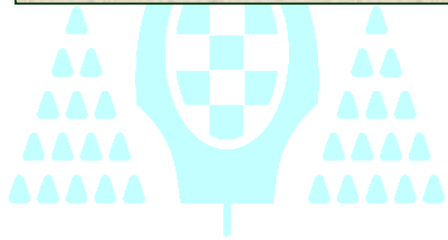


Topic 1

Microprocessor Architecture



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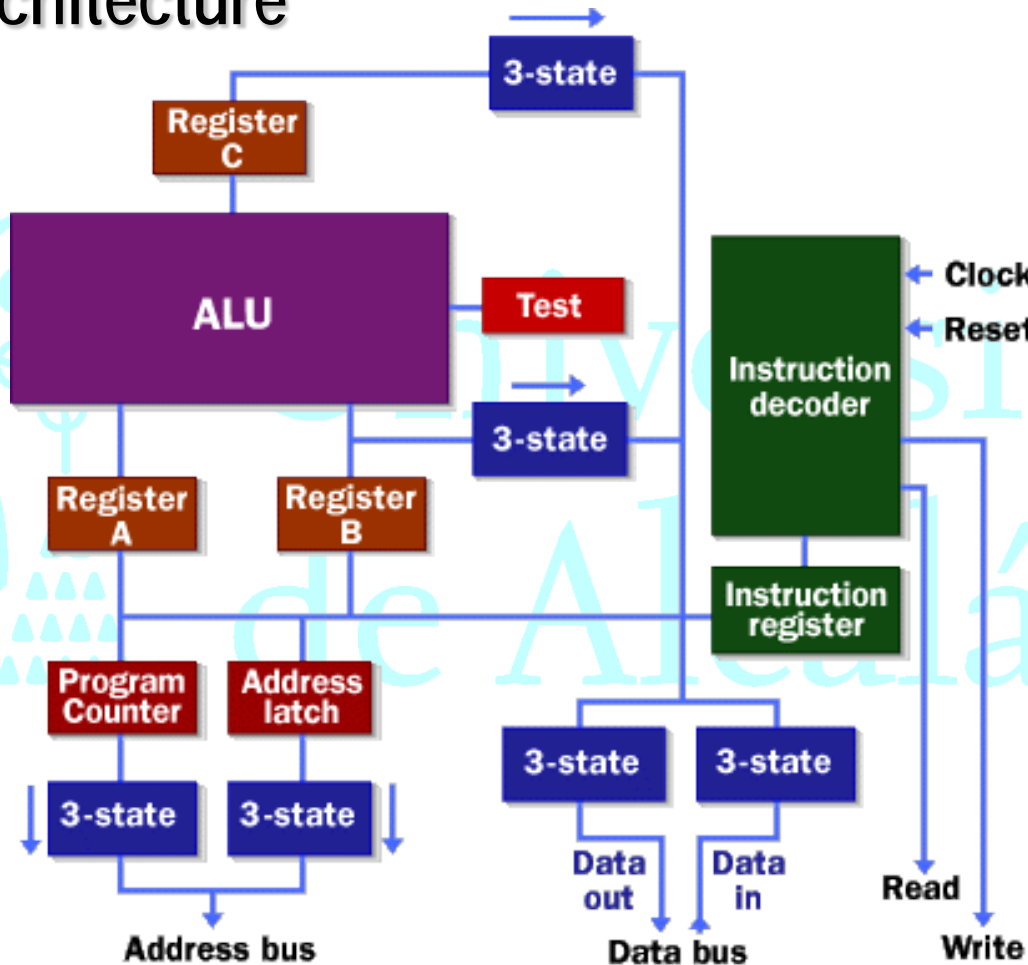
Department of Electronics

Academic Year 13/14

(ver 25-09-2013)

