Complete 8086 instruction set

Quick reference:

Operand types:

REG: AX, BX, CX, DX, AH, AL, BL, BH, CH, CL, DH, DL, DI, SI, BP, SP.

SREG: DS, ES, SS, and only as second operand: CS.

memory: [BX], [BX+SI+7], variable, etc...(see **Memory Access**).

immediate: 5, -24, 3Fh, 10001101b, etc...

Notes:

- When two operands are required for an instruction they are separated by comma. For example:

  ```
  REG, memory
  ```

- When there are two operands, both operands must have the same size (except shift and rotate instructions). For example:

  ```
  AL, DL
  DX, AX
  m1 DB ?
  AL, m1
  m2 DW ?
  AX, m2
  ```

- Some instructions allow several operand combinations. For example:

  ```
  memory, immediate
  ```

```
REG, immediate

memory, REG
REG, SREG
```

- Some examples contain macros, so it is advisable to use **Shift + F8** hot key to *Step Over* (to make macro code execute at maximum speed set **step delay** to zero), otherwise emulator will step through each instruction of a macro. Here is an example that uses PRINTN macro:

```
include 'emu8086.inc'
ORG 100h
MOV AL, 1
MOV BL, 2
PRINTN 'Hello World!'   ; macro.
MOV CL, 3
PRINTN 'Welcome!'       ; macro.
RET
```

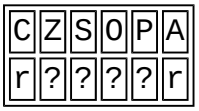
These marks are used to show the state of the flags:

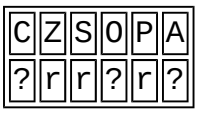
1 - instruction sets this flag to **1**.
0 - instruction sets this flag to **0**.
r - flag value depends on result of the instruction.
? - flag value is undefined (maybe **1** or **0**).

Some instructions generate exactly the same machine code, so disassembler may have a problem decoding to your original code. This is especially important for Conditional Jump instructions (see "Program Flow Control" in Tutorials for more information).

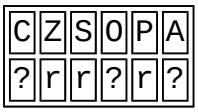
Instructions in alphabetical order:

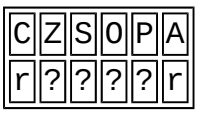
Instruction	Operands	Description
		ASCII Adjust after Addition. Corrects result in AH and AL after addition when working with BCD values. It works according to the following Algorithm: `if low nibble of AL > 9 or AF = 1 then:`

AAA	No operands	• AL = AL + 6
		• AH = AH + 1
		• AF = 1
		• CF = 1
		
		else
		
		• AF = 0
		• CF = 0
		
		in both cases:
		clear the high nibble of AL.
		
		Example:
		
		`MOV AX, 15 ; AH = 00, AL = 0Fh`
		`AAA ; AH = 01, AL = 05`
		`RET`
		
		 
		
		 

AAD	No operands	ASCII Adjust before Division.
		Prepares two BCD values for division.
		
		Algorithm:
		
		• AL = (AH * 10) + AL
		• AH = 0
		
		Example:
		
		`MOV AX, 0105h ; AH = 01, AL = 05`
		`AAD ; AH = 00, AL = 0Fh (15)`
		`RET`
		
		 
		
		 

		ASCII Adjust after Multiplication. Corrects the result of multiplication of two BCD values. Algorithm: • AH = AL / 10 • AL = remainder

AAM	No operands	Example:
		`MOV AL, 15 ; AL = 0Fh`
		`AAM ; AH = 01, AL = 05`
		`RET`
		 

AAS	No operands	ASCII Adjust after Subtraction.
		Corrects result in AH and AL after subtraction when working with BCD values.
		Algorithm:
		`if low nibble of AL > 9 or AF = 1 then:`
		• AL = AL - 6
		• AH = AH - 1
		• AF = 1
		• CF = 1
		`else`
		• AF = 0
		• CF = 0
		`in both cases:`
		`clear the high nibble of AL.`
		Example:
		`MOV AX, 02FFh ; AH = 02, AL = 0FFh`
		`AAS ; AH = 01, AL = 09`
		`RET`
		 

ADC	REG, memory memory, REG REG, REG	Add with Carry. Algorithm: `operand1 = operand1 + operand2 + CF` Example:

	memory, immediate REG, immediate	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

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

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
		Transfers control to procedure, return address is (IP) is pushed to stack. *4-byte address* may be entered in this form: 1234h:5678h, first value is a

CALL	procedure name
	label
	4-byte address
		segment second value is an offset (this is a far call, so CS is also pushed to stack).
		
		Example:
		
		`ORG 100h  ; for COM file.`
		
		`CALL p1`
		
		`ADD AX, 1`
		
		`RET  ; return to OS.`
		
		`p1 PROC  ; procedure declaration.`
		`  MOV AX, 1234h`
		`  RET  ; return to caller.`
		`p1 ENDP`
		
		C Z S O P A
		unchanged
		
		 

CBW	No operands	Convert byte into word.
		
		Algorithm:
		
		if high bit of AL = 1 then:
		
		• AH = 255 (0FFh)
		
		else
		
		• AH = 0
		
		Example:
		
		`MOV AX, 0  ; AH = 0, AL = 0`
		`MOV AL, -5  ; AX = 000FBh (251)`
		`CBW  ; AX = 0FFFBh (-5)`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

		Clear Carry flag. Algorithm: CF = 0

CLC	No operands	C 0
CLD	No operands	Clear Direction flag. SI and DI will be incremented by chain instructions: CMPSB, CMPSW, LODSB, LODSW, MOVSB, MOVSW, STOSB, STOSW. Algorithm: DF = 0 D 0
CLI	No operands	Clear Interrupt enable flag. This disables hardware interrupts. Algorithm: IF = 0 I 0
CMC	No operands	Complement Carry flag. Inverts value of CF. Algorithm: if CF = 1 then CF = 0 if CF = 0 then CF = 1 C r
		Compare. Algorithm: operand1 - operand2

CMP	REG, memory
	memory, REG
	REG, REG
	memory, immediate
	REG, immediate
		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
		
		 

CMPSB	No operands	Compare bytes: ES:[DI] from DS:[SI].
		
