Addressing Modes

- When the 8088 executes an instruction, it performs the specified function on data
- These data, called operands,
  - May be a part of the instruction
  - May reside in one of the internal registers of the microprocessor
  - May be stored at an address in memory

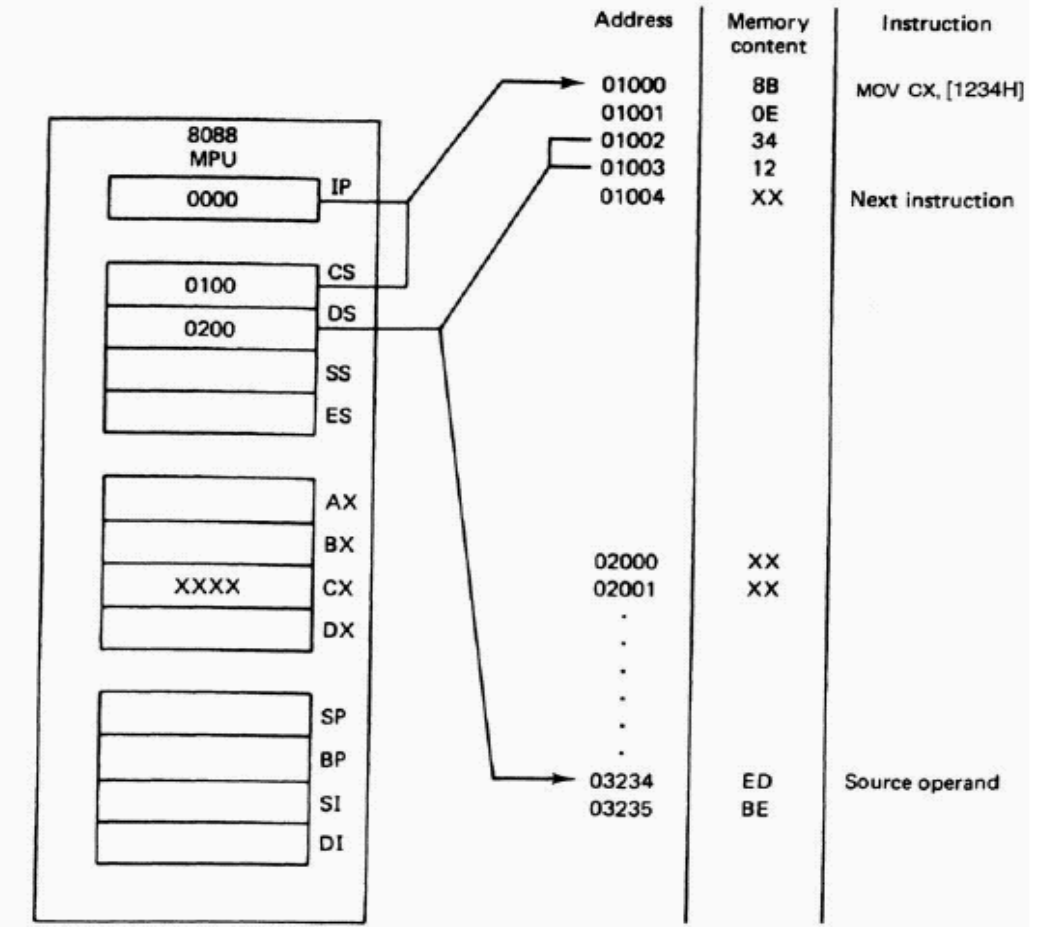
$$PA = \begin{bmatrix} CS \\ SS \\ DS \\ ES \end{bmatrix} : \begin{bmatrix} BX \\ BP \end{bmatrix} + \begin{bmatrix} SI \\ DI \end{bmatrix} + \begin{bmatrix} 8\text{ bit displacement} \\ 16\text{ bit displacement} \end{bmatrix}$$

Immediate Addressing

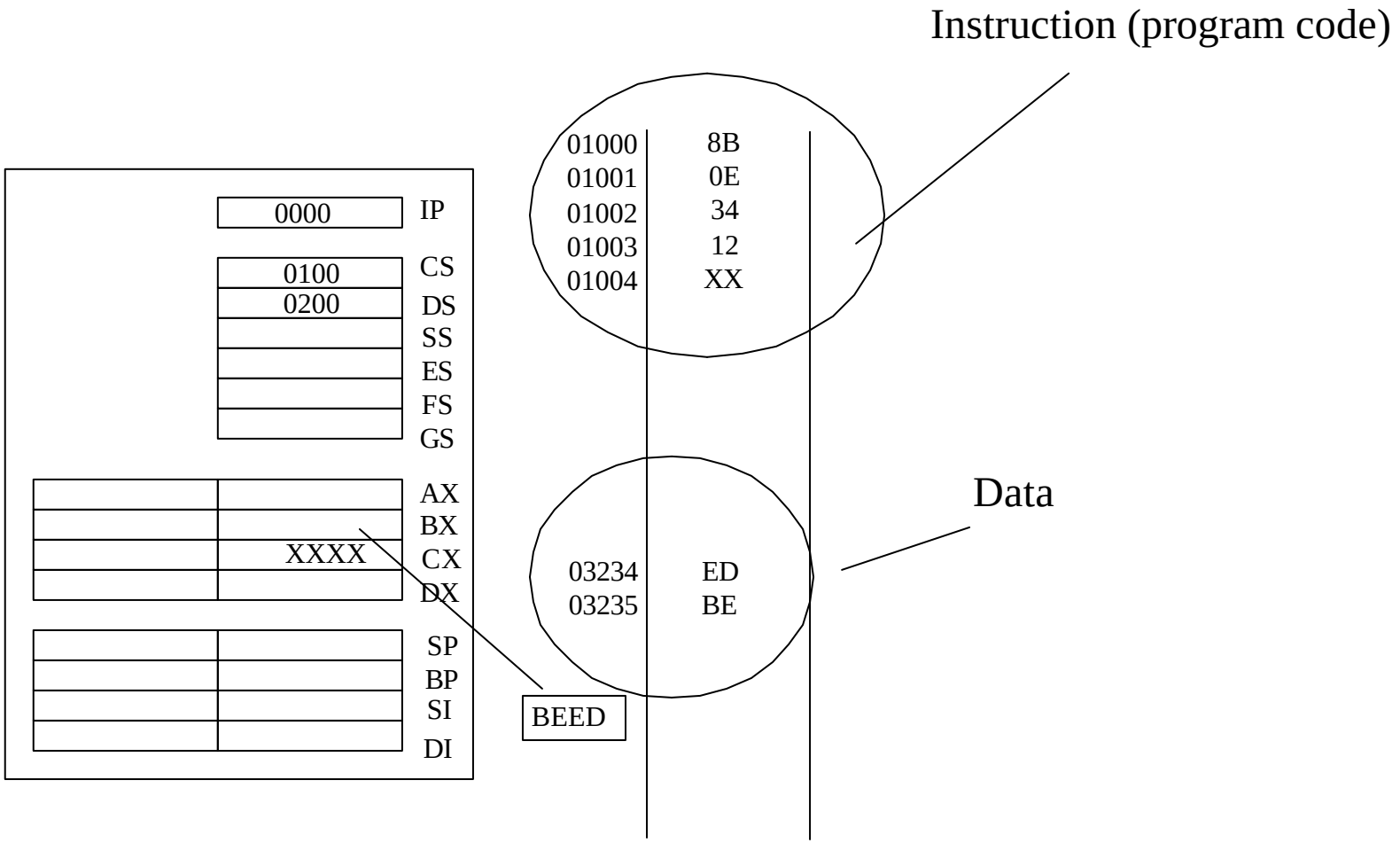
- In immediate addressing, source operand is a constant
- Used to load information to any one of the registers except for the segment registers and the flag register
  - MOV AX,2550h
  - MOV CX, 625 ; decimal 625
  - MOV BL,40h

