16-bit ALU

Introduction:-

ALU_TOP is the fundamental building block of the processor, which is responsible for carrying out different functions: -

- **Signed Arithmetic** functions through **ARITHMETIC_UNIT** block.

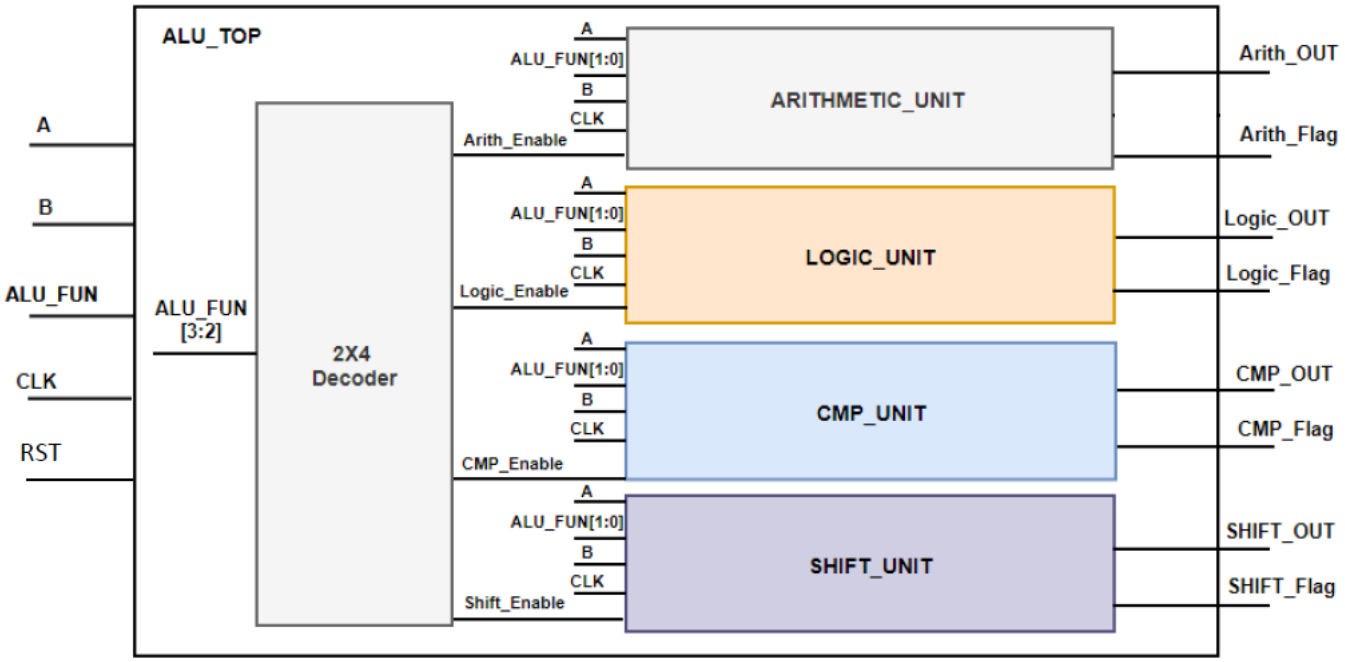
- **Logic** functions through **LOGIC_UNIT** block.

- **Shift** functions through **SHIFT _UNIT** block.

- **Comparison** functions through **CMP_UNIT** block.

- **Decoder Unit** responsible for enable which Function to operate according to the highest Most significant **2-bit** of the ALU_FUNC control bus **ALU_FUNC [3:2].**

Block Diagram:-



TOP Module (ALU_TOP) Port Description:-

Signal Name	Width (bits)
A	parameterized
B	parameterized
ALU_FUNC	4
CLK	1
RST	1
Arith_OUT	parameterized
Arith_Flag	1
Logic_OUT	parameterized
Logic_Flag	1
CMP_OUT	parameterized
CMP_Flag	1
SHIFT_OUT	parameterized
SHIFT_Flag	1

Specifications:-

- **All Outputs are registered.**
- All registers are cleared using **Asynchronous active low reset**
- **Arith_flag** is activated "High" only when ALU performs one of the arithmetic operations (Signed Addition, Signed Subtraction, Signed Multiplication, Signed Division), otherwise "LOW"
- **Logic_flag** is activated "High" only when ALU performs one of the Boolean operations (AND, OR, NAND, NOR), otherwise "LOW"
- **CMP_flag** is activated "High" only when ALU performs one of the Comparison operations (Equal, Greater than, less than) or NOP, otherwise "LOW"
- **Shift_flag** is activated "High" only when ALU performs one of the shifting operations (shift right, shift left), otherwise "LOW"
- The ALU function is carried out according to the value of the **ALU_FUN** input signal stated in the following table

ALU_FUN Table:-

ALU_FUN	Operation	ALU_OUT
0000	Arithmatic : **Signed Addition**	
0001	Arithmatic : **Signed Subtraction**	
0010	Arithmatic : **Signed Multiplication**	
0011	Arithmatic : **Signed Division**	
0100	Logic : **AND**	
0101	Logic : **OR**	
0110	Logic : **NAND**	
0111	Logic : **NOR**	
1000	**NOP**	**Equal to 0**
1001	CMP: **A = B**	**Equal to 1 else Equal to 0**
1010	CMP: **A > B**	**Equal to 2 else Equal to 0**
1011	CMP: **A < B**	**Equal to 3 else Equal to 0**
1100	SHIFT: **A >> 1**	
1101	SHIFT: **A << 1**	
1110	SHIFT: **B >> 1**	
1111	SHIFT: **B << 1**	

Decoder Truth Table:-

ALU_FUNC[3:2]	Arith_En	Logic_En	CMP_EN	SHIFT_EN
00	1	0	0	0
01	0	1	0	0
10	0	0	1	0
11	0	0	0	1

Note: Arith_Enable, Logic_Enable, SHIFT_Enable and **CMP_Enable** are called block enable which responsible for enabling the function of the block or not