Segment 3A

8086 Addressing Modes

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Addressing Modes: Definition and classification

Addressing Modes:

- Addressing mode provide different ways for access an address to given data to a processor.
- When 8086 executes an instruction, it performs the specified function on data. Operated data is stored in the memory location. There are various techniques to specify address of data. These techniques are called Addressing Modes.

Classification of Addressing Modes:

Data-Addressing Modes:

This mode is related to data transfer operation, that is, data is transferred either from the memory to internal registers of 8086 processors or from one register to another register.
Example: MOV AX, DX

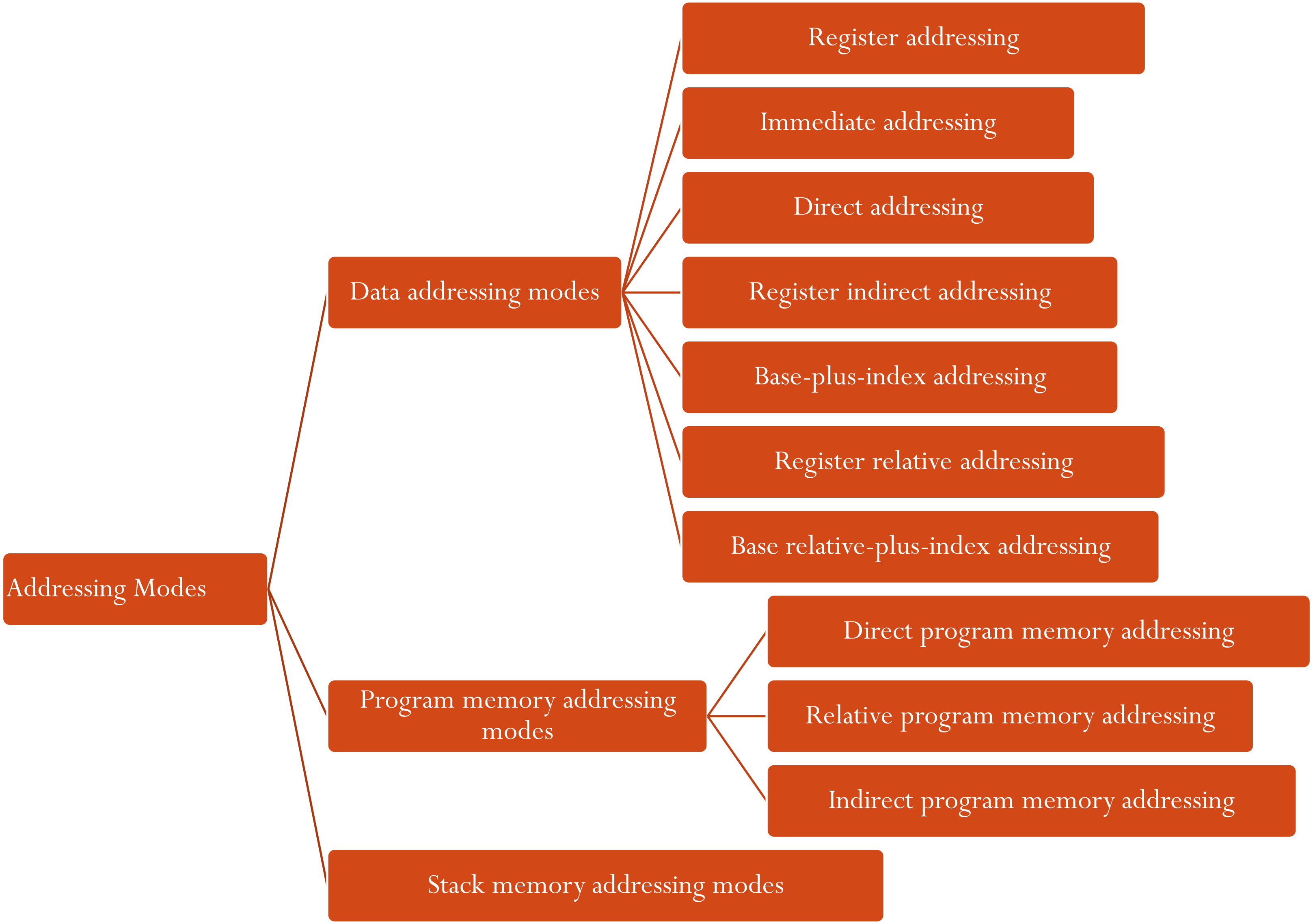
Program Memory addressing Modes:

This mode involves program memory addresses during various operations.
Example: JMP AX, in this instruction, the code execution control jumps to the current code segment location addressed by the contents of AX register.

