Microprocessor

Assembly Instructions

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Intel Assembly

Assembly Programming

- Machine Language
  - binary
  - hexadecimal
  - machine code or object code
- Assembly Language
  - mnemonics
  - assembler
- High-Level Language
  - Python, Java Script, C++, Matlab
  - compiler

32-bit Instructions

- Instructions are represented in memory by a series of "opcode bytes."
- A variance in instruction size means that disassembly is position specific.
- Most instructions take zero, one, or two arguments:

```
instruction destination, source
```

For example: `add eax, ebx`

is equivalent to the expression eax = eax + ebx

Program Segments

- A segment is an area of memory that includes up to 64K bytes
- Begins on an address evenly divisible by 16

- 8088/86 stayed compatible with 8085
  - Range of 1MB of memory, it has 20 address pins (2^{20} = 1 MB)
  - Can handle 64KB of code, 64KB of data, 64KB of stack

- A typical Assembly language program consist of three segments:
  - Code segments
  - Data segment
  - Stack segment
  - Extra Segment

Program Segments

The 8086 fetches the instructions (opcodes and operands) from the code segments.

The 8086 address types:

- Physical address
- Offset address
- Logical address

- Physical address
  - Segment register içeriği 16 bit.
  - 20-bit address that is actually put on the address pins of 8086
  - Decoded by the memory interfacing circuitry
  - A range of 00000H to FFFFFH
  - It is the actual physical location in RAM or ROM within 1 MB mem. range

- Offset address (indis)
  - A location within a 64KB segment range
  - A range of 0000H to FFFFH

- Logical address
  - consist of a segment value and an offset address

Program Segments…*example*

Define the addresses for the 8086 when it fetches the instructions (opcodes and operands) from the code segments.

- Logical address:
  - Consist of a **CS** (code segment) and an **IP** (instruction pointer)
    format is **CS:IP**

- Offset address
  - **IP** contains the offset address

- Physical address
  - generated by shifting the **CS** left one hex digit and then adding it to the **IP**
  - the resulting 20-bit address is called the physical address

Program Segments…*example*

Suppose we have:

CS	2500
IP	95F3

- Logical address:
  - Consist of a **CS** (code segment) and an **IP** (instruction pointer)
    format is **CS:IP** **2500:95F3H**

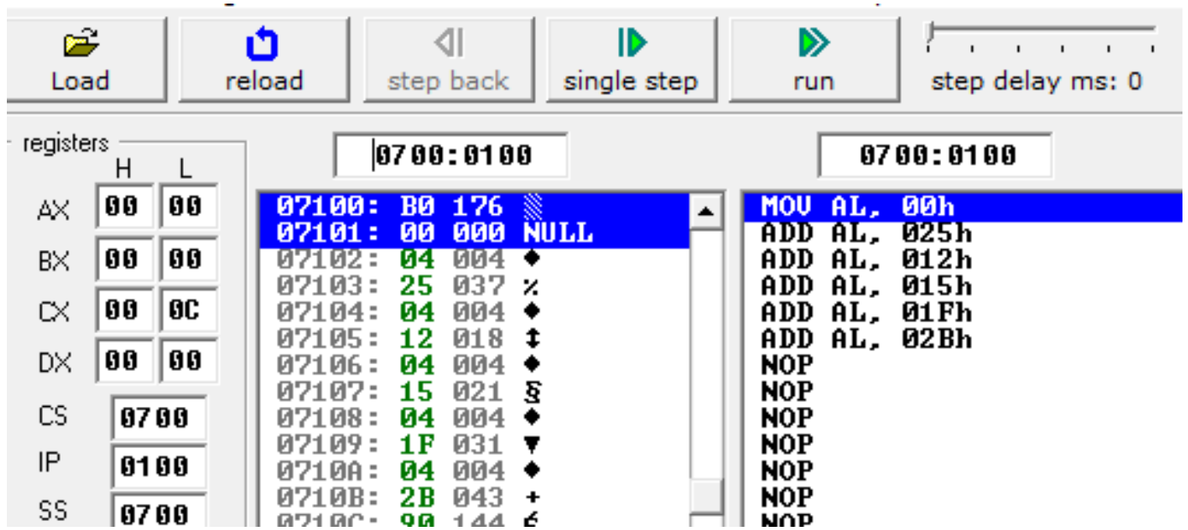
- Offset address
  - **IP** contains the offset address which is **95F3H**

- Physical address
  - generated by shifting the **CS** left one hex digit and then adding it to the **IP**
    25000 + 95F3 = 2E5F3H

Example:
Add 5 bytes of data: 25H, 12H, 15H, 1FH, 2BH

Not using data segment

```
MOV     AL,00H      ;clear AL
ADD     AL,25H      ;add 25H to AL
ADD     AL,12H
ADD     AL,15H
ADD     AL,1FH
ADD     AL,2BH
```



Format:
CS:IP ; 0700:0100
Fiziksel adres: 07100h (0700**0**+0100)
Fiziksel adres hesaplanırken sağ tarafa 0h ya da (0000)b, 4 bit 0 eklenir.

Program Segments

Data segment

Example:

Add 5 bytes of data: 25H, 12H, 15H, 1FH, 2BH

using data segment with a constant offset

Data location in memory:

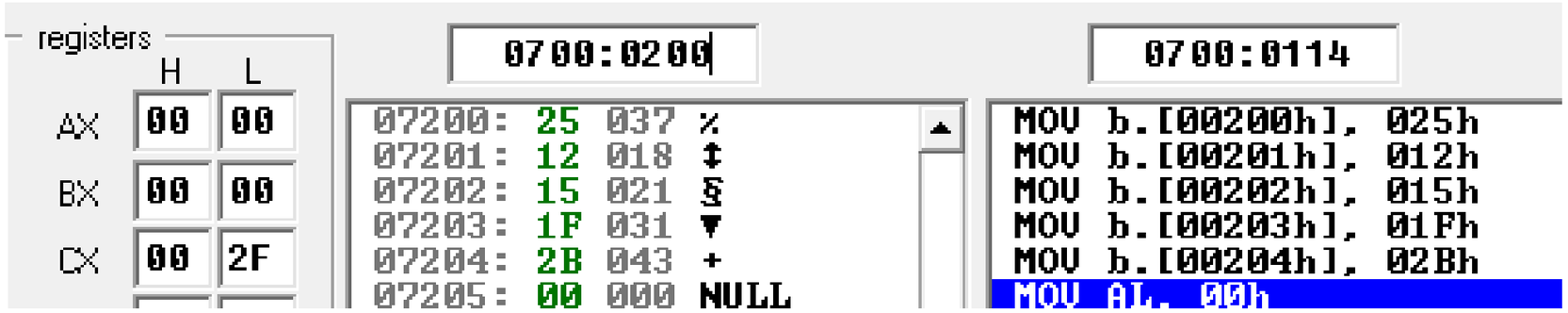
```
MOV [0200h], 25h
MOV [0201h], 12h
MOV [0202h], 15h
MOV [0203h], 1Fh
MOV [0204h], 2Bh
```

Program:

```
MOV   AL,0
ADD   AL,[0200h]
ADD   AL,[0201h]
ADD   AL,[0202h]
ADD   AL,[0203h]
ADD   AL,[0204h]
```

Fiziksel adres:
07000h + 200h=7200h

Köşeli parentez, bellek adresi gösterir. Eğer önünde indis segment register kodu yok ise default olarak data segment 'I belirtir.

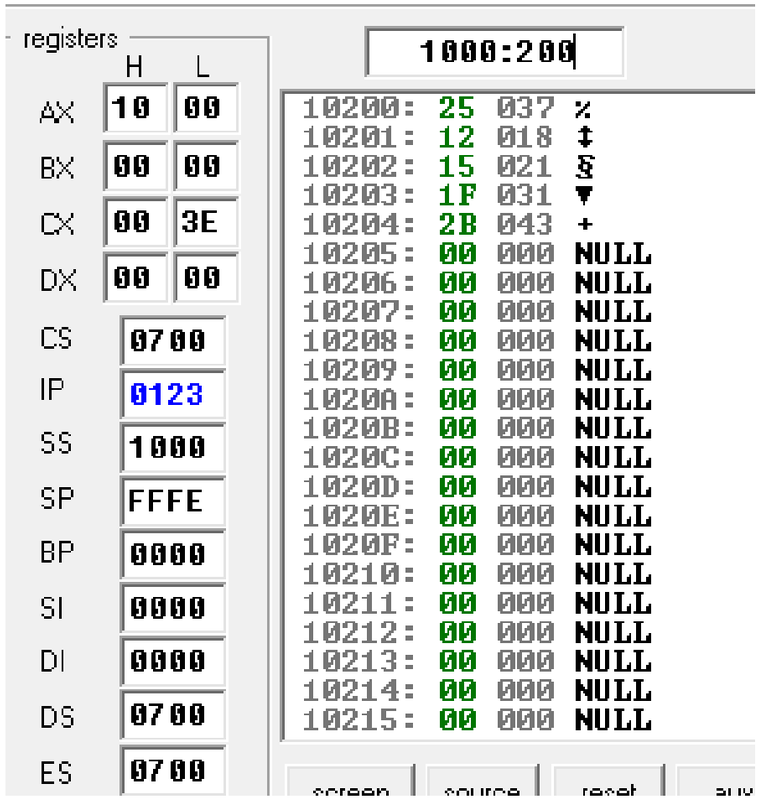


Program Segments

Stack segment

Example:

Add 5 bytes of data: 25H, 12H, 15H, 1FH, 2BH



Köşeli parentez, bellek adresi gösterir.
Eğer önünde indis segment register kodu yok ise default olarak data segment ‘i belirtir.

Fiziksel adres:
10000h + 200h=10200h

```
org 100h

Mov AX, 1000h
MOV SS,AX

MOV SS:[0200h], 25h
MOV SS:[0201h], 12h
MOV SS:[0202h], 15h
MOV SS:[0203h], 1Fh
MOV SS:[0204h], 2Bh

MOV     AL,0
ADD     AL,SS:[0200h]
ADD     AL,SS:[0201h]
ADD     AL,SS:[0202h]
ADD     AL,SS:[0203h]
ADD     AL,SS:[0204h]
```

Program Segments

Data segment

Example:

Add 5 bytes of data: 25H, 12H, 15H, 1FH, 2BH

using data segment with an offset register

Program:

```
MOV     AL,0
 MOV    BX,0200H
 ADD    AL,[BX]
 INC    BX              ;same as “ADD BX,1”
 ADD    AL,[BX]
 INC    BX
 ADD    AL,[BX]
 INC    BX
 ADD    AL,[BX]
```

Program Segments

Stack segment

Example:

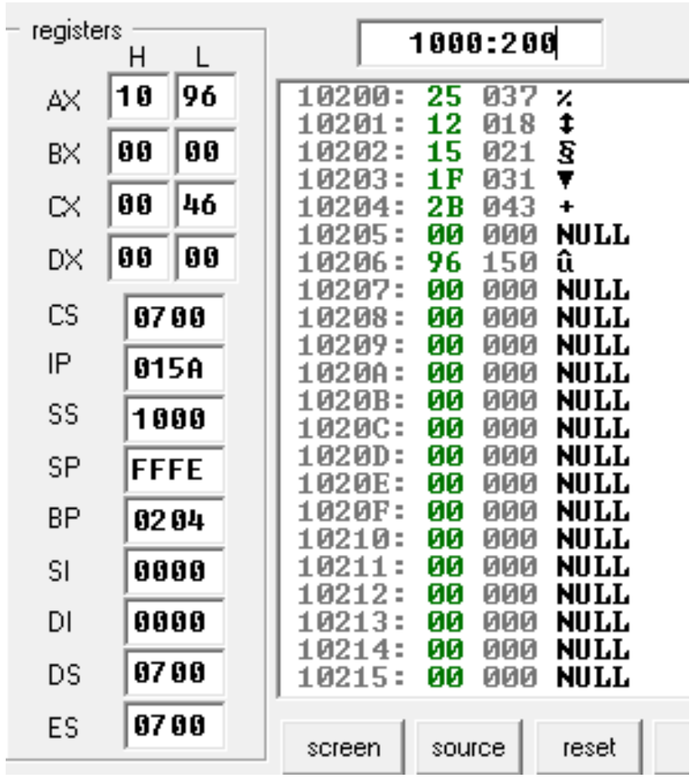
Add 5 bytes of data: 25H, 12H, 15H, 1FH, 2BH

using stacak segment with an offset register

Program:

```
 org 100h
Mov AX, 1000h
MOV SS,AX
Mov BP, 200h
MOV SS:[BP], 25h
inc BP
MOV SS:[BP], 12h
inc BP
MOV SS:[BP], 15h
inc BP
MOV SS:[BP], 1Fh
inc BP
MOV SS:[BP], 2Bh
```

```
MOV      AL,0
Mov BP, 200h
ADD      AL,SS:[BP]
inc BP
ADD      AL,SS:[bP]
inc BP
ADD      AL,SS:[BP]
inc BP
ADD      AL,SS:[BP]
inc BP
ADD      AL,SS:[BP]

MOV SS:[BP+2], AL
```



Program Segments

Stack segment

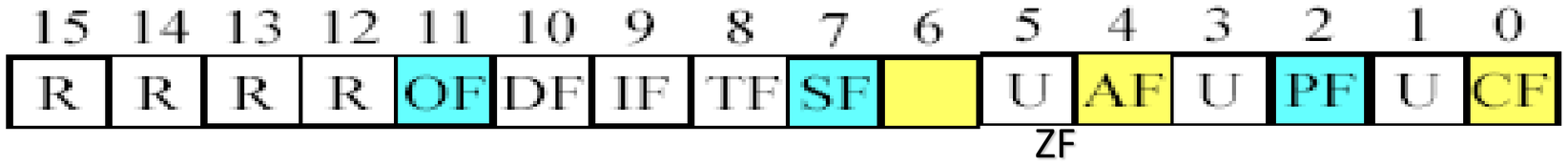
Stack

A section of RAM memory used by the CPU to store information temporarily.

