Personal Computer

MZ-80B

Z-80 Assembler

SHARP

NOTICE

The MZ-80 series of sophisticated personal computers is manufactured by the SHARP CORPORATION. Hardware and software specifications are subject to change without prior notice; therefore, you are requested to pay special attention to version numbers of the monitor and the system software (supplied in the form of cassette tape or mini-floppy disk files).

This manual is for reference only and the SHARP CORPORATION will not be responsible for difficulties arising out of inconsistencies caused by version changes, typographical errors of omissions in the descriptions.

This manual is based on the SB-1500 series monitor and the SB-7000 series Floppy DOS.

— CONTENTS —

INTRODUCTION

The assembler translates a source file written in assembly language to generate a relocatable binary file; the source file is one which has been generated and edited by the text editor, and the relocatable binary file is an intermediate file between the source file and object file. It is possible to link several relocatable files by the linker.

The assembly source file is coded in assembly language. It consists of labels, mnemonic operations codes, assembler directives, comments and an end directive; these are arranged according to the rules of the assembler. The source file edited by the editor is written in ASCII code. The assembler translates the source file to generate a relocatable file and outputs messages which indicate definition conditions and syntax errors. These messages are included in the assembly listing which is displayed on the CRT or printed on the printer.

The following DOS commands activate the assembler.

- **ASM SAMPLE**

  Activates the assembler. The assembler translates source file SAMPLE.ASC and generates relocatable file SAMPLE.RB.

- **ASM SAMPLE, $LPT/L, $CRT/E**

  Activates the assembler. The assembler translates source file SAMPLE.ASC, generates relocatable file SAMPLE.RB, prints the assembly listing on the printer and display only erroneous lines and external reference lines of the CRT screen.

- **ASM/N SAMPLE, $SOA/L**

  Activates the assembler. The assembler translates source file SAMPLE.ASC and outputs the assembly listing to serial output port A ($SOA), but does not generate a relocatable file since global switch/N is specified.

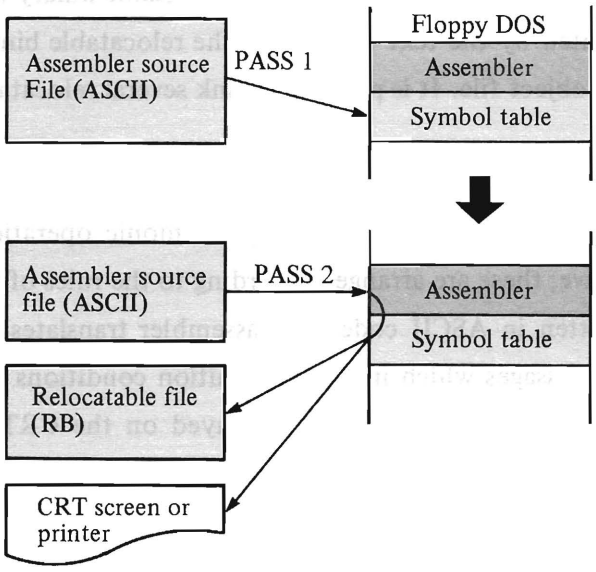
- **ASM SAMPLE, $FD3; SAMLIST/L**

  Activates the assembler. The assembler translates source file SAMPLE.ASC, generates relocatable file SAMPLE.RB and outputs the assembly listing in the same form as that printed on the printer to SAMLIST.ASC on FD3 in ASCII code.

- **ASM SAMPLE, $LPT/L, $4000**

  Activates the assembler. The assembler translates source file SAMPLE.ASC, generates relocatable file SAMPLE.RB and prints the assembly listing on the printer with a bias of $4000 added to the relocatable address. Relocatable file is not affected by the bias of $4000.

The assembler basically uses a 2-pass system. A pass is the process in which the assembler reads a source file from its beginning to end. The following shows operation of the assembler with the 2-pass system.



During pass 1, the assembler stores label symbols according to the assembler rules in the symbolic label table. Label symbols help the operator to read and understand the program easily.

During pass 2, the assembler generates a relocatable file with reference to the symbol table generated during pass 1, then outputs the assembly listing (on the CRT or printer).

The relocatable file and the assembly listing do not occupy space in RAM, which is only used by the symbol table. Therefore, the size of the source file to be assembled is not limited by the amount of RAM.