Direct Addressing Mode

MOV CX, [1234h]



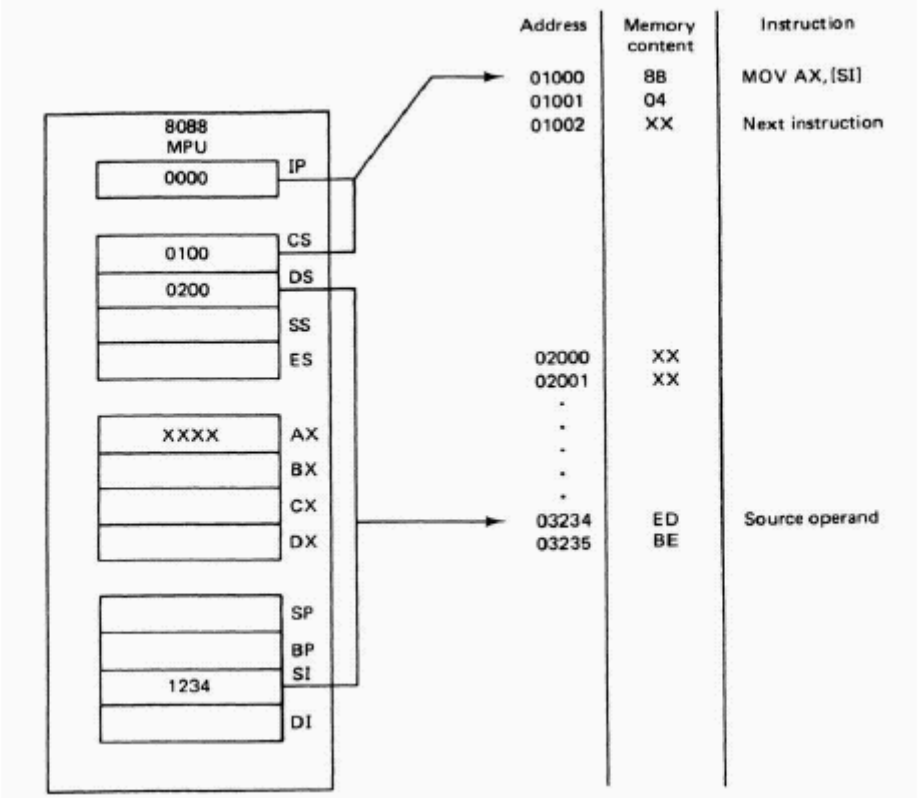
– **Direct Addressing Mode**
  - PA = Segment Base : Direct Address
  - MOV CX, [1234H]



Register Indirect Addressing Mode

MOV AX, [SI]

- Effective address is found in either the BX, BP, SI, DI register
- SUB DX, [BX]



Examples

ASSUMPTION: ASSUME all specified offsets are in the DATA Segment:

BX contains 0400h	Offset 0400h contains ABCDh
SI contains 0500h	Offset 0500h contains 1000h
DI contains 0600h	Offset 0600h contains 0045h