		Algorithm:
		
		• DS:[SI] - ES:[DI]
		• set flags according to result: OF, SF, ZF, AF, PF, CF
		• if DF = 0 then
		  ○ SI = SI + 1
		  ○ DI = DI + 1
		else
		  ○ SI = SI - 1
		  ○ DI = DI - 1
		
		Example:
		open **cmpsb.asm** from c:\emu8086\examples
		
		C Z S O P A
		r r r r r r
		
		 

CMPSW	No operands	Compare words: ES:[DI] from DS:[SI].
		
		Algorithm:
		
		• DS:[SI] - ES:[DI]
		• set flags according to result: OF, SF, ZF, AF, PF, CF
		• if DF = 0 then
		  ○ SI = SI + 2
		  ○ DI = DI + 2
		else
		  ○ SI = SI - 2
		  ○ DI = DI - 2

		example: open **cmpsw.asm** from c:\emu8086\examples C Z S 0 P A r r r r r r 

CWD	No operands	Convert Word to Double word.
		
		Algorithm:
		
		`if high bit of AX = 1 then:`
		
		• `DX = 65535 (0FFFFh)`
		
		`else`
		
		• `DX = 0`
		
		Example:
		
		`MOV DX, 0 ; DX = 0`
		`MOV AX, 0 ; AX = 0`
		`MOV AX, -5 ; DX AX = 00000h:0FFFBh`
		`CWD ; DX AX = 0FFFFh:0FFFBh`
		`RET`
		
		C Z S 0 P A
		unchanged
		
		 

DAA	No operands	Decimal adjust After Addition.
		Corrects the result of addition of two packed BCD values.
		
		Algorithm:
		
		`if low nibble of AL > 9 or AF = 1 then:`
		
		• `AL = AL + 6`
		• `AF = 1`
		
		`if AL > 9Fh or CF = 1 then:`
		
		• `AL = AL + 60h`
		• `CF = 1`
		
		Example:

		MOV AL, 0Fh ; AL = 0Fh (15) DAA ; AL = 15h RET C Z S O P A r r r r r r

DAS	No operands	Decimal adjust After Subtraction.
		Corrects the result of subtraction of two packed BCD values.
		
		Algorithm:
		
		if low nibble of AL > 9 or AF = 1 then:
		
		• AL = AL - 6
		• AF = 1
		
		if AL > 9Fh or CF = 1 then:
		
		• AL = AL - 60h
		• CF = 1
		
		Example:
		
		MOV AL, 0FFh ; AL = 0FFh (-1)
		DAS ; AL = 99h, CF = 1
		RET
		
		C Z S O P A
		r r r r r r

DEC	REG memory	Decrement. Algorithm: operand = operand - 1 Example: MOV AL, 255 ; AL = 0FFh (255 or -1) DEC AL ; AL = 0FEh (254 or -2) RET Z S O P A r r r r r CF - unchanged!

<table>
<tr>
<td>DIV</td>
<td>REG
memory</td>
<td>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:

<pre>MOV AX, 203   ; AX = 00CBh
MOV BL, 4
DIV BL   ; AL = 50 (32h), AH = 3
RET</pre>
<table><tr><td>C</td><td>Z</td><td>S</td><td>O</td><td>P</td><td>A</td></tr><tr><td>?</td><td>?</td><td>?</td><td>?</td><td>?</td><td>?</td></tr></table>
  </td>
</tr>
<tr>
<td>HLT</td>
<td>No operands</td>
<td>Halt the System.

Example:

<pre>MOV AX, 5
HLT</pre>
<table><tr><td>C</td><td>Z</td><td>S</td><td>O</td><td>P</td><td>A</td></tr><tr><td colspan="6">unchanged</td></tr></table>
  </td>
</tr>
<tr>
<td>IDIV</td>
<td>REG
memory</td>
<td>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:

<pre>MOV AX, -203 ; AX = 0FF35h
MOV BL, 4
IDIV BL   ; AL = -50 (0CEh), AH = -3 (0FDh)
RET</pre></td>
</tr>
</table>

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

IMUL	REG
	memory
		Signed multiply.
		
		Algorithm:
		
		when operand is a **byte**:
		AX = AL * operand.
		
		when operand is a **word**:
		(DX AX) = AX * operand.
		
		Example:
		
		`MOV AL, -2`
		`MOV BL, -4`
		`IMUL BL ; AX = 8`
		`RET`
		
		C Z S O P A
		r ? ? r ? ?
		CF=OF=0 when result fits into operand of IMUL.

IN	AL, im.byte
	AL, DX
	AX, im.byte
	AX, DX
		Input from port into **AL** or **AX**.
		Second operand is a port number. If required to access port number over 255 - **DX** register should be used.
		Example:
		
		`IN AX, 4 ; get status of traffic lights.`
		`IN AL, 7 ; get status of stepper-motor.`
		
		C Z S O P A
		unchanged

INC	REG
	memory
		Increment.
		
		Algorithm:
		
		operand = operand + 1
		
		Example:
		
		`MOV AL, 4`
		`INC AL ; AL = 5`

		RET Z S O P A r r r r r CF - unchanged! 

INT	immediate byte	Interrupt numbered by immediate byte (0..255).
		
		Algorithm:
		
		Push to stack:
		○ flags register
		○ CS
		○ IP
		• IF = 0
		• Transfer control to interrupt procedure
		
		Example:
		
		MOV AH, 0Eh ; teletype.
		MOV AL, 'A'
		INT 10h ; BIOS interrupt.
		RET
		
		C Z S O P A I
		unchanged 0
		 

INTO	No operands	Interrupt 4 if Overflow flag is 1.
		
