

# Lab\_HW\_#5

## M1522.000700 Logic Design (2019 Fall)

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### 1. Klingon number system

(1) 코드의 구현은 다음과 같다. 좌측은 rtl, 우측은 gate level 로 구현하였다.

```
Activities Text Editor Mon 19:40 EN
Open Kllngon_number_system rtl.v Save X Open Kllngon_number_system_gate.v Save X
Kllngon_number_system
Kllngon_number_system_gate

timescale 1ns / 1ps

module Kllngon_number_system_rtl(
    input [3:0] bcd,
    output [8:0] kllngon
);

    assign kllngon = (bcd == 4'b0000)? 7'b11111110 :
(bcd == 4'b0001)? 7'b10000000 :
(bcd == 4'b0010)? 7'b10000001 :
(bcd == 4'b0011)? 7'b10010001 :
(bcd == 4'b0100)? 7'b01000011 :
(bcd == 4'b0101)? 7'b00111011 :
(bcd == 4'b0110)? 7'b01001011 :
(bcd == 4'b0111)? 7'b00100011 :
(bcd == 4'b1000)? 7'b01101010 :
(bcd == 4'b1001)? 7'b01101111 :
7'b00000000;

endmodule

module Kllngon_number_system_gate(
    input [3:0] bcd,
    output [8:0] kllngon
);

    wire [3:0] n_bcd;
    wire nand;
    wire and;
    wire a;
    wire nandncnd;
    wire ad;
    wire bnd;
    wire bd;
    wire nbncnd;
    wire bncd;
    wire nbcd;
    wire bcnd;
    wire wbcd;
