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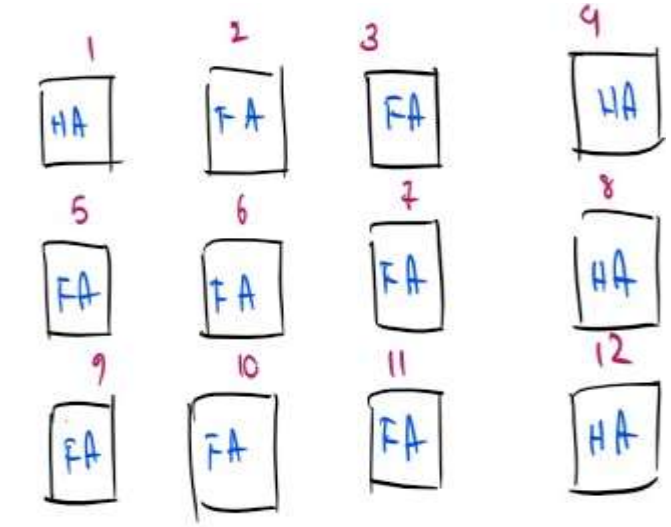
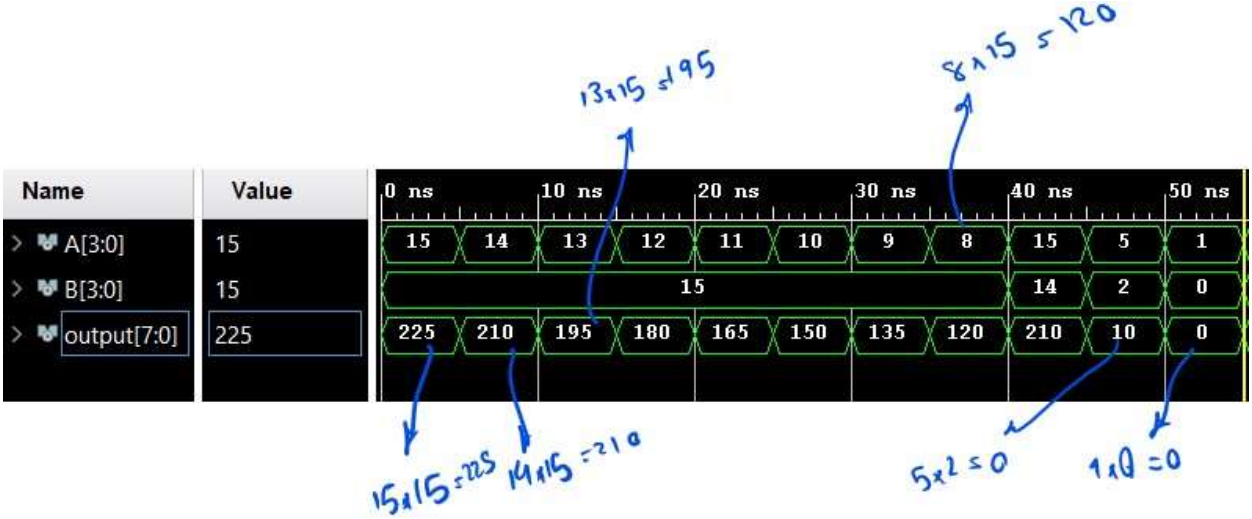
Multiplier:

```
and_gate1:  AND_gate port map(a => A(0), b => B(0), output => AB0(0));
and_gate2:  AND_gate port map(a => A(1), b => B(0), output => AB0(1));
and_gate3:  AND_gate port map(a => A(2), b => B(0), output => AB0(2));
and_gate4:  AND_gate port map(a => A(3), b => B(0), output => AB0(3));

and_gate5:  AND_gate port map(a => A(0), b => B(1), output => AB1(0));
and_gate6:  AND_gate port map(a => A(1), b => B(1), output => AB1(1));
and_gate7:  AND_gate port map(a => A(2), b => B(1), output => AB1(2));
and_gate8:  AND_gate port map(a => A(3), b => B(1), output => AB1(3));

and_gate9:  AND_gate port map(a => A(0), b => B(2), output => AB2(0));
and_gate10: AND_gate port map(a => A(1), b => B(2), output => AB2(1));
and_gate11: AND_gate port map(a => A(2), b => B(2), output => AB2(2));
and_gate12: AND_gate port map(a => A(3), b => B(2), output => AB2(3));

and_gate13: AND_gate port map(a => A(0), b => B(3), output => AB3(0));
and_gate14: AND_gate port map(a => A(1), b => B(3), output => AB3(1));
and_gate15: AND_gate port map(a => A(2), b => B(3), output => AB3(2));
and_gate16: AND_gate port map(a => A(3), b => B(3), output => AB3(3));

FA1: full_adder port map( a => AB0(2), b => AB1(1), Cin => C1(0), Cout => C1(1), sum => P1(1));
FA2: full_adder port map( a => AB0(3), b => AB1(2), Cin => C1(1), Cout => C1(2), sum => P1(2));
FA3: full_adder port map( a => P1(2), b => AB2(1), Cin => C2(0), Cout => C2(1), sum => P2(1));
FA4: full_adder port map( a => P1(3), b => AB2(2), Cin => C2(1), Cout => C2(2), sum => P2(2));
FA5: full_adder port map( a => C1(3), b => AB2(3), Cin => C2(2), Cout => C2(3), sum => P2(3));
FA6: full_adder port map( a => P2(2), b => AB3(1), Cin => C3(0), Cout => C3(1), sum => P3(1));
FA7: full_adder port map( a => P2(3), b => AB3(2), Cin => C3(1), Cout => C3(2), sum => P3(2));
FA8: full_adder port map( a => C2(3), b => AB3(3), Cin => C3(2), Cout => C3(3), sum => P3(3));
HA1: half_adder port map( a => AB0(1), b => AB1(0), cout =>  C1(0), sum => P1(0));
HA2: half_adder port map( a => AB1(3), b => C1(2), cout => C1(3), sum => P1(3));
HA3: half_adder port map( a => P1(1) , b => AB2(0), cout =>  C2(0), sum => P2(0));
HA4: half_adder port map( a => P2(1) , b => AB3(0), cout =>  C3(0), sum => P3(0));
```