Stack memory addressing Modes:

This mode involves stack registry operations.
Example: PUSH AX, this instruction copies the contents of AX register to the stack.

Addressing Modes: classification



- Addressing Modes
  - Data addressing modes
    - Register addressing
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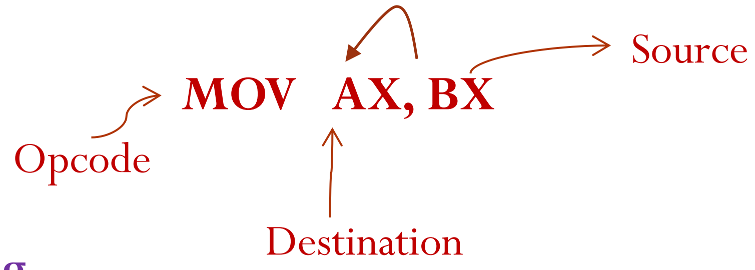
    - Direct addressing
    - Register indirect addressing
    - Base-plus-index addressing
    - Register relative addressing
    - Base relative-plus-index addressing
  - Program memory addressing modes
    - Direct program memory addressing
    - Relative program memory addressing
    - Indirect program memory addressing
  - Stack memory addressing modes

Data addressing modes

Note: We will use MOV instruction to explain all the data addressing modes.



MOV AX, BX

Source

Opcode

Destination

Register addressing

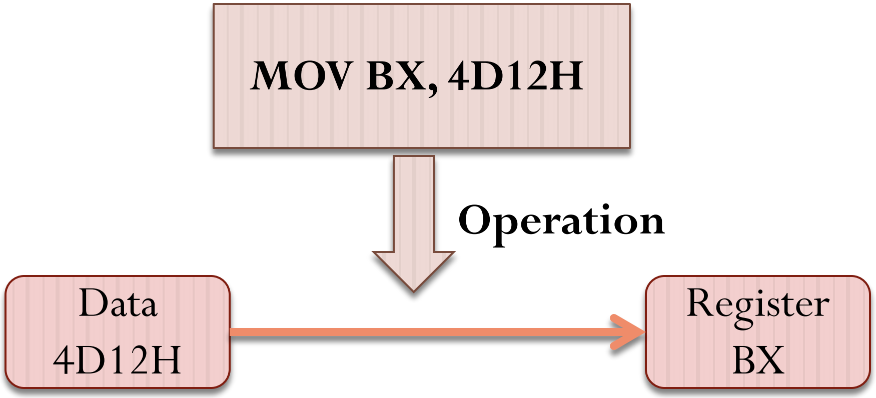
- Register addressing transfers a copy of a byte or word from the source register to destination register. Register addressing is the most common form of data addressing and once the register names are learned, is the easiest to apply.
- 8-bit register names with register addressing: AH, AL, BH, BL, CH, CL, DH, DL.
- 16-bit register names: AX, BX, CX, DX, SP, BP, SI ,DI, IP, CS, SS, DS and ES.
- Never mix an 8-bit register with 16-bit, it is not allowed in microprocessor.
- Code segment register (CS) is never used as destination.
- Segment to segment MOV instruction is not allowed.
- Example:

  ```
  Example:  MOV  AL, BL    ; Copies 8-bit content of BL into AL
             MOV   AX, CX   ; Copies 16-bit content of  CX  into AX
             MOV   EX, DS  ;  Not allowed (segment to segment)
             MOV  BL, DX  ; Not allowed (mixed size)
             MOV  CS, AX   ; Not allowed (Code segment register may not be destination register)
  ```

Data addressing modes (Continued)

Immediate addressing

- Immediate addressing transfers the source, an immediate byte or word data, into the destination register.
- Immediate data means constant data, whereas data transferred from a register or memory location are variable data.
- Example: MOV BL, 44   ; Copies 44 decimal (2CH) into BL
  MOV AX, 44H ; Copies 0044H into AX
  MOV AL, ‘A’   ; Copies ASCII A into AL



Data addressing modes (Continued)

