



CSE 331L: Microprocessor Interfacing & Embedded System Lab

Faculty: DR. DIHAN MD. NURUDDIN HASAN

Instructor: Moin Shahriyar

EEE 332/ CSE 331 Lab 2

Topic: Variables, Basic Arithmetic Operations, Array

Topics to be covered in class today:

- Creating Variables
- Basic Arithmetic Operations (addition, subtraction, multiplication, division)
- Creating Arrays
- Create Constants
- Introduction to INC, DEC, LEA instruction
- Learn how to access Memory.

Creating Variable:

Syntax for a variable declaration:

"name" DB "value"

e.g. a DB 9

name DW value

e.g. a DW 9

DB - stands for Define Byte. (8 bit) define byte

DW - stands for Define Word. (16 bit) define word

name - can be any letter or digit combination, though it should start with a letter. It's possible to declare unnamed variables by not specifying the name (this variable will have an address but no name).

value - can be any numeric value in any supported numbering system (hexadecimal, binary, or decimal), or "?" symbol for variables that are not initialized.

****Variable must declare after return.**

Creating Constants:

Constants are just like variables, but they exist only until your program is compiled (assembled). After definition of a constant its value cannot be changed. To define constants EQU directive is used: (always 16 bit)

name EQU < any expression >

For example:

- k EQU 5
- MOV AX, k

Creating Arrays:

Arrays can be seen as chains of variables. A text string is an example of a byte array; each character is presented as an ASCII code value (0-255).

Here are some array definition examples:

- a DB 48h, 65h, 6Ch, 6Ch, 6Fh, 00h
- b DB 'Hello', 0

You can access the value of any element in array using square brackets, for example:

- MOV AL, a [3]

You can also use any of the memory index registers BX, SI, DI, BP, for example:

- MOV SI, 3
- MOV AL, a[SI]

If you need to declare a large array you can use DUP operator.

The syntax for DUP:

number DUP (value(s))

number - number of duplicate to make (any constant value).

value - expression that DUP will duplicate.

for example:

- c DB 5 DUP (9)

an alternative way of declaring is:

- c DB 9, 9, 9, 9, 9

one more example:

- `d DB 5 DUP (1, 2)`

an alternative way of declaring is:

- `d DB 1, 2, 1, 2, 1, 2, 1, 2, 1, 2`

Memory Access:

To access memory we can use these four registers: BX, SI, DI, BP. Combining these registers inside [] symbols, we can get different memory locations.

$[BX + SI]$ $[BX + DI]$ $[BP + SI]$ $[BP + DI]$	$[SI]$ $[DI]$ $d16$ (variable offset only) $[BX]$	$[BX + SI + d8]$ $[BX + DI + d8]$ $[BP + SI + d8]$ $[BP + DI + d8]$
$[SI + d8]$ $[DI + d8]$ $[BP + d8]$ $[BX + d8]$	$[BX + SI + d16]$ $[BX + DI + d16]$ $[BP + SI + d16]$ $[BP + DI + d16]$	$[SI + d16]$ $[DI + d16]$ $[BP + d16]$ $[BX + d16]$

Displacement can be an immediate value or offset of a variable, or even both. if there are several values, assembler evaluates all values and calculates a single immediate value.

Displacement can be inside or outside of the [] symbols, assembler generates the same machine code for both ways.

Displacement is a signed value, so it can be both positive or negative.

Instructions

Instruction	Operands	Description
INC	REG MEM	Increment. Algorithm: operand = operand + 1 Example: MOV AL, 4 INC AL; AL = 5 RET
DEC	REG MEM	Decrement. Algorithm: operand = operand - 1 Example: MOV AL, 86 DEC AL; AL = 85 RET
LEA	REG, MEM	Load Effective Address. Algorithm: REG = address of memory (offset) Example: MOV BX, 35h MOV DI, 12h LEA SI, [BX+DI]
ADD	REG, memory memory, REG REG, REG memory, immediate REG, immediate	Add. Algorithm: operand1 = operand1 + operand2 Example: MOV AL, 5; [AL = 5] ADD AL, -3; [AL = 2] RET

SUB	REG, memory memory, REG REG, REG memory, immediate REG, immediate	<p>Subtract. Algorithm: $\text{operand1} = \text{operand1} - \text{operand2}$</p> <p>Example:</p> <pre>MOV AL, 5 SUB AL, 1 ; AL = 4 RET</pre>
MUL	REG memory	<p>Unsigned multiply. Algorithm: when operand is a byte: $\text{AX} = \text{AL} * \text{operand}$. when operand is a word: $(\text{DX AX}) = \text{AX} * \text{operand}$.</p> <p>Example:</p> <pre>MOV AL, 200 ; [AL = 0C8h] MOV BL, 4; MUL BL ; [AX = 0320h (800)] RET</pre>
DIV	REG memory	<p>Unsigned divide. Algorithm: when operand is a byte: $\text{AL} = \text{AX} / \text{operand}$ $\text{AH} = \text{remainder (modulus)}$</p> <p>when operand is a word: $\text{AX} = (\text{DX AX}) / \text{operand}$ $\text{DX} = \text{remainder (modulus)}$</p> <p>Example:</p> <pre>MOV AX, 203; [AX = 00CBh] MOV BL, 4; DIV BL; [AL = 50 (32h), AH = 3] RET</pre>