Project Report

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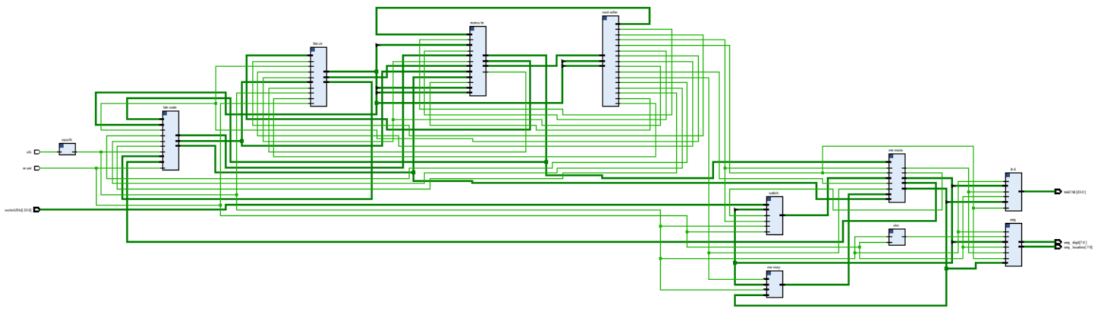
1. Functions and Usage of CPU

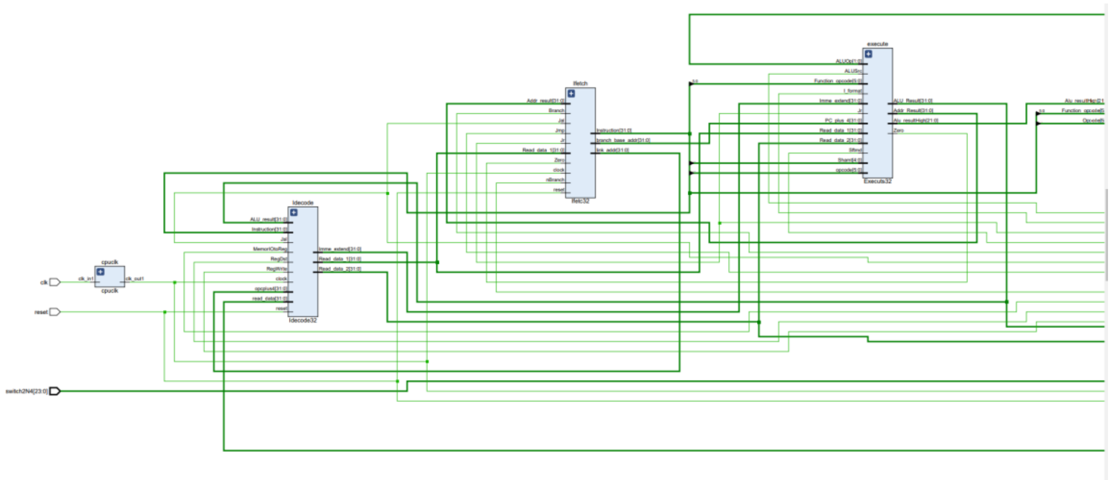
CPI=1, single cycle CPU. Reset signal is determined by the P20 button, test mode switching signal is Y9 switch. Y8, Y9, W9 switches are matched with the SW21, SW22, SW23 defined in the testing PDF file. Other 16 0/1 signals are determined by the 16 switches from the right to the left.

