**Problem 0:**

Total area: 521.314  
Cell counts: 207

**Problem 1: Deliverable**

1. RTL, testbench, SDC attached to submission  
2. Xcelium screenshots shown below:  
A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

3. Synthesis values:

Area Report Screenshot (Total Area = 309.747, Cell Count = 104):

A screenshot of a computer

Description automatically generated

Timing Report Screenshot (Timing Slack = 171):

A screenshot of a computer

Description automatically generated

5. Copied in supporting files:

**alu.v:**

`timescale 1ps/1ps

module alu(

input [7:0] a,b,

input [2:0] F,

output [7:0] Q,

output Cout

);

assign {Cout,Q} = (F == 3'b000) ? a+b :

(F == 3'b001) ? a-b :

(F == 3'b010) ? {1'bx,a|b} :

(F == 3'b011) ? {1'bx,a&b} :

(F == 3'b100) ? {1'bx,a^b} :

(F == 3'b101) ? {1'bx,~a} :

(F == 3'b110) ? {1'bx,a} << 1 :

(F == 3'b111) ? a >> 1 : 0;

endmodule

**alu\_tb.v:**

`timescale 1ns/10ps

module alu\_tb;

reg [7:0] a,b;

reg [2:0] F;

wire [7:0] Q;

wire Cout;

alu myalu(a,b,F,Q,Cout);

always

begin

$dumpfile("alu.vcd");

$dumpvars(0,alu\_tb);

a = 3;

b = 5;

F = 0;

#10

a = 250;

b = 6;

#10

F = 1;

#10

a = 6;

b = 250;

#10

F = 2;

#10

F = 3;

#10

F = 4;

#10

F = 5;

#10

F = 6;

#10

F = 7;

#10

$finish;

end

endmodule

**alu.sdc:**

set\_max\_delay 1 -from [all\_inputs] -to [all\_outputs]

**alu\_syn.v:**

// Generated by Cadence Genus(TM) Synthesis Solution 18.14-s037\_1

// Generated on: Nov 14 2024 04:40:46 CST (Nov 14 2024 10:40:46 UTC)

// Verification Directory fv/alu

module alu(a, b, F, Q, Cout);

input [7:0] a, b;

input [2:0] F;

output [7:0] Q;

output Cout;

wire [7:0] a, b;

wire [2:0] F;

wire [7:0] Q;

wire Cout;

wire UNCONNECTED, n\_0, n\_1, n\_2, n\_3, n\_4, n\_5, n\_6;

wire n\_7, n\_8, n\_9, n\_10, n\_11, n\_12, n\_13, n\_14;

wire n\_15, n\_16, n\_17, n\_18, n\_19, n\_20, n\_21, n\_22;

wire n\_23, n\_24, n\_25, n\_26, n\_27, n\_28, n\_29, n\_30;

wire n\_31, n\_32, n\_33, n\_34, n\_35, n\_36, n\_37, n\_38;

wire n\_39, n\_40, n\_41, n\_42, n\_43, n\_44, n\_45, n\_46;

wire n\_47, n\_48, n\_49, n\_50, n\_51, n\_52, n\_53, n\_54;

wire n\_56, n\_58, n\_59, n\_60, n\_61, n\_62, n\_63, n\_64;

wire n\_65, n\_66, n\_67, n\_68, n\_69, n\_70, n\_71, n\_72;

wire n\_73, n\_74, n\_75, n\_76, n\_77, n\_78, n\_79, n\_81;

wire n\_83, n\_84, n\_85, n\_87, n\_88, n\_89, n\_91, n\_93;

wire n\_94, n\_95, n\_96, n\_98, n\_100, n\_102, n\_103, n\_104;

wire n\_106, n\_107, n\_108, n\_109, n\_111, n\_132;

NAND2\_X1 g3341\_\_8780(.A1 (n\_111), .A2 (n\_67), .ZN (Q[7]));

OAI211\_X1 g3343\_\_4296(.A (n\_109), .B (n\_76), .C1 (n\_21), .C2 (a[7]),

.ZN (n\_111));

MUX2\_X1 g3342\_\_3772(.A (n\_108), .B (n\_40), .S (F[2]), .Z (Cout));

MUX2\_X1 g3344\_\_1474(.A (n\_107), .B (n\_41), .S (F[1]), .Z (n\_109));

XNOR2\_X1 g3345\_\_4547(.A (n\_106), .B (n\_27), .ZN (n\_108));

FA\_X1 g3346\_\_9682(.A (n\_25), .B (a[7]), .CI (n\_102), .CO (n\_106), .S

(n\_107));