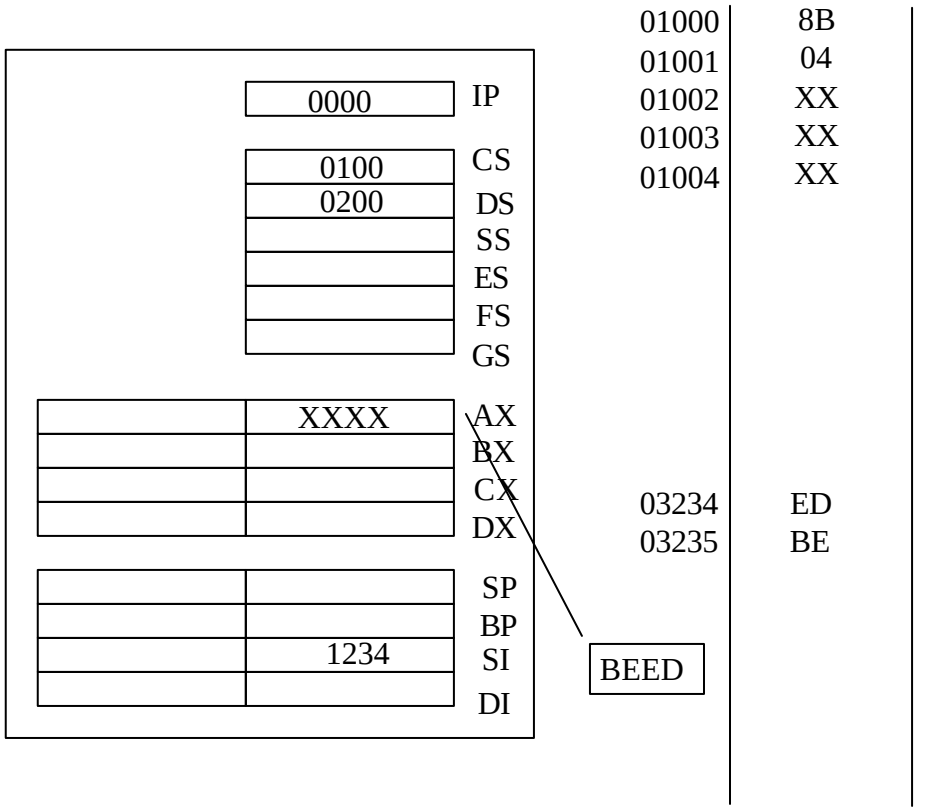
INSTRUCTIONS:	RESULTS:
1. MOV AX,BX	AX: 0400h
2. MOV AX,[BX]	AX: ABCDh
3. MOV AX,SI	AX: 0500h
4. MOV AX,[SI]	AX: 1000h

Register Indirect Addressing

```
mov  al,  [bp]      ;al gets 8 bits at SS:BP

mov  ah,  [bx]      ;ah gets 8 bits at DS:BX

mov  ax,  [di]      ;ax gets 16 bits at DS:SI

mov  eax, [si]      ;eax gets 32 bits at DS:SI
```

– **Register Indirect Addressing Mode**

- PA = Segment Base : Indirect Address {BX,BP,SI,DI}
- example : MOV AX, [SI]



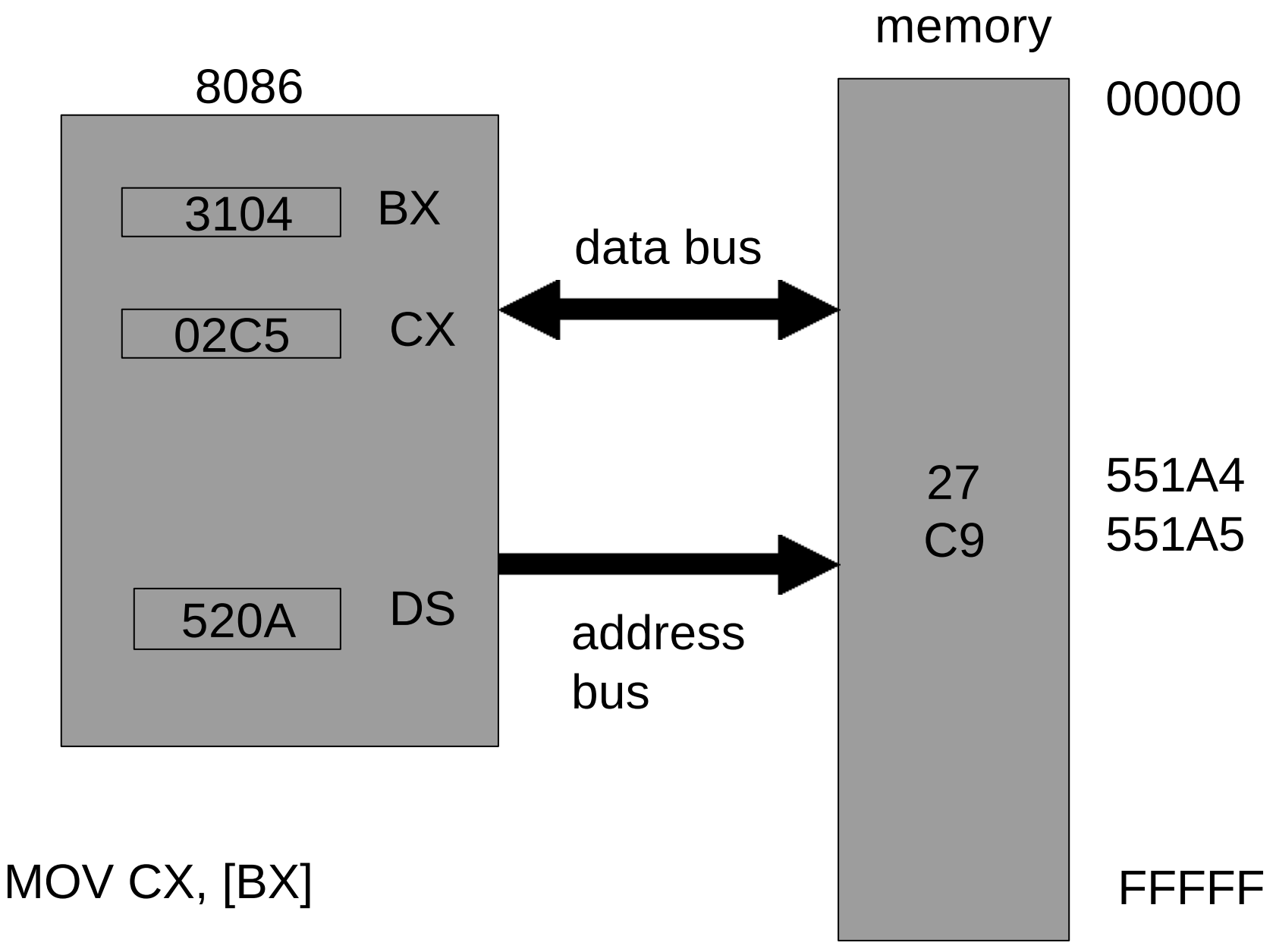
MOV CX, [BX]

