

## Indian Institute of Technology (IIT-Kharagpur)

AUTUMN Semester, 2024

COMPUTER SCIENCE AND ENGINEERING

Computer Organization Laboratory

Arithmetic Logic Unit for Processors

Verilog Assignment: Design of K\_ALU

In this assignment, you are required to design the *KGP-Arithmetic Logic Unit (K-ALU)*. This K-ALU block has to be designed as an 8-bit Arithmetic Logic Unit. Your design must be extendable, in the sense that for future assignment(s) you should be able to extend it to a 32-bit version.

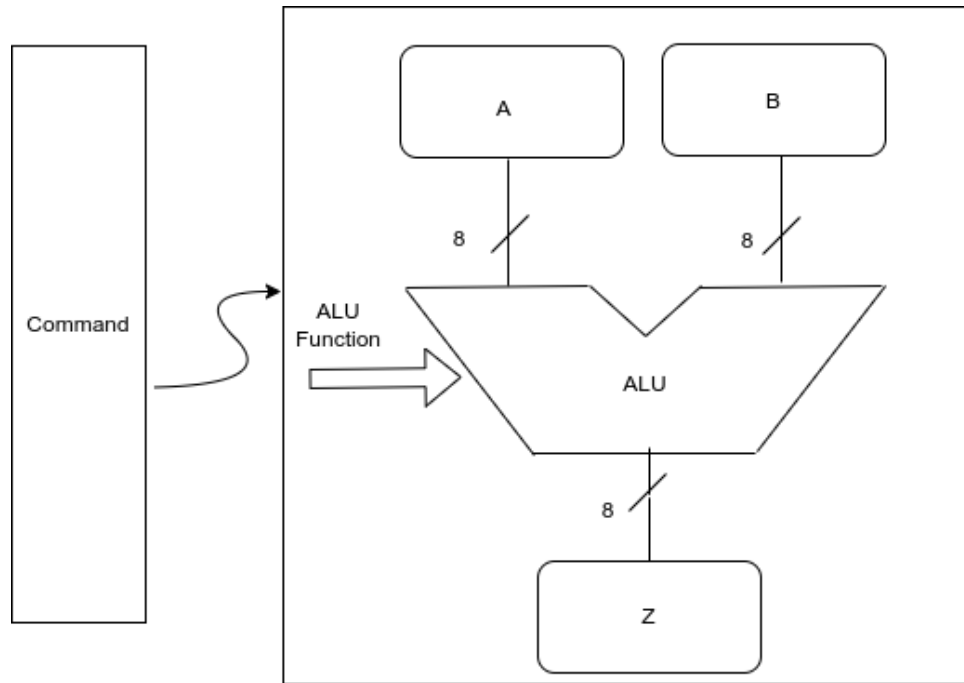


Figure 1: Top Level Diagram of K\_ALU

1. The schematic block diagram of K\_ALU is depicted in Figure 1. A and B refer to two 8-bit inputs, and Z the 8-bit output of K\_ALU.

For the ALU operation, you need to specify the values of A and B, and also the ALU Function. Assume that this is represented by a 32-bit input **Command** whose description is shown in Figure 2.

The various functions that must be supported by K\_ALU are shown in Table 1.

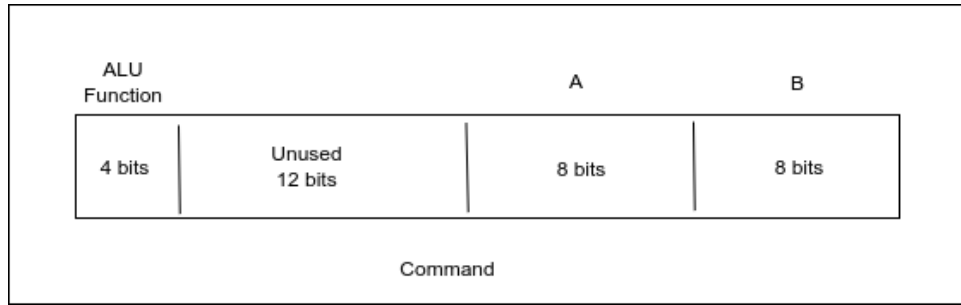


Figure 2: Structure of Command for K\_ALU

Table 1: Functionalities of K\_ALU

ALU Function	Function Realized
0 0 0 0	$A + B$
0 0 0 1	$A - B$
0 0 1 0	$A * B$
0 0 1 1	$A / B$
0 1 0 0	$A \wedge B$
0 1 0 1	$A \vee B$
0 1 1 0	$A \oplus B$
0 1 1 1	$\overline{A}$
1 0 0 0	$A$
1 0 0 1	$B$
1 0 1 0	$A << B$
1 0 1 1	$A >> B$ (logical)
1 1 0 0	$A >> B$ (arithmetic)
1 1 0 1	$A + 4$
1 1 1 0	$A - 4$
1 1 1 1	$\text{HAM}(A)$

Note:  $\text{HAM}(A)$  indicates the Hamming weight of  $A$

- Write a Verilog top-level module to implement K\_ALU, along with other modules as required. Other than multiplication and division, all other functions must be implemented in structural level.

For this assignment, implement multiplication and division in behavioral level; however, in some future assignment(s), you will have to replace these by equivalent structural designs.

- Generate the bitmap file for the design and download it on the FPGA board. Verify the functionality of K\_ALU by applying various Command inputs through switches, and observing the outputs on LEDs.