- Registers: SS (Stack Segment) and SP (stack Pointer)
- Operations: PUSH and POP
  - PUSH – the storing of a CPU register in the stack
  - POP – loading the contents of the stack back into the CPU
- Logical and offset address format: SS:SP

Flag Register

- Flag Register (status register)
  - 16-bit register
  - Conditional flags: CF, PF, AF, ZF, SF, OF
  - Control flags: TF, IF, DF

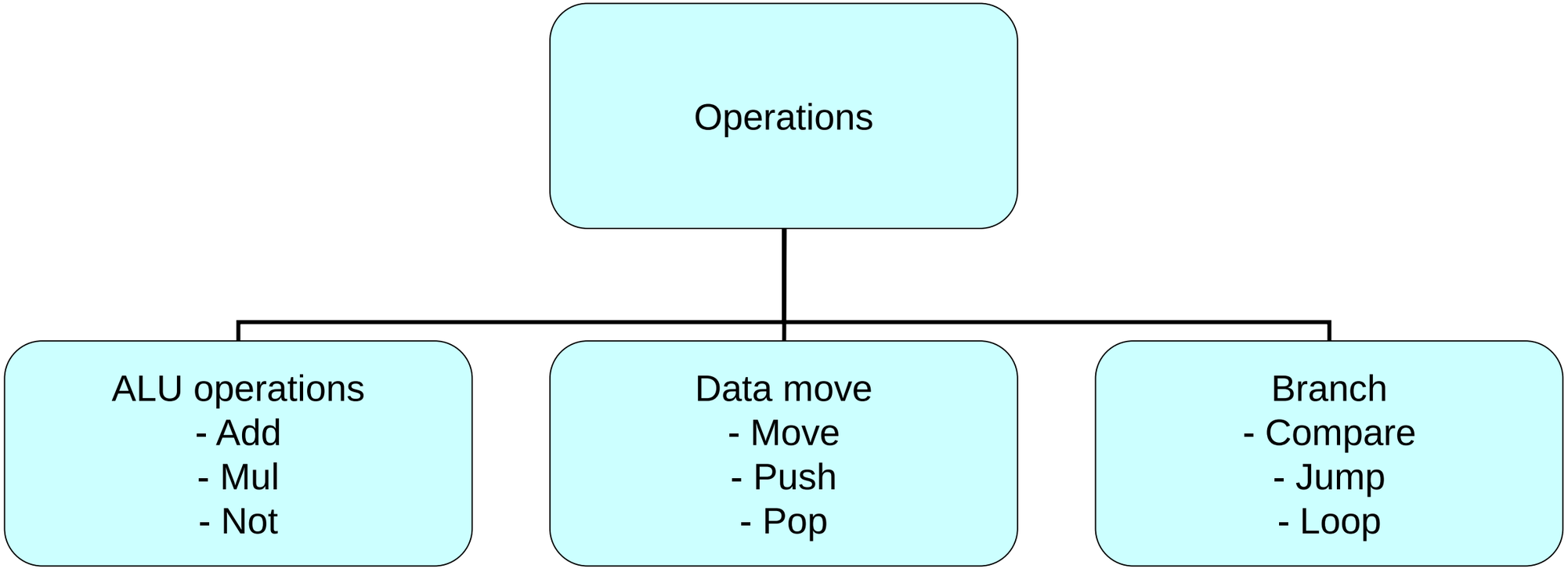


R = reserved
U = undefined
OF = overflow flag
DF = direction flag
IF = interrupt flag
TF = trap flag

SF = sign flag
ZF = zero flag
AF = auxiliary carry flag
PF = parity flag
CF = carry flag

Assembly Komutlar

Instructions



Instruction Set

1. Data Transfer Instructions
2. Arithmetic Instructions
3. Logical Instructions
4. Shift and Rotate Instructions
5. Flow of Control
6. String manipulation Instructions
7. Process Control Instructions
8. Control Transfer Instructions

Data Transfer Instructions

- MOV dest, source dest ← source
- Stack instructions

```
PUSH byte ;increment stack pointer,
 ;move byte on stack
POP byte        ;move from stack to byte,
  ;decrement stack pointer
```

Section B.1: The 8086 Instruction Set

Page 865

MOV Move

Flags: Unchanged

Format: MOV dest, source ; copy source to dest

Function: Copy a word or byte from a register, memory location, or immediate number to a register or memory location. Source and destination must be of the same size and cannot both be memory locations.

Assembly Instruction format

General format

mnemonic	operand(s)	;comments

MOV	destination,source	;copy source operand to destination

Example:

MOV DX,CX

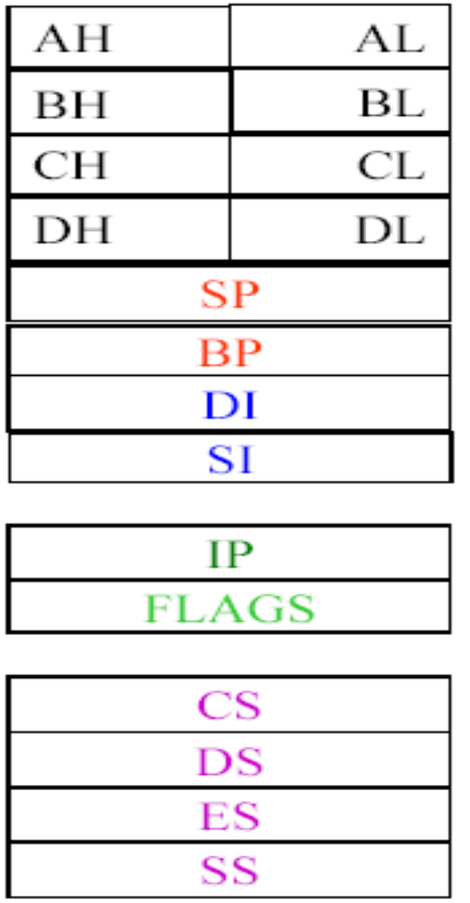
AH	AL
BH	BL
CH	CL
DH	DL

org 100h

Mov cl,55h
Mov dl,cl
Mov ah,dl
Mov al,ah
Mov bh, cl
Mov ch, bh

MOV instruction (16 bits)

```
MOV     CX,468H
MOV     AX,CX
MOV     DX,AX
MOV     BX,DX
MOV     DI,BX
MOV     SI,DI
MOV     DS,SI
MOV     BP,DI
```



What if …

MOV AL,DX

Rule #1:

moving a value that is too large into a register will cause an error

```
MOV    BL,7F2H        ;Illegal: 7F2H is larger than 8 bits
MOV    AX,2FE456H     ;Illegal
```

Rule #2:

Data can be moved directly into nonsegment registers only

(Values cannot be loaded directly into any segment register. To load a value into a segment register, first load it to a nonsegment register and then move it to the segment register.)

```
MOV    AX,2345H          MOV    DI,1400H
MOV    DS,AX             MOV    ES,DI
```

Rule #3:

If a value less than FFH is moved into a 16-bit register, the rest of the bits are assumed to be all zeros.

```
MOV BX, 5          BX =0005
                   BH = 00, BL = 05
```

Arithmetic instructions

Arithmetic Instructions

- **Add**
- **Subtract**
- **Increment**
- **Decrement**
- Multiply
- Divide
- Decimal adjust

Arithmetic Instructions

Mnemonic	Description
`ADD A, byte`	add *A* to byte, put result in *A*
`ADDC A, byte`	add with carry
`SUBB A, byte`	subtract with borrow
`INC A`	increment *A*
`INC byte`	increment byte in memory
`INC DPTR`	increment data pointer
`DEC A`	decrement accumulator
`DEC byte`	decrement byte
`MUL AB`	multiply accumulator by b register
`DIV AB`	divide accumulator by b register
`DA A`	decimal adjust the accumulator

There are 3 groups of instructions. First Group

First group: ADD, SUB

- These types of operands are supported:
- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

- REG: AX, BX, CX, DX, AH, AL, BL, BH, CH, CL, DH, DL, DI, SI, BP, SP.
- memory: [BX], ES:[BX+SI+7], variable, etc...
- immediate: 5, -24, 3Fh, 0FAh, 10001101b, etc...
- İşlenenler arasındaki işlemden sonra, sonuç her zaman ilk işlenende saklanır.
- CMP ve TEST komutları yalnızca bayrakları etkiler ve bir sonucu saklamaz (bu komutlar programın yürütülmesi sırasında karar vermek için kullanılır).

ADD ve SUB instructions

- Flag Register that may be affected
- Conditional flags: CF, PF, AF, ZF, SF, OF
- ADD - add second operand to first.
- SUB - Subtract second operand to first.

ADD Signed or Unsigned ADD

Flags: Affected: OF,SF,ZF,AF,PF,CF

Format: ADD dest, source ; dest=dest+source

Function: Adds source operand to destination operand and places the result in destination. Both source and destination operands must match (e.g.,both byte size or word size) and only one of them can be in memory.

ADD instruction

ADD destination,source ;ADD the source operand to the destination

```
MOV   AL,25H
MOV   BL,34H
ADD   AL,BL
```

You can do this,

```
MOV   DH,25H
ADD   DH,34H
```

```
org 100h

Mov al,25h
add al,0A0h
```

- What is the corresponding C++ code ?
- The way C++ compiler implements '+' operation is fixed
- Assembly language has more flexibility
- Assembly language can tailor the code closer to the hardware

(That is where the efficiency comes from)

ADD

- ADD Operand1, Operand2
- Algorithm: operand1 = operand1 + operand2

Operand1, Operand2:

- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

- **Example:**

```
Org 100h
MOV AL, 5 ; AL = 5
mov bl, -5
ADD AL, -3 ; AL = 2
add al,bl    ; AL = -3

RET
```

Soru-1

- (-5)d=(?)b
- (5)d=(0000 0101)b
- İndis: 7 6 5 4 3 2 1 0
- (0000 0101)b ifadesinde 1'lerin yerine 0; 0'ların yerine 1 konur.
- (1111 1010)b +1
- (1111 1011)b=(FB)h

Soru-2

- (FD)h=(-?)d
- (FD)h=(1111 1101)b
- (1111 1101)b – (1)b= (1111 1100)b
- (1111 1100)b ifadesinde 1'lerin yerine 0; 0'ların yerine 1 konur.
- (0000 0011)b
- İndis: 7 6 5 4 3 2 1 0
- (0000 0011)b=(-3)d (3=2^1+2^0)

ADD Operan1, Operand2

ADD	REG, memory
	memory, REG
	REG, REG
	memory, immediate
	REG, immediate
		Algorithm:
		
		operand1 = operand1 + operand2
		
		Example:
		MOV AL, 5 ; AL = 5
		ADD AL, -3 ; AL = 2
		RET

C	Z	S	O	P	A
r	r	r	r	r	r

ADC Operan1, Operand2

ADC	REG, memory memory, REG REG, REG memory, immediate REG, immediate	Algorithm: operand1 = operand1 + operand2 + CF Example: STC ; set CF = 1 MOV AL, 5 ; AL = 5 ADC AL, 1 ; AL = 7 RET

C	Z	S	O	P	A
r	r	r	r	r	r

```
org 100h

Mov al,01h
stc
adc al,02h
```

ADC:Add with Carry.