The following program list will help you understand the function of the assembler. This program is only for reference and has no meaning.

```
    **  Z80 ASSEMBLER SB-7201  <A>  PAGE 01          ??/??/??
01  0000                ;
02  0000                ; SAMPLE LIST
03  0000                ;
04  2000                        ORG     2000H
05  2000  3E33                  LD      A,'3'
06  2002  FE43                  CP      43H
07  2004  FE43                  CP      'C'
08  2006  FE05                  CP      'H'
09  2008  22                    DEFB    '"'
10  2009  27                    DEFB    "'"
11  200A  43                    DEFB    'C'
12  200B  02                    DEFB    '⇧'
13  200C  06050201              DEFM    'C H⇧⇩⇨⇦'
14  2010  0304
15  2012  7E                    LD      A,(HL)
16  2013  7E                    LD      A,M             ; M may be used in place of (HL).
17  2014                ;
18  2014                ;
19  2014  P             XYZ:    EQU     10
20  2014  C32120                JP      ABC+XYZ         ; Relocatable address ± EQU defined aymbol value.
21  2017  C30A00        ABC:    JP      XYZ
22  201A  C31420                JP      ABC-3
23  201D  C30A00                JP      10              ; Absolute address 10
24  2020  C32A20                JP      +10             ; Relative address 2AH (20H+10)
25  2023  2100D0                LD      HL,D000         ; Handled as a hexadecimal number.
26  2026  213930                LD      HL,12345
27  2029  212120                LD      HL,ABC+XYZ
28  202C  3E0D                  LD      A,XYZ+3         ; EQU defined label value ± numerica data
29  202E  3EFF                  LD      A,-1            ; Negative value is converted into one's complement.
30  2030  21FFFF                LD      HL,-1
31  2033  21F0FF                LD      HL,-10H
32  2036  C33520                JP      -1
33  2039
34  2039  CD4A20                CALL    ZZZ
35  203C  CD5420                CALL    ZZZ+10
36  203F  CD4B20                CALL    ZZZ+XXX
37  2042  21FFFF                LD      HL,-XXX
38  2045  21FEFF                LD      HL,-XXX-XXX
39  2048  4920                  DEFW    ZZZ-XXX
40  204A  00            ZZZ:    NOP
41  204B  P             XXX:    EQU     1
42  204B                        END
    **  Z80 ASSEMBLER SB-7201  <A>  PAGE 02          ??/??/??
ABC     2017  XXX   0001  XYZ   000A  ZZZ   204A    ; Indicates the contents of the symbol table.
```

ASSEMBLY LANGUAGE RULES

The source program must be coded according to assembly language rules. This paragraph describes the structure of the source program and the assembly language rules.

The assembly source program consists of the following.

Z80 instruction mnemonic codes

Label symbols

Comments

Assembler directives (Pseudo instructions)
- **Definition directives**
- **Entry directives**
- **Skip directives**
- **End directive**

Comments may be used as needed by the programmer; they have no effect on execution of the program and are not included in the relocatable file.

All assembly source programs must be ended with the assembler directive END.

Z80 instruction mnemonic codes from the body of the assembly source program. These are explained in a separate volume.

A mnemonic code consists of an op-code of up to 4 characters, separators (space, comma, etc.) and operands.

A label symbol symbolically represents an address or data. A label symbol is either placed in the label column and separated from the following instruction with a colon (:), or placed in an operand.

The first 6 characters of a label symbol are significant and the 7th and following characters (if used) are ignored. Therefore, ABCDEFG and ABCDEFH are treated as the same label symbol.

Alphanumerics are generally used for label symbols, but any characters other than those used for separators and special symbols may be used.

Comments are written between the separator " ; " and a [CR] code; these have no influence on program execution.

Assembler directives will be explained later in this manual. These are written in the same column as the Z80 instruction mnemonic codes.

An END directive is one of the assembler directives; all assembly source programs must end with this directive.

—Characters—

Characters which are used in an assembly source program are alphanumerics, sepecial symbols and other characters. The special symbols have functional meanings. (Separators, [CR], [SPACE], etc.)

1) Alphabetic characters: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

These characters are used to represent symbols and instruction mnemonic codes. A ~ F are also used for representing hexadecimal values. Further, D is used to indicate decimal and H is used to indicate hexadecimal.

2) Numerics: 0 1 2 3 4 5 6 7 8 9

These are used to represent constants and symbols. Whether a constant is a hexadecimal number or a decimal number is determined according to the rules of constants.