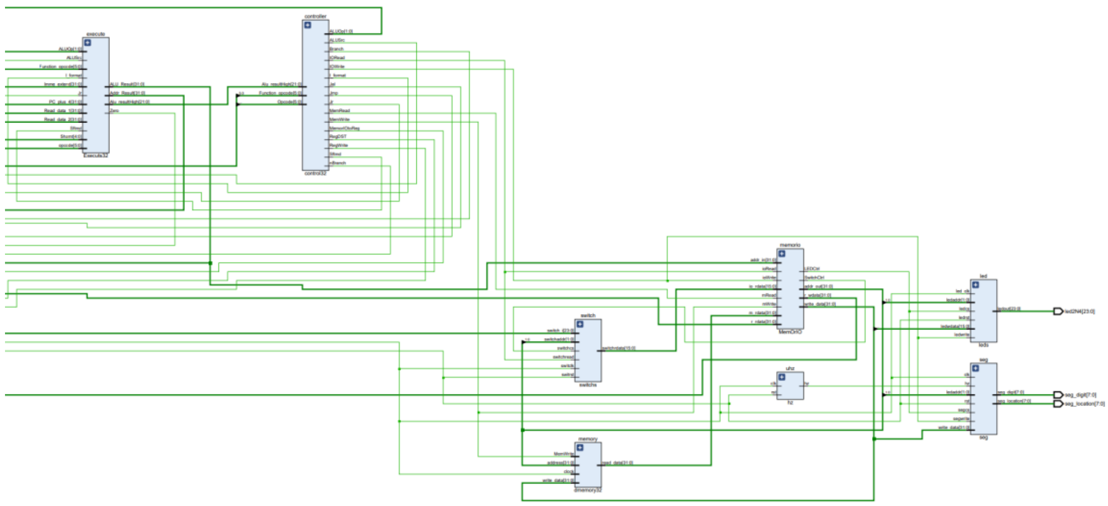
When Y9 is off, the testing mode is one, and when Y9 is on, the testing mode is two.

The LEDs and display tubes in both testing scenarios will function. LEDs stands for the binary value of the presented numbers, while the display tubes stands for the hexadecimal value of the numbers.

2. Top module

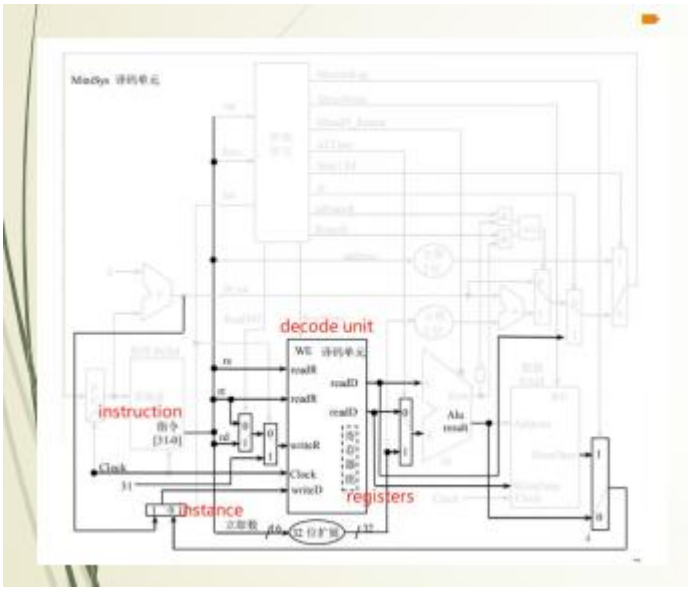



clk
reset
switch2N4[23:0]
cpuclk
Idecode
Ifetch
execute


execute
controller
memorio
switch
memory
led
seg
led2N4[23:0]
seg_digit[7:0]
seg_location[7:0]

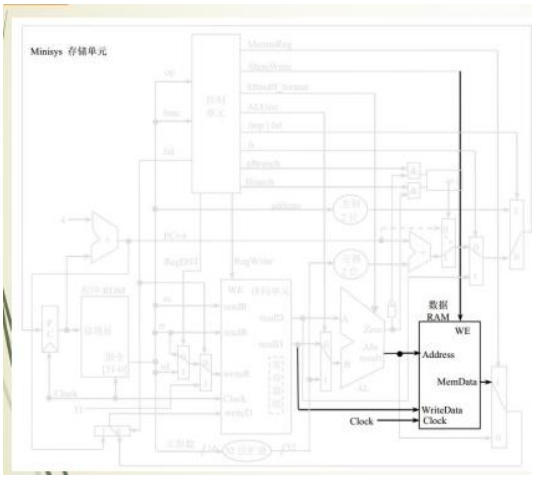
3. Submodule

Idecoder:



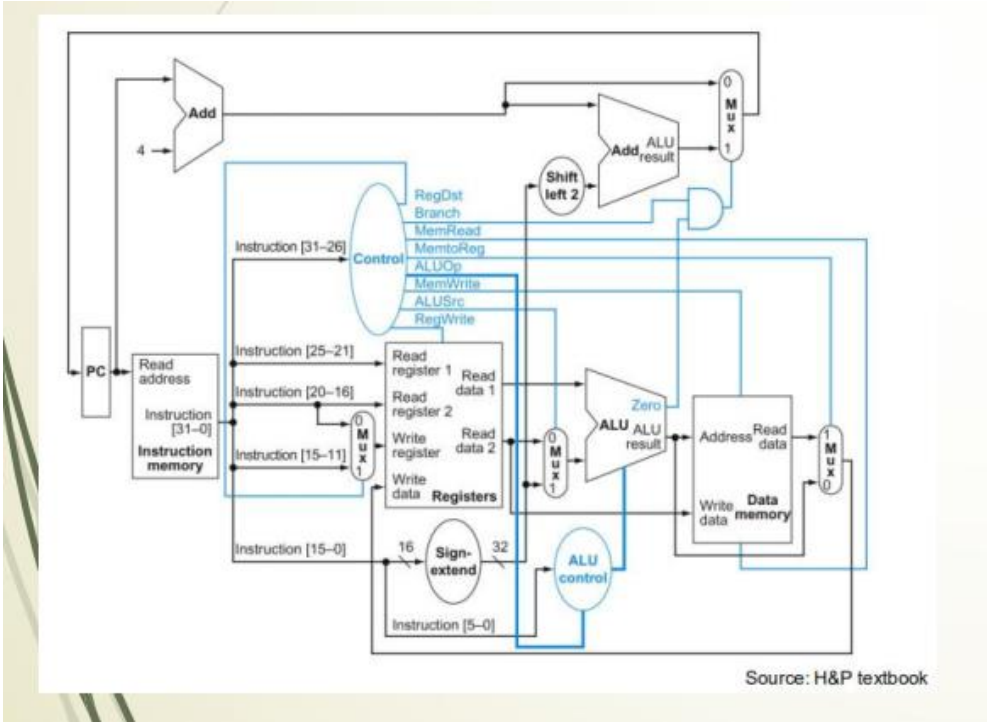
Decoder get data from the instruction directly or indirectly. Immediate data in the instruction[15:0] need to be sign-extended to 32 bits. And for data in the register, the address of the register is coded in the instruction. Besides, for data in the memory, the address of the memory unit needs to be calculated ALU with base address stored int the register and offset as immediate data in the instruction.

dmemory:



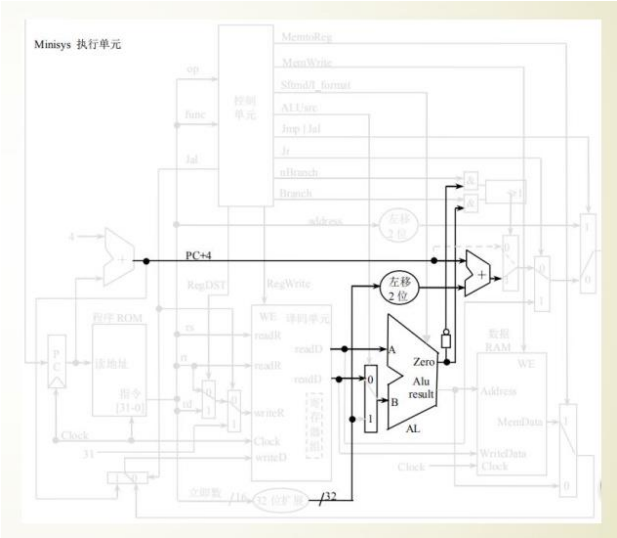
Memory stores the data that is needs in load and store instruction.