OAI211\_X1 g3347\_\_2683(.A (n\_104), .B (n\_74), .C1 (n\_46), .C2 (a[6]),

.ZN (Q[6]));

OAI21\_X1 g3348\_\_1309(.A (n\_44), .B1 (n\_103), .B2 (F[1]), .ZN (n\_104));

FA\_X1 g3349\_\_6877(.A (n\_28), .B (a[6]), .CI (n\_132), .CO (n\_102), .S

(n\_103));

OR2\_X1 g3350\_\_2900(.A1 (n\_100), .A2 (n\_77), .ZN (Q[5]));

NOR4\_X1 g3351\_\_2391(.A1 (n\_98), .A2 (n\_20), .A3 (n\_12), .A4 (F[2]),

.ZN (n\_100));

OAI211\_X1 g3352\_\_7675(.A (n\_96), .B (n\_71), .C1 (n\_51), .C2 (a[4]),

.ZN (Q[4]));

AOI211\_X1 g3353\_\_7118(.A (F[1]), .B (n\_95), .C1 (n\_94), .C2 (n\_93),

.ZN (n\_98));

OAI21\_X1 g3355\_\_1786(.A (n\_43), .B1 (n\_91), .B2 (F[1]), .ZN (n\_96));

NOR2\_X1 g3356\_\_5953(.A1 (n\_94), .A2 (n\_93), .ZN (n\_95));

FA\_X1 g3358\_\_5703(.A (n\_31), .B (a[4]), .CI (n\_87), .CO (n\_94), .S

(n\_91));

OAI211\_X1 g3359\_\_7114(.A (n\_89), .B (n\_69), .C1 (n\_42), .C2 (a[3]),

.ZN (Q[3]));

OAI21\_X1 g3360\_\_5266(.A (n\_48), .B1 (n\_88), .B2 (F[1]), .ZN (n\_89));

FA\_X1 g3361\_\_2250(.A (n\_34), .B (a[3]), .CI (n\_83), .CO (n\_87), .S

(n\_88));

OAI211\_X1 g3362\_\_6083(.A (n\_85), .B (n\_70), .C1 (n\_47), .C2 (a[2]),

.ZN (Q[2]));

OAI21\_X1 g3363\_\_2703(.A (n\_45), .B1 (n\_84), .B2 (F[1]), .ZN (n\_85));

FA\_X1 g3364\_\_5795(.A (n\_26), .B (a[2]), .CI (n\_78), .CO (n\_83), .S

(n\_84));

OAI211\_X1 g3365\_\_7344(.A (n\_81), .B (n\_75), .C1 (n\_53), .C2 (a[1]),

.ZN (Q[1]));

OAI21\_X1 g3366\_\_1840(.A (n\_54), .B1 (n\_79), .B2 (F[1]), .ZN (n\_81));

OAI221\_X1 g3368\_\_5019(.A (n\_66), .B1 (n\_68), .B2 (F[2]), .C1 (n\_35),

.C2 (a[0]), .ZN (Q[0]));

FA\_X1 g3367\_\_1857(.A (n\_38), .B (a[1]), .CI (n\_24), .CO (n\_78), .S

(n\_79));

OAI221\_X1 g3370\_\_9906(.A (n\_59), .B1 (n\_49), .B2 (a[5]), .C1 (n\_37),

.C2 (n\_76), .ZN (n\_77));

AOI221\_X1 g3371\_\_8780(.A (n\_64), .B1 (n\_73), .B2 (a[0]), .C1 (n\_72),

.C2 (a[2]), .ZN (n\_75));

AOI221\_X1 g3372\_\_4296(.A (n\_60), .B1 (n\_73), .B2 (a[5]), .C1 (n\_72),

.C2 (a[7]), .ZN (n\_74));

AOI221\_X1 g3373\_\_3772(.A (n\_62), .B1 (n\_73), .B2 (a[3]), .C1 (n\_72),

.C2 (a[5]), .ZN (n\_71));

AOI221\_X1 g3376\_\_1474(.A (n\_58), .B1 (n\_73), .B2 (a[1]), .C1 (n\_72),

.C2 (a[3]), .ZN (n\_70));

AOI221\_X1 g3377\_\_4547(.A (n\_61), .B1 (n\_73), .B2 (a[2]), .C1 (n\_72),

.C2 (a[4]), .ZN (n\_69));

AOI222\_X1 g3369\_\_9682(.A1 (n\_29), .A2 (b[0]), .B1 (n\_65), .B2 (n\_11),

.C1 (n\_36), .C2 (a[0]), .ZN (n\_68));