    wire b;
    wire ncnd;
    wire c;

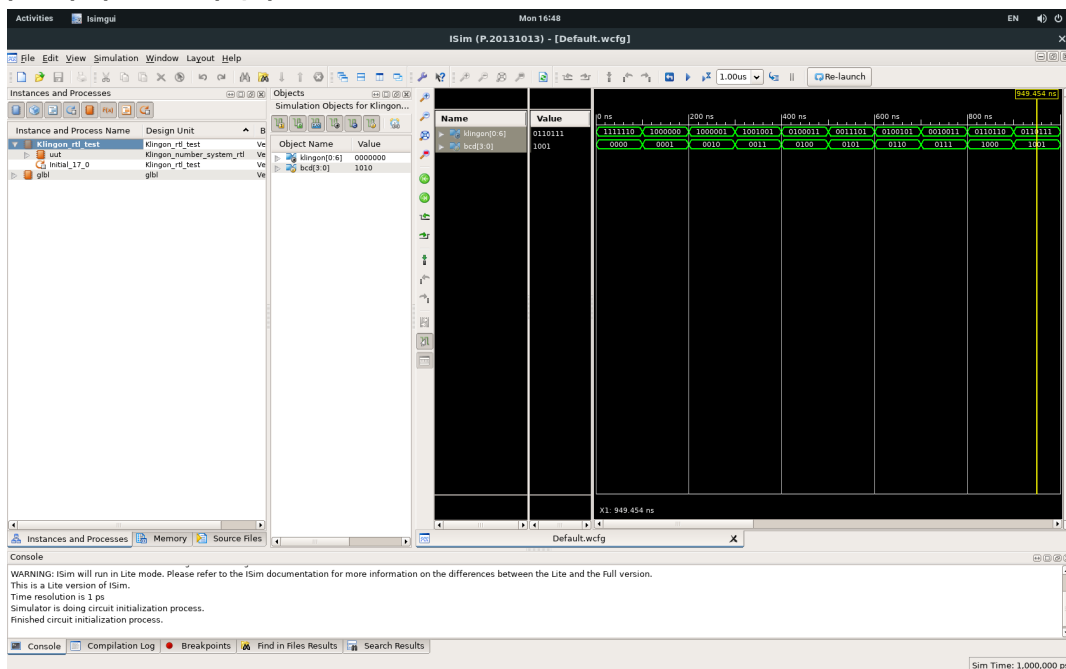
    not U1(n_bcd[3], bcd[3]); // n_a
    not U2(n_bcd[2], bcd[2]);
    not U3(n_bcd[1], bcd[1]);
    not U4(n_bcd[0], bcd[0]); // d

    and U5(nand, n_bcd[3], n_bcd[2]);
    and U6(bnd, bcd[1], n_bcd[0]);
    and U7(ncnd, n_bcd[1], n_bcd[0]);
    and U8(anb, bcd[3], n_bcd[2]);
    and U9(a, bcd[3]); //
    and U10(bd, bcd[2], bcd[0]); //
    and U11(nbncnd, n_bcd[2], n_bcd[1], n_bcd[0]);
    and U12(nandncnd, n_bcd[3], n_bcd[2], n_bcd[1], n_bcd[0]);
    and U13(bncd, bcd[2], n_bcd[1], bcd[0]);
    and U14(nbcd, n_bcd[2], bcd[1], bcd[0]);
    and U15(bcnd, bcd[2], bcd[1], n_bcd[0]);
    and U16(wbcd, bcd[2], bcd[1], bcd[0]);
    and U17(b, bcd[2]);
    and U18(c, bcd[1]);
    and U19(ad, bcd[3], bcd[0]);

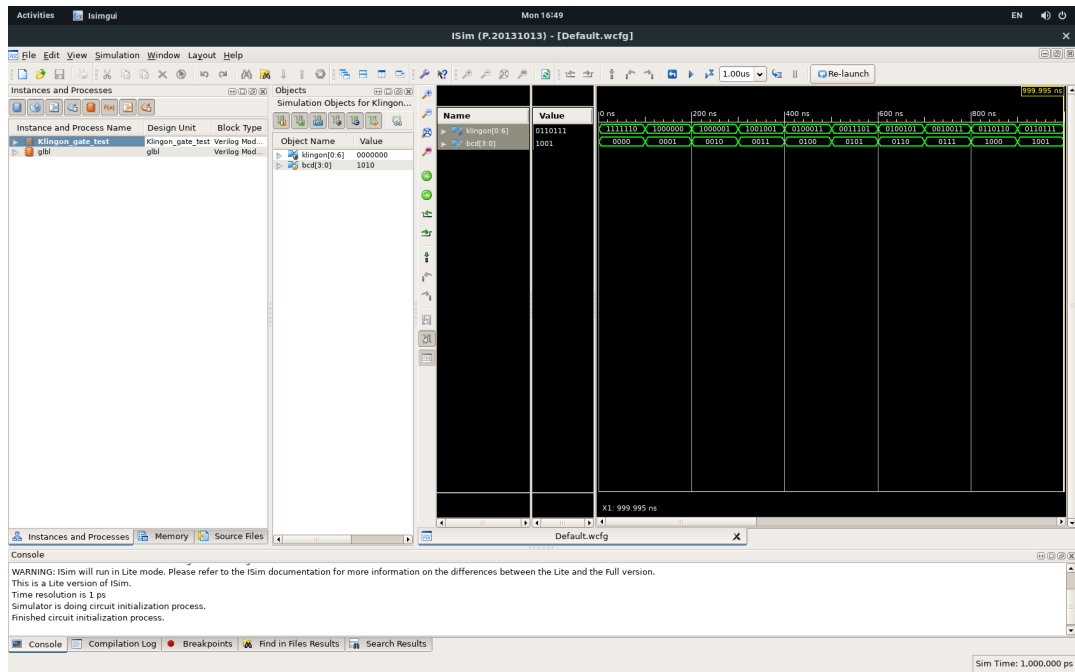
    or U20(kllngon[0], nand);
    or U21(kllngon[1], bnd, ncnd, anb);
    or U22(kllngon[2], a, bd, nbncnd);
    or U23(kllngon[3], nandncnd, bncd, nbcd);
    or U24(kllngon[4], nandncnd, a, bncd, bcnd);
    or U25(kllngon[5], a, ncnd, wbcd);
    or U26(kllngon[6], b, c, ad);

endmodule
```