Internal architecture of a microprocessor

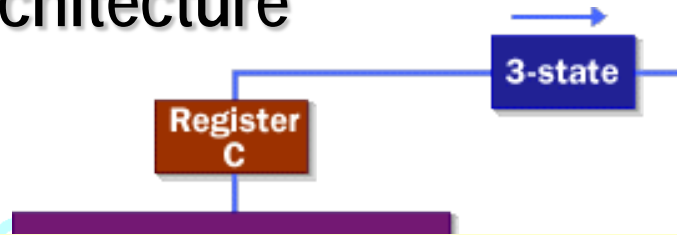
◆ Internal architecture



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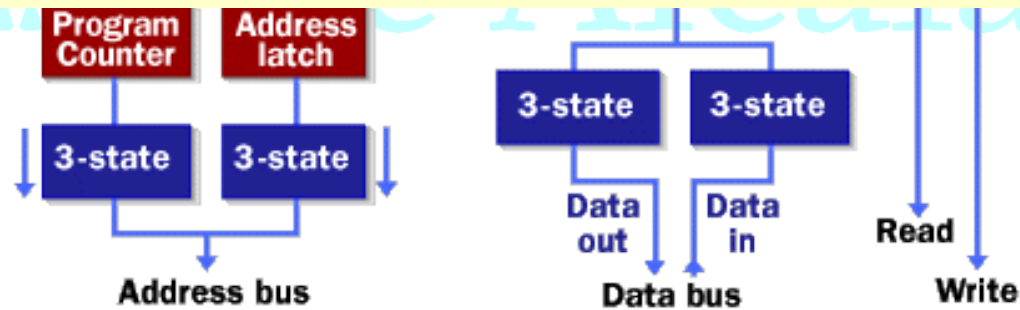
Internal architecture of a microprocessor

◆ Internal architecture



OPERATIONS THAT A CPU CAN PERFORM:

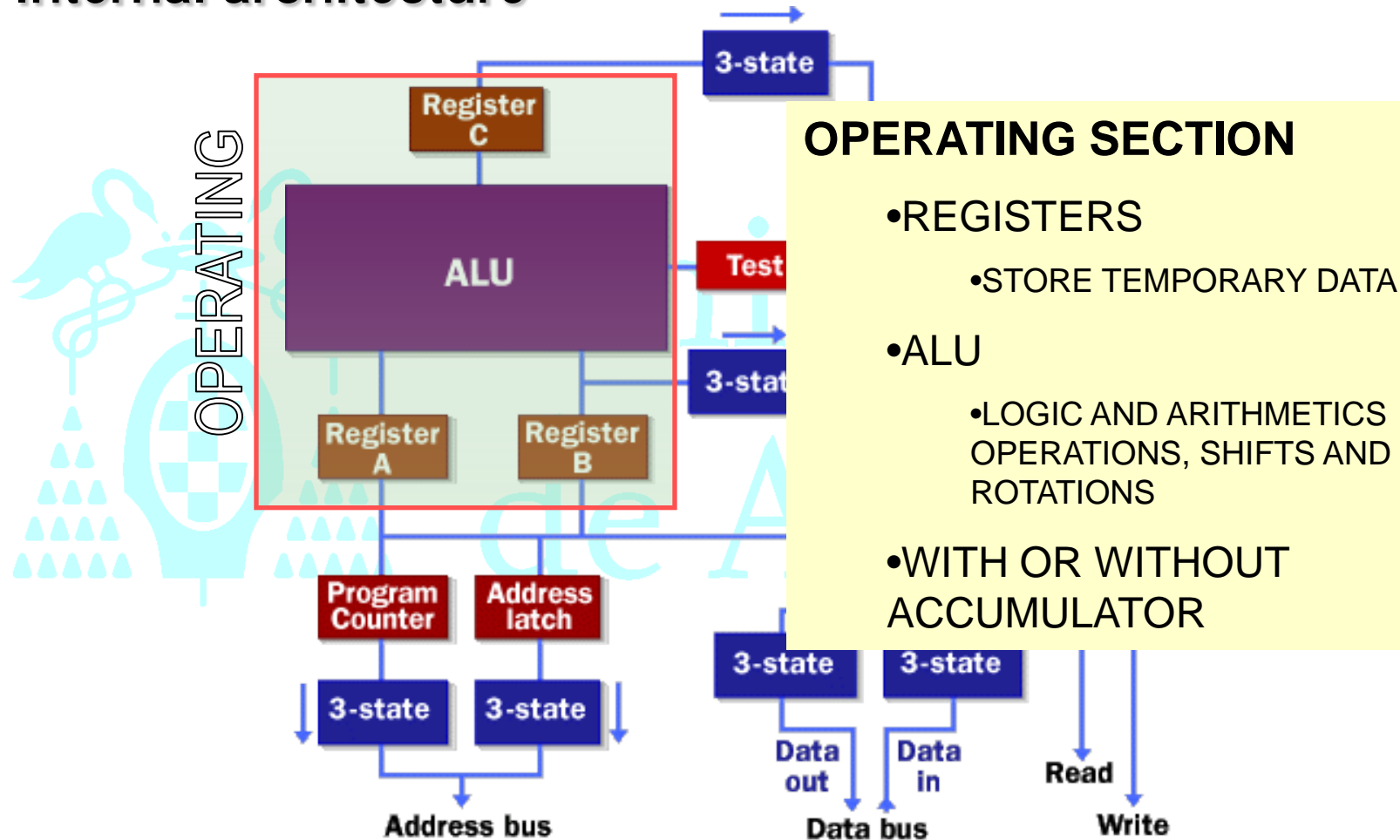
- LOAD REGISTERS
- READ OR WRITE MEMORY LOCATIONS
- PERFORM ARITHMETIC OR LOGIC OPERATIONS
- ROTATIONS AND SHIFTS