Direct data addressing

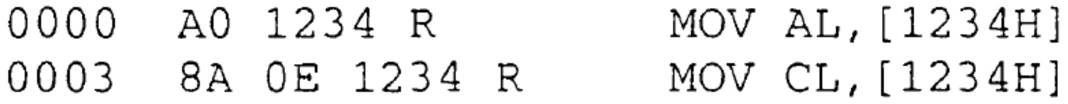
- Direct addressing moves a byte or word between a data segment memory location and register.
- The instruction set does not support a memory to memory transfer except with the MOVS instruction.
- There are two basic form of direct data addressing: (1) Direct addressing (2) Displacement addressing

Direct addressing:

- Direct addressing with a MOV instruction transfers data between a memory location, located within the data segment, and the AL (8-bit) or, AX (16-bit).
- A MOV instruction using this type of addressing is usually a three byte long instruction.
- Example: MOV AL, DS:[1234H]

Displacement addressing:

- Direct addressing with a MOV instruction transfers data between a memory location, located within the data segment, and registers other than AL or AX.
- It is almost identical to direct addressing except that the instruction is four byte wide instead of three.
- Example: MOV CL, DS:[1234H]



```
0000  A0 1234 R        MOV AL,[1234H]
0003  8A 0E 1234 R     MOV CL,[1234H]
```

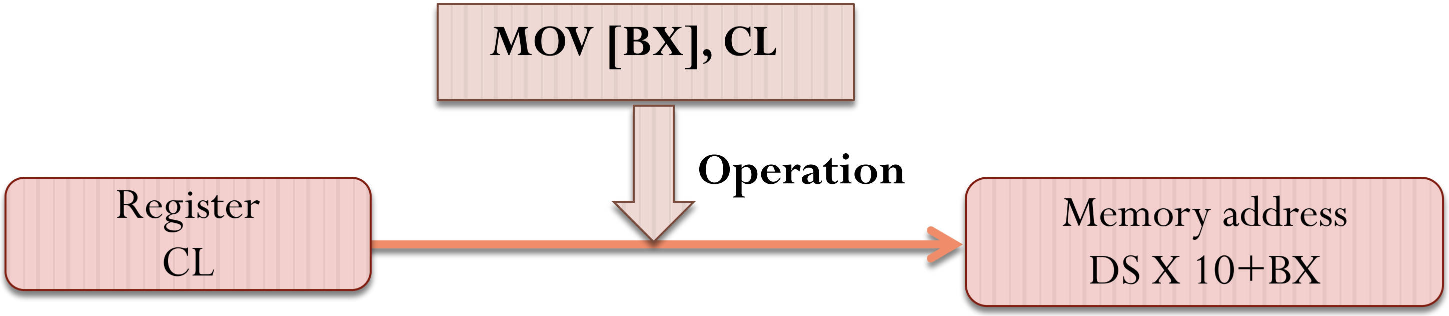
Data addressing modes (Continued)

Register Indirect addressing

- Register addressing transfers a byte or word between a register and memory location addressed by an index or base register.
- The index and base registers are BP, BX, DI and SI. These registers hold the offset address of the memory location.
- The data segment is used by default with register indirect addressing or any other addressing modes that uses BX, DI or, SI to address memory.
- If BP register addresses memory, the stack segment is used by default.
- The [ ] symbol denote indirect addressing in assembly language.
- Example: MOV CX, [BX] ; Copies the word contents of the data segment memory location addressed by BX into CX.

  MOV [BP], DL ; Copies DL into stack segment memory location addressed by DI.

  MOV [DI], [BX] ; Memory to memory transfers are not allowed except with string inst.



