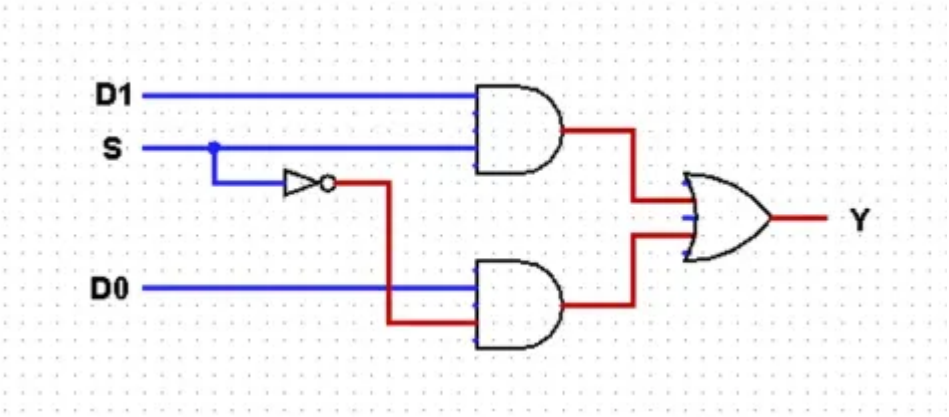
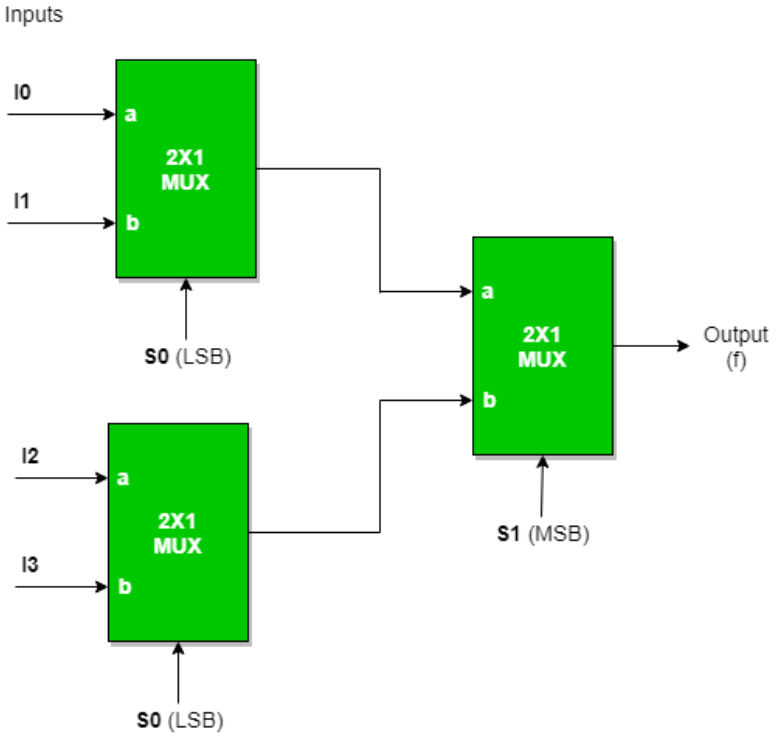
a) Design a 2x1 MUX.
b) Using 2 2x1 MUX, design a 4x1 MUX.
c) Design and implementation of 1 bit Logic unit.