		Algorithm:
		
		if OF = 1 then INT 4
		
		Example:
		
		; -5 - 127 = -132 (not in -128..127)
		; the result of SUB is wrong (124),
		; so OF = 1 is set:
		MOV AL, -5
		SUB AL, 127 ; AL = 7Ch (124)
		INTO ; process error.
		RET
		 

		Interrupt Return.

IRET	No operands	Algorithm: Pop from stack: ○ IP ○ CS ○ flags register C Z S O P A popped 

JA	label	Short Jump if first operand is Above second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		if (CF = 0) and (ZF = 0) then jump
		
		Example:
		
		include 'emu8086.inc'
		ORG 100h
		MOV AL, 250
		CMP AL, 5
		JA label1
		PRINT 'AL is not above 5'
		JMP exit
		label1:
		PRINT 'AL is above 5'
		exit:
		RET
		
		C Z S O P A
		unchanged
		
		 

JAE	label	Short Jump if first operand is Above or Equal to second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		if CF = 0 then jump
		
		Example:
		
		include 'emu8086.inc'
		ORG 100h
		MOV AL, 5
		CMP AL, 5
		JAE label1
		PRINT 'AL is not above or equal to 5'
		JMP exit
		label1:

```
   PRINT 'AL is above or equal to 5'
exit:
   RET
```

C	Z	S	O	P	A
unchanged					

JB	label	Short Jump if first operand is Below second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		`if CF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, 1`
		`CMP AL, 5`
		`JB label1`
		`PRINT 'AL is not below 5'`
		`JMP exit`
		`label1:`
		`PRINT 'AL is below 5'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JBE	label	Short Jump if first operand is Below or Equal to second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		`if CF = 1 or ZF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, 5`
		`CMP AL, 5`
		`JBE label1`
		`PRINT 'AL is not below or equal to 5'`
		`JMP exit`
		`label1:`
		`PRINT 'AL is below or equal to 5'`
		`exit:`
		`RET`
		
		□□□□□□

		C Z S O P A unchanged

JC	label	Short Jump if Carry flag is set to 1.
		
		Algorithm:
		
		`if CF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, 255`
		`ADD AL, 1`
		`JC label1`
		`PRINT 'no carry.'`
		`JMP exit`
		`label1:`
		`PRINT 'has carry.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged

JCXZ	label	Short Jump if CX register is 0.
		
		Algorithm:
		
		`if CX = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV CX, 0`
		`JCXZ label1`
		`PRINT 'CX is not zero.'`
		`JMP exit`
		`label1:`
		`PRINT 'CX is zero.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged

		Short Jump if first operand is Equal to second operand (as set by CMP instruction).

JE	label	Signed/Unsigned.
		
		Algorithm:
		
		`if ZF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, 5`
		`CMP AL, 5`
		`JE label1`
		`PRINT 'AL is not equal to 5.'`
		`JMP exit`
		`label1:`
		`PRINT 'AL is equal to 5.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JG	label	Short Jump if first operand is Greater then second operand (as set by CMP instruction). Signed.
		
		Algorithm:
		
		`if (ZF = 0) and (SF = OF) then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, 5`
		`CMP AL, -5`
		`JG label1`
		`PRINT 'AL is not greater -5.'`
		`JMP exit`
		`label1:`
		`PRINT 'AL is greater -5.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

		Short Jump if first operand is Greater or Equal to second operand (as set by CMP instruction). Signed. Algorithm:

JGE	label	if SF = OF then jump
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, -5`
		`JGE label1`
		`PRINT 'AL < -5'`
		`JMP exit`
		`label1:`
		`PRINT 'AL >= -5'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JL	label	Short Jump if first operand is Less then second operand (as set by CMP instruction). Signed.
		
		Algorithm:
		
		if SF <> OF then jump
		
		Example:
		
		`include 'emu8086.inc'`
		`ORG 100h`
		`MOV AL, -2`
		`CMP AL, 5`
		`JL label1`
		`PRINT 'AL >= 5.'`
		`JMP exit`
		`label1:`
		`PRINT 'AL < 5.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

		Short Jump if first operand is Less or Equal to second operand (as set by CMP instruction). Signed. Algorithm: if SF <> OF or ZF = 1 then jump Example:

JLE	label	include 'emu8086.inc'
		ORG 100h
		MOV AL, -2
		CMP AL, 5
		JLE label1
		PRINT 'AL > 5.'
		JMP exit
		label1:
		PRINT 'AL <= 5.'
		exit:
		RET
		
		C Z S O P A
		unchanged
		 

JMP	label
	4-byte address
		Unconditional Jump. Transfers control to another part of the program. *4-byte address* may be entered in this form: 1234h:5678h, first value is a segment second value is an offset.
		
		Algorithm:
		
		always jump
		
		Example:
		
		include 'emu8086.inc'
		ORG 100h
		MOV AL, 5
		JMP label1 ; jump over 2 lines!
		PRINT 'Not Jumped!'
		MOV AL, 0
		label1:
		PRINT 'Got Here!'
		RET
		
		C Z S O P A
		unchanged
		 

JNA	label	Short Jump if first operand is Not Above second operand (as set by CMP instruction). Unsigned. Algorithm: if CF = 1 or ZF = 1 then jump Example: include 'emu8086.inc' ORG 100h MOV AL, 2

```
   CMP AL, 5
   JNA label1
   PRINT 'AL is above 5.'
   JMP exit
label1:
   PRINT 'AL is not above 5.'
exit:
   RET
```

C	Z	S	O	P	A
unchanged					

JNAE	label	Short Jump if first operand is Not Above and Not Equal to second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		`if CF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, 5`
		`JNAE label1`
		`PRINT 'AL >= 5.'`
		`JMP exit`
		`label1:`
		`PRINT 'AL < 5.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JNB	label	Short Jump if first operand is Not Below second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		`if CF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 7`
		`CMP AL, 5`
		`JNB label1`
		`PRINT 'AL < 5.'`

```
   JMP exit
label1:
   PRINT 'AL >= 5.'
exit:
   RET
```

C	Z	S	O	P	A
unchanged					

JNBE	label	Short Jump if first operand is Not Below and Not Equal to second operand (as set by CMP instruction). Unsigned.
		