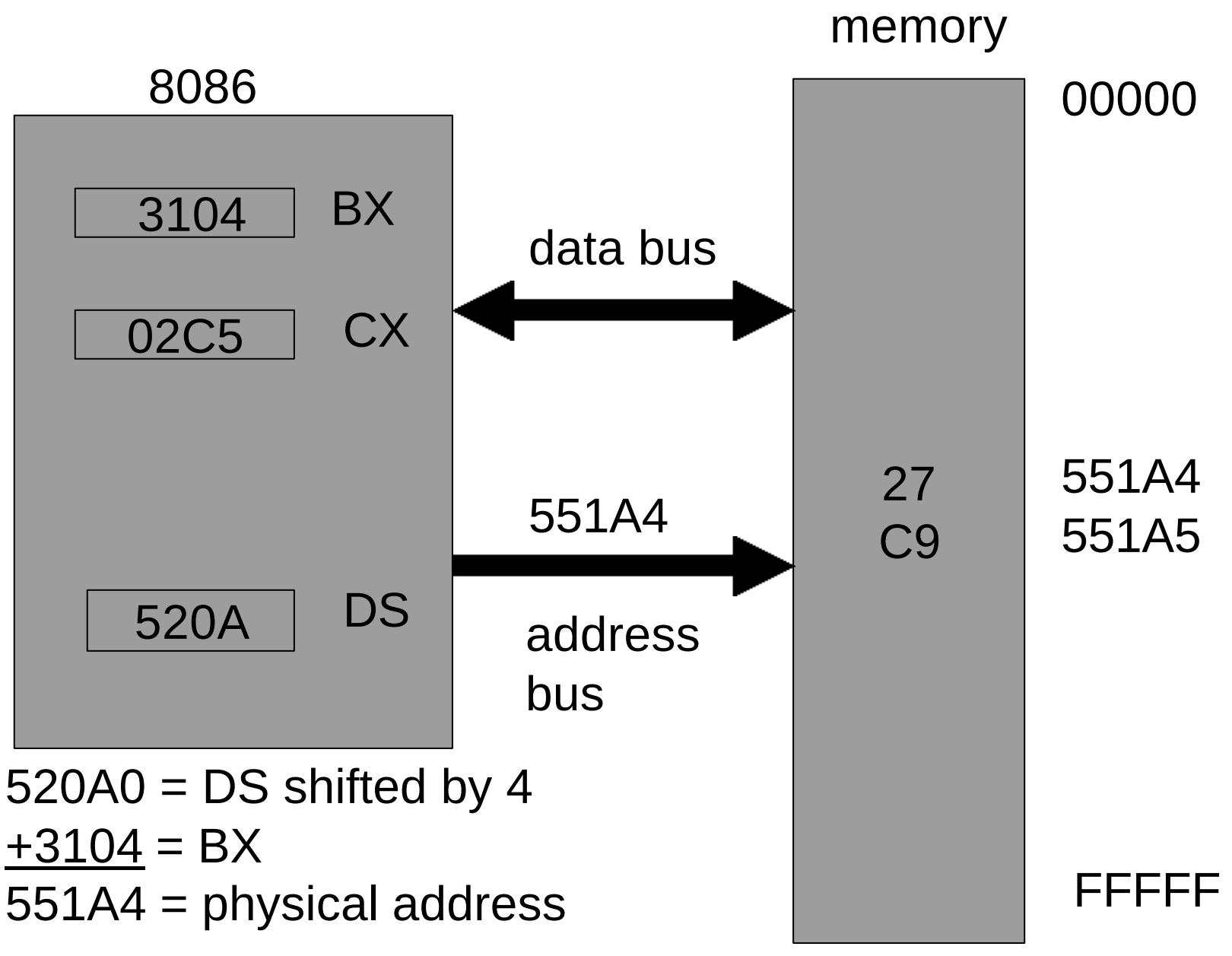
CX = destination — register
[BX] = source — memory location

