module half\_adder(

A,B,Sum,Carry );

inputA,B;

output Sum, Carry;

assign Sum = A ^ B; //XOR operation

assign Carry = A & B; //AND operation

endmodule

module full\_adder(

A, B, C, Sum,Carry

);

input A,B,C;

output Sum,Carry;

wire ha1\_sum;

wire ha2\_sum;

wire ha1\_carry;

wire ha2\_carry;

wire Sum;

wire Carry;

half\_adder ha1(

. A(A),

. B(B),

. Sum(ha1\_sum),

. Carry(ha1\_carry)

);

half\_adder ha2(

. A(C),

. B(ha1\_sum),

. Sum(ha2\_sum),

. Carry(ha2\_carry)

);

assign Sum = ha2\_sum;

assign Carry = ha1\_carry | ha2\_carry;

endmodule

module wallace(A,B,prod);

input [3:0] A,B;

output [7:0] prod;

wire s11,s12,s13,s14,s15,s22,s23,s24,s25,s26,s32,s33,s34,s35,s36,s37;

wire c11,c12,c13,c14,c15,c22,c23,c24,c25,c26,c32,c33,c34,c35,c36,c37;

wire [6:0] p0,p1,p2,p3;

assign p0 = A & {4{B[0]}};

assign p1 = A & {4{B[1]}};

assign p2 = A & {4{B[2]}};

assign p3 = A & {4{B[3]}};

assign prod[0] = p0[0];

assign prod[1] = s11;

assign prod[2] = s22;

assign prod[3] = s32;

assign prod[4] = s34;

assign prod[5] = s35;

assign prod[6] = s36;

assign prod[7] = s37;

half\_adder ha11 (p0[1],p1[0],s11,c11);

full\_adder fa12(p0[2],p1[1],p2[0],s12,c12);

full\_adder fa13(p0[3],p1[2],p2[1],s13,c13);

full\_adder fa14(p1[3],p2[2],p3[1],s14,c14);

half\_adder ha15(p2[3],p3[2],s15,c15);

half\_adder ha22 (c11,s12,s22,c22);

full\_adder fa23 (p3[0],c12,s13,s23,c23);

full\_adder fa24 (c13,c32,s14,s24,c24);

full\_adder fa25 (c14,c24,s15,s25,c25);

full\_adder fa26 (c15,c25,p3[3],s26,c26);

half\_adder ha32(c22,s23,s32,c32);

half\_adder ha34(c23,s24,s34,c34);

half\_adder ha35(c34,s25,s35,c35);

half\_adder ha36(c35,s26,s36,c36);

half\_adder ha37(c36,c26,s37,c37);

endmodule

module tb;

reg [3:0] A;

reg [3:0] B;

wire [7:0] prod;

integer i,j,error;

wallace uut (

.A(A),

.B(B),

.prod(prod)

);

initial

begin

$monitor(" %3d %3d %7d |",A,B,prod);

error = 0;

for(i=0;i <=15;i = i+1)

for(j=0;j <=15;j = j+1)

begin

A <= i;

B <= j;

#1;

if(prod != A\*B)

error = error + 1;

end

end

endmodule