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Internal architecture of a microprocessor

◆ Internal architecture

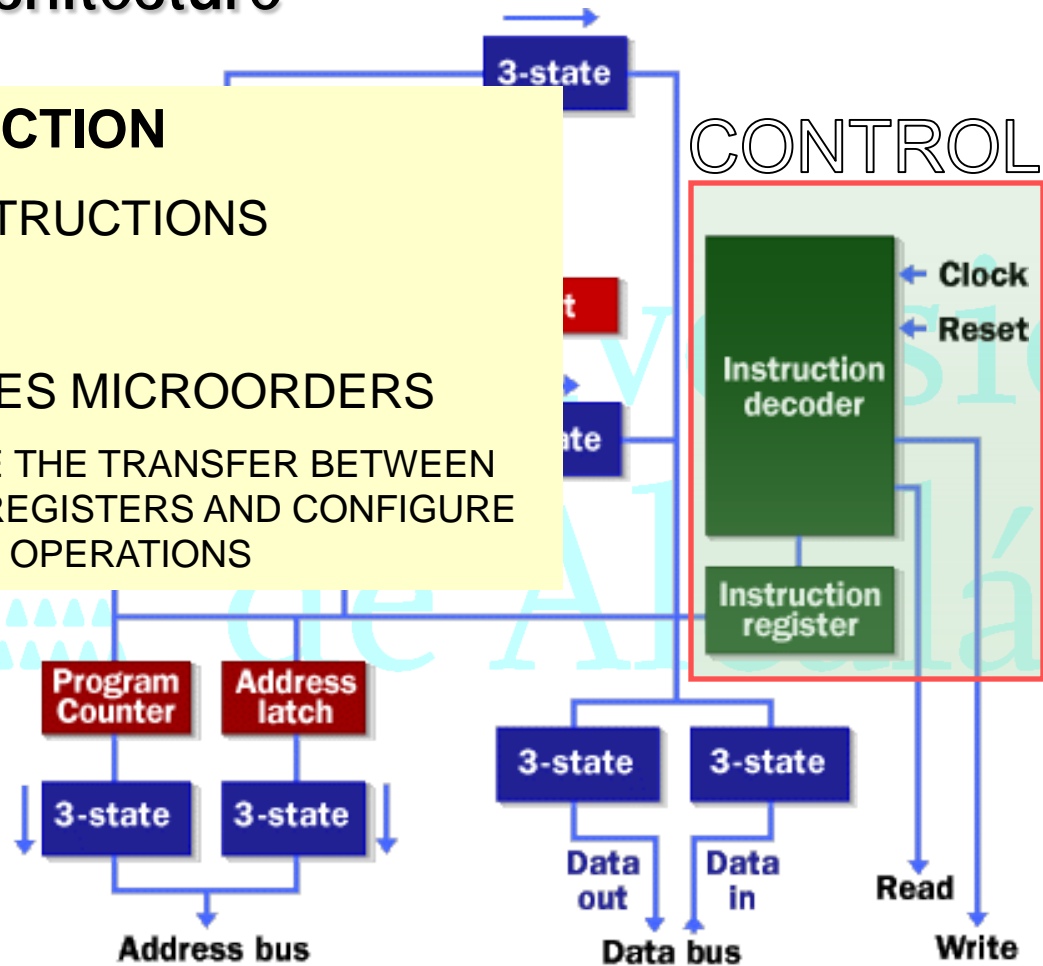


Internal architecture of a microprocessor

◆ Internal architecture

CONTROL SECTION

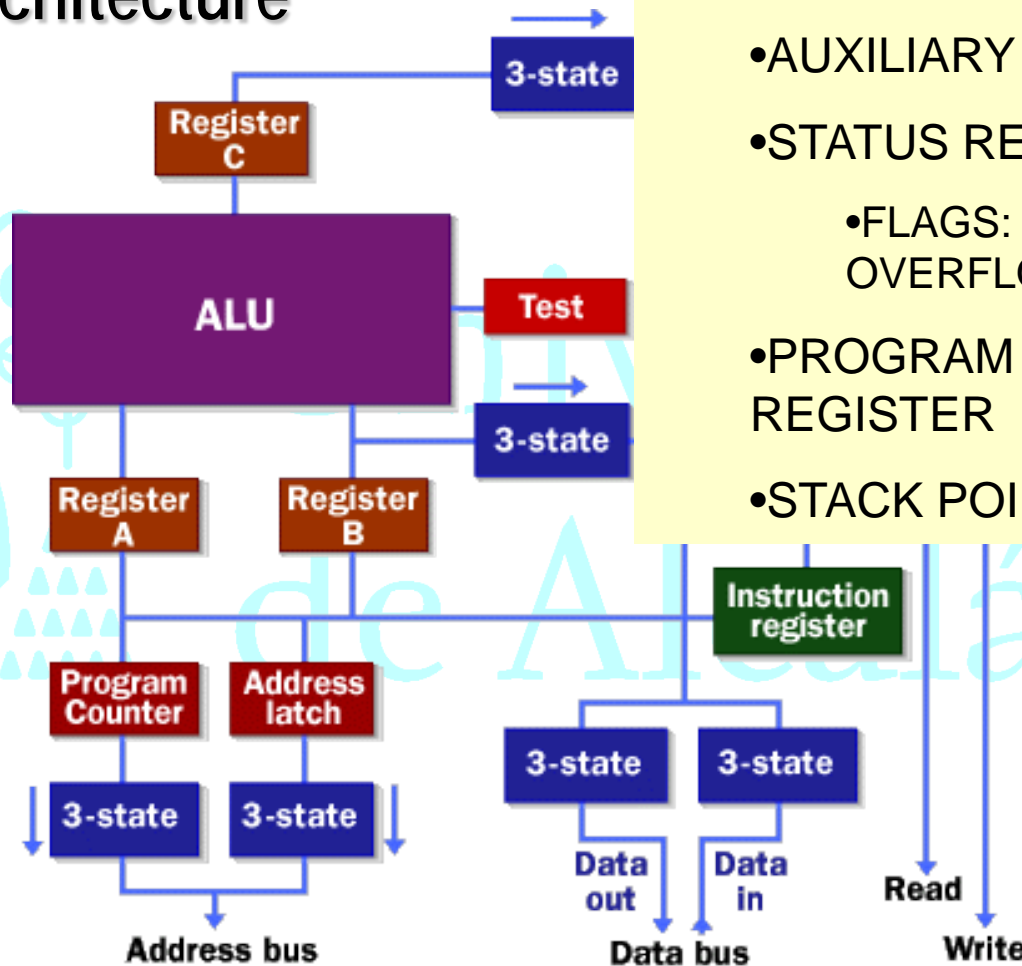
- LOAD INSTRUCTIONS
- DECODE
- GENERATES MICROORDERS
 - ENABLE THE TRANSFER BETWEEN THESE REGISTERS AND CONFIGURE THE ALU OPERATIONS



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Internal architecture of a microprocessor

◆ Internal architecture



- ### OTHERS REGISTERS
- AUXILIARY REGISTERS
 - STATUS REGISTER
 - FLAGS: ZERO, SIGN CARRY, OVERFLOW
 - PROGRAM COUNTER REGISTER
 - STACK POINTER REGISTER

Internal architecture of a microprocessor

◆ Instruction register

- ◆ It loads the operation code from the memory.
- ◆ The decoder generates microorders depending on its content.

◆ Program counter

- ◆ It contains the address of the instruction to be executed.
- ◆ After execution of an instruction PC is modified to point to the next one.

Internal architecture of a microprocessor

◆ Status register

- ◆ It contains flags that provide information on the outcome of an operation: sign, zero, carry, overflow.
- ◆ It allows decisions conditional on the outcome of the previous operation.

◆ Stack pointer

- ◆ It stores a memory address where data can be stored automatically or manually.

Internal architecture of a microprocessor

◆ Internal bus

- ◆ It's a communication bus between the various components of the microprocessor.
- ◆ The number of bus lines is determined by the number of bits processed in parallel in the ALU and it's one of the parameters to classify microprocessors.
- ◆ This bus is related to the external data bus through the data bus buffer.

Instructions. General concepts

◆ What is a program?

- ◆ It's a sequential set of instructions that describe, define or characterize the execution of a task in a microprocessor

◆ What is an instruction?