2x1 MUX



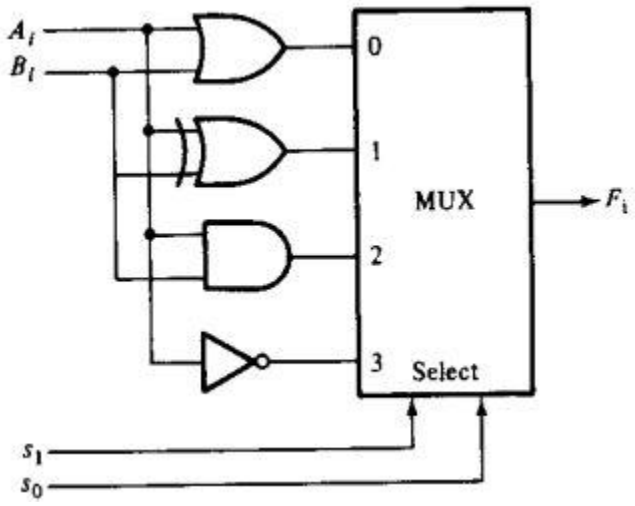
2 2x1 to form 4x1

Truth Table

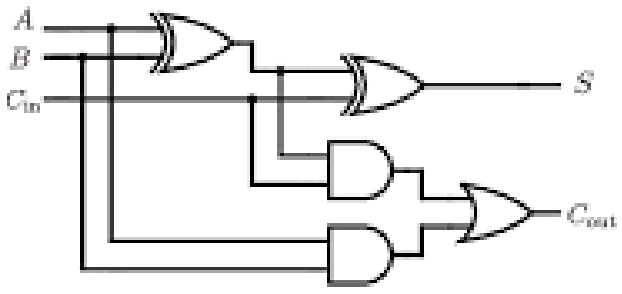
S0	S1	f
0	0	I0
0	1	I1
1	0	I2
1	1	I3

LU

s_1	s_0	Output	Operation
0	0	$F_i = A_i + B_i$	OR
0	1	$F_i = A_i \oplus B_i$	XOR
1	0	$F_i = A_i B_i$	AND
1	1	$F_i = A_i'$	NOT



AU

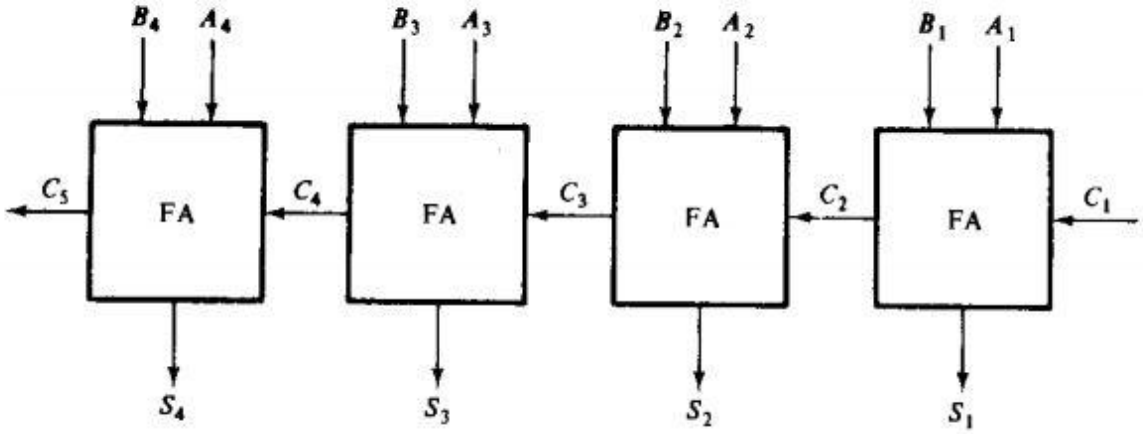


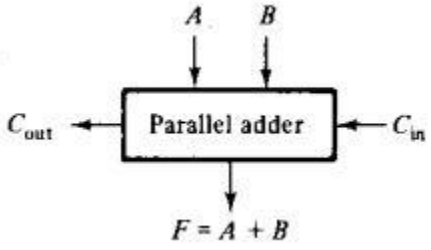
Inputs			Outputs	
A	B	C_{in}	S	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