- ADC Operand1, Operand2
- Algorithm: operand1 = operand1 + operand2 + CF

Operand1, Operand2:

- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

- **Example:**

```
Org 100h
Mov al, 254

mov bl, 6
add al,bl
RET
```

Al:254d x
Bl: 6d
Add al, bl
Al:260 olması gerekirken al 8bitlik register olduğu için 4d değer geldi; fakat
CF: 1 olduğu için
Sonuc: 104h
(0001 0000 0100)b=(2^2+2^8)d=(4+256)d=(260)d

```
; registerlar 8bitlik yerine 16bit alınırsa CF'e gerek kalmadan toplama yapılır.
Org 100h
mov ax, 254
mov bx, 6
add ax,bx
RET
```

Simple arithmetic instructions

- Both types of overflow occur independently and are signaled separately by CF
- Örnek:

```
Org 100h
mov al, 0FFh
add al,1                ; AL=00h, OF=0, CF=1

Örnek:
Org 100h
mov ax,0FFh
add ax, 1

Sonuç:   ax=(0100)h= (0000 0001 0000 0000)b=(2^8)d=256d
```

Simple arithmetic instructions

- Both types of overflow occur independently and are signaled separately by CF and OF

```
Örnek:
mov al,7Fh
add al, 1              ; AL=80h, OF=1, CF=0
mov al,80h
add al,80h            ; AL=00h, OF=1, CF=1
```

- Hence: we can have either type of overflow or both of them at the same time

SUB Operan1, Operand2

SUB	REG, memory
	memory, REG
	REG, REG
	memory, immediate
	REG, immediate
		Subtract.
		
		Algorithm:
		operand1 = operand1 - operand2
		
		Example:
		MOV AL, 5
		SUB AL, 1 ; AL = 4
		
		RET

C	Z	S	O	P	A
r	r	r	r	r	r

SUB: Subtract

- SUB Operand1, Operand2
- Algorithm: operand1 = operand1 - operand2

Operand1, Operand2:

- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

- **Example:**

```
MOV AL, 5
SUB AL, 1 ; AL = 4
RET
```

SBB Operand1, Operand2

SBB	REG, memory memory, REG REG, REG memory, immediate REG, immediate	Subtract with Borrow. Algorithm: operand1 = operand1 - operand2 - CF Example: STC MOV AL, 5 SBB AL, 3 ; AL = 5 - 3 - 1 = 1 RET

C	Z	S	O	P	A
r	r	r	r	r	r

SBB: Subtract with Borrow

- SBB Operand1, Operand2
- Algorithm: operand1 = operand1 - operand2 – CF

Operand1, Operand2:

- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

- **Example:**

```
STC
MOV AL, 5
SBB AL, 3 ; AL = 5 - 3 - 1 = 1
RET
```

Examples

```
org 100h
mov al,5
mov bl, -3
mov cl, 10
sub bl,al
add cl, bl
end
```

Dizi toplamını ve ortalamasını bulan assembly program

```
org 100h
    lea bx, vec1
    mov cl, N ; dizideki eleman sayisi
    mov al, 0
  sum:
    add al, [bx]  ; indis:  bx. Segment ragister: DS
    inc bx
    loop sum
    div N
    ret

  vec1 db 13, 26, 31, 45
  N db 4
```

		7	6	5	4	3	2	1	0			
	73h	0	1	1	1	0	0	1	1	115		
										28.75		
											112	
											3	
	28d	0	0	0	1	1	1	0	0	1Ch		

Bölüm, AL: 1ch
Kalan, AH: 3

Dizi ortalamasını bulan assembly program

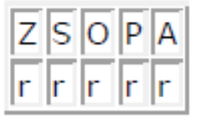
```
        ORG    100h
        mov cl,N
        lea dx,a
        mov bx, offset a
        mov al,0
        mov si,0
don:
        add al,a[si]
        inc si
        loop don

        div N
        ret

        a db 5,6,3,2,7,8,5,4,5
        N db 9
```

INC, DEC

- These types of operands are supported: REG, memory
- REG: AX, BX, CX, DX, AH, AL, BL, BH, CH, CL, DH, DL, DI, SI, BP, SP.
- memory: [BX], [BX+SI+7], variable, etc...
- INC, DEC instructions affect these flags only: ZF, SF, OF, PF, AF.

INC & DEC Instructions

- INC AX — legal
- DEC BL — legal
- INC [BX] — illegal
- INC Byte PTR [BX] — legal
- DEC I — legal
- INC DS — illegal

INC	REG memory	operand = operand + 1 Example: MOV AL, 4 INC AL ; AL = 5 RET  CF - unchanged!
DEC	REG memory	operand = operand - 1 Example: MOV AL, 255 ; AL = 0FFh (255 or -1) DEC AL ; AL = 0FEh (254 or -2) RET  CF - unchanged!

INC Operand (Increment)

- **INC Operand**
- Algorithm: operand = operand + 1

Operand:

- REG
- Memory

Example:

```
ORG 100h
MOV AL, 4
INC AL ; AL = 5
RET
```

INC

INC	REG memory	Increment. **Algorithm:** operand = operand + 1 **Example:** MOV AL, 4 INC AL ; AL = 5 RET  CF - unchanged!

DEC Operand (Decrement)

- DEC Operand
- Algorithm: operand = operand - 1

Operand
- REG
- Memory

- Example:

```
MOV AL, 255 ; AL = 0FFh (255 or -1)
DEC AL ; AL = 0FEh (254 or -2)
RET
```

Arithmetic Instructions

- Add
- Subtract
- Increment
- Decrement
- **Multiply**
- **Divide**
- Decimal adjust

Second group: MUL, IMUL, DIV, IDIV

- These types of operands are supported: REG, memory
- REG: AX, BX, CX, DX, AH, AL, BL, BH, CH, CL, DH, DL, DI, SI, BP, SP.
- memory: [BX], [BX+SI+7], variable, etc...
- MUL and IMUL instructions affect these flags only: CF, OF
- When result is over operand size these flags are set to 1, when result fits in operand size these flags are set to 0.

MUL / IMUL – DIV - IDIV

- MUL - Unsigned multiply: Mul operand
  - when operand is a byte: AX = AL * operand.
  - when operand is a word: (DX AX) = AX * operand.
- IMUL - Signed multiply: Imul operand
  - when operand is a byte: AX = AL * operand.
  - when operand is a word: (DX AX) = AX * operand.
- DIV - Unsigned divide: Div Operand
  - when operand is a byte: AL = AX / operand; AH = remainder (modulus). .
  - when operand is a word: AX = (DX AX) / operand; DX = remainder (modulus). .
- IDIV - Signed divide:
  - when operand is a byte: AL = AX / operand; AH = remainder (modulus). .
  - when operand is a word: AX = (DX AX) / operand; DX = remainder (modulus). .

MUL Operand (Unsigned multiply)

- MUL Operand

Algorithm:

- when operand is a byte: AX = AL * Operand.
- when operand is a word: (DX AX) = AX * Operand.

(320)h=(0011 0010 0000)b
=(2^5+2^8+2^9)d=(32+256+512)d
=(32+768)d=(800)d

Operand:

- REG
- memory

- **Example:**

```
ORG 100h
MOV AL, 200 ; AL = 0C8h
MOV BL, 4
MUL BL ; AX = 0320h (800)
RET
```

CF, OF değişir.

IMUL Operand (Signed multiply)

- **IMUL Operand**

Algorithm:

- when operand is a byte: AX = AL * operand.
- when operand is a word: (DX AX) = AX * operand.

Operand:

- REG
- memory

- **Example:**

```
Org 100h
MOV AL, -2
MOV BL, -4
IMUL BL ; AX = 8
RET
```

IMUL instruction

- IMUL (signed integer multiply) multiplies an 8-, 16-, or 32-bit signed operand by either AL, AX, or EAX (there are one/two/three operand format)
- Preserves the sign of the product by sign-extending it into the upper half of the destination register

Example: multiply 48 * 4, using 8-bit operands:

```
mov  al,48
mov  bl,4
imul bl     ; AX = 00C0h, OF=1
```

OF=1 because AH is not a sign extension of AL.

Örnek

when operand is a word: (DX AX) = AX * operand.

In this example, Operand is Bx

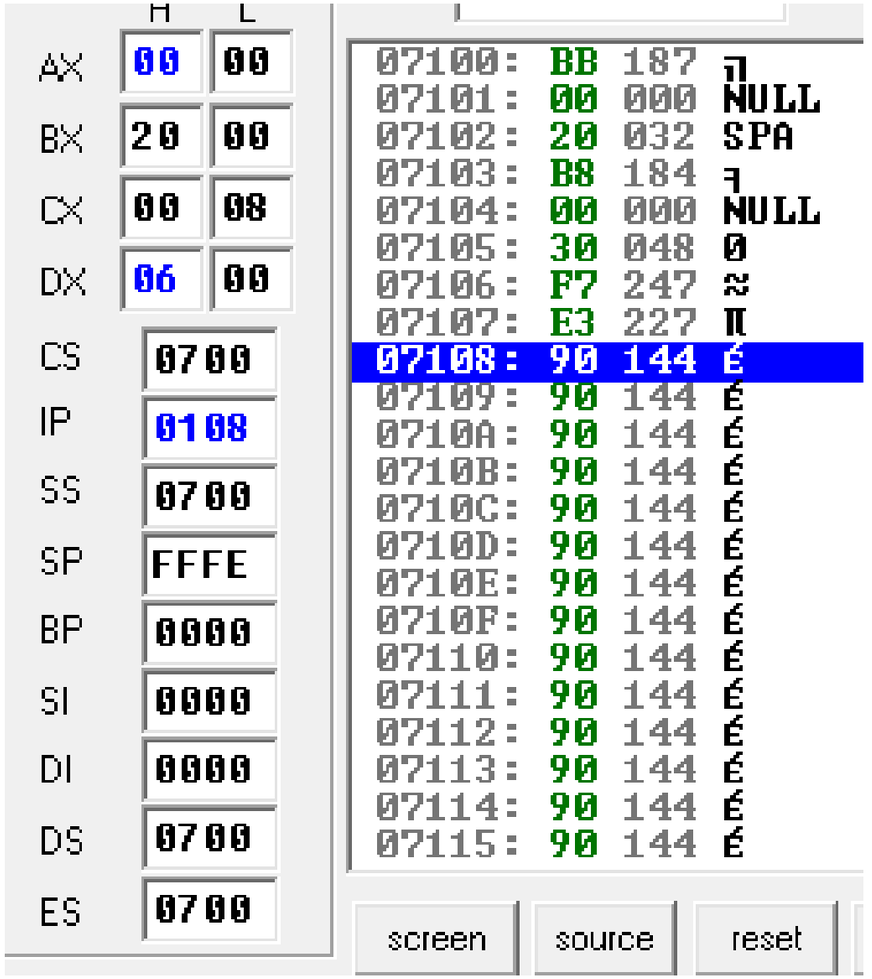
Org 100h

Mov Bx, 2000h

Mov Ax, 3000h

Mul Bx

Sonuç= DxAx: (06 00 00 00)h



Örnek

when operand is a byte: AX = AL * operand.