MOV [BX], CL

Operation

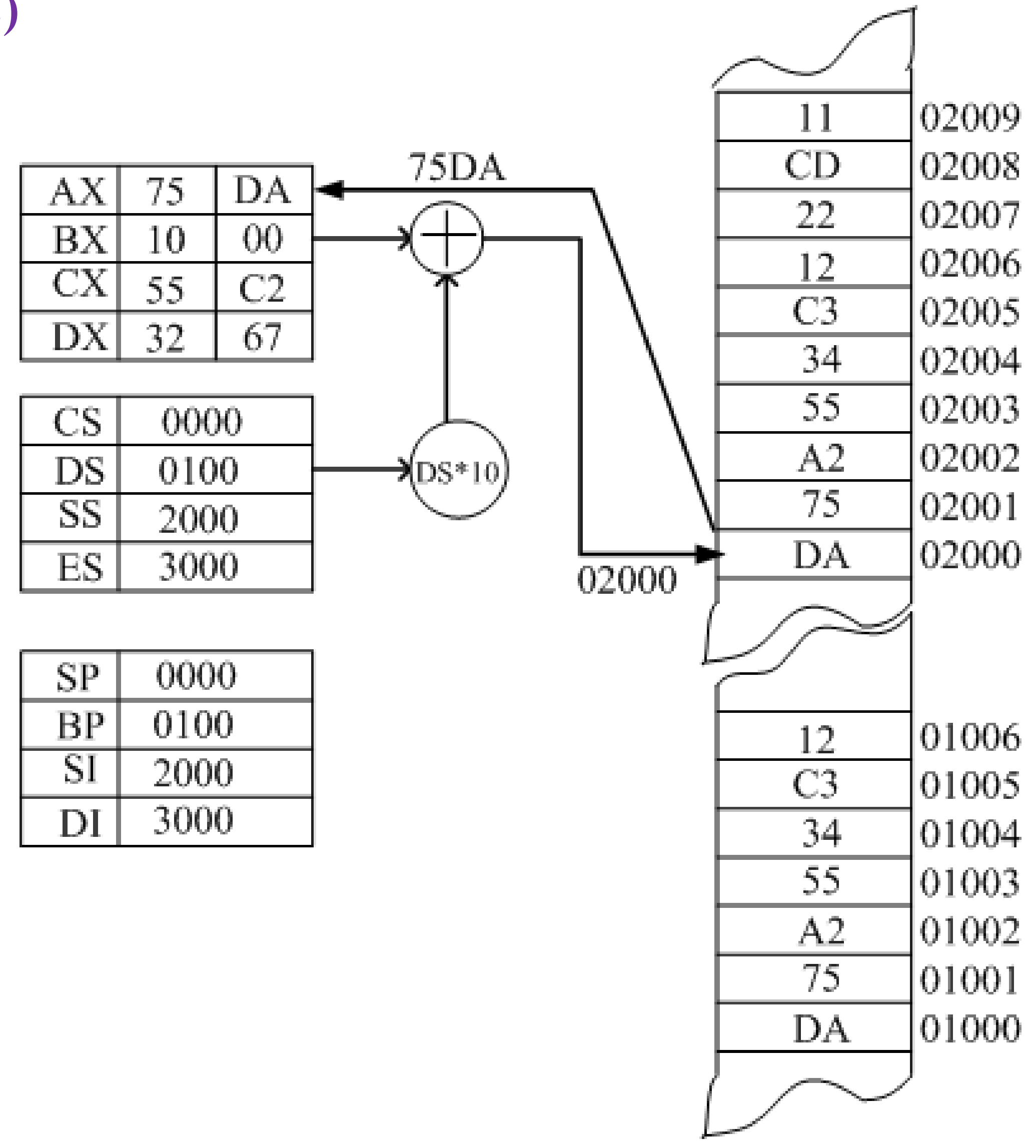
Register
CL

Memory address
DS X 10+BX

Data addressing modes (Continued)

Register Indirect addressing (Cont.)

Operation of MOV AX, [BX] instruction



AX	75	DA
BX	10	00
CX	55	C2
DX	32	67

CS	0000
DS	0100
SS	2000
ES	3000

SP	0000
BP	0100
SI	2000
DI	3000

11	02009
CD	02008
22	02007
12	02006
C3	02005
34	02004
55	02003
A2	02002
75	02001
DA	02000

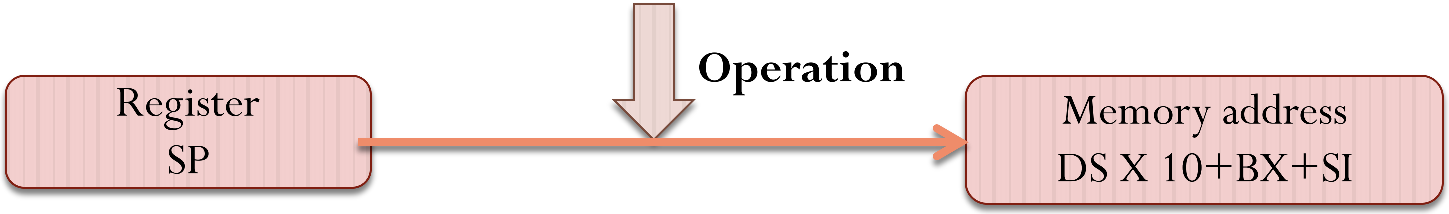
12	01006
C3	01005
34	01004
55	01003
A2	01002
75	01001
DA	01000