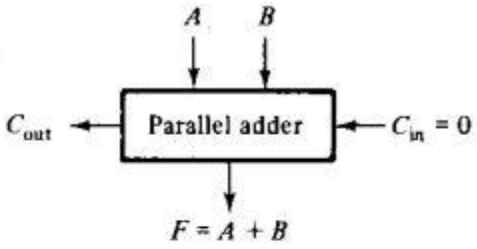
FA

$S = (A \oplus B) \oplus C_{in}$

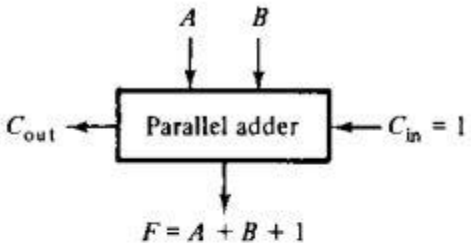
$C = A.B + (A \oplus B)$



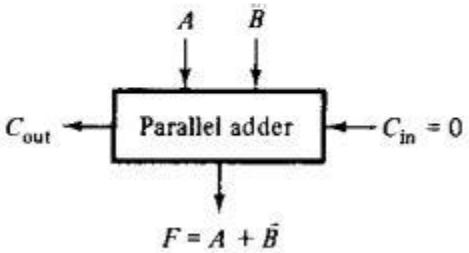




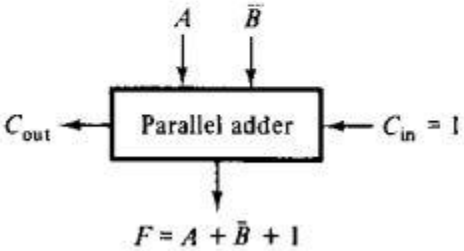
(a) Addition



(b) Addition with carry



(c) A plus 1's complement of B



(d) Subtraction

Note : 4 bit parallel adder IC : 7483

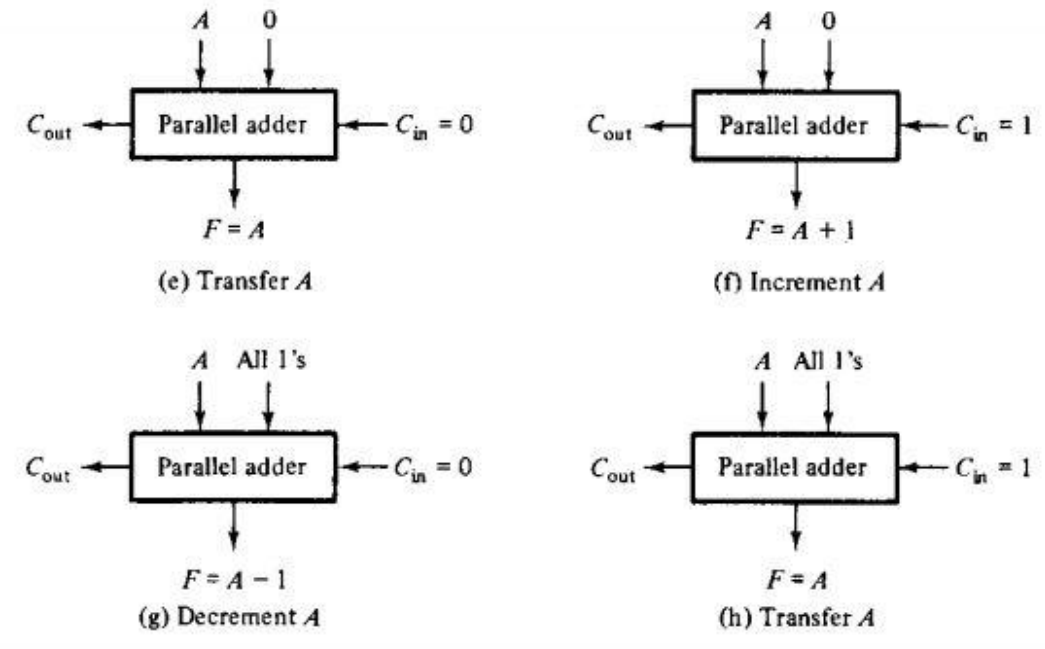
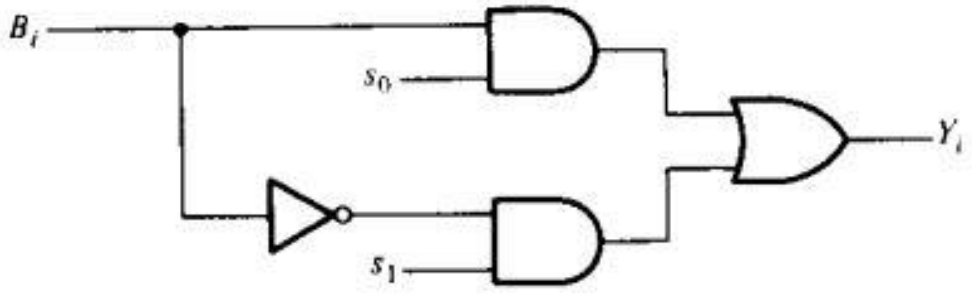