		Algorithm:
		
		`if (CF = 0) and (ZF = 0) then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 7`
		`CMP AL, 5`
		`JNBE label1`
		`PRINT 'AL <= 5.'`
		`JMP exit`
		`label1:`
		`PRINT 'AL > 5.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JNC	label	Short Jump if Carry flag is set to 0.
		
		Algorithm:
		
		`if CF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`ADD AL, 3`
		`JNC  label1`
		`PRINT 'has carry.'`
		`JMP exit`
		`label1:`
		`PRINT 'no carry.'`
		`exit:`

```
   RET
```

C	Z	S	O	P	A
unchanged					

JNE	label	Short Jump if first operand is Not Equal to second operand (as set by CMP instruction).
		Signed/Unsigned.
		
		Algorithm:
		
		`if ZF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, 3`
		`JNE label1`
		`PRINT 'AL = 3.'`
		`JMP exit`
		`label1:`
		`PRINT 'Al <> 3.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JNG	label	Short Jump if first operand is Not Greater then second operand (as set by CMP instruction).
		Signed.
		
		Algorithm:
		
		`if (ZF = 1) and (SF <> OF) then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, 3`
		`JNG label1`
		`PRINT 'AL > 3.'`
		`JMP exit`
		`label1:`
		`PRINT 'Al <= 3.'`
		`exit:`
		`RET`

		C Z S O P A unchanged 

JNGE	label	Short Jump if first operand is Not Greater and Not Equal to second operand (as set by CMP instruction). Signed.
		
		Algorithm:
		
		`if SF <> OF then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, 3`
		`JNGE label1`
		`PRINT 'AL >= 3.'`
		`JMP exit`
		`label1:`
		`PRINT 'Al < 3.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		 

JNL	label	Short Jump if first operand is Not Less then second operand (as set by CMP instruction). Signed.
		
		Algorithm:
		
		`if SF = OF then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, -3`
		`JNL label1`
		`PRINT 'AL < -3.'`
		`JMP exit`
		`label1:`
		`PRINT 'Al >= -3.'`
		`exit:`
		`RET`
		
		C Z S O P A

		unchanged 

JNLE	label	Short Jump if first operand is Not Less and Not Equal to second operand (as set by CMP instruction). Signed.
		
		Algorithm:
		
		`if (SF = OF) and (ZF = 0) then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 2`
		`CMP AL, -3`
		`JNLE label1`
		`PRINT 'AL <= -3.'`
		`JMP exit`
		`label1:`
		`PRINT 'Al > -3.'`
		`exit:`
		`RET`
		
		C Z S 0 P A
		unchanged 

JNO	label	Short Jump if Not Overflow.
		
		Algorithm:
		
		`if OF = 0 then jump`
		
		Example:
		
		`; -5 - 2 = -7 (inside -128..127)`
		`; the result of SUB is correct,`
		`; so OF = 0:`
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, -5`
		`SUB AL, 2 ; AL = 0F9h (-7)`
		`JNO label1`
		`PRINT 'overflow!'`
		`JMP exit`
		`label1:`
		`PRINT 'no overflow.'`
		`exit:`
		`RET`
		
		C Z S 0 P A

		unchanged 

JNP	label	Short Jump if No Parity (odd). Only 8 low bits of result are checked. Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if PF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 00000111b ; AL = 7`
		`OR AL, 0 ; just set flags.`
		`JNP label1`
		`PRINT 'parity even.'`
		`JMP exit`
		`label1:`
		`PRINT 'parity odd.'`
		`exit:`
		`RET`
		
		C Z S 0 P A
		unchanged
		 

JNS	label	Short Jump if Not Signed (if positive). Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if SF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 00000111b ; AL = 7`
		`OR AL, 0 ; just set flags.`
		`JNS label1`
		`PRINT 'signed.'`
		`JMP exit`
		`label1:`
		`PRINT 'not signed.'`
		`exit:`
		`RET`
		
		C Z S 0 P A
		unchanged

JNZ	label	Short Jump if Not Zero (not equal). Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if ZF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 00000111b ; AL = 7`
		`OR AL, 0 ; just set flags.`
		`JNZ label1`
		`PRINT 'zero.'`
		`JMP exit`
		`label1:`
		`PRINT 'not zero.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged

JO	label	Short Jump if Overflow.
		
		Algorithm:
		
		`if OF = 1 then jump`
		
		Example:
		
		`; -5 - 127 = -132 (not in -128..127)`
		`; the result of SUB is wrong (124),`
		`; so OF = 1 is set:`
		
		`include 'emu8086.inc'`
		
		`org 100h`
		`MOV AL, -5`
		`SUB AL, 127 ; AL = 7Ch (124)`
		`JO label1`
		`PRINT 'no overflow.'`
		`JMP exit`
		`label1:`
		`PRINT 'overflow!'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged

JP	label	Short Jump if Parity (even). Only 8 low bits of result are checked. Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if PF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 00000101b ; AL = 5`
		`OR AL, 0 ; just set flags.`
		`JP label1`
		`PRINT 'parity odd.'`
		`JMP exit`
		`label1:`
		`PRINT 'parity even.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

JPE	label	Short Jump if Parity Even. Only 8 low bits of result are checked. Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if PF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 00000101b ; AL = 5`
		`OR AL, 0 ; just set flags.`
		`JPE label1`
		`PRINT 'parity odd.'`
		`JMP exit`
		`label1:`
		`PRINT 'parity even.'`
		`exit:`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

		Short Jump if Parity Odd. Only 8 low bits of result

JPO	label	are checked. Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if PF = 0 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 00000111b ; AL = 7`
		`OR AL, 0 ; just set flags.`
		`JPO label1`
		`PRINT 'parity even.'`
		`JMP exit`
		`label1:`
		`PRINT 'parity odd.'`
		`exit:`
		`RET`
		
		C Z S 0 P A
		unchanged
		
		 

JS	label	Short Jump if Signed (if negative). Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.
		
