

Similarly, 5 consecutively coast pulses arrive and cruise_speed and speed will fall to 50 mph.

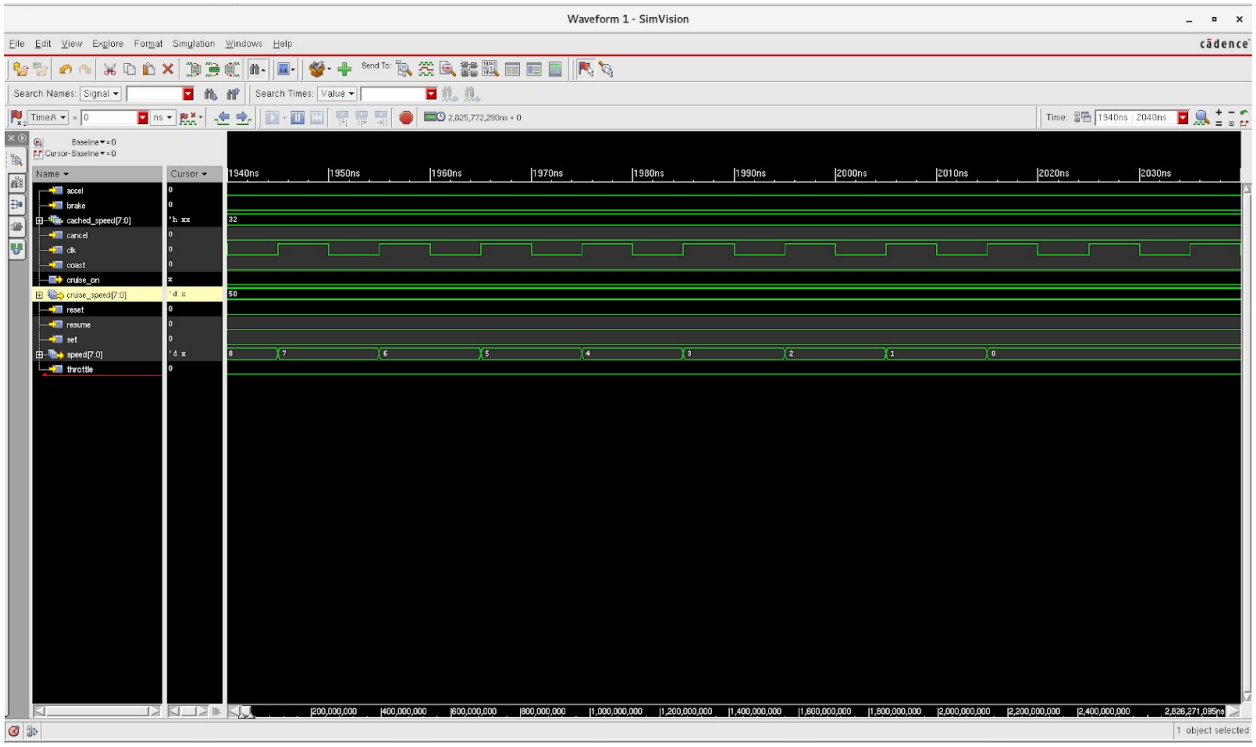

Fig. 11

Finally, cancel pulse arrives and the cruise mode is off now. The speed will decrease 1 mph/clk_cycle until speed is 0 mph.