Array multiplier:

```
and_1_1: AND_gate port map(a => in1(0), b => in2(0), output => output_mul(0));
and_1_2: AND_gate port map(a => in1(1), b => in2(0), output => and_out(0));
and_1_3: AND_gate port map(a => in1(2), b => in2(0), output => and_out(1));
and_1_4: AND_gate port map(a => in1(3), b => in2(0), output => and_out(2));

and_1_5: AND_gate port map(a => in1(0), b => in2(1), output => and_out(4));
and_1_6: AND_gate port map(a => in1(1), b => in2(1), output => and_out(5));
and_1_7: AND_gate port map(a => in1(2), b => in2(1), output => and_out(6));
and_1_8: AND_gate port map(a => in1(3), b => in2(1), output => and_out(7));

adder_1: carry_lookahead_adder_4_bit port map
(
    A       => and_out(3 downto 0),
    B       => and_out(7 downto 4),
    Cin     => and_out(3),
    S       => adder_out(4 downto 0),
    Cout    => open
);

and_2_1: AND_gate port map(a => in1(0), b => in2(2), output => and_out(8));
and_2_2: AND_gate port map(a => in1(1), b => in2(2), output => and_out(9));
and_2_3: AND_gate port map(a => in1(2), b => in2(2), output => and_out(10));
and_2_4: AND_gate port map(a => in1(3), b => in2(2), output => and_out(11));

adder_2: carry_lookahead_adder_4_bit port map
(
    A => and_out(11 downto 8),
    B => adder_out(4 downto 1),
    Cin => and_out(3),
    S => adder_out(9 downto 5),
    Cout => open
);

and_3_1: AND_gate port map(a => in1(0), b => in2(3), output => and_out(12));
and_3_2: AND_gate port map(a => in1(1), b => in2(3), output => and_out(13));
and_3_3: AND_gate port map(a => in1(2), b => in2(3), output => and_out(14));
and_3_4: AND_gate port map(a => in1(3), b => in2(3), output => and_out(15));

adder_3: carry_lookahead_adder_4_bit port map
(
    A => and_out(15 downto 12),
    B => adder_out(9 downto 6),
    Cin => and_out(3),
    S => output_mul(7 downto 3),
    Cout => open
);
```