		Algorithm:
		
		`if SF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 10000000b ; AL = -128`
		`OR AL, 0 ; just set flags.`
		`JS label1`
		`PRINT 'not signed.'`
		`JMP exit`
		`label1:`
		`PRINT 'signed.'`
		`exit:`
		`RET`
		
		C Z S 0 P A
		unchanged
		
		 

		Short Jump if Zero (equal). Set by CMP, SUB, ADD, TEST, AND, OR, XOR instructions.

JZ	label	Algorithm:
		
		`if ZF = 1 then jump`
		
		Example:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AL, 5`
		`CMP AL, 5`
		`JZ label1`
		`PRINT 'AL is not equal to 5.'`
		`JMP exit`
		`label1:`
		`PRINT 'AL is equal to 5.'`
		`exit:`
		`RET`
		
		C Z S 0 P A
		unchanged
		
		 

LAHF	No operands	Load AH from 8 low bits of Flags register.
		
		Algorithm:
		
		`AH = flags register`
		
		`AH bit: 7 6 5 4 3 2 1 0`
		`[SF] [ZF] [0] [AF] [0] [PF] [1] [CF]`
		
		`bits 1, 3, 5 are reserved.`
		
		C Z S 0 P A
		unchanged
		
		 

		Load memory double word into word register and DS. Algorithm: • `REG = first word` • `DS = second word` Example: `ORG 100h`

LDS	REG, memory	LDS AX, m RET m DW 1234h DW 5678h END AX is set to 1234h, DS is set to 5678h. C Z S O P A unchanged 

LEA	REG, memory	Load Effective Address.
		
		Algorithm:
		
		• REG = address of memory (offset)
		
		Example:
		
		MOV BX, 35h
		MOV DI, 12h
		LEA SI, [BX+DI] ; SI = 35h + 12h = 47h
		
		Note: The integrated 8086 assembler automatically replaces **LEA** with a more efficient **MOV** where possible. For example:
		
		org 100h
		LEA AX, m ; AX = offset of m
		RET
		m dw 1234h
		END
		
		C Z S O P A
		unchanged
		
		 

		Load memory double word into word register and ES. Algorithm:

<table>
<tr>
<td>LES</td>
<td>REG, memory</td>
<td>

REG = first word
ES = second word

Example:
<pre>
ORG 100h

LES AX, m

RET

m DW 1234h
   DW 5678h

END
</pre>
AX is set to 1234h, ES is set to 5678h.
<table>
<tr><td>C</td><td>Z</td><td>S</td><td>O</td><td>P</td><td>A</td></tr>
<tr><td colspan="6">unchanged</td></tr>
</table>

</td>
</tr>
<tr>
<td>LODSB</td>
<td>No operands</td>
<td>
Load byte at DS:[SI] into AL. Update SI.
Algorithm:

AL = DS:[SI]
if DF = 0 then

SI = SI + 1

else

SI = SI - 1

Example:
<pre>
ORG 100h

LEA SI, a1
MOV CX, 5
MOV AH, 0Eh

m: LODSB
INT 10h
LOOP m

RET

a1 DB 'H', 'e', 'l', 'l', 'o'
</pre>
<table>
<tr><td>C</td><td>Z</td><td>S</td><td>O</td><td>P</td><td>A</td></tr>
<tr><td colspan="6">unchanged</td></tr>
</table>
</td>
</tr>
</table>

LODSW	No operands	Load word at DS:[SI] into AX. Update SI.
		
		Algorithm:
		
		• AX = DS:[SI]
		• if DF = 0 then
		  ○ SI = SI + 2
		else
		  ○ SI = SI - 2
		
		Example:
		
		`ORG 100h`
		
		`LEA SI, a1`
		`MOV CX, 5`
		
		`REP LODSW  ; finally there will be 555h in AX.`
		
		`RET`
		
		`a1 dw 111h, 222h, 333h, 444h, 555h`
		
		C Z S O P A
		unchanged
		
		 

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:
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV CX, 5`
		`label1:`
		`PRINTN 'loop!'`
		`LOOP label1`
		`RET`
		
		C Z S O P A
		unchanged

LOOPE	label	Decrease CX, jump to label if CX not zero and Equal (ZF = 1).
		
		Algorithm:
		
		• CX = CX - 1
		• if (CX <> 0) and (ZF = 1) then
		  ○ jump
		  else
		  ○ no jump, continue
		
		Example:
		
		`; Loop until result fits into AL alone,`
		`; or 5 times. The result will be over 255`
		`; on third loop (100+100+100),`
		`; so loop will exit.`
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AX, 0`
		`MOV CX, 5`
		`label1:`
		`PUTC '*'`
		`ADD AX, 100`
		`CMP AH, 0`
		`LOOPE label1`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

LOOPNE	label	Decrease CX, jump to label if CX not zero and Not Equal (ZF = 0).
		
		Algorithm:
		
		• CX = CX - 1
		• if (CX <> 0) and (ZF = 0) then
		  ○ jump
		  else
		  ○ no jump, continue
		
		Example:
		
		`; Loop until '7' is found,`
		`; or 5 times.`
		
		`include 'emu8086.inc'`
		
		`ORG 100h`

```
   MOV SI, 0
   MOV CX, 5
label1:
   PUTC '*'
   MOV AL, v1[SI]
   INC SI          ; next byte (SI=SI+1).
   CMP AL, 7
   LOOPNE label1
   RET
   v1 db 9, 8, 7, 6, 5
```

C	Z	S	O	P	A
unchanged					

LOOPNZ	label	Decrease CX, jump to label if CX not zero and ZF = 0.
		