AOI22\_X1 g3375\_\_2683(.A1 (n\_39), .A2 (n\_52), .B1 (n\_73), .B2 (a[6]),

.ZN (n\_67));

AOI22\_X1 g3378\_\_1309(.A1 (n\_63), .A2 (n\_65), .B1 (n\_72), .B2 (a[1]),

.ZN (n\_66));

AND3\_X1 g3394\_\_6877(.A1 (n\_63), .A2 (n\_1), .A3 (a[1]), .ZN (n\_64));

AND3\_X1 g3395\_\_2900(.A1 (n\_63), .A2 (n\_30), .A3 (a[4]), .ZN (n\_62));

AND3\_X1 g3396\_\_2391(.A1 (n\_63), .A2 (n\_32), .A3 (a[3]), .ZN (n\_61));

AND3\_X1 g3400\_\_7675(.A1 (n\_63), .A2 (n\_4), .A3 (a[6]), .ZN (n\_60));

NAND3\_X1 g3399\_\_7118(.A1 (n\_63), .A2 (n\_0), .A3 (a[5]), .ZN (n\_59));

AND3\_X1 g3398\_\_8757(.A1 (n\_63), .A2 (n\_3), .A3 (a[2]), .ZN (n\_58));

XNOR2\_X1 g3374\_\_1786(.A (n\_56), .B (a[5]), .ZN (n\_93));

AOI211\_X1 g3383\_\_7114(.A (F[2]), .B (n\_18), .C1 (n\_8), .C2 (F[1]),

.ZN (n\_54));

AOI21\_X1 g3388\_\_5266(.A (n\_50), .B1 (n\_52), .B2 (b[1]), .ZN (n\_53));

AOI21\_X1 g3389\_\_2250(.A (n\_50), .B1 (n\_52), .B2 (b[4]), .ZN (n\_51));

AOI21\_X1 g3390\_\_6083(.A (n\_50), .B1 (n\_52), .B2 (b[5]), .ZN (n\_49));

AOI211\_X1 g3380\_\_2703(.A (F[2]), .B (n\_22), .C1 (n\_10), .C2 (F[1]),

.ZN (n\_48));

AOI21\_X1 g3392\_\_5795(.A (n\_50), .B1 (n\_52), .B2 (b[2]), .ZN (n\_47));

AOI21\_X1 g3393\_\_7344(.A (n\_50), .B1 (n\_52), .B2 (b[6]), .ZN (n\_46));

AOI211\_X1 g3385\_\_1840(.A (F[2]), .B (n\_16), .C1 (n\_5), .C2 (F[1]),

.ZN (n\_45));

AOI211\_X1 g3384\_\_5019(.A (F[2]), .B (n\_17), .C1 (n\_9), .C2 (F[1]),

.ZN (n\_44));

AOI211\_X1 g3379\_\_1857(.A (F[2]), .B (n\_15), .C1 (n\_6), .C2 (F[1]),

.ZN (n\_43));

AOI21\_X1 g3391\_\_9906(.A (n\_50), .B1 (n\_52), .B2 (b[3]), .ZN (n\_42));

OR2\_X1 g3410\_\_8780(.A1 (n\_40), .A2 (b[7]), .ZN (n\_41));

OAI22\_X1 g3387\_\_4296(.A1 (n\_7), .A2 (a[7]), .B1 (n\_19), .B2 (b[7]),

.ZN (n\_39));

MUX2\_X1 g3386\_\_3772(.A (n\_33), .B (a[0]), .S (b[0]), .Z (n\_38));

AOI22\_X1 g3397\_\_1474(.A1 (n\_36), .A2 (a[4]), .B1 (n\_13), .B2 (a[6]),

.ZN (n\_37));

INV\_X1 g3408(.A (n\_50), .ZN (n\_35));

XNOR2\_X1 g3404\_\_4547(.A (n\_33), .B (n\_32), .ZN (n\_34));

XNOR2\_X1 g3401\_\_9682(.A (n\_33), .B (n\_30), .ZN (n\_31));

INV\_X1 g3416(.A (n\_23), .ZN (n\_29));

NOR2\_X1 g3414\_\_2683(.A1 (n\_14), .A2 (F[0]), .ZN (n\_63));

XNOR2\_X1 g3403\_\_1309(.A (n\_27), .B (b[6]), .ZN (n\_28));

XNOR2\_X1 g3402\_\_6877(.A (n\_27), .B (b[2]), .ZN (n\_26));