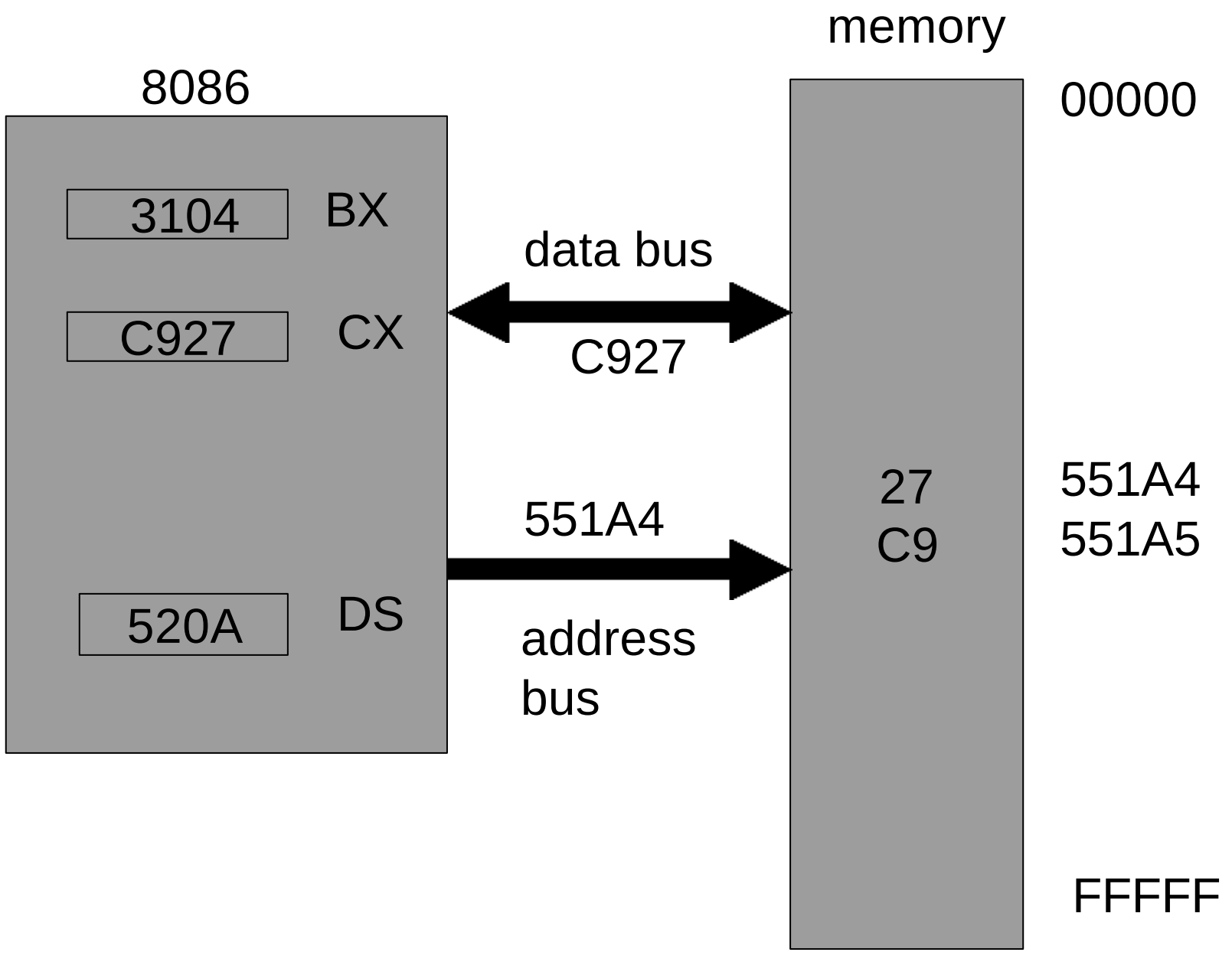
1. Generate physical address for memory location from contents of BX and DS (shifted by 4)
— put on address bus

2. Retrieve contents of word in memory — put on data bus

3. Write data into CX


memory
8086
00000
3104
BX
data bus
02C5
CX
27
C9
551A4
551A5
520A
DS
address
bus
MOV CX, [BX]
FFFFF


memory
8086
00000
3104
BX
data bus
02C5
CX
27
C9
551A4
551A5
551A4
520A
DS
address
bus
520A0 = DS shifted by 4
+3104 = BX
551A4 = physical address
FFFFF


memory
8086
00000
3104
BX
C927
CX
data bus
C927
27
C9
551A4
551A5
551A4
520A
DS
address
bus
FFFFF

Example

Copy the contents of a block of memory (16 bytes) starting at location 20100h to another block of memory starting at 20120h

```
        MOV AX,2000h
        MOV DS,AX
        MOV SI, 100h
        MOV DI, 120h
        MOV CX, 10h
NXTPT:  MOV, AH, [SI]
        MOV [DI], AH
        INC SI
        INC DI
        DEC CX
        JNZ  NXTPT
```

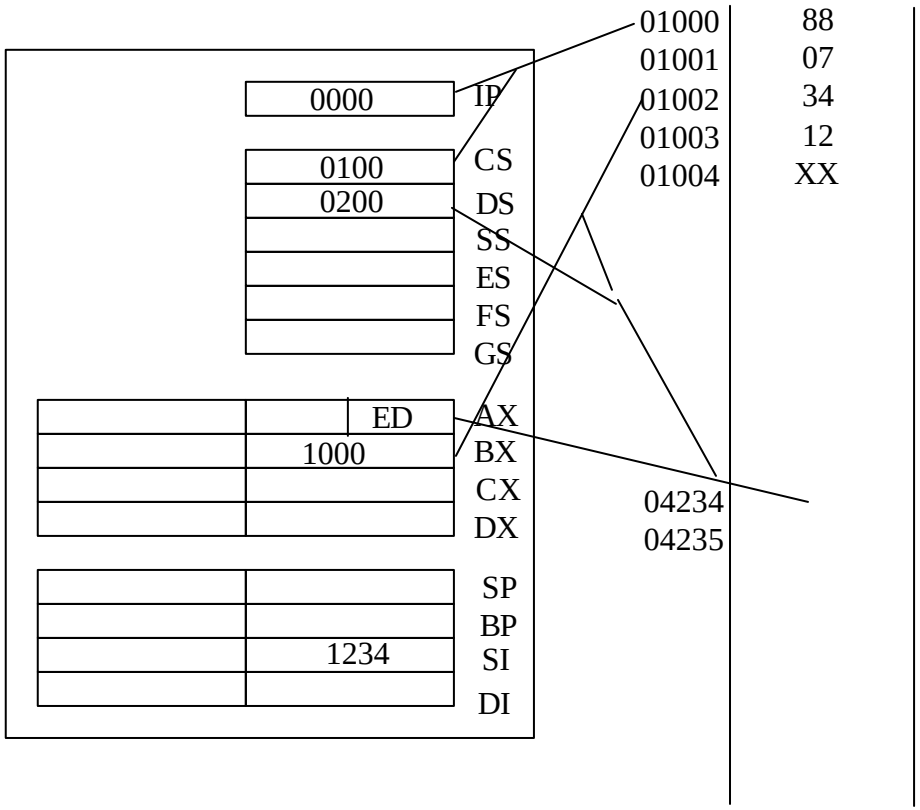
Based relative Addressing Mode

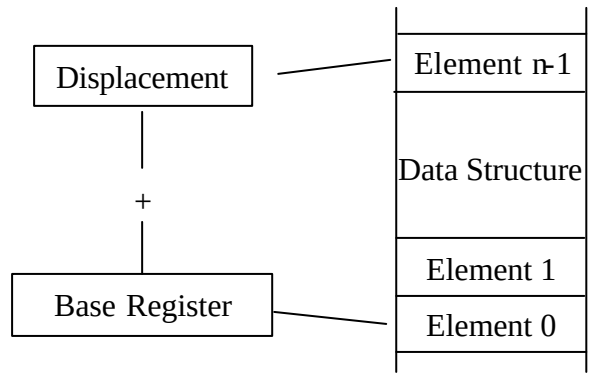
- MOV CX,[BX]+10
  - Physical Address : DS (shifted left) + BX + 10
- MOV AL,[BP]+5
  - Physical Address: SS (shifted left) + BP + 5