Data addressing modes (Continued)

Base-Plus-Index addressing

- Base-plus-index addressing transfer a byte or word between a register and a memory location addressed by a base register (BP or BX) plus an index register (DI or SI).
- The base register often holds the beginning location of a memory array, whereas the index register holds the relative position of an element in the array.
- When BP addresses memory, stack segment is selected by default and when BX addresses memory data segment is selected by default.
- Example: MOV CX, [BX+DI] ; Copies the word content of the data segment memory location addressed by BX plus DI into CX.
  MOV [BP+DI], AH ; Copies AH into stack segment memory location addressed by BP plus DI

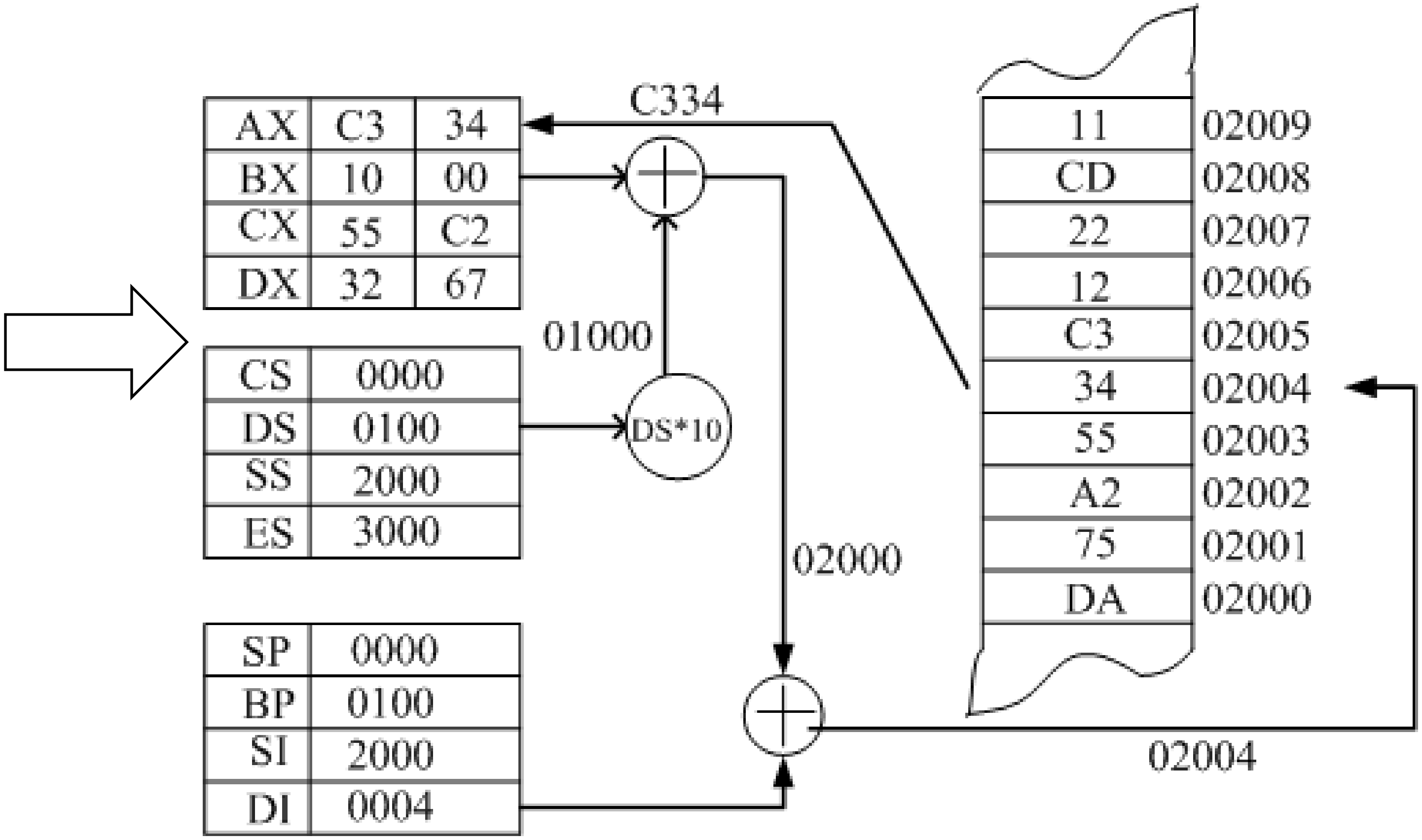
MOV [BX+SI], SP



Data addressing modes (Continued)

Base-Plus-Index addressing (Continued)