In this example, Operand is Bl

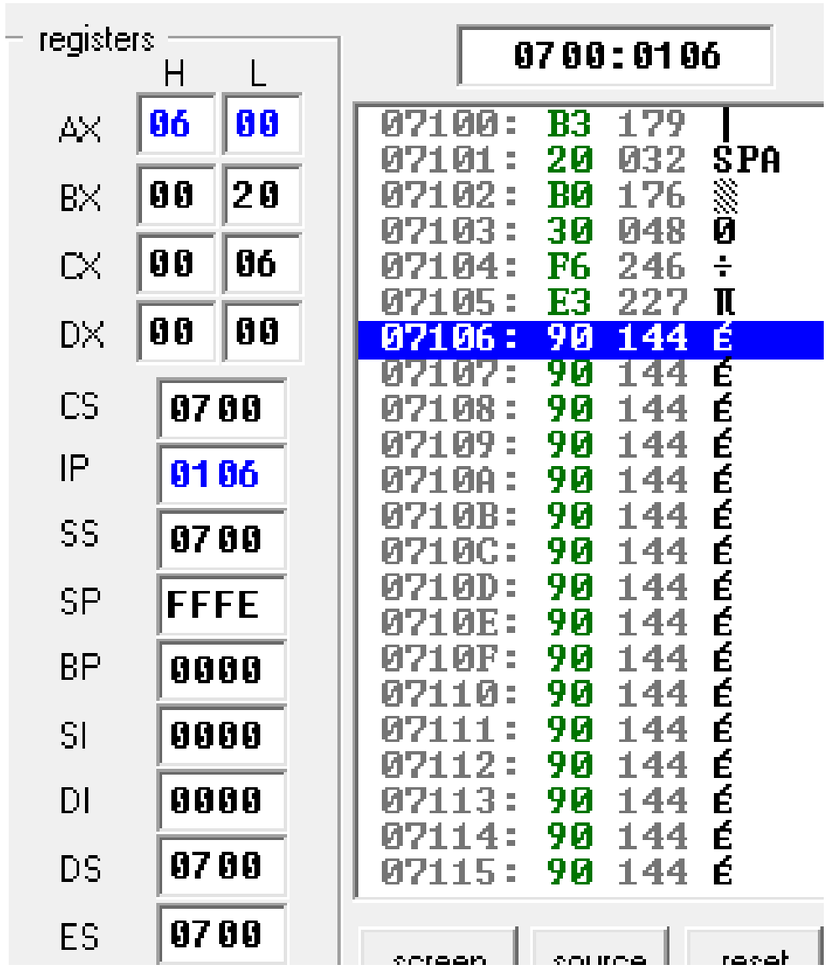
Org 100h

Mov Bl, 20h

Mov Al, 30h

Mul Bl

Sonuç= Ax:(06 00)h



Örnek

when operand is a word: AX = (DX AX) / operand;
DX = remainder (modulus). .

In this example, Operand is Bx

```
Org 100h
Mov Bx, 2000h
Mov Ax, 8000h
Div Bx
```

Sonuç= Ax:(00 004)h

DIV Operand

Algorithm:

- when operand is a byte: AL = AX / operand, AH = remainder (modulus)
- when operand is a word: AX = (DX AX) / operand, DX = remainder (modulus)

Operand

- REG
- memory
- Unsigned divide.

- **Example:**

```
Org 100h
MOV AX, 203 ; AX = 00CBh
MOV BL, 4
DIV BL ; AL = 50 (32h), AH = 3
RET
```

DIV - IDIV

DIV

REG
memory

Unsigned divide.

Algorithm:

when operand is a **byte**:
AL = AX / operand
AH = remainder (modulus)
when operand is a **word**:
AX = (DX AX) / operand
DX = remainder (modulus)

Example:

```
MOV AX, 203   ; AX = 00CBh
MOV BL, 4
DIV BL        ; AL = 50 (32h), AH = 3
RET
```

C	Z	S	O	P	A
?	?	?	?	?	?

IDIV

REG
memory

Signed divide.

Algorithm:

when operand is a **byte**:
AL = AX / operand
AH = remainder (modulus)
when operand is a **word**:
AX = (DX AX) / operand
DX = remainder (modulus)

Example:

```
MOV AX, -203 ; AX = 0FF35h
MOV BL, 4
IDIV BL      ; AL = -50 (0CEh), AH = -3 (0FDh)
RET
```

C	Z	S	O	P	A
?	?	?	?	?	?

IDIV Operand (Signed divide)

IDIV Operand

Algorithm:

- when operand is a byte: AL = AX / operand; AH = remainder (modulus)
- when operand is a word: AX = (DX AX) / operand; DX = remainder (modulus)

Operand:

- REG,
- memory

- **Example:**

```
Org 100h
MOV AX, -203 ; AX = 0FF35h
MOV BL, 4
IDIV BL ; AL = -50 (0CEh), AH = -3 (0FDh)
RET
```

IDIV Operand

- IDIV (signed divide) performs signed integer division
- Uses same operands as DIV

Example: 8-bit division of –48 by 5

```
mov al,-48
cbw             ; extend AL into AH
mov bl,5
idiv bl         ; AL = -9,  AH = -3
```

Logical Operations

Sayısal Mantığın Temelleri

- Sayısal mantık değerlerini temsil etmek için ikili sayı sistemi kullanılır.
- Bit:1/0 (Doğru /Yanlış, İyi /Kötü, Gece/Gündüz, 0V /5V)
- Sayısal mantık değerlerinin matematiksel işlemleri, Boole cebirinin kurallarında belirtilen yasalara tabidir.
- Boole cebirinin kurallarında belirtilen yasaların matematiksel girdileri ve çıktıları ikili sayı (1/0) sistemi ile temsil edilir.
- Her türlü aritmetiksel işlemlerin girdileri ve çıktıları ya 1 ya da 0'dır.
- Bilgisayar sistemlerinin donanımını oluşturan mantıksal kapılarının girişler, 1/0; çıkışları: 1/0
    - AND, OR, NOT, NAND, NOR, XOR, XNOR.
- Mantık kapıları, transistörler kullanılarak oluşturulur.
    - NOT gate can be implemented by a single transistor
    - AND gate requires 3 transistors
- Transistörler bilgisayar sistemlerinin temel devre elemanlarıdır.
    - Pentium consists of 3 million transistors
    - Compaq Alpha consists of 9 million transistors
    - Now we can build chips with more than 100 million transistors

Boole Cebri Teoremleri

1. a) $a+b=b+a$ Değişme Özelliği
   b) $a \cdot b=b \cdot a$
2. a) $a+b+c=a+(b+c)$ Birleşme Özelliği
   b) $a \cdot b \cdot c=a \cdot (b \cdot c)$
3. a) $a+b \cdot c= (a+b) \cdot (a+c)$ Dağılma Özelliği
   b) $a \cdot (b+c) = a \cdot b + a \cdot c$
4. a) $a+a=a$ Değişkende Fazlalık Özelliği
   b) $a \cdot a=a$
5. a) $a+a.b=a$ Yutma Özelliği
   b) $a \cdot (a+b)=a$
6. a) (a)^n $=a$ işlemde Fazlalık Özelliği
   b) $(a$ x n$) =a$
7. a) $\overline{(a+b)}=\bar{a} \cdot \bar{b}$ De Morgan Kuralı
   b) $\overline{(a \cdot b)}=\bar{a} + \bar{b}$

8. a) $a+\bar{a}$ =1 Sabit Özelliği
   b) $a \cdot \bar{a}$ =0
9. a) 0+a=a Etkisizlik Özelliği
   b) 1$\cdot a=a$
10. a) 1+a=1 Yutan Sabit Özelliği
    b) 0$\cdot a$=0
11. a) $(a+b) \cdot b=b$
    b) $a \cdot b + b=b$

- The 12 Rules of Boolean Algebra
  - A + 0 = A
  - A + 1 = 1
  - A · 0 = 0
  - A · 1 = A
  - A + A = A
  - $A + \overline{A} = 1$
  - A · A = A
  - $A \cdot \overline{A} = 0$
  - $\overline{\overline{A}} = A$
  - A + AB = A
  - $A + \overline{A}B = A + B$
  - (A + B)(A + C) = A + BC

Mantıksal işlemlerde tü değişkenler 1/0 iki sayı sisteminde çalışır.
Giriş ya da çıkışlar: 1/0

Boole Cebirinin Kuralları ve Yasaları

Tek değişkenli temel kurallar:

- Boole Cebirinin Kurallarının ve Yasalarının her birinin bir kanıtı, değişkenin yalnızca iki bit(0/1) değere sahip olabileceği gerçeğinden yararlanılarak kolayca ispat edilebilir.
- Not: A=0 ya da 1 olur.
- A + A + A + A + A .... + A + 1 = 1 ; OR kapısında girişlerden herhangi biri 1 ise çıkış birdir. Diğer ispat etme yöntemi, 1 ve 0 değerleri verilerek doğruluk aranır.
- A + A + A + ... + A=A (Neden? İki değişkenli 0 ya da 1 girişler mevcuttur)
- (a+b) x b=axb+bxb= axb+b= (a+1)xb=b; bxb=b, a+1=1
- 1 + 1 + 1 + 1 + 1=1
- A A A ... A = A
  - If A = 0 then 0 + 1 = 1
  - If A = 1 then 1 + 1 = 1

$A + 0 = A$	$A \cdot 0 = 0$
$A + 1 = 1$	$A \cdot 1 = A$
$A + A = A$	$A \cdot A = A$
$A + \overline{A} = 1$	$A \cdot \overline{A} = 0$

It should be noted that $\overline{\overline{A}} = A$

Boole Cebirinin Kuralları ve Yasaları

Mantıksal matematiği ikili (0/1) sayı sisteminde hesaplama yapılır.
Soru: Boole cebrini kullanarak aşağıdaki işlemi yapınız. A+1+1+1=?
a) 0 b)1 c)10 d) 8 A+3

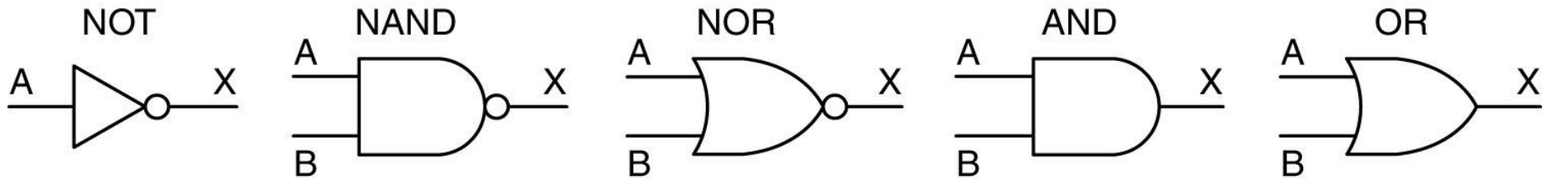
Soru: Boole cebrinde A hangi değerleri alır? a) 0 b)1 c) 0/1 d) 0,1,2, …, 9 d)Her değeri e)hiçbir değeri

Soru: Boole cebrinde A=1 ise, A+A+A+A+A=? A)1 B)0 C)A D)5 D)5A E) Hiçbiri

Soru: Boole Cebrinde A*A*A*A=? A)A B) A^4

Soru: 1+a+b+c+ ... + z=?

Mantık Kapıları için semboller ve işlevsel davranış



A	X
0	1
1	0

(a)

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

(b)

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

(c)

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

(d)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

(e)

AND Kapısı: Girişlerden herhangi biri 0 ise çıkış 0 dır. Girişlerin tümü 1 ise çıkış 1 dir.

OR Kapısı: Girişlerden herhangi biri 1 ise çıkış 1 dır. Girişlerin tümü 0 ise çıkış 0 dir.

NOT Kapısı: girişin evriğini alır.

Mantık kapısı, bir Boole işlevini uygulayan idealleştirilmiş veya fiziksel bir devredir, yani bir veya daha fazla mantık girişinde mantıksal bir işlem gerçekleştirir ve tek bir mantık çıkışı üretir.

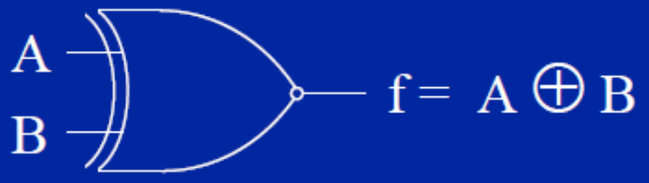
Logic Gates

Toplama

The EXCLUSIVE OR Truth Table

A	B	f = A XOR B
0	0	0
0	1	1
1	0	1
1	1	0

The XOR Gate

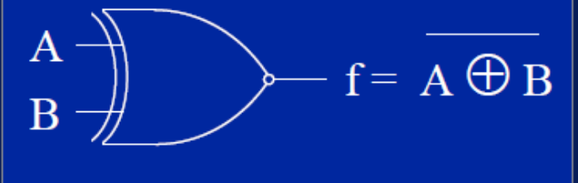


Karşılaştırma

The EXCLUSIVE NOR Truth Table

A	B	f = A XNOR B
0	0	1
0	1	0
1	0	0
1	1	1

EXCLUSIVE NOR Gate



This is called the equivalence gate

Karşılaştırma ve Aritmetik toplama işlemlerinde XOR kapıları kullanılır.
Girişlerin tümü birbirine eşit (0 ya da 1) çıkış sıfır ise XOR, çıkış 1 ise XNOR kapısıdır.