- Offsets of data is found by adding some value to the base register

MOV AX, [BX-2]

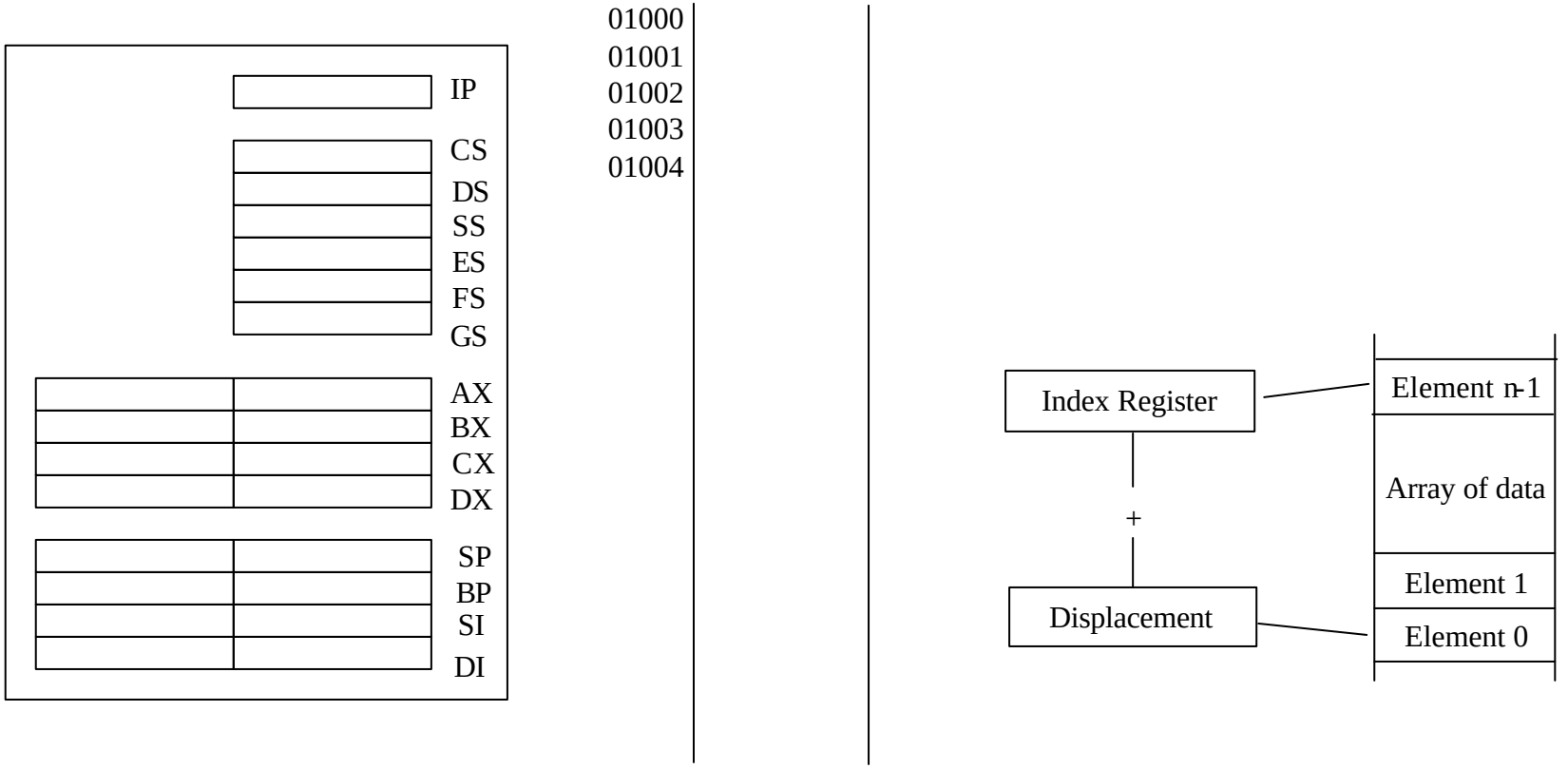
– Based Addressing Mode
  - PA = Segment Base : {BX or BP} + {8-bit or 16-bit displacement}
  - Base register : the beginning of a data structure
  - See Fig 3.16 (b) in page 74
  - Example: MOV [BX]+1234H, AL





– **Indexed Addressing Mode**

- PA = Segment Base : {SI, DI}+{8-bit or 16-bit displacement}
- Displacement : the starting address of an array; Index: selects the specific element in the array
- Example: MOV AL, [SI]+2000H