Operation of MOV AX, [BX+DI] instruction



AX	C3	34
BX	10	00
CX	55	C2
DX	32	67

CS	0000
DS	0100
SS	2000
ES	3000

SP	0000
BP	0100
SI	2000
DI	0004

11	02009
CD	02008
22	02007
12	02006
C3	02005
34	02004
55	02003
A2	02002
75	02001
DA	02000

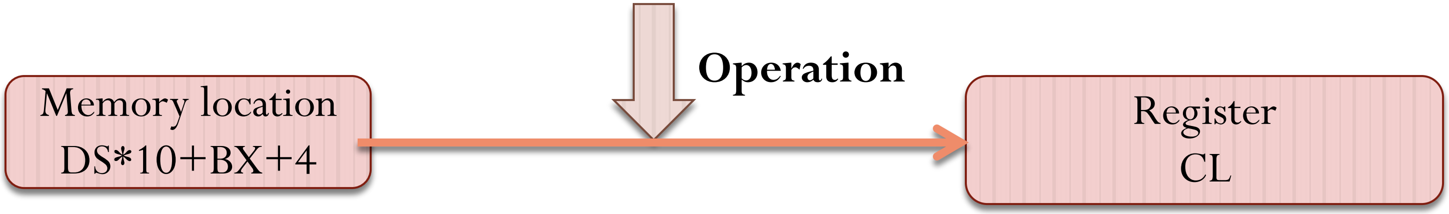
Data addressing modes (Continued)

Register Relative addressing

- Register relative addressing moves a byte or word between a register and the memory location addressed by an index or base register (BP, BX, DI or SI) plus a displacement.
- Remember that BX, DI or SI addresses data segment and BP addresses the stack segment.
- Example: MOV AX, [DI+100H] ; Copies the word content of the data segment memory location addressed by DI plus 100H into AX.

  MOV ARRAY[SI], BL ; Copies BL into the data segment memory location addressed by ARRAY plus SI