Logic Instructions

- Bitwise logic operations
  - (AND, OR, XOR, NOT)
- Clear
- Rotate
- Swap

Logic instructions do NOT affect the flags in PSW

Bitwise Logic

AND ➔ AND

OR ➔ OR

XOR ➔ XOR

CP ➔ Complement

Examples:

```
          00001111
AND       10101100
          --------
          00001100
```

```
          00001111
OR        10101100
          --------
          10101111
```

```
          00001111
XOR       10101100
          --------
          10100011
```

```
CP        10101100
          --------
          01010011
```

Boolean Operation Instructions

- NOT
- AND
- OR
- XOR

- Example: OR EAX, EBX

These instructions affect these flags only: CF, ZF, SF, OF, PF, AF.

- AND - Logical AND between all bits of two operands.
- These rules apply: 1 AND 1 = 1; 1 AND 0 = 0; 0 AND 1 = 0; 0 AND 0 = 0. As you see we get 1 only when both bits are 1.

- TEST - The same as AND but for flags only.

- OR - Logical OR between all bits of two operands. These rules apply: 1 OR 1 = 1; 1 OR 0 = 1; 0 OR 1 = 1; 0 OR 0 = 0

- **XOR** - LogiAs you see we get 1 every time when at least one of the bits is 1.cal XOR (exclusive OR) between all bits of two operands. These rules apply: 1 XOR 1 = 0; 1 XOR 0 = 1; 0 XOR 1 = 1; 0 XOR 0 = 0. As you see we get **1** every time when bits are different from each other.

AND Operand1, Operand2 (Operand1=Operand1 and Operand2)

AND	REG, memory memory, REG REG, REG memory, immediate REG, immediate	Logical AND between all bits of two operands. Result is stored in operand1. These rules apply: 1 AND 1 = 1 1 AND 0 = 0 0 AND 1 = 0 0 AND 0 = 0 Example: MOV AL, 'a' ; AL = 01100001b AND AL, 11011111b ; AL = 01000001b ('A') RET C Z S O P 0 r r 0 r

AND: Logical AND between all bits of two operands.

- AND Operand1, Operand2

Operand1, Operand2:

- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

Not: Logical AND between all bits of two operands. Result is stored in operand1.

- These rules apply:
- 1 AND 1 = 1
- 1 AND 0 = 0
- 0 AND 1 = 0
- 0 AND 0 = 0

- **Example:**

```
org 100h
MOV AL, 'a' ; AL = 01100001b
Mov Ah, 'A'

Mov Bh, '8'
Mov BL, 8
AND AL, 11011111b ; AL = 01000001b ('A')
AND AH, 00000001b ;

RET
```

OR

OR	REG, memory memory, REG REG, REG memory, immediate REG, immediate	Logical OR between all bits of two operands. Result is stored in first operand. These rules apply: 1 OR 1 = 1 1 OR 0 = 1 0 OR 1 = 1 0 OR 0 = 0 Example: MOV AL, 'A' ; AL = 01000001b OR AL, 00100000b ; AL = 01100001b ('a') RET

C	Z	S	O	P	A
0	r	r	0	r	?

OR: Logical OR

- OR Operand1, Operand2

Operand:

- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

Not: Logical OR between all bits of two operands. Result is stored in first operand.

- These rules apply:
- 1 OR 1 = 1
- 1 OR 0 = 1
- 0 OR 1 = 1
- 0 OR 0 = 0

- **Example:**

```
MOV AL, 'A' ; AL = 01000001b
OR AL, 00100000b ; AL = 01100001b ('a')
RET
```

XOR (Aritmetik Toplama)

XOR

REG, memory memory, REG REG, REG memory, immediate REG, immediate	Logical XOR (Exclusive OR) between all bits of two operands. Result is stored in first operand. These rules apply: 1 XOR 1 = 0 1 XOR 0 = 1 0 XOR 1 = 1 0 XOR 0 = 0 Example: MOV AL, 00000111b XOR AL, 00000010b ; AL = 00000101b RET

C	Z	S	O	P	A
0	r	r	0	r	?

XOR: Logical XOR (Exclusive OR) between all bits of two operands.

- **XOR Operand1, Operand2**

Operand1, Operand2:
- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

Not: Logical XOR (Exclusive OR) between all bits of two operands. Result is stored in first operand.
- These rules apply:
- 1 XOR 1 = 0
- 1 XOR 0 = 1
- 0 XOR 1 = 1
- 0 XOR 0 = 0

- **Example:**

```
MOV AL, 00000111b
XOR AL, 00000010b ; AL = 00000101b
RET
```

NOT, NEG

- These types of operands are supported: REG, memory
- REG: AX, BX, CX, DX, AH, AL, BL, BH, CH, CL, DH, DL, DI, SI, BP, SP.
- memory: [BX], [BX+SI+7], variable, etc...
- NOT instruction does not affect any flags!
- NEG instruction affects these flags only: CF, ZF, SF, OF, PF, AF.
- NOT - Reverse each bit of operand.
- NEG - Make operand negative (two's complement). Actually it reverses each bit of operand and then adds 1 to it. For example 5 will become -5, and -2 will become 2.

NOT

NOT	REG memory	Invert each bit of the operand. Algorithm: • if bit is 1 turn it to 0. • if bit is 0 turn it to 1. Example: MOV AL, 00011011b NOT AL ; AL = 11100100b RET C Z S O P A unchanged

```
org 100h
MOV AL, 'a' ; AL = 01100001b
Mov Ah, 'A'
Mov Bh, '8'
Mov BL, 8


NOT AL
NOT AH
NOT BL
NOT BH

RET

AL: (61)h=(0110 0001)b
NOT AL= (1001 1110)b=(9E)h
```

NOT: Invert each bit of the operand.

- NOT Operand

Algorithm:

- if bit is 1 turn it to 0.
- if bit is 0 turn it to 1.

Operand:

- REG
- memory

- **Example:**

```
MOV AL, 00011011b
NOT AL ; AL = 11100100b
RET
```

NEG

NEG	REG memory	Negate. Makes operand negative (two's complement). Algorithm: • Invert all bits of the operand • Add 1 to inverted operand Example: MOV AL, 5 ; AL = 05h NEG AL ; AL = 0FBh (-5) NEG AL ; AL = 05h (5) RET C Z S O P A r r r r r r

TEST

TEST	REG, memory memory, REG REG, REG memory, immediate REG, immediate	Logical AND between all bits of two operands for flags only. These flags are effected: **ZF, SF, PF.** Result is not stored anywhere. These rules apply: 1 AND 1 = 1 1 AND 0 = 0 0 AND 1 = 0 0 AND 0 = 0 Example: MOV AL, 00000101b TEST AL, 1 ; ZF = 0. TEST AL, 10b ; ZF = 1. RET C Z S O P 0 r r 0 r

Mantıksal işlemlere ait örnek

- Aşağıda kodu yazılmış assemble programın sonucunda AL register içeriği ne olur?

  MOV AL, 10

  MOV BL, 8

  OR AL, BL

  (10)d=(1010)b

  (8)d=(1000)b

  (1010)b OR (1000)b =(1010)b=(10)d

- Aşağıda kodu yazılmış assemble programın sonucunda AL register içeriği ne olur?

  MOV AL, 12

  NOT AL

  (12)d=(1100)b

  NOT(1100)b=(0011)b=(3)d

- Aşağıda kodu yazılmış assemble programın sonucunda AL register içeriği ne olur?

  MOV AL, 12

  MOV BL, 9

  AND AL,BL

  (12)d=(1100)b

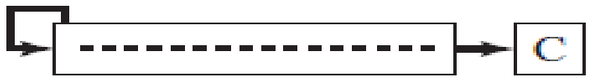
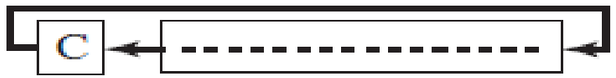
  (9)d=(1001)b

  (1100)B AND (1001)b =(1000)b=(8)d

Shift and Rotate
(Çarpma ve Bölme)

Shift instruction

TABLE 10-5
Typical Shift Instructions

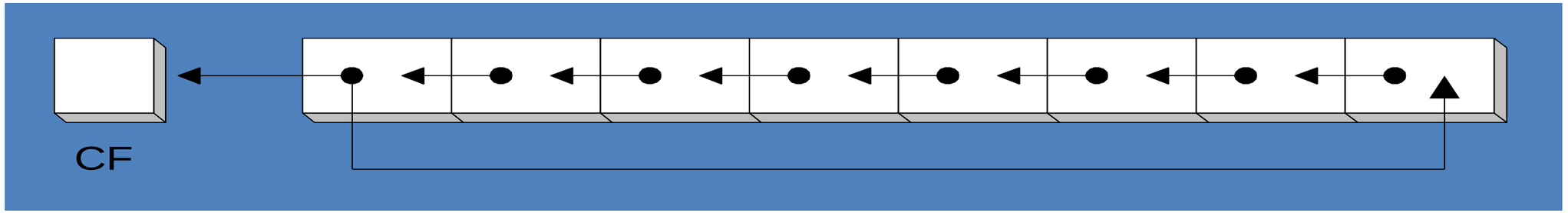
Name	Mnemonic	Diagram
Logical shift right	SHR	
Logical shift left	SHL	
Arithmetic shift right	SHRA	
Arithmetic shift left	SHLA	
Rotate right	ROR	
Rotate left	ROL	
Rotate right with carry	RORC	
Rotate left with carry	ROLC	

Shift and Rotate Instructions

- Logical vs Arithmetic Shifts
- SHL Instruction
- SHR Instruction
- SAL and SAR Instructions
- ROL Instruction
- ROR Instruction
- RCL and RCR Instructions
- SHLD/SHRD Instructions

ROL instruction

- ROL (rotate) shifts each bit to the left
- The highest bit is copied into both the Carry flag and into the lowest bit
- No bits are lost




```
mov al,11110000b
rol al,1; AL = 11100001b

mov dl,3Fh
rol dl,4; DL = F3h
```

ROL: Rotate operand1 left

- **ROL Operand1, Operand2**
- Algorithm: Tüm bitleri sola kaydırılır, giden bit CF'ye ayarlanır ve aynı bit en sağdaki konuma eklenir.
- Not: Operand1'i sola döndürülür. Döndürme sayısı Operand2 tarafından belirlenir.

Operand:

- memory, immediate
- REG, immediate
- memory, CL
- REG, CL

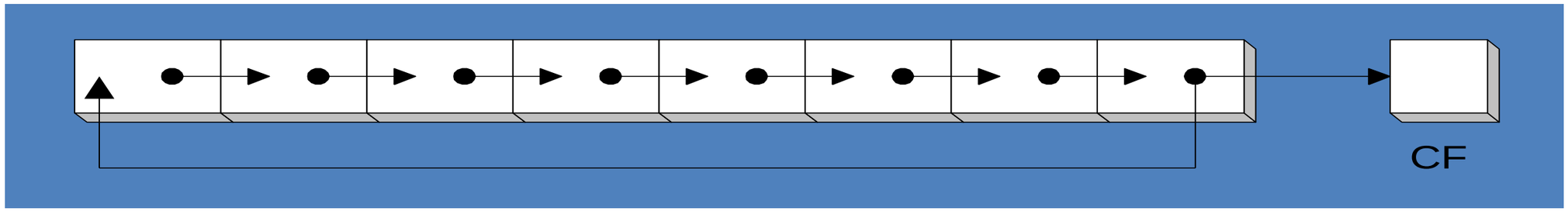
- **Example:**

```
MOV AL, 1Ch ; AL = 00011100b
ROL AL, 1 ; AL = 00111000b, CF=0.
RET
```

```
org 100h
MOV AL, 80h
ROL AL,1

MOV BL, 11110000b
ROL BL,1


RET
```

ROR instruction

- ROR (rotate right) shifts each bit to the right
- The lowest bit is copied into both the Carry flag and into the highest bit
- No bits are lost




```
mov al,11110000b
ror al,1              ; AL = 01111000b

mov dl,3Fh
ror dl,4              ; DL = F3h
```

ROR: Rotate operand1 right

- **ROR Operand1, Operand2**
- Algorithm: Tüm bitleri sağa kaydırılır, giden bit CF'ye ayarlanır ve aynı bit en soldaki konuma eklenir.
- Not: Operand1'i sağa döndürülür. Döndürme sayısı Operand2 tarafından belirlenir.