(2) rtl 구현의 테스트 결과이다.



### (3) gate level 구현의 테스트 결과이다.



## 2. 1-bit ALU

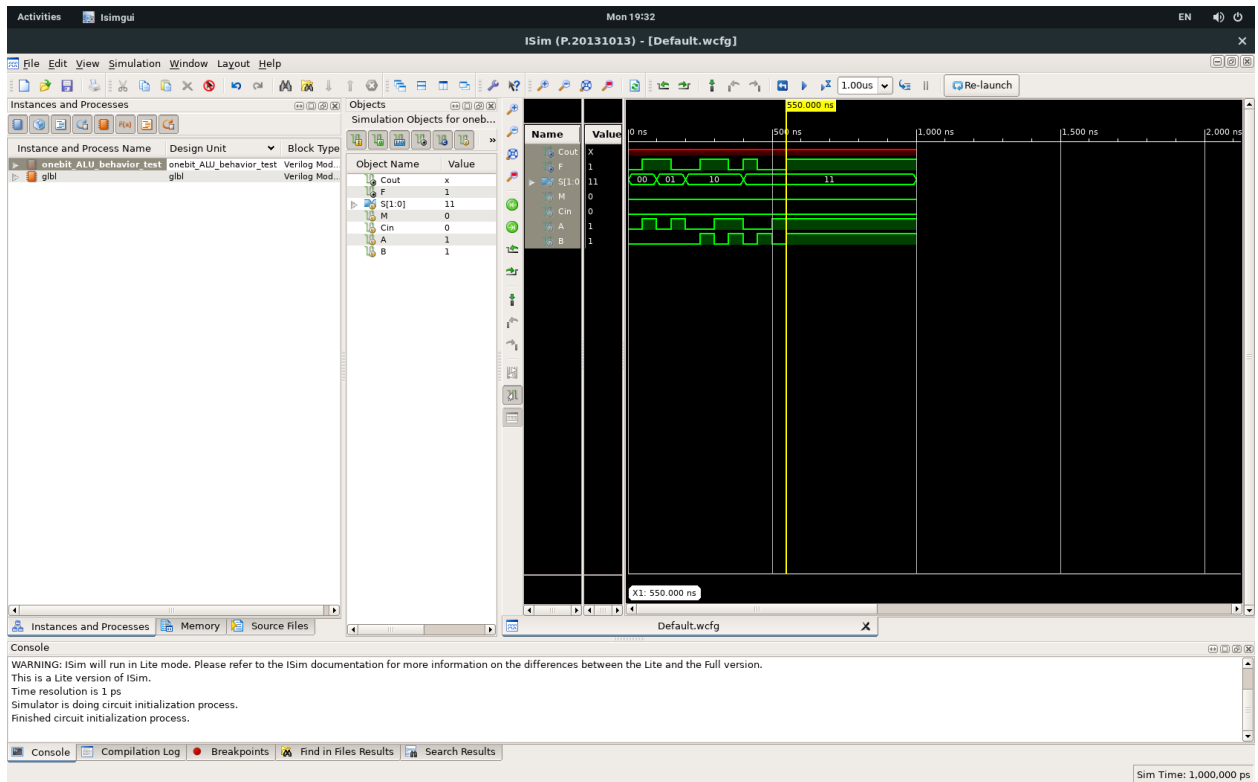
### (1) behavior 구현을 통해 코드를 작성했으며, 다음과 같다.

```
module onebit_ALU_behavior(
    input [1:0] S, [0:0] M, [0:0] CIn, [0:0] A, [0:0] B,
    output reg Cout, F
);

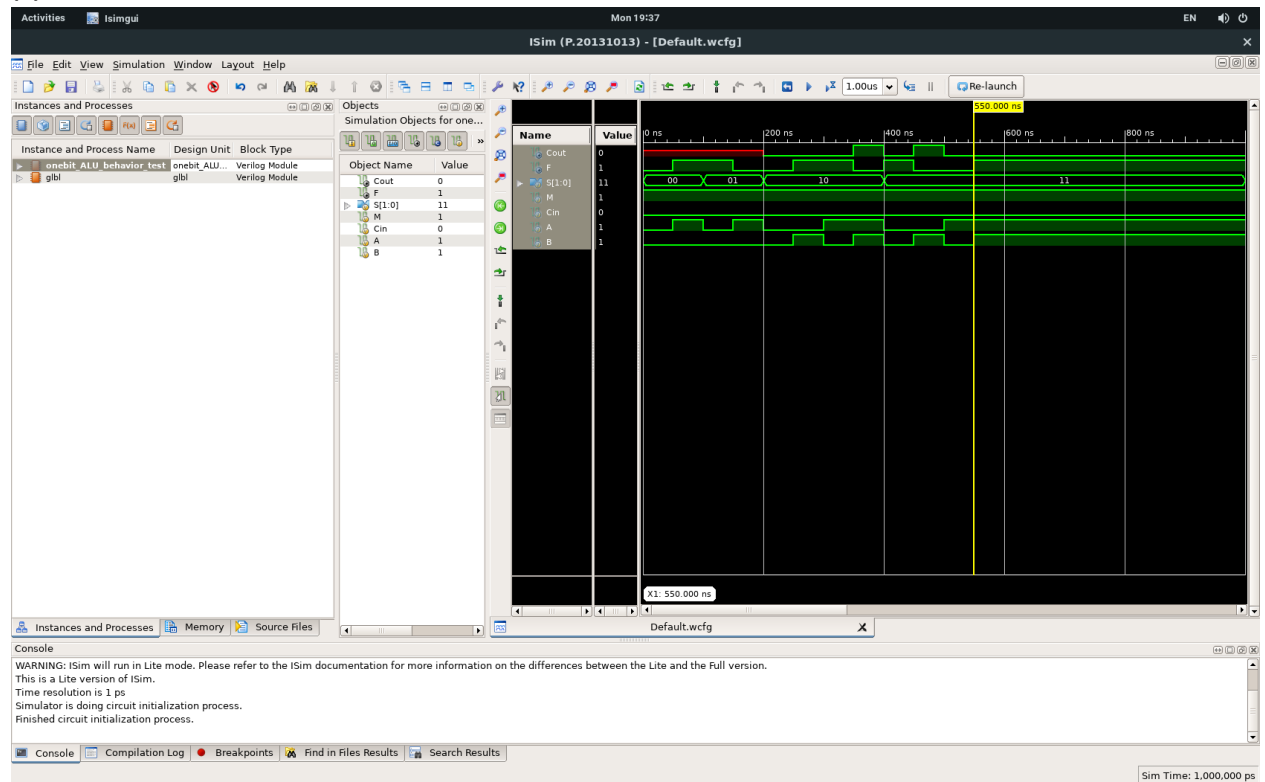
wire [2:0] In = {CIn, A, B};

always @(S or M or In)
begin
    if (M == 0) begin
        case(5)
            2'b000 : begin
                casez(In)
                    3'b700 : F = '1'b0;
                    3'b717 : F = '1'b1;
                endcase
            end
            2'b01 : begin
                casez(In)
                    3'b707 : F = '1'b1;
                    3'b717 : F = '1'b0;
                endcase
            end
            2'b10 : begin
                casez(In)
                    3'b700 : F = '1'b0;
                    3'b701 : F = '1'b1;
                    3'b710 : F = '1'b1;
                    3'b711 : F = '1'b0;
                endcase
            end
            2'b11 : begin
                casez(In)
                    3'b700 : F = '1'b1;
                    3'b701 : F = '1'b0;
                    3'b710 : F = '1'b0;
                    3'b711 : F = '1'b1;
                endcase
            end
        endcase
    end
    else if (M == 1) begin
        case(5)
            2'b000 : begin
                casez(In)
                    3'b007 : F = '1'b0;
                    3'b017 : F = '1'b1;
                    3'b107 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                    3'b117 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                endcase
            end
            2'b01 : begin
                casez(In)
                    3'b007 : F = '1'b1;
                    3'b017 : F = '1'b0;
                    3'b107 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                    3'b117 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                endcase
            end
            2'b10 : begin