– **Based-Indexed Addressing Mode**

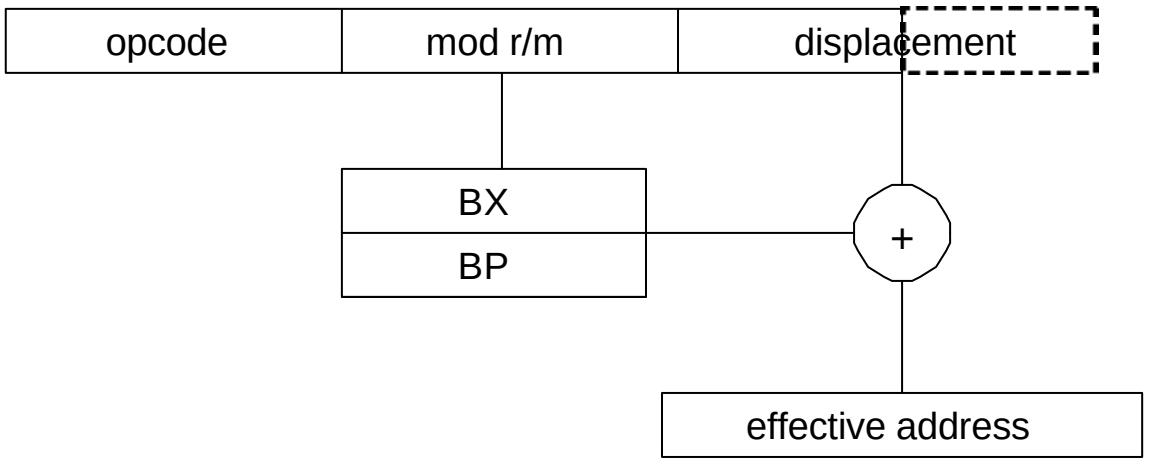
- PA= Seg Base: {BX, BP}+{SI,DI}+{8-bit or 16-bit displacement}
- to access complex data structures
- See fig 3.20 in page 80
- Example: MOV AH, [BX][SI]+1234H

  opcode : 8A 44 34 12

```
MOV BX, 0600h
(Based relative addressing mode)
MOV SI, 0010h  ;4 x 4 = 16
(Indexed relative addressing mode)
MOV AL, [BX + SI + 3]
Based-indexed relative addressing mode)
```

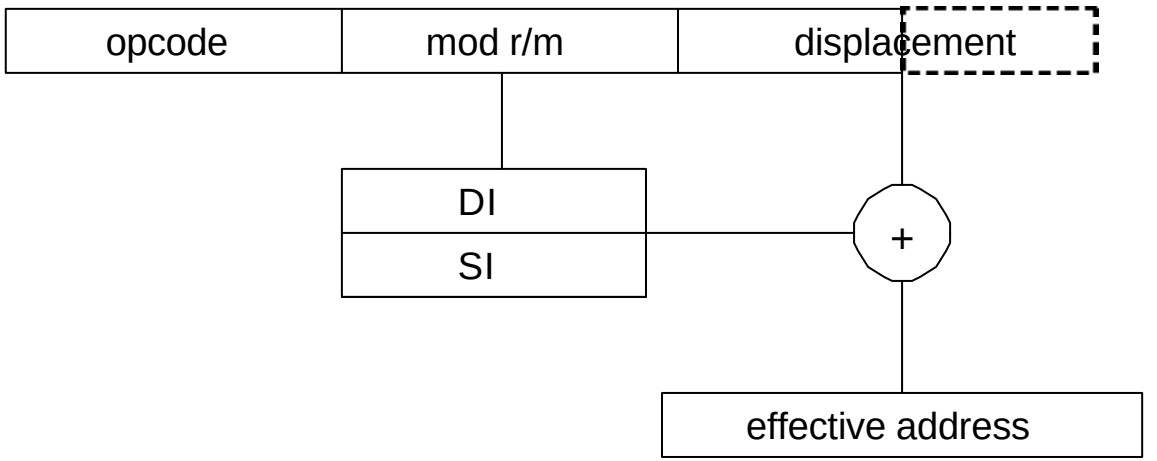
Based Indirect Addressing

```
mov    al,    [bp+2]        ;al gets 8 bits at SS:BP+2

mov    ah,    [bx-4]        ;ah gets 8 bits at DS:BX-4
```



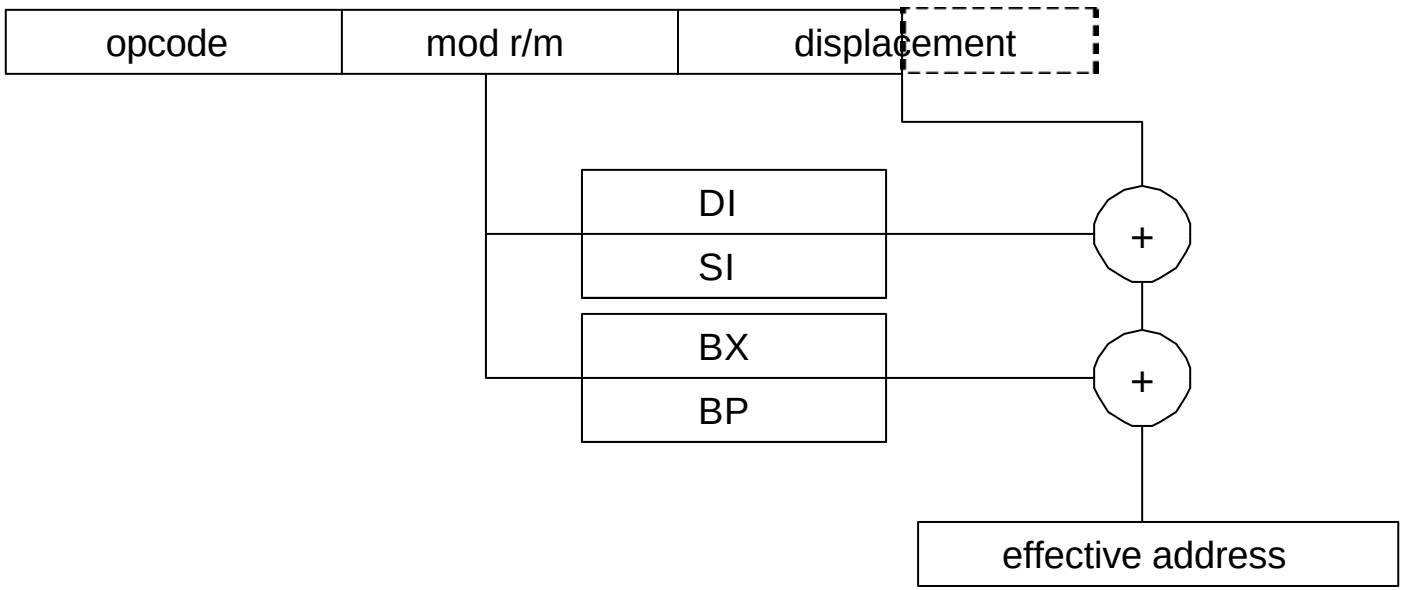
Indexed Indirect Addressing

```
mov    ax,    [si+1000h]    ;ax gets 16 bits at DS:SI+1000h

mov    eax,   [si+300h]     ;eax gets 32 bits at DS:SI+300h

Mov    [di+100h],    al     ;DS:DI+100h gets 8 bits in al
```