Operand1, Operand2:

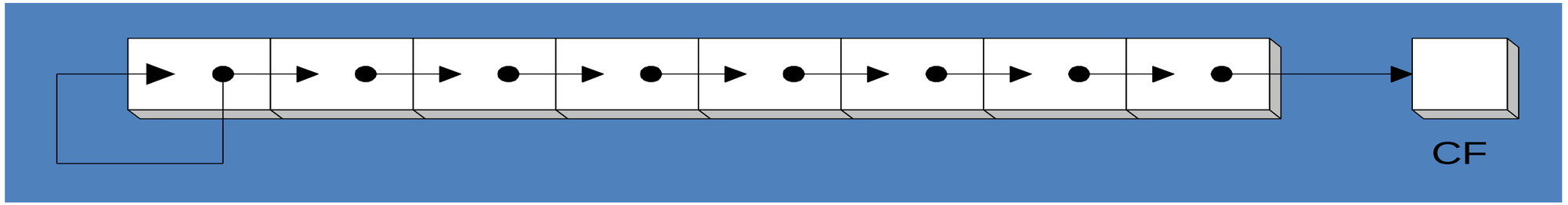
- memory, immediate
- REG, immediate
- memory, CL
- REG, CL

- **Example:**

```
MOV AL, 1Ch ; AL = 00011100b
ROR AL, 1 ; AL = 00001110b, CF=0.
RET
```

SAL and SAR instructions

- SAL (shift arithmetic left) is identical to SHL.
- SAR (shift arithmetic right) performs a right arithmetic shift on the destination operand.



An arithmetic shift preserves the number's sign.

```
mov dl,-80
sar dl,1; DL = -40
sar dl,2; DL = -10
```

SAL: Shift Arithmetic operand1 Left.

- **SAL Operand1, Operand2**
- Algorithm: Tüm bitleri sola kaydırın, giden bit CF'ye ayarlanır. Sıfır biti en sağdaki konuma eklenir.
- Not: Aritmetik olarak Operand1 Sola kaydırılır. Kaydırma sayısı Operand2 tarafından belirlenir

Operand1, Operand2:

- memory, immediate
- REG, immediate
- memory, CL
- REG, CL

- **Example:**

```
MOV AL, 0E0h ; AL = 11100000b
SAL AL, 1 ; AL = 11000000b, CF=1.
RET
```

SAR: Shift Arithmetic operand1 Right

- **SAR Operand1, Operand2**
- Algorithm: Tüm bitleri sağa kaydırılır, giden bit CF'ye ayarlanır. Sıfır biti en soldaki konuma eklenir.
- Not: Aritmetik olarak Operand1 sağa kaydırılır. Kaydırma sayısı Operand2 tarafından belirlenir

Operand1, Operand2

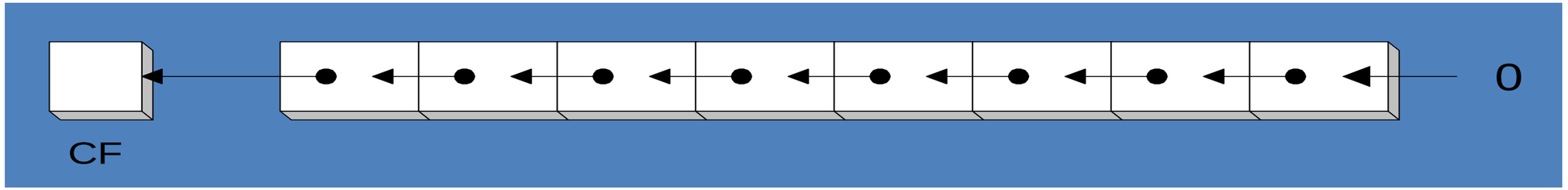
- memory, immediate
- REG, immediate
- memory, CL
- REG, CL

- **Example:**

```
MOV AL, 0E0h ; AL = 11100000b
SAR AL, 1 ; AL = 11110000b, CF=0.
MOV BL, 4Ch ; BL = 01001100b
SAR BL, 1 ; BL = 00100110b, CF=0.
RET
```

SHL instruction

- The SHL (shift left) instruction performs a logical left shift on the destination operand, filling the lowest bit with 0.



- Operand types: **SHL** ***destination,count***

```
SHL reg,imm8
SHL mem,imm8
SHL reg,CL
SHL mem,CL
```

Örnek:
MOV AL, 8
SHL AL,1

(8)d=(0000 1000)b

SHL (0000 1000)b= (0001 0000)b=(16)d

SHL: Shift operand1 Left.

- **SHL Operand1, Operand2**
- Algorithm: Shift all bits left, the bit that goes off is set to CF. Zero bit is inserted to the right-most position.
- Not: Shift operand1 Left. The number of shifts is set by operand2.

Operand1, Operand2:

- memory, immediate
- REG, immediate
- memory, CL
- REG, CL

- **Example:**

```
MOV AL, 11100000b
SHL AL, 1 ; AL = 11000000b, CF=1.
RET
```

SHR: Shift operand1 Right.

- **SHR Operand1, Operand2**
- Algorithm: Shift all bits right, the bit that goes off is set to CF. Zero bit is inserted to the left-most position.
- Not: Shift operand1 Right. The number of shifts is set by operand2.

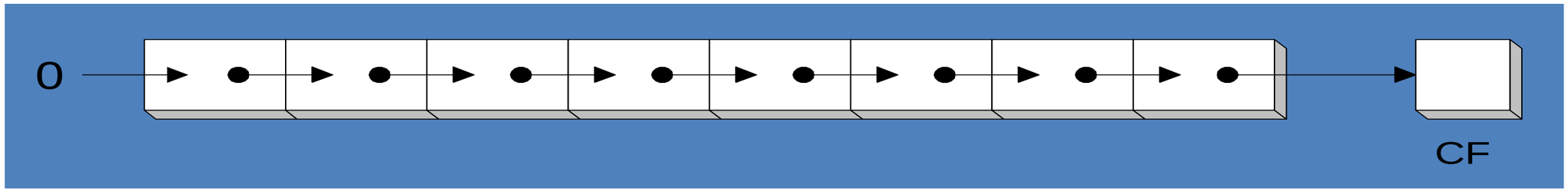
- **Operand1, Operand:**
- memory, immediate
- REG, immediate
- memory, CL
- REG, CL

- **Example:**

```
MOV AL, 00000111b
SHR AL, 1 ; AL = 00000011b, CF=1.
RET
```

SHR instruction

- The SHR (shift right) instruction performs a logical right shift on the destination operand. The highest bit position is filled with a zero.



Shifting right n bits divides the operand by 2^n

```
mov dl,80
shr dl,1; DL = 40
shr dl,2; DL = 10
```

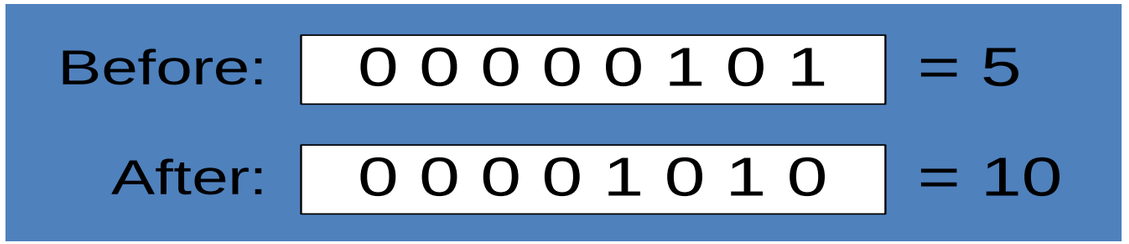
Örnek:
MOV AL, 8
SHR AL,1

(8)d=(0000 1000)b
SHR (0000 1000)b= (0000 0100)b=(4)d

Fast multiplication

Shifting left 1 bit multiplies a number by 2

```
mov dl,5
shl dl,1
```



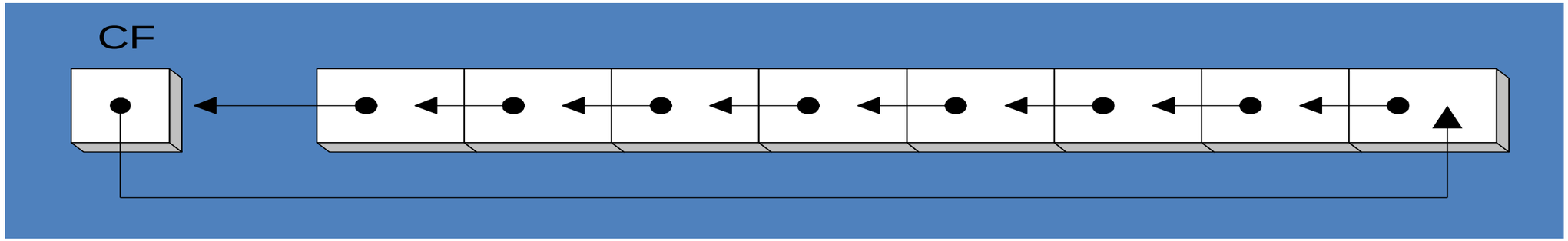
Shifting left *n* bits multiplies the operand by 2^n

For example, $5 * 2^2 = 20$

```
mov dl,5
shl dl,2              ; DL = 20
```

RCL instruction

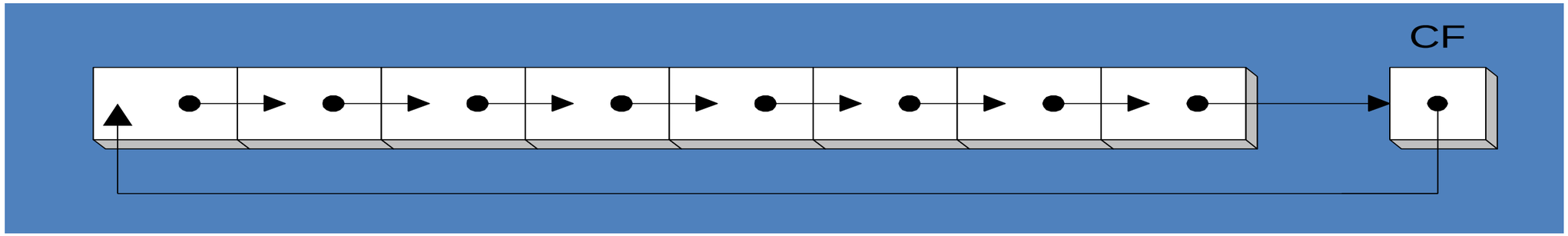
- RCL (rotate carry left) shifts each bit to the left
- Copies the Carry flag to the least significant bit
- Copies the most significant bit to the Carry flag




```
clc                 ; CF = 0
mov bl,88h          ; CF,BL = 0 10001000b
rcl bl,1            ; CF,BL = 1 00010000b
rcl bl,1            ; CF,BL = 0 00100001b
```

RCR instruction

- RCR (rotate carry right) shifts each bit to the right
- Copies the Carry flag to the most significant bit
- Copies the least significant bit to the Carry flag




```
stc                 ; CF = 1
mov ah,10h          ; CF,AH = 00010000 1
rcr ah,1            ; CF,AH = 10001000 0
```

Comparison Instructions
Program Flow Control

CMP Operand1, Opernad2

CMP	REG, memory
	memory, REG
	REG, REG
	memory, immediate
	REG, immediate
		operand1 - operand2
		
		result is not stored anywhere, flags are set (OF, SF, ZF, AF, PF, CF) according to result.
		