- ◆ It's the CPU elementary command
- ◆ It's a set of digital input signals to the decoder
- ◆ The instruction decoder (sequential circuit) state evolves and it changes its outputs sequentially based on these signals.
- ◆ The output signals of the instruction decoder are the microorders.

Instructions. General concepts

◆ Coding Instructions

- ◆ The instructions are stored in memory
- ◆ Binary format, set '1' and '0', machine code

◆ Possible generation of binary codes

- ◆ Directly from a conversion table function / code
- ◆ Using an assembly starting from an assembly language
 - ◆ Assembly language: set of mnemonics associated with the instructions
- ◆ Using a compiler, starting from a high level language
 - ◆ Generates machine code from a program in high level language (eg C)

Instructions. General concepts

◆ Example of Instruction

- ◆ Add 2 to the contents of register 'A'
 - ◆ (Historical solution) Using a conversion table it shows that this operation corresponds to the code 0x23, followed by the value 0x02.
 - ◆ (Tedious solution) Using an assembler program, It would be written to a file: "add 2, A", the result would be the same after you run the assembler (0x23, 0x02).
 - ◆ (Current solution) Using a high-level language: "A + = 2", and after compiling, the result would be the same again (0x23, 0x02).

Instructions. General concepts

◆ Instruction format

- ◆ Opcode + [Source operand] + [Destination operand]

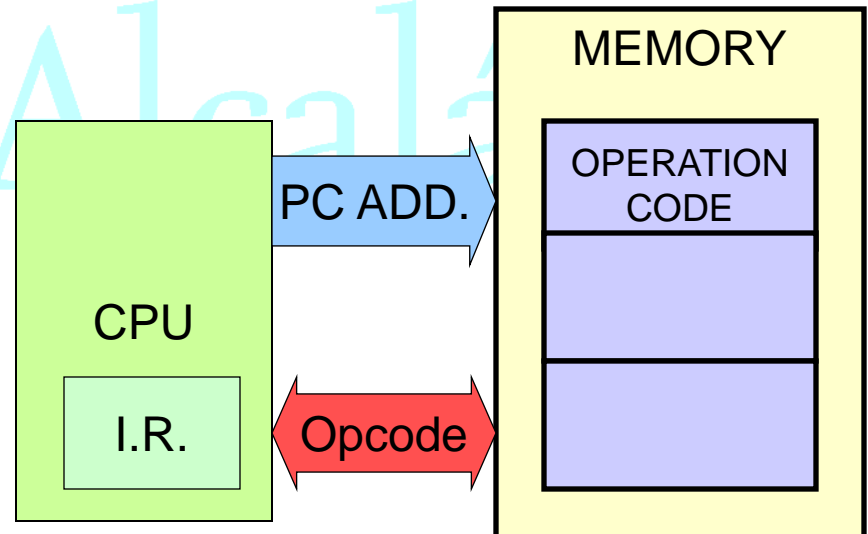
◆ Access to the operands

- ◆ Effective address: location of the operand
- ◆ Addressing Modes: Different ways to express the effective address
 - ◆ Provide power to the device
 - ◆ Simplify programming

Instructions. General concepts

◆ Steps in the execution of an instruction

- ◆ Instruction fetch
 - ◆ PC → ADDRESS BUS; READING OPCODE
- ◆ Calculation of the effective address
- ◆ Search operands
- ◆ Executing operation
- ◆ Store the result
- ◆ Increased PC, new cycle



Type of instructions

◆ Transfer instructions

- ◆ To Copy information from registers, registers and memory, or between memory.

◆ Arithmetic instructions

- ◆ They perform simple arithmetic operations: addition, subtraction, etc..

◆ Logical Instructions

- ◆ They perform logic operations on the operands: AND, OR, XOR, etc..

Types of instructions

◆ Bit manipulation instructions

- ◆ They modify a single bit of the operand

◆ Shift Instructions

- ◆ They shift the contents of a register in both directions

◆ Program Control Instructions

- ◆ They change the flow of program execution

Addressing modes

- ◆ Mechanism for specifying the location of an operand.
- ◆ A microprocessor has several addressing modes.
- ◆ Objectives of addressing modes:
 - ◆ Facilitate the management of the data structures.
 - ◆ Allow relocation code.
 - ◆ Reduce the memory space occupied by the instructions.

Addressing modes

◆ Possible addressing modes:

- ◆ Implicit
- ◆ Register direct
- ◆ Immediate
- ◆ Memory direct
- ◆ Indirect
- ◆ Indirect with offset
- ◆ Indirect with Index
- ◆ Indirect with pre-indexed
- ◆ Indirect with post-indexed

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