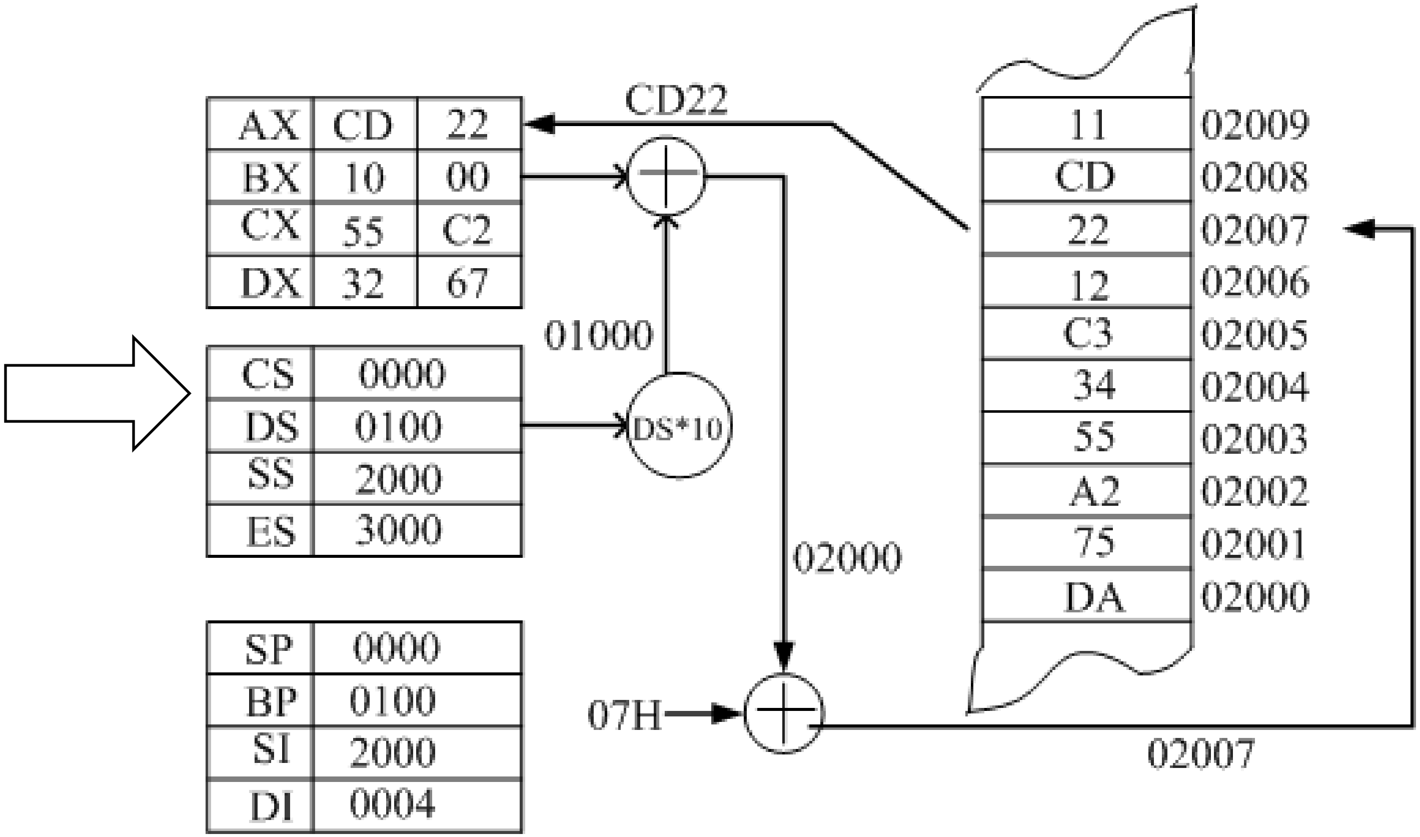
MOV CL, [BX+4]



Data addressing modes (Continued)

Register Relative addressing (Continued)

Operation of
MOV AX, [BX+07H]
instruction



AX	CD	22
BX	10	00
CX	55	C2
DX	32	67

CS	0000
DS	0100
SS	2000
ES	3000

SP	0000
BP	0100
SI	2000
DI	0004

11	02009
CD	02008
22	02007
12	02006
C3	02005
34	02004
55	02003
A2	02002
75	02001
DA	02000

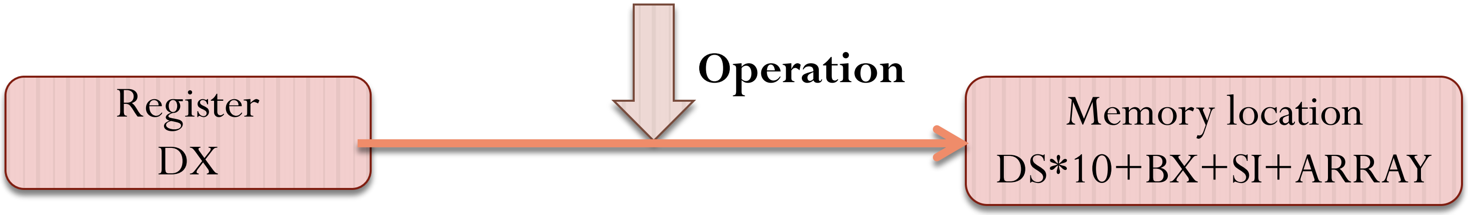
Data addressing modes (Continued)

Base Relative plus Index addressing

- Base relative plus index addressing transfers a byte or word between a register and a memory location addressed by a base and an index register plus displacement.
- It is similar to base plus index addressing, but it adds a displacement beside using a base register and an index register.
- This type of addressing mode often addresses a two-dimensional array of memory data.
- Example: MOV DH, [BX+DI+20H] ; Copies the byte content of data segment memory location addressed by the sum of BX, DI and 20H into DH.