Figure 9-6 Operations obtained by controlling one set of inputs to a parallel adder

S_1	S_0	Y_i
0	0	0
0	1	B_i
1	0	B_i'
1	1	1



Function select			Y equals	Output equals	Function
s_1	s_0	C_{in}			
0	0	0	0	$F = A$	Transfer A
0	0	1	0	$F = A + 1$	Increment A
0	1	0	B	$F = A + B$	Add B to A
0	1	1	B	$F = A + B + 1$	Add B to A plus 1
1	0	0	$\overline{B}$	$F = A + \overline{B}$	Add 1's complement of B to A
1	0	1	$\overline{B}$	$F = A + \overline{B} + 1$	Add 2's complement of B to A
1	1	0	All 1's	$F = A - 1$	Decrement A
1	1	1	All 1's	$F = A$	Transfer A

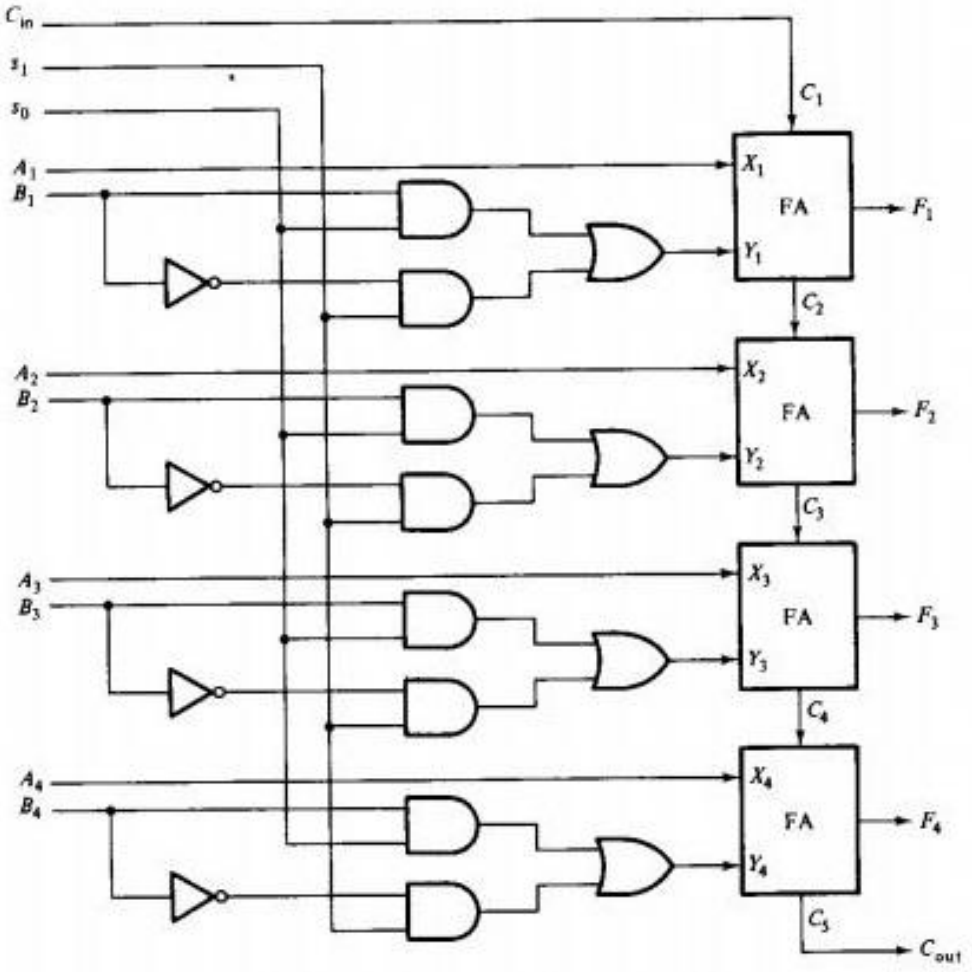
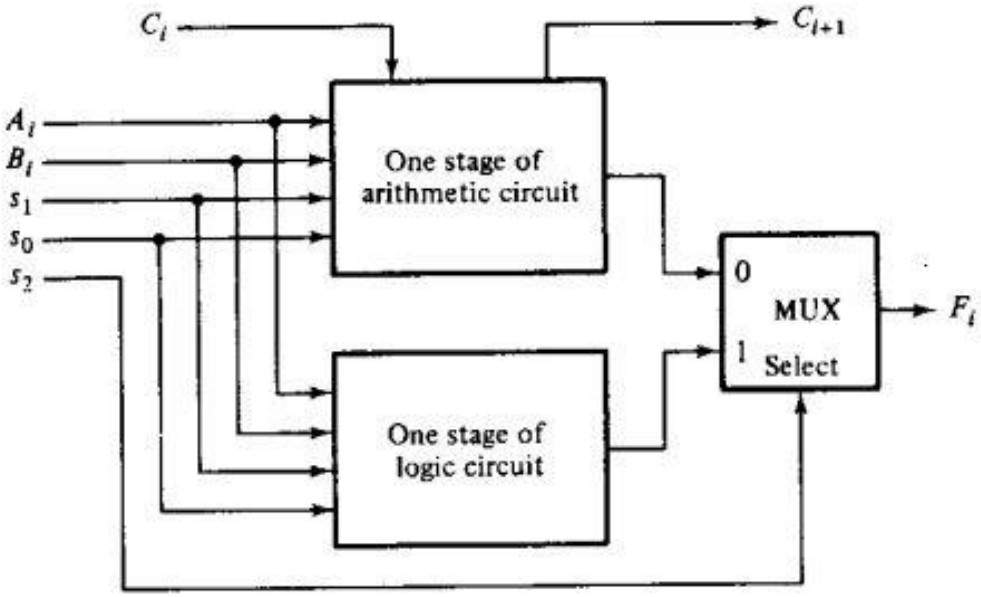