Control32:



Controller use opcode and function code as input, generate the control signals which will be used in other modules. Controller gets data from the instructions, for each type of instructions, such as R type, I type and J type, controller gets different information from the bits of instruction. Through this information, controller generate control signals to control the instruction execution.

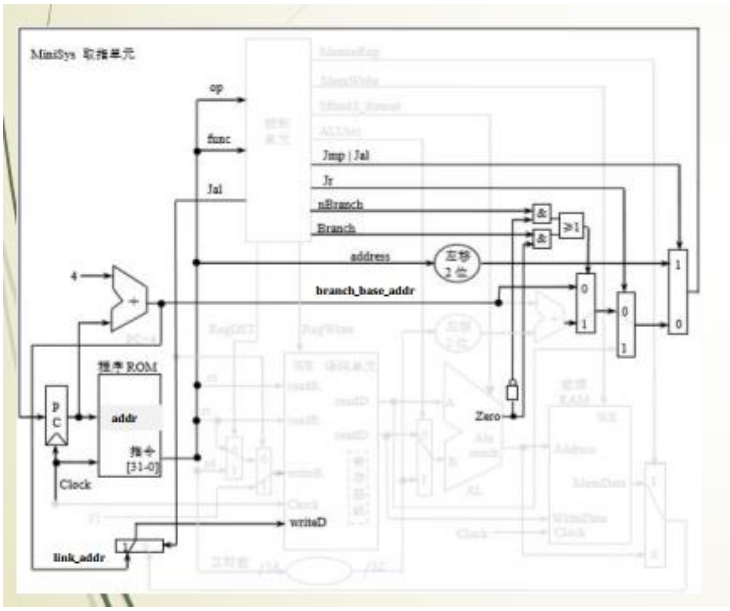
Executs:



ALU do math operations such as arithmetic and logic calculation, shift calculation,

special calculation and address calculation. It is also a MUX for operand selection. ALUOp is generated by Controller, which is the basic relationship between instruction and operation. Exe_code is generated by ALU. ALU_ctrl is generated by ALU based on ALUOp and Exe_code specify most of the operation details in ALU.

Ifetch:



Instruction Fetch using ROM as instruction memory, updates the value of the PC register, which resets the value of the PC register, adds 4 to value of the PC register and update the value or the PC register according to the jump instructions. Besides, instruction fetch fetches the instruction according to the value of the PC register.

CPU_TOP:

It is the top module that controls the clock, led, seg location and seg digit. CPU_TOP invokes the other modules to generate information on I/O device.

I/O read: It is a module that reads the switch input.

leds: It is a module that writes the signals to the leds with the input of switch operands and mode.

Seg: It is a module that chooses the data location and conveys the seg digits.

Seg_frequency: It adjusts the refreshing frequency of the seg tubes.

Seg_tube：It is a module that conveys the seg digits.

Switch: It is a module that conveys the signals on the switch to CPU.

Relationship between clock and the program behavior:

At low level voltage, the CPU fetches instructions from Instruction Memory, decodes the instructions, and ALU takes charge of the increment of PC. Then it reads the value of base register from the register files.

The ALU adds the value of the base register with Instruction[15:0]. Then the result of ALU will be the address of data memory, and data memory will read the corresponding data and sends it to the writing port of register files.

At the rising edge of the clock signal, the writing ports of PC and registers are open, receiving data from the data memory.

At high level voltage, PC will finish the increment, the data has been written into the registers.

At the falling edge, the writing ports are closed.