XNOR2\_X1 g3406\_\_2900(.A (n\_27), .B (b[7]), .ZN (n\_25));

XNOR2\_X1 g3405\_\_2391(.A (n\_27), .B (b[5]), .ZN (n\_56));

XNOR2\_X1 g3407\_\_7675(.A (n\_27), .B (b[1]), .ZN (n\_24));

AOI21\_X1 g3420\_\_7118(.A (n\_36), .B1 (a[0]), .B2 (F[1]), .ZN (n\_23));

AND2\_X1 g3412\_\_8757(.A1 (n\_36), .A2 (F[2]), .ZN (n\_73));

AND2\_X1 g3415\_\_1786(.A1 (n\_52), .A2 (F[0]), .ZN (n\_50));

AOI21\_X1 g3409\_\_5953(.A (n\_21), .B1 (a[3]), .B2 (b[3]), .ZN (n\_22));

AOI21\_X1 g3411\_\_5703(.A (n\_21), .B1 (a[5]), .B2 (b[5]), .ZN (n\_20));

INV\_X1 g3424(.A (n\_19), .ZN (n\_40));

NOR2\_X1 g3413\_\_7114(.A1 (n\_21), .A2 (n\_76), .ZN (n\_72));

AOI21\_X1 g3419\_\_5266(.A (n\_21), .B1 (a[1]), .B2 (b[1]), .ZN (n\_18));

AOI21\_X1 g3418\_\_2250(.A (n\_21), .B1 (a[6]), .B2 (b[6]), .ZN (n\_17));

AOI21\_X1 g3417\_\_6083(.A (n\_21), .B1 (a[2]), .B2 (b[2]), .ZN (n\_16));

AOI21\_X1 g3422\_\_2703(.A (n\_21), .B1 (a[4]), .B2 (b[4]), .ZN (n\_15));

INV\_X1 g3425(.A (n\_52), .ZN (n\_14));

INV\_X1 g3432(.A (n\_21), .ZN (n\_13));

NOR3\_X1 g3421\_\_5795(.A1 (n\_11), .A2 (a[5]), .A3 (b[5]), .ZN (n\_12));

NOR2\_X1 g3429\_\_7344(.A1 (n\_11), .A2 (F[0]), .ZN (n\_36));

NAND2\_X1 g3428\_\_1840(.A1 (n\_2), .A2 (a[7]), .ZN (n\_19));

XOR2\_X1 g3423\_\_5019(.A (a[0]), .B (b[0]), .Z (n\_65));

INV\_X1 g3426(.A (n\_27), .ZN (n\_33));

NOR2\_X1 g3430\_\_1857(.A1 (n\_76), .A2 (F[1]), .ZN (n\_52));

NOR2\_X1 g3435\_\_9906(.A1 (a[3]), .A2 (b[3]), .ZN (n\_10));

NOR2\_X1 g3436\_\_8780(.A1 (a[6]), .A2 (b[6]), .ZN (n\_9));

NOR2\_X1 g3431\_\_4296(.A1 (F[1]), .A2 (F[0]), .ZN (n\_27));

NAND2\_X1 g3438\_\_3772(.A1 (F[1]), .A2 (F[0]), .ZN (n\_21));

NOR2\_X1 g3434\_\_1474(.A1 (a[1]), .A2 (b[1]), .ZN (n\_8));

NOR2\_X1 g3427\_\_4547(.A1 (b[7]), .A2 (F[0]), .ZN (n\_7));

NOR2\_X1 g3433\_\_9682(.A1 (a[4]), .A2 (b[4]), .ZN (n\_6));

NOR2\_X1 g3437\_\_2683(.A1 (a[2]), .A2 (b[2]), .ZN (n\_5));

INV\_X1 g3445(.A (b[6]), .ZN (n\_4));

INV\_X1 g3443(.A (b[2]), .ZN (n\_3));

INV\_X1 g3441(.A (F[0]), .ZN (n\_2));

INV\_X1 g3447(.A (F[1]), .ZN (n\_11));

INV\_X1 g3444(.A (b[1]), .ZN (n\_1));

INV\_X1 g3442(.A (b[5]), .ZN (n\_0));

INV\_X1 g3440(.A (b[4]), .ZN (n\_30));

INV\_X1 g3439(.A (b[3]), .ZN (n\_32));

INV\_X1 g3446(.A (F[2]), .ZN (n\_76));

FA\_X1 g2(.A (n\_56), .B (a[5]), .CI (n\_94), .CO (n\_132), .S

(UNCONNECTED));

endmodule