		Algorithm:
		
		• CX = CX - 1
		• if (CX <> 0) and (ZF = 0) then
		  ○ jump
		else
		  ○ no jump, continue
		
		Example:
		
		`; Loop until '7' is found,`
		`; or 5 times.`
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV SI, 0`
		`MOV CX, 5`
		`label1:`
		`PUTC '*'`
		`MOV AL, v1[SI]`
		`INC SI ; next byte (SI=SI+1).`
		`CMP AL, 7`
		`LOOPNZ label1`
		`RET`
		`v1 db 9, 8, 7, 6, 5`
		
		C Z S O P A
		unchanged
		
		 

		Decrease CX, jump to label if CX not zero and ZF = 1. Algorithm: • CX = CX - 1

LOOPZ	label	• if (CX <> 0) and (ZF = 1) then
		  ○ jump
		  else
		  ○ no jump, continue
		
		Example:
		
		`; Loop until result fits into AL alone,`
		`; or 5 times. The result will be over 255`
		`; on third loop (100+100+100),`
		`; so loop will exit.`
		
		`include 'emu8086.inc'`
		
		`ORG 100h`
		`MOV AX, 0`
		`MOV CX, 5`
		`label1:`
		`PUTC '*'`
		`ADD AX, 100`
		`CMP AH, 0`
		`LOOPZ label1`
		`RET`
		
		C Z S O P A
		unchanged
		
		 

MOV	REG, memory
	memory, REG
	REG, REG
	memory, immediate
	REG, immediate
	
	SREG, memory
	memory, SREG
	REG, SREG
	SREG, REG
		Copy operand2 to operand1.
		
		The MOV instruction cannot:
		
		• set the value of the CS and IP registers.
		• copy value of one segment register to another segment register (should copy to general register first).
		• copy immediate value to segment register (should copy to general register first).
		
		Algorithm:
		
		`operand1 = operand2`
		
		Example:
		
		`ORG 100h`
		`MOV AX, 0B800h  ; set AX = B800h (VGA memory).`
		`MOV DS, AX  ; copy value of AX to DS.`
		`MOV CL, 'A'  ; CL = 41h (ASCII code).`
		`MOV CH, 01011111b ; CL = color attribute.`
		`MOV BX, 15Eh  ; BX = position on screen.`
		`MOV [BX], CX  ; w.[0B800h:015Eh] = CX.`
		`RET  ; returns to operating system.`
		
		 

		C Z S O P A unchanged 

MOVSB	No operands	Copy byte at DS:[SI] to ES:[DI]. Update SI and DI.
		
		Algorithm:
		
		• ES:[DI] = DS:[SI]
		• if DF = 0 then
		  ○ SI = SI + 1
		  ○ DI = DI + 1
		else
		  ○ SI = SI - 1
		  ○ DI = DI - 1
		
		Example:
		
		`ORG 100h`
		
		`CLD`
		`LEA SI, a1`
		`LEA DI, a2`
		`MOV CX, 5`
		`REP MOVSB`
		
		`RET`
		
		`a1 DB 1,2,3,4,5`
		`a2 DB 5 DUP(0)`
		
		C Z S O P A
		unchanged
		 

		Copy **word** at DS:[SI] to ES:[DI]. Update SI and DI.
		
		Algorithm:
		
		• ES:[DI] = DS:[SI]
		• if DF = 0 then
		  ○ SI = SI + 2
		  ○ DI = DI + 2
		else
		  ○ SI = SI - 2
		  ○ DI = DI - 2
		
		Example:

MOVSW	No operands	ORG 100h CLD LEA SI, a1 LEA DI, a2 MOV CX, 5 REP MOVSW RET a1 DW 1,2,3,4,5 a2 DW 5 DUP(0) C Z S O P A unchanged 

MUL	REG
	memory
		Unsigned multiply.
		
		Algorithm:
		
		when operand is a **byte**:
		AX = AL * operand.
		
		when operand is a **word**:
		(DX AX) = AX * operand.
		
		Example:
		
		MOV AL, 200 ; AL = 0C8h
		MOV BL, 4
		MUL BL ; AX = 0320h (800)
		RET
		
		C Z S O P A
		r ? ? r ? ?
		CF=OF=0 when high section of the result is zero.
		
		 

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 
NOP	No operands	No Operation. Algorithm: • Do nothing Example: ; do nothing, 3 times: NOP NOP NOP RET C Z S O P A unchanged 
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 
	REG, memory	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

OR	memory, REG
	REG, REG
	memory, immediate
	REG, immediate
		Example:
		
		`MOV AL, 'A'  ; AL = 01000001b`
		`OR AL, 00100000b  ; AL = 01100001b  ('a')`
		`RET`
		
		C Z S O P A
		0 r r 0 r ?

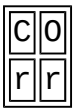
OUT	im.byte, AL
	im.byte, AX
	DX, AL
	DX, AX
		Output from **AL** or **AX** to port.
		First operand is a port number. If required to access port number over 255 - **DX** register should be used.
		
		Example:
		
		`MOV AX, 0FFFh ; Turn on all`
		`OUT 4, AX  ; traffic lights.`
		
		`MOV AL, 100b  ; Turn on the third`
		`OUT 7, AL  ; magnet of the stepper-motor.`
		
		C Z S O P A
		unchanged

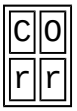
POP	REG
	SREG
	memory
		Get 16 bit value from the stack.
		
		Algorithm:
		
		• operand = SS:[SP] (top of the stack)
		• SP = SP + 2
		
		Example:
		
		`MOV AX, 1234h`
		`PUSH AX`
		`POP  DX  ; DX = 1234h`
		`RET`
		
		C Z S O P A
		unchanged

		Pop all general purpose registers DI, SI, BP, SP, BX, DX, CX, AX from the stack.

