CSE 306_Assignment1
4-Bit Arithmetic and Logic Unit

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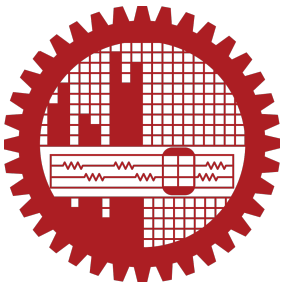

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1 Design of Arithmetic Unit

Truth Table : Arithmetic Operations

cs_2	cs_1	$cs_0(c_{in})$	Arithmetic Operation	x_i	y_i
0	0	0	Subtract with borrow	A_i	$\overline{B_i}$
0	0	1	Subtract	A_i	$\overline{B_i}$
0	1	0	Decrement A	A_i	1
0	1	1	Transfer A	A_i	1

Subtract :
$= A - B$
$= (A + \overline{B} + 1)$

Subtract with borrow explanation:
$= A - B - 1$
$= (A + \overline{B} + 1) - 1$
$= A + \overline{B}$

Decrement A :
$= A - 1$
$= A + (all1) + 0$

Transfer A :
$= A$
$= A + (all1) + 1$

So, $Y_i = \overline{CS_1}.\overline{B_i} + CS_1 = \overline{(CS_1 + B_i)} + CS_1$

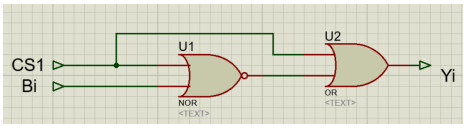

Figure 1: Design of Yi

2 Design of Logic Unit

Truth Table : Logical Operations

cs_2	cs_1	$cs_0(c_{in})$	x_i	y_i	$F_i = X_i \oplus Y_i$	Operation
1	0	0	$A_i + \overline{B_i}$	B_i	$A_i.B_i$	AND
1	0	1	$A_i + \overline{B_i}$	B_i	$A_i.B_i$	AND
1	1	0	$\overline{A_i}$	0	$\overline{A_i}$	Complement A
1	1	1	$\overline{A_i}$	0	$\overline{A_i}$	Complement A

Explanation:
we can't modify Y_i because that would change the arithmetic operations and neither can omit A_i in any input, So we change X_i,
Let,

$X_i = A_i + K_i$

$F_i = X_i \oplus Y_i$
$F_i = X_i \oplus 0$
$F_i = X_i$
$F_i = A_i + K_i$

But the desired output is $A_i + B_i$. So putting $K_i = B_i$
$F_i = X_i \oplus Y_i$
$F_i = (A_i \oplus K_i) \oplus \overline{B_i}$
$F_i = (A_i \oplus K_i)B_i + \overline{(A_i \oplus K_i)}.\overline{B_i}$
$F_i = A_iB_i + K_iB_i + \overline{A_i}.\overline{K_i}.\overline{B_i}$
Here our desired operation is A_iB_i
So, $A_iB_i + K_iB_i + \overline{A_i}.\overline{K_i}.\overline{B_i} = A_iB_i$
if $K_i = \overline{B_i}$ Then $F_i = A_iB_i$
So we need $K_i = B_i$ when we will do OR operation and $K_i = \overline{B_i}$ for AND operation.

cs_2	cs_1	cs_0	B
1	0	0	$\overline{B_i}$
1	0	1	$\overline{B_i}$
1	1	0	0
1	1	1	0

So from the truth table we can derive,
$X_i = A_i + CS_2.\overline{CS_1}.\overline{B_i} = A_i + CS_2\overline{(CS_1 + B_i)}$

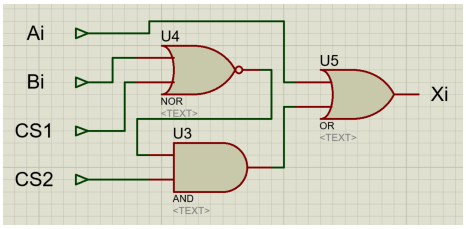

Figure 2: Design of X_i

3 Final Diagram

$X_i = A_i + CS_2\overline{(CS_1 + B_i)}$

$Y_i = \overline{(CS_1 + B_i)} + CS_1$

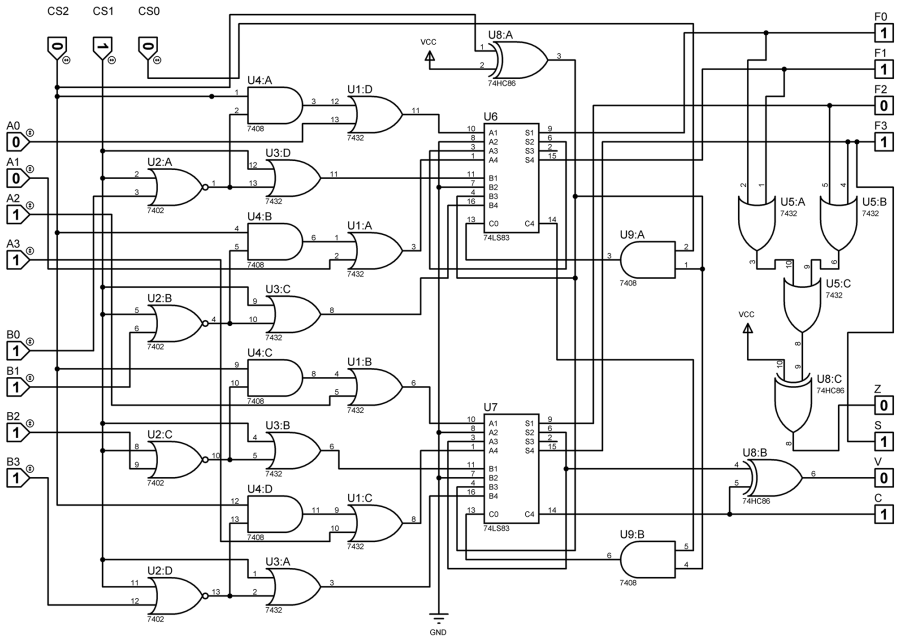

Figure 3: Diagram of ALU