  MOV LIST[BP+DI], CL ; Copies CL into the stack segment memory location addressed by the sum of LIST, BP, SI and 4.

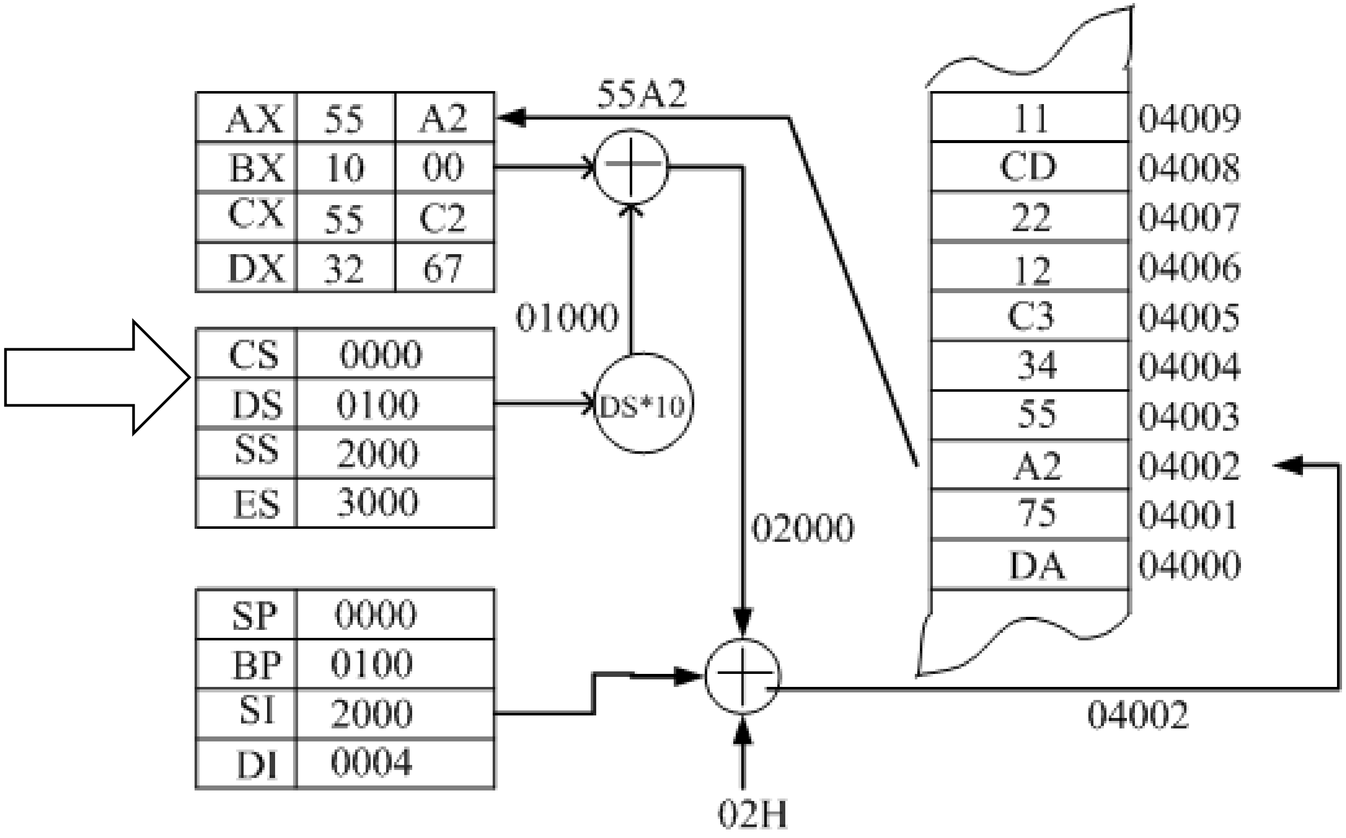
MOV ARRAY[BX+SI], DX



Data addressing modes (Continued)

Base Relative plus Index addressing (Cont.)

Operation of
MOV AX, [BX+SI+02H]
instruction



AX	55	A2
BX	10	00
CX	55	C2
DX	32	67

CS	0000
DS	0100
SS	2000
ES	3000

SP	0000
BP	0100
SI	2000
DI	0004

11	04009
CD	04008
22	04007
12	04006
C3	04005
34	04004
55	04003
A2	04002
75	04001
DA	04000