                casez(In)
                    3'b000 : begin
                        F = '1'b0;
                        Cout = '1'b0;
                    end
                    3'b001 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                    3'b010 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                    3'b011 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                    3'b100 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                    3'b101 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                    3'b110 : begin
                        F = '1'b1;
                        Cout = '1'b1;
                    end
                    3'b111 : begin
                        F = '1'b1;
                        Cout = '1'b1;
                    end
                endcase
            end
            2'b11 : begin
                casez(In)
                    3'b000 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                    3'b001 : begin
                        F = '1'b0;
                        Cout = '1'b0;
                    end
                    3'b010 : begin
                        F = '1'b1;
                        Cout = '1'b0;
                    end
                    3'b011 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                    3'b100 : begin
                        F = '1'b1;
                        Cout = '1'b1;
                    end
                    3'b101 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                    3'b110 : begin
                        F = '1'b1;
                        Cout = '1'b1;
                    end
                    3'b111 : begin
                        F = '1'b0;
                        Cout = '1'b1;
                    end
                endcase
            end
        endcase
    end
end
```

(2)  $m = 0$  에서 테스트 결과는 다음과 같다.



(3)  $m = 1, cin = 0$  에서 테스트 결과는 다음과 같다.



(2)  $m = 0$ ,  $cin = 1$  에서 테스트 결과는 다음과 같다.