POPA	No operands	SP value is ignored, it is Popped but not set to SP register). Note: this instruction works only on **80186** CPU and later! Algorithm: • POP DI • POP SI • POP BP • POP xx (SP value ignored) • POP BX • POP DX • POP CX • POP AX C Z S O P A unchanged 
POPF	No operands	Get flags register from the stack. Algorithm: • flags = SS:[SP] (top of the stack) • SP = SP + 2 C Z S O P A popped 
PUSH	REG SREG memory immediate	Store 16 bit value in the stack. Note: **PUSH immediate** works only on 80186 CPU and later! Algorithm: • SP = SP - 2 • SS:[SP] (top of the stack) = operand Example: MOV AX, 1234h PUSH AX POP DX ; DX = 1234h RET

		C Z S 0 P A unchanged
PUSHA	No operands	Push all general purpose registers AX, CX, DX, BX, SP, BP, SI, DI in the stack. Original value of SP register (before PUSHA) is used. Note: this instruction works only on **80186** CPU and later! Algorithm: • PUSH AX • PUSH CX • PUSH DX • PUSH BX • PUSH SP • PUSH BP • PUSH SI • PUSH DI C Z S 0 P A unchanged
PUSHF	No operands	Store flags register in the stack. Algorithm: • SP = SP - 2 • SS:[SP] (top of the stack) = flags C Z S 0 P A unchanged
		Rotate operand1 left through Carry Flag. The number of rotates is set by operand2. When **immediate** is greater then 1, assembler generates several **RCL xx, 1** instructions because 8086 has machine code only for this instruction (the same principle works for all other shift/rotate instructions). Algorithm:

RCL	memory, immediate
	REG, immediate
	
	memory, CL
	REG, CL
		shift all bits left, the bit that goes off is set to CF and previous value of CF is inserted to the right-most position.
		
		Example:
		
		`STC ; set carry (CF=1).`
		`MOV AL, 1Ch ; AL = 00011100b`
		`RCL AL, 1 ; AL = 00111001b, CF=0.`
		`RET`
		
		 
		
		OF=0 if first operand keeps original sign.

RCR	memory, immediate
	REG, immediate
	
	memory, CL
	REG, CL
		Rotate operand1 right through Carry Flag. The number of rotates is set by operand2.
		
		Algorithm:
		
		shift all bits right, the bit that goes off is set to CF and previous value of CF is inserted to the left-most position.
		
		Example:
		
		`STC ; set carry (CF=1).`
		`MOV AL, 1Ch ; AL = 00011100b`
		`RCR AL, 1 ; AL = 10001110b, CF=0.`
		`RET`
		
		 
		
		OF=0 if first operand keeps original sign.

		Repeat following MOVSB, MOVSW, LODSB, LODSW, STOSB, STOSW instructions CX times. Algorithm: check_cx: if CX <> 0 then • do following chain instruction

REP	chain instruction	• CX = CX - 1 • go back to check_cx else • exit from REP cycle 

REPE	chain instruction	Repeat following CMPSB, CMPSW, SCASB, SCASW instructions while ZF = 1 (result is Equal), maximum CX times.
		
		Algorithm:
		
		check_cx:
		
		if CX <> 0 then
		
		• do following chain instruction
		• CX = CX - 1
		• if ZF = 1 then:
		  ○ go back to check_cx
		else
		  ○ exit from REPE cycle
		
		else
		
		• exit from REPE cycle
		
		example:
		open **cmpsb.asm** from c:\emu8086\examples
		
		 

		Repeat following CMPSB, CMPSW, SCASB, SCASW instructions while ZF = 0 (result is Not Equal), maximum CX times. Algorithm: check_cx: if CX <> 0 then • do following chain instruction

REPNE	chain instruction	• CX = CX - 1
		• if ZF = 0 then:
		  ○ go back to check_cx
		else
		  ○ exit from REPNE cycle
		
		else
		
		• exit from REPNE cycle
		
		 
		 

REPNZ	chain instruction	Repeat following CMPSB, CMPSW, SCASB, SCASW instructions while ZF = 0 (result is Not Zero), maximum CX times.
		
		Algorithm:
		
		check_cx:
		
		if CX <> 0 then
		
		• do following chain instruction
		• CX = CX - 1
		• if ZF = 0 then:
		  ○ go back to check_cx
		else
		  ○ exit from REPNZ cycle
		
		else
		
		• exit from REPNZ cycle
		
		 
		 

		Repeat following CMPSB, CMPSW, SCASB, SCASW instructions while ZF = 1 (result is Zero), maximum CX times. Algorithm: check_cx: if CX <> 0 then

REPZ	chain instruction	• do following chain instruction
		• CX = CX - 1
		• if ZF = 1 then:
		  ○ go back to check_cx
		else
		  ○ exit from REPZ cycle
		
		else
		
		• exit from REPZ cycle
		
		Z
		r

RET	No operands
	or even immediate
		Return from near procedure.
		
		Algorithm:
		
		• Pop from stack:
		  ○ IP
		• if immediate operand is present:
		SP = SP + operand
		
		Example:
		
		`ORG 100h ; for COM file.`
		`CALL p1`
		`ADD AX, 1`
		`RET ; return to OS.`
		`p1 PROC ; procedure declaration.`
		`MOV AX, 1234h`
		`RET ; return to caller.`
		`p1 ENDP`
		
		C Z S O P A
		unchanged

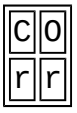
RETF	No operands
	or even immediate
		Return from Far procedure.
		
		Algorithm:
		
		• Pop from stack:
		  ○ IP
		  ○ CS
		• if immediate operand is present:

		SP = SP + operand C Z S 0 P A unchanged 

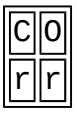
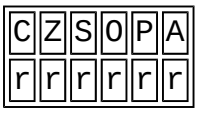
ROL	memory, immediate
	REG, immediate
	
	memory, CL
	REG, CL
		Rotate operand1 left. The number of rotates is set by operand2.
		