Based Indexed Indirect Addressing

```
mov     ax,     [bp+di]       ;ax gets 16 bits at SS:BP+DI

mov     ax,     [di+bp]       ;ax gets 16 bits at DS:BP+DI

mov     eax,    [bx+si+10h]   ;eax gets 32 bits at DS:BX+SI+10h

mov     cx,     [bp+si-7]     ;cx gets 16 bits at SS:BP+SI-7
```



Addressing Mode Examples

```
mov al,   bl          ;8-bit register addressing
mov di,   bp          ;16-bit register addressing
mov eax,  eax         ;32-bit register addressing
```

Register

```
mov al,   12          ;8-bit immediate,  al<-0ch
mov cx,   faceh       ;16-bit immediate, cx<-64,206
mov ebx,  2h          ;32-bit immediate, ebx<-00000002h
```

Immediate

```
mov al,   LIST        ;al<-8 bits stored at label LIST
mov ch,   DATA        ;ch<-8 bits stored at label DATA
mov ds,   DATA2       ;ds<-16 bits stored at label DATA2
```

Direct

```
mov al,   [bp]        ;al<-8 bits stored at SS:BP
mov ah,   [bx]        ;ah<-8 bits stored at DS:BX
mov ax,   [bp]        ;ax<-16 bits stored at SS:BP
mov eax,  [bx]        ;eax<-32 bits stored at DS:BX
mov al,   [bp+2]      ;al<-8 bits stored at SS:(BP+2)
mov ax,   [bx-4]      ;ax<-16 bits stored at DS:(BX-4)
mov al,   LIST[bp]    ;al<-8 bits stored at SS:(BP+LIST)
mov bx,   LIST[bx]    ;bx<-16 bits stored at DS:(BX+LIST)
mov al,   LIST[bp+2]  ;al<-8 bits stored at SS:(BP+2+LIST)
mov ax,   LIST[bx-12h];ax<-16 bits stored at DS:(BX-
                                              12+LIST)
```

Based

More Addressing Mode Examples

Indexed

```
mov al,   [si]          ;al<-8 bits stored at DS:SI
mov ah,   [di]          ;ah<-8 bits stored at DS:DI
mov ax,   [si]          ;ax<-16 bits stored at DS:SI
mov eax,  [di]          ;eax<-32 bits stored at DS:DI
mov ax,   es:[di]       ;ax<-16 bits stored at ES:DI
mov al,   [si+2]        ;al<-8 bits stored at DS:(SI+2)
mov ax,   [di-4]        ;ax<-16 bits stored at DS:(DI-4)
mov al,   LIST[si]      ;al<-8 bits stored at DS:(SI+LIST)
mov bx,   LIST[di]      ;bx<-16 bits stored at DS:(DI+LIST)
mov al,   LIST[si+2]    ;al<-8 bits stored at DS:(SI+2+LIST)
mov ax,   LIST[di-12h]  ;ax<-16 bits stored at DS:(DI-18+LIST)
```

Based Indexed

```
mov al,   [bp+di]       ;al<-8 bits from SS:(BP+DI)
mov ah,   ds:[bp+si]    ;ah<-8 bits from DS:(BP+SI)
mov ax,   [bx+si]       ;ax<-16 bits from DS:(BX+SI)
mov eax,  es:[bx+di]    ;eax<-32 bits from ES:(BX+DI)
mov al,   LIST[bp+di]   ;al<-8 bits from SS:(BP+DI+LIST)
mov ax,   LIST[bx+si]   ;ax<-16 bits from DS:(BX+SI+LIST)
mov al,   LIST[bp+di-10h]     ;al<-8 bits from SS:(BP+DI-16+LIST)
mov ax,   LIST[bx+si+1AFH]    ;ax<-16 bits from DS:(BX+SI+431+LIST)
```

Examples: Based and Index Addressing Modes

INSTRUCTION	MEANING
SUB CX,[DI+4]	Subtract from CX the word located in the data segment at an offset designated by the contents of DI + 4
MOV AH,[4+DI]	Move to AH the byte located in the data segment at an offset designated by the contents of 4 + DI
CMP AX,[BP]+4	Compare the contents of AX with the word on the STACK that is located at SS + the contents of BP + 4
CMP AX,4+[BP]	Compare the contents of AX with the word on the STACK that is located at SS + 4 + the contents of BP
ADD CX,NUMBERS[SI]	Add to CX the word in memory located in the array named NUMBERS that is offset from the beginning of the array by the value in SI

Accessing the STACK

- When BP is used in register indirect mode, it is understood that the segment address is in SS
- Thus BP can be used to access the STACK without changing the STACK or the Stack Pointer (SP)
- Example:

```
MOV     BP,SP           ; Set BP to the value in the stack pointer
MOV     AX,[BP]         ; move the top word on the stack to AX
MOV     BX,[BP+2]       ; move the second word from the top to BX
MOV     CX,[BP+4]       ; move the third word from the top to CX
```

Moves the 1st (top three) values in the stack to AX, BX, and CX respectively without changing SP