		Example:
		MOV AL, 5
		MOV BL, 5
		CMP AL, BL ; AL = 5, ZF = 1 (so equal!)
		RET

C	Z	S	O	P	A
r	r	r	r	r	r

Short Conditional Jumps

Instruction	Description	Flags
JO	Jump if overflow	OF = 1
JNO	Jump if not overflow	OF = 0
JS	Jump if sign	SF = 1
JNS	Jump if not sign	SF = 0
JE **JZ**	Jump if equal Jump if zero	ZF = 1
JNE **JNZ**	Jump if not equal Jump if not zero	ZF = 0
JB **JNAE** **JC**	Jump if below Jump if not above or equal Jump if carry	CF = 1
JNB **JAE** **JNC**	Jump if not below Jump if above or equal Jump if not carry	CF = 0
JBE **JNA**	Jump if below or equal Jump if not above	CF = 1 or ZF = 1

Short Conditional Jumps

Instruction	Description	Flags
JA **JNBE**	Jump if above Jump if not below or equal	CF = 0 and ZF = 0
JL **JNGE**	Jump if less Jump if not greater or equal	SF <> OF
JGE **JNL**	Jump if greater or equal Jump if not less	SF = OF
JLE **JNG**	Jump if less or equal Jump if not greater	ZF = 1 or SF <> OF
JG **JNLE**	Jump if greater Jump if not less or equal	ZF = 0 and SF = OF
JP **JPE**	Jump if parity Jump if parity even	PF = 1
JNP **JPO**	Jump if not parity Jump if parity odd	PF = 0
JCXZ **JECXZ**	Jump if CX register is 0 Jump if ECX register is 0	CX = 0 ECX = 0

CMP: Compare

- CMP Operand1, Operand2
- Algorithm: operand1 - operand2
- Not: result is not stored anywhere, flags are set (OF, SF, ZF, AF, PF, CF) according to result. Bu komuttan sonra JMp ya da j.. (JE, JNE, ...) Komutlarından biri gelir.

- **Operand1, Operand1:**
- REG, memory
- memory, REG
- REG, REG
- memory, immediate
- REG, immediate

- **Example:**

```
Org 100h
MOV AL, 5
MOV BL, 5
CMP AL, BL ; AL = 5, ZF = 1 (so equal!)
RET
```

Örnek: JE - JG

```
 ORG 100h
 MOV AL, 5
MOV BL,6
 CMP AL, BL
 JE label1
 call m1
 JMP exit
label1:    call m2
exit:
RET

m1 PROC
mov dx, offset msg1
mov ah, 9
int 21h
ret
m1 ENDP

m2 PROC
mov dx, offset msg2
mov ah, 9
int 21h
ret
m2 ENDP
msg1 db "AL is not equal to
BL $"
msg2 db "AL is equal to  BL
$"
END
```

Örnek: JE - JG

```
 ORG 100h
 MOV AL, 5
MOV BL,6
CMP AL, BL
 JG label1
 call m1
 JMP exit
label1:    call m2
exit:  RET

m1 PROC
mov dx, offset msg1
mov ah, 9
int 21h
ret
m1 ENDP

m2 PROC
mov dx, offset msg2
mov ah, 9
int 21h
ret
m2 ENDP
msg1 db "AL is not greater BL $"
msg2 db "AL is  greater BL $"
END
```

Jump instructions for signed numbers

- JE, JZ
- JNE, JNZ
- JA, JNBE
- JB, JNAE, JC
- JAE, JNB, JNC
- JBE, JNA

Jump instructions for unsigned numbers

- JE, JZ
- JNE, JNZ
- JG, JNLE
- JL, JNGE
- JGE, JNL
- JLE, JNG

Örnek: Dizi Toplamını Bulan Yazılım

- ORG 100h
- mov si,0h
- mov cx,0h

- atla: cmp si,12
- je stop

- add cl, a[si]
- inc si
- jmp atla
- stop: ret
- a db 1h, 2h, 3h, 4h, 5h,4h,7h,8h,4h,0ah,0bh, 0ch, 0dh

Set

STC, CLC

- STC No operands
- Set Carry flag.
- Algorithm:
- CF = 1

- CLC No operands
- Clear Carry flag.
- Algorithm:
- CF = 0

Loop

Loop

- **LOOP label;** Decrease CX, jump to label if CX not zero.

- **Algorithm:**

  CX = CX - 1
  if CX <> 0 then
  jump
  else
  no jump, continue

- Example:

```
ORG 100h
MOV CX, 5
label1:
    mov dx, offset msg
    mov ah, 9
    int 21h
    LOOP label1
RET
msg db "Esenyurt University $"
END
```

1’den N’e kadar sayıların toplamını bulan assembly program,TOP= N*(N+1)/2

```
ORG    100h
            mov cx,20
mov ax,0

dongu: add ax,cx
            loop dongu
 ret
```

Örnek: Dizide benzer sayının bulunması

```
org 100h

        lea bx, vec1
        mov cl,7
        mov dl,39h

   ali:  mov al,[bx]
        cmp dl,al
        je TIK
        inc bx
        loop ali

    TIK:     ret


    vec1 db 23h, 26h, 22h, 35h, 39h, 0ach,0bch
```

Looping using zero flag

- The zero flag is set (ZF=1), when the counter becomes zero (CX=0)

- *Example:* add 5 bytes of data

```
        MOV   CX,05          ;CX holds the loop count
        MOV   BX,0200H       ;BX holds the offset data address
        MOV   AL,00          ;initialize AL
ADD_LP: ADD   AL,[BX]                ;add the next byte to AL
        INC   BX             ;increment the data pointer
        DEC   CX             ;decrement the loop counter
        CMP   CX,0
        JNZ   ADD_LP         ;jump to next iteration if counter
                             ;not zero
```

The loop instruction

instruction	operation and jump condition	opposite instruction
LOOP	decrease CX, jump to label if CX not zero.	DEC CX and JCXZ
LOOPE	decrease cx, jump to label if cx not zero and equal (zf = 1).	LOOPNE
LOOPNE	decrease cx, jump to label if cx not zero and not equal (zf = 0).	LOOPE
LOOPNZ	decrease cx, jump to label if cx not zero and zf = 0.	LOOPZ
LOOPZ	decrease cx, jump to label if cx not zero and zf = 1.	LOOPNZ
JCXZ	jump to label if cx is zero.	OR CX, CX and JNZ

Example

```
org  100h; Finds the array
        lea bx, vec1
        mov cx, 4
        mov al, 0
sum:
        add al, [bx]
        inc bx
        loop sum
        ret
vec1 db 3, 6, 1, 5
```

```
        ORG    100h     ; TOP= N*(N+1)/2
        mov cx,20
        mov ax,0
dongu: add ax,cx
        loop dongu
        ret
```

FOR LOOP

Example:

For 80 times DO

Display ‘*’

END_IF

Assemly :

```
        MOV CX, 80
        MOV AH, 2
        MOV DL, ‘*’
Next:   INT 21H
        Loop Next
```

While Loop

Example:

Initialize count to 0
Read a character
While character <> Carriage Return DO
Count = Count + 1
Read a character
END_While

Assembly:

```
        MOV DX, 0
        MOV AH, 1
        INT 21H
While_: CMP AL, 0DH
        JE End_While
        INC DX
        INT 21H
        JMP While_
End_While:
```

Repeat Loop

Example:

Repeat

Read a character

Until character is blank

Assembly:

```
        MOV AH, 1
Repeat:
        INT 21H
; until
        CMP AL, ' '
        JNE Repeat
```

Application of Loope

- **Example: Search for a number in a Table**

```
        Table DB 1,2,3,4,5,6,7,8,9
        XOR SI, SI
        MOV CX, 9
Next:   INC SI
        CMP Table[SI-1], 7
        Loopne Next
```

Example

```
org 100h ; Is there same number in the given
array?
        lea bx, vec1
        mov cl,7
        mov dl,39h

   ali:  mov al,[bx]
        cmp dl,al
        je TIK
        inc bx
        loop ali

    TIK:     ret


    vec1 db 23h, 26h, 22h, 35h, 39h, 0ach,0bch
```

```
    org 100h; Is there  number in the given array?
        lea bx, vec1
        mov cl,7
        mov dl,39h
ali:  mov al,[bx]
      cmp dl,al
      je TIK
      inc bx
      loop ali
 TIK:     ret
vec1 db 23h, 26h, 22h, 35h, 39h, 0ach,0bch
```

Example

```
ORG    100h; teletype function number.
LEA    SI, msg       ; DS: aaaa0 + SI

next_char:
               CMP  [SI], 0
               JE   stop
                MOV  AL, [SI]      ; next get ASCII char.
               MOV  AH, 0Eh      ; teletype function number.
               INT  10h             ; using interrupt to print a char in AL.
               inc  SI
               JMP  next_char
stop:           ENDP
msg    DB  "Hello World!", 0
```

Examples

```
org 100h;    Find the big element in the array
  mov cl,1
  mov ch,N       ; dizi uzunlugu
  lea bx,vec     ; dizinini baslangic adresi
  mov dh,[bx]    ; max=vec[1]
        L3:   inc cl
              inc bx
              mov dl,[bx]
              cmp dh,dl   ; max > vec[i]
              ja L1
              mov dh,dl
               L1:
              cmp ch,cl
              jne L3
endp
N    db 8
vec  db 43h, 1h, 3h,75h, 9h,7h,2h,66h
```

```
ORG    100h; Average program
   mov cx,9
   mov si,cx
   dec si
   mov ax,0
   mov dx,0
 git:       mov dl, a[si]
            add ax,dx
            cmp si,0
            je cik
            dec si
            jmp git
cik:        div cl
            ret
            a db 5,6,3,2,7,8,5,4,5
```

String Instructions

String Instructions

- **Five categories**
  - MOVS, MOVSB, MOVSW
  - CMPS, CMPSB, CMPSW
  - SCAS, SCASB, SCASW
  - LODS, LODSB, LODSW
  - STOS, STOSB, STOSW
- **Source is always in DS:[SI]**
- **Destination is always in ES:[DI]**
- **If DF=0, SI and DI are incremented**
- **If DF=1, SI and DI are decremented**
- **To clear direction flag: CLD**
- **To set direction flag: STD**

String Instructions – Cont.

- **MOVSB**
  - ES:[DI] ← DS:[SI]
  - DI ← DI+1; SI ←SI+1 (if DF=0)
  - DI ← DI-1; SI ←SI-1 (if DF=1)
- **MOVSW**
  - ES:[DI+1:DI] ← DS:[SI+1:SI]
  - DI ← DI+2; SI ←SI+2 (if DF=0)
  - DI ← DI-2; SI ←SI-2 (if DF=1)
- **MOVS destination, source**
  - Replaced by either MOVSB or MOVSW depending on operands size

String Instructions – Cont.

- **CMPSB**
  - DS:[SI] - ES:[DI]
  - DI ← DI+1; SI ←SI+1 (if DF=0)
  - DI ← DI-1; SI ←SI-1 (if DF=1)
- **CMPSW**
  - DS:[SI+1:SI] - ES:[DI+1:DI]
  - DI ← DI+2; SI ←SI+2 (if DF=0)
  - DI ← DI-2; SI ←SI-2 (if DF=1)
- **CMPS destination, source**
  - Replaced by either CMPSB or CMPSW depending on operands size

String Instructions – Cont.

- **SCASB**
  - AL - ES:[DI]
  - DI ← DI+1; (if DF=0)
  - DI ← DI-1 (if DF=1)
- **SCASW**
  - AX - ES:[DI+1:DI]
  - DI ← DI+2; (if DF=0)
  - DI ← DI-2; (if DF=1)
- **SCAS destination**
  - Replaced by either SCASB or SCASW depending on operands size

String Instructions – Cont.

- **LODSB**
  - AL ← DS:[SI]
  - SI ← SI+1; (if DF=0)
  - SI ← SI-1 (if DF=1)
- **LODSW**
  - AX ← DS:[SI+1:SI]
  - SI ← SI+2; (if DF=0)
  - SI ← SI-2; (if DF=1)
- **LODS destination**
  - Replaced by either LODSB or LODSW depending on operands size

String Instructions – Cont.