		Algorithm:
		
		shift all bits left, the bit that goes off is set to CF and the same bit is inserted to the right-most position.
		
		Example:
		
		`MOV AL, 1Ch ; AL = 00011100b`
		`ROL AL, 1 ; AL = 00111000b, CF=0.`
		`RET`
		
		C O
		r r
		OF=0 if first operand keeps original sign.
		 

ROR	memory, immediate
	REG, immediate
	
	memory, CL
	REG, CL
		Rotate operand1 right. The number of rotates is set by operand2.
		
		Algorithm:
		
		shift all bits right, the bit that goes off is set to CF and the same bit is inserted to the left-most position.
		
		Example:
		
		`MOV AL, 1Ch ; AL = 00011100b`
		`ROR AL, 1 ; AL = 00001110b, CF=0.`
		`RET`
		
		C O
		r r
		OF=0 if first operand keeps original sign.
		 

		Store AH register into low 8 bits of Flags register. Algorithm:

SAHF	No operands	flags register = AH AH bit: 7 6 5 4 3 2 1 0 [SF] [ZF] [0] [AF] [0] [PF] [1] [CF] bits 1, 3, 5 are reserved.  
SAL	memory, immediate REG, immediate memory, CL REG, CL	Shift Arithmetic operand1 Left. The number of shifts is set by operand2. Algorithm: • Shift all bits left, the bit that goes off is set to CF. • Zero bit is inserted to the right-most position. Example: MOV AL, 0E0h ; AL = 11100000b SAL AL, 1 ; AL = 11000000b, CF=1. RET  OF=0 if first operand keeps original sign. 

SAR	memory, immediate
	REG, immediate
	
	memory, CL
	REG, CL
		Shift Arithmetic operand1 Right. The number of shifts is set by operand2.
		
		Algorithm:
		
		• Shift all bits right, the bit that goes off is set to CF.
		• The sign bit that is inserted to the left-most position has the same value as before shift.
		
		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

		 OF=0 if first operand keeps original sign.
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 

SCASB	No operands	Compare bytes: AL from ES:[DI].
		
		Algorithm:
		
		• AL - ES:[DI]
		• set flags according to result: OF, SF, ZF, AF, PF, CF
		• if DF = 0 then
		  ○ DI = DI + 1
		else
		  ○ DI = DI - 1
		
		 

SCASW	No operands	Compare words: AX from ES:[DI]. Algorithm: • AX - ES:[DI] • set flags according to result: OF, SF, ZF, AF, PF, CF • if DF = 0 then ○ DI = DI + 2

		else ○ DI = DI - 2 C Z S O P A r r r r r r 
SHL	memory, immediate REG, immediate memory, CL REG, CL	Shift operand1 Left. The number of shifts is set by operand2. Algorithm: • Shift all bits left, the bit that goes off is set to CF. • Zero bit is inserted to the right-most position. Example: MOV AL, 11100000b SHL AL, 1 ; AL = 11000000b, CF=1. RET C O r r OF=0 if first operand keeps original sign. 
SHR	memory, immediate REG, immediate memory, CL REG, CL	Shift operand1 Right. The number of shifts is set by operand2. Algorithm: • Shift all bits right, the bit that goes off is set to CF. • Zero bit is inserted to the left-most position. Example: MOV AL, 00000111b SHR AL, 1 ; AL = 00000011b, CF=1. RET C O r r OF=0 if first operand keeps original sign. 

STC	No operands	Set Carry flag. Algorithm: CF = 1 C 1
STD	No operands	Set Direction flag. SI and DI will be decremented by chain instructions: CMPSB, CMPSW, LODSB, LODSW, MOVSB, MOVSW, STOSB, STOSW. Algorithm: DF = 1 D 1
STI	No operands	Set Interrupt enable flag. This enables hardware interrupts. Algorithm: IF = 1 I 1

STOSB	No operands	Store byte in AL into ES:[DI]. Update DI.
		
		Algorithm:
		
		• ES:[DI] = AL
		• if DF = 0 then
		  ○ DI = DI + 1
		else
		  ○ DI = DI - 1
		
		Example:
		
		ORG 100h
		
		LEA DI, a1

		MOV AL, 12h
		MOV CX, 5
		
		REP STOSB
		
		RET
		
		a1 DB 5 dup(0)
		
		C Z S O P A
		unchanged
		
		 

STOSW	No operands	Store word in AX into ES:[DI]. Update DI.
		
		Algorithm:
		
		• ES:[DI] = AX
		• if DF = 0 then
		  ○ DI = DI + 2
		else
		  ○ DI = DI - 2
		
		Example:
		
		ORG 100h
		
		LEA DI, a1
		MOV AX, 1234h
		MOV CX, 5
		
		REP STOSW
		
		RET
		
		a1 DW 5 dup(0)
		
		C Z S O P A
		unchanged
		
		 

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 
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 

XCHG	REG, memory
	memory, REG
	REG, REG
		Exchange values of two operands.
		
		Algorithm:
		
		operand1 < - > operand2
		
		Example:
		
		MOV AL, 5
		MOV AH, 2
		XCHG AL, AH ; AL = 2, AH = 5
		XCHG AL, AH ; AL = 5, AH = 2
		RET
		
		C Z S O P A
		unchanged
		 

		Translate byte from table. Copy value of memory byte at DS:[BX + unsigned AL] to AL register. Algorithm:

XLATB	No operands	AL = DS:[BX + unsigned AL]
		
		Example:
		
		`ORG 100h`
		`LEA BX, dat`
		`MOV AL, 2`
		`XLATB ; AL = 33h`
		
		`RET`
		
		`dat DB 11h, 22h, 33h, 44h, 55h`
		
		C Z S O P A
		unchanged
		
		 

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 ?