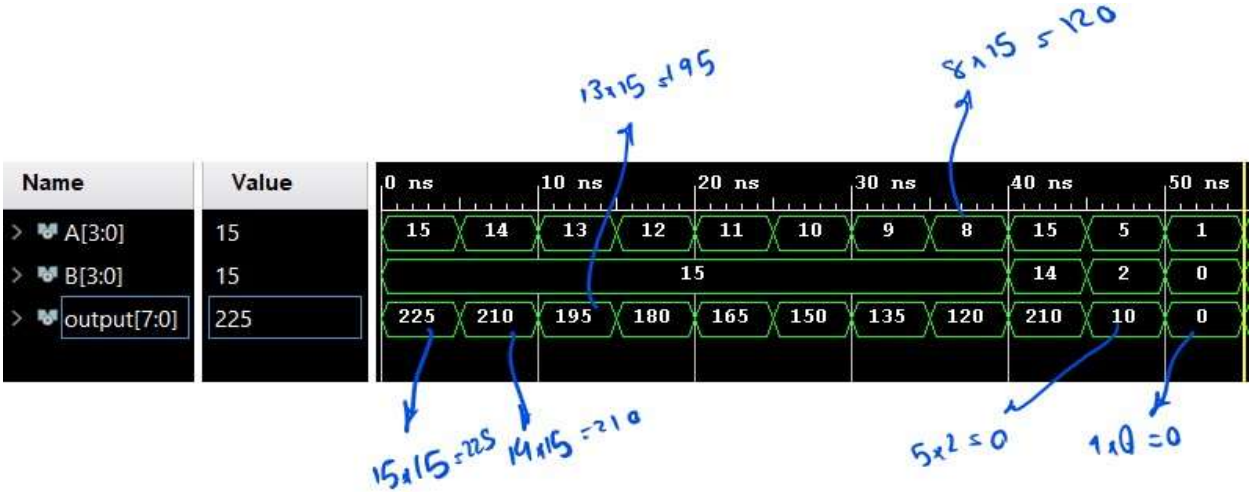
1
4-bit Adder

2
4-bit Adder

3
4bit Adder

output to input

output to input



Carry save adder:

```
and_gate1:  AND_gate port map(a => A(0), b => B(0), output => ab(0)(0));
and_gate2:  AND_gate port map(a => A(0), b => B(1), output => ab(0)(1));
and_gate3:  AND_gate port map(a => A(0), b => B(2), output => ab(0)(2));
and_gate4:  AND_gate port map(a => A(0), b => B(3), output => ab(0)(3));
and_gate5:  AND_gate port map(a => A(1), b => B(0), output => ab(1)(0));
and_gate6:  AND_gate port map(a => A(1), b => B(1), output => ab(1)(1));
and_gate7:  AND_gate port map(a => A(1), b => B(2), output => ab(1)(2));
and_gate8:  AND_gate port map(a => A(1), b => B(3), output => ab(1)(3));
and_gate9:  AND_gate port map(a => A(2), b => B(0), output => ab(2)(0));
and_gate10: AND_gate port map(a => A(2), b => B(1), output => ab(2)(1));
and_gate11: AND_gate port map(a => A(2), b => B(2), output => ab(2)(2));
and_gate12: AND_gate port map(a => A(2), b => B(3), output => ab(2)(3));
and_gate13: AND_gate port map(a => A(3), b => B(0), output => ab(3)(0));
and_gate14: AND_gate port map(a => A(3), b => B(1), output => ab(3)(1));
and_gate15: AND_gate port map(a => A(3), b => B(2), output => ab(3)(2));
and_gate16: AND_gate port map(a => A(3), b => B(3), output => ab(3)(3));

ha01: half_adder port map(a => ab(0)(1), b => ab(1)(0), sum => sums(0)(2), cout => couts(0)(2));
ha02: half_adder port map(a => ab(1)(1), b => ab(2)(0), sum => sums(0)(1), cout => couts(0)(1));
ha03: half_adder port map(a => ab(2)(1), b => ab(3)(0), sum => sums(0)(0), cout => couts(0)(0));

fa01: full_adder port map(a => ab(0)(2), b => sums(0)(1), cin => couts(0)(2), sum => sums(1)(2), cout => couts(1)(2));
fa02: full_adder port map(a => ab(1)(2), b => sums(0)(0), cin => couts(0)(1), sum => sums(1)(1), cout => couts(1)(1));
fa03: full_adder port map(a => ab(2)(2), b => ab(3)(1),  cin => couts(0)(0), sum => sums(1)(0), cout => couts(1)(0));
fa04: full_adder port map(a => ab(0)(3), b => sums(1)(1), cin => couts(1)(2), sum => sums(2)(2), cout => couts(2)(2));
fa05: full_adder port map(a => ab(1)(3), b => sums(1)(0), cin => couts(1)(1), sum => sums(2)(1), cout => couts(2)(1));
fa06: full_adder port map(a => ab(2)(3), b => ab(3)(2),  cin => couts(1)(0), sum => sums(2)(0), cout => couts(2)(0));

ha04: half_adder port map(a => sums(2)(1), b => couts(2)(2), sum => sums(3)(2), cout => couts(3)(2));
fa07: full_adder port map(a => sums(2)(0), b => couts(2)(1), cin => couts(3)(2), sum => sums(3)(1), cout => couts(3)(1));
fa08: full_adder port map(a => ab(3)(3), b => couts(2)(0), cin => couts(3)(1), sum => sums(3)(0), cout => couts(3)(0));
```