Figure 9-8 Logic diagram of arithmetic circuit

Combine



More Efficient Design

Required

s_2	s_1	s_0	X_i	Y_i	C_i	$F_i = X_i \oplus Y_i$	Operation	Required operation
1	0	0	A_i	0	0	$F_i = A_i$	Transfer A	OR
1	0	1	A_i	B_i	0	$F_i = A_i \oplus B_i$	XOR	XOR
1	1	0	A_i	B_i'	0	$F_i = A_i \odot B_i$	Equivalence	AND
1	1	1	A_i	1	0	$F_i = A_i'$	NOT	NOT

OR

For OR,
We push A+B in X when
Input is 100

Else, X = A

Therefore, X = Ai + s2.s1'.s0'.Bi

AND

For AND,
We, put
X = Ai + Ki
When input is 110

So, Fi = (Ai+Ki).Bi + (Ai+Ki)'Bi'
= AiBi + KiBi + Ai'Ki'Bi'

If we put, Ki = Bi'
We get Fi = AiBi

So, X = Ai + s2.s1'.s0'.Bi + s2.s1.s0'.Bi'

Finally

$$X_i = A_i + s_2 s_1' s_0' B_i + s_2 s_1 s_0' B_i'$$
$$Y_i = s_0 B_i + s_1 B_i'$$
$$Z_i = s_2' C_i$$

s_2

Selection				Output	Function
s_2	s_1	s_0	C_{in}		
0	0	0	0	$F = A$	Transfer A
0	0	0	1	$F = A + 1$	Increment A
0	0	1	0	$F = A + B$	Addition
0	0	1	1	$F = A + B + 1$	Add with carry
0	1	0	0	$F = A - B - 1$	Subtract with borrow
0	1	0	1	$F = A - B$	Subtraction
0	1	1	0	$F = A - 1$	Decrement A
0	1	1	1	$F = A$	Transfer A
1	0	0	X	$F = A \vee B$	OR
1	0	1	X	$F = A \oplus B$	XOR
1	1	0	X	$F = A \wedge B$	AND
1	1	1	X	$F = \overline{A}$	Complement A