- **STOSB**
  - ES:[DI] ← AL
  - DI ← DI+1; (if DF=0)
  - DI ← DI-1 (if DF=1)
- **STOSW**
  - ES:[DI+1:DI] ← AX
  - DI ← DI+2; (if DF=0)
  - DI ← DI-2 (if DF=1)
- **STOS destination**
  - Replaced by either STOSB or STOSW depending on operands size

Copying a String to another

```
.DATA
    String1 DB “Hello”
    String2 DB 5 dup(?)
.CODE
            MOV AX, @DATA
            MOV DS, AX
            MOV ES, AX
            CLD
            MOV CX, 5
            LEA SI, String1
            LEA DI, String2
    REP     MOVSB
```

Copying a String to another in Reverse Order

```
.DATA
    String1 DB “Hello”
    String2 DB 5 dup(?)
.CODE
            MOV AX, @DATA
            MOV DS, AX
            MOV ES, AX
            STD
            MOV CX, 5
            LEA SI, String1+4
            LEA DI, String2
    Next:   MOVSB
            ADD DI, 2
            LOOP Next
```

String Instructions

Simple Byte Transfers

LODSB	Load String Byte	AL ← [SI] SI ← SI+1
STOSB	Store String Byte	[DI] ← AL DI ← DI+1

Simple Word Transfers

LODSW	Load String Word	AL ← [SI] AH ← [SI+1] SI ← SI+2
STOSW	Store String Word	[DI] ← AL [DI+1] ← AH DI ← DI+2

String Example

```
      org 0x100
section .data
     s_1 db "0123456789",0
     v_1 times 11 db 0
section .text
     MOV SI, s_1     ; SI ← pointer to s_1
     MOV DI, v_1     ; DI ← pointer to v_1
L1:  LODSB           ; AL ← [SI]
                     ; SI ← SI + 1
     CMP AL, 0
     JZ end
     SUB AL, 30      ; AL ← AL - 30 = numerical value of ASCII char
     STOSB           ; [DI] ← AL
                     ; DI ← DI + 1
     JMP L1          ; loop
end: STOSB           ; store \null
     mov ax,4C00h
     int 21h
```

Processor Control Instructions

Processor Control Instructions

Mnemonics	Explanation
STC	Set CF ← 1
CLC	Clear CF ← 0
CMC	Complement carry CF ← CF/
STD	Set direction flag DF ← 1
CLD	Clear direction flag DF ← 0
STI	Set interrupt enable flag IF ← 1
CLI	Clear interrupt enable flag IF ← 0
NOP	No operation
HLT	Halt after interrupt is set
WAIT	Wait for TEST pin active
ESC opcode mem/ reg	Used to pass instruction to a coprocessor which shares the address and data bus with the 8086
LOCK	Lock bus during next instruction

ALT Programlama

Control Transfer Instructions

- Transfer the control to a specific destination or target instruction
- Do not affect flags

Mnemonics	Explanation
CALL reg/ mem/ disp16	Call subroutine
RET	Return from subroutine
JMP reg/ mem/ disp8/ disp16	Unconditional jump

Procedures

```
ORG 100h
MOV AL, 1
MOV BL, 2
CALL m2
CALL m2
CALL m2
CALL m2
RET ; return to operating system.

m2 PROC
MUL BL ; AX = AL * BL.
RET ; return to caller.
m2 ENDP
END
```

Örnek: Call

Örnek-1:

```
ORG 100h
CALL m1
MOV AX, 2
ADD AX, BX
RET ; return to operating system.

m1 PROC
MOV BX, 5
RET ; return to caller.
m1 ENDP
END
```

Örnek-2:

```
ORG 100h
MOV AL, 1
MOV BL, 2
CALL m2
CALL m2
CALL m2
CALL m2
RET ; return to operating system.

m2 PROC
MUL BL ; AX = AL * BL.
RET ; return to caller.
m2 ENDP
END
```

Örnek: Call and Loop

```
ORG 100h
MOV AL, 1
MOV BL, 2
Mov CX,4
don:
CALL m2

LOOP don
RET ; return to operating system.
m2 PROC
MUL BL ; AX = AL * BL.
RET ; return to caller.
m2 ENDP
END
```

Applications

Örnek: Ekrana Mesaj Yazma

```
org 100h
    ; write msg1
    mov dx, offset a1
    mov ah, 9
    int 21h

    ; write msg2
    mov dx, offset a2
    mov ah, 9
    int 21h

    ; write msg3
    mov dx, offset a3
    mov ah, 9
    int 21h
    ret

a1 db " Cahit Karakus", 0Dh,0Ah, "$"
a2 db " Computer Engineering" , 0Dh,0Ah, "$"
a3 db " Esenyurt University" , 0Dh,0Ah, "$"
```

Örnek: Ekrandan Karakter Okunması

```
org 100h
    ; write msg1
    mov dx, offset a1
    mov ah, 9
    int 21h
  ; read character in al:
    mov ah, 1
    int 21h
    ret
     ; yazilan karekter AL icerisindedir.

    a1 db " Bir Tusa Basiniz", 0Dh,0Ah, "$"
```

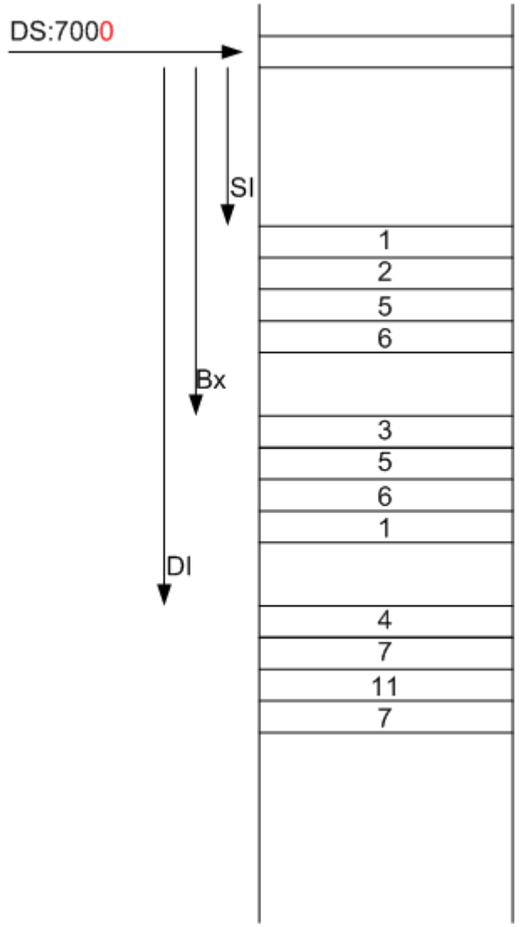
Örnek: Ekrandan 0 ile 99 arasında sayı girilmesi

```
org 100h
; write msg1
        mov dx, offset a1
        mov ah, 9
        int 21h
; read character in al:
git1:   mov ah, 1
        int 21h
        cmp al, 30h
        jb git1
        cmp al, 39h
        ja git1
        mov bh, al
         ; write msg1
        mov dx, offset a1
        mov ah, 9
        int 21h
```

```
; read character in al:
git2:   mov ah, 1
        int 21h
        cmp al, 30h
        jb git2
        cmp al, 39h
        ja git2
                mov bl, al
                sub bh, 30h
        sub bl, 30h
        mov al, bh
        mov cl,10
        mul cl

        add al,bl

        ret

a1 db " 0 ile 99 arasinda bir sayi giriniz: $"
```

Example: the sum of a vector with; another vector and saves result in third vector.

```
org 100h
jmp start
vec1 db 1, 2, 5, 6
vec2 db 3, 5, 6, 1
vec3 db ?, ?, ?, ?

start:      lea si, vec1
            lea bx, vec2
            lea di, vec3
            mov cx, 4
sum:
            mov al, [si]
            add al, [bx]
            mov [di], al
            inc si
            inc bx
            inc di
            loop sum
            ret
```

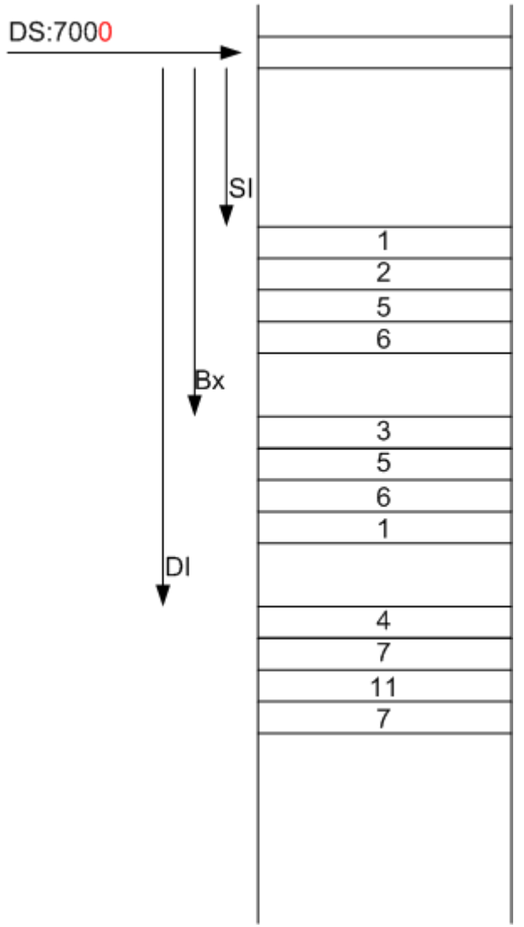


Example: add al, [bx]

1- AA: [indis] ifadesinde AA: segment register tanımlar: CS, DS, SS, ES. 16 bittir: (YYYY)h. Eğer AA yok ise default olarak DS tanımlar. 20 bit fiziksel adrese dönüşür: (YYYY0). İndis ,16 bitlik register tanımlar: BX, SI, DI, BP, SP.

2- datanın yeri: (YYYY0)+indis

3- Al olmasından dolayı 1 byte veri okunacak ve AL registerine transfer edilecektir.



Example: counts the number of characters of a zero terminated string.

```
name "counter"
org 100h
jmp start
      str1 db " Cahit Karakus – Computer Engineering – Esenyut University ", 0
start:      lea bx, str1 ; load address of string.
            mov ax, 0 ; reset counter.
compare:  cmp [bx], 0 ; is it end of string?
            je done  ; if zero, then it's the end.
            inc ax   ; count char.
            inc bx   ; next memory position in string.
            jmp compare
done:       ret
```

Example: 1 den N’e kadar sayıların toplanması

```
        name "calc-sum"
        org 100h ; directive make tiny com file.

        mov cl, 15    ; number of elements:
        mov al, 0     ; al will store the sum:
next:   add al, cl    ; sum elements:
        loop next     ; loop until cx=0:
        mov bh, al    ; store result in bl:
        ret
```

Example: Dizideki sayıların toplanması ve ortalamanının bulunması

```
        ORG    100h
        mov cl,N
        lea dx,a
        mov bx, offset a
        mov al,0
        mov si,0
don:
        add al,a[si]
        inc si
        loop don

        div N
        ret

        a db 5,6,3,2,7,8,5,4,5
        N db 9
```

Example: 0 dan 99 kadar iki basamaklı sayı okunması

```
org 100h
; write msg1
        mov dx, offset a1
        mov ah, 9
        int 21h
; read character in al:
 git1:  mov ah, 1
        int 21h
        cmp al, 30h
        jb git1
        cmp al, 39h
        ja git1
        mov bl, al
```

```
git2:  mov ah, 1
        int 21h
        cmp al, 30h
        jb git2
        cmp al, 39h
        ja git2

        sub al,30h
        sub bl,30h
        xchg al, bl
        mov cl,10
        mul cl
        add al,bl
        ret

    a1 db " 0 ile 9 arasinda bir sayi giriniz: $"
```

Example: Mantıksal İşlemler

```
Org 100h
MOV AL, 01010101b
MOV CL, AL

MOV BL, 10101010b
AND AL, BL


MOV CH, BL
OR CL, CH

NOT AL
NOT BL
RET
```

Example: Dizide aynı olan sayıyı bulma

```
org 100h

        lea bx, vec1
        mov cl,7
        mov dl,39h

don1:   mov al,[bx]
        cmp dl,al
        je git
        inc bx
        loop don1

git:    ret

vec1 db 23h, 26h, 22h, 35h, 39h, 0ach,0bch
```

Example: Dizide büyük elamanı bulma

```
        org 100h
        mov cl,N       ; dizi uzunlugu
        dec cl
        lea bx, vec    ; dizinini baslangic adresi
        mov al, [bx]    ; max=vec[1]

L3:     inc bx
        mov ah, [bx]
        cmp al, ah   ; max > vec[i]
        jae L1
        mov al, ah
L1:     loop L3
        ret

        N    db 8
        vec  db 43h, 1h, 3h,75h, 9h,7h,0AAh,66h
        end
```

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
- b is an exact copy of the a array, when compiler sees a string inside
- quotes it automatically converts it to set of bytes. This chart shows
- a part of the memory where these arrays are declared:

Usage Notes

- A lot of slides are adopted from the presentations and documents published on internet by experts who know the subject very well.
- I would like to thank who prepared slides and documents.
- Also, these slides are made publicly available on the web for anyone to use
- If you choose to use them, I ask that you alert me of any mistakes which were made and allow me the option of incorporating such changes (with an acknowledgment) in my set of slides.

Sincerely,

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