3) Space

Spaces are treated as separators except when they are used in comments. They perform the tabulation function on the assembly listing when they are placed between op-code and operand or between operand and comment as shown below:

Example:

```
                OR [SP] F0H [SP]; A<--X0
                XYZ : PUSH [SP] AF
                ADD [SP] HL, BC [SP]; BC = COUNT
                        ⬇
                OR      F0H       ; A<--X0
XYZ:            PUSH    AF
                ADD     HL, BC    ; BC = COUNT
                        ↑         ↑
                      Tab set   Tab set
```

Editor list

Assembly listing

4) Colon " : "

A colon behaves as a separator when it is placed between a label symbol and an instruction. It performes the tabulation function on the assembly listing.

Example:

```
START:  LD      SP, START
MAIN:   ENT
↑       ↑
Tab set Tab set
```

An address is assigned to the label symbol even if no instruction follows. (See the prargraph on symbols.)

Example:

```
ENTRY:                    ←"ENTRY" is assigned the same address as "TOP0".
TOP0:   PUSH    HL
```

5) Semicolon " ; "

A semicolon represents the beginning of a comment. None of the characters between a semicolon and a [CR] code have any influence on execution of the program. The semicolon is placed at the top of a line or the beginning of a comment column.

Example:

```
;
; SAMPLE PROGRAM
;
CMMNT:  ENT             ; COMMENT
                          Comment column
```

All lines are comments.

6) Carriage return (CR)

A carriage return code represents the end of a line.

7) Other special symbols: + – ' ( ) ,

All these are special symbols used in instructiln statements.

8) Other symbols

Other characters are not generally used, although they may be used as symbol labels or in the comment column.

—Line—

Each line of a source program is formed of alphanumerics and symbols, and is ended with a carriage return. Except for comments, each line includes only one of the Z80 instructions, an assembler directive, an end statement or an empty statement for a skip.

Components on each line are arranged according to the tab settings when it is listed. (See the assembly listing on page 7.)

—Label Symbols—

All characters other than special symbols may be used for label symbols, but generally alphanumerics are used. Each label symbol can consist of up to 6 characters; the 7th and following characters, if used, are ignored by the assembler.

Example:	Correct	ABC	START	BUFFER	50STEP	
	Incorrect	(ABC)	,HL	IY+3	XYZ+3	← Special characters are used.
		COMPARE0 ↵				The following label are treated as the same label symbol "COMPAR".
		COMPARE1 ↵				

Assembler directive EQU defines data (1 byte or 2 bytes) for a label symbol and assigns it to the label.

```
Example:  ABC:     EQU   3
          CR:      EQU   0DH
          VRAM0:   EQU   D000H
```

Assembler directive ENT defines a label symbol as a global symbol. A colon (:) placed between a label symbol and a following instruction defines the label symbol as a relocatable instruction address.

```
Example:  RLDR:    ENT
          RLDR0:   PUSH  HL
```

When a label symbol is referenced (that is, when it is used as an operand), the assembler first searches the symbol table for the specified label symbol; if it is not found, the assembler treats it as hexadecimal data. For example, when CALL ABC is encountered, the assembler searches the symbol table for ABC; if it is not found, the assembler treats it as 0ABCH and calls address 0ABC.

A label symbol used as an operand must be defined in the assembly source program unit in which it is used, or must be defined as a global symbol in another assembly source program unit. Otherwise, it is converted into binary and left undefined.

A label symbol which has once been defined cannot be defined again.

Multiple label symbols may be defined as relocatable instruction addresses as follows.

```
Example:  ABCD:   ENT
          EFGH:   ENT
          IJK     LD      A, B
```

Label symbols ABCD, EFGH and IJK are all defined as relocatable addresses of LD A, B. ABCD and EFGH are also defined as global symbols.

```
          ABCD:
          EFGH:
          IJK:    LD      A, B
```

Same as the above, except that ABCD and EFGH are not global symbols.

—Constants—

There are two types of constants: decimal and hexadecimal. + and – signs can be attached to these. A character string which is defined as a label symbol is treated as a label symbol even if it satisfies the requirements for a constant.

The assembler treats a constant as a decimal constant when it consists of numerics only or it consists of numerics followed by D.

Example: 23 999 +3 –62 16D 0003D

(16D = 16, 0003D = 3)

The assembler treats a constant as a hexadecimal constant when it consists of 0~9, A, B, C, D, E and /or F followed by H.

Example: 2AH CDH +01H –BH 0010H 00ADH 00H

A constant used in the operand of a JP, JR, DJNZ or CALL instruction represents an absolute address when it has no sign and a location relative to the current address when it has a sign. In other cases, constants without signs and those with a + sign represent numerics, while those with a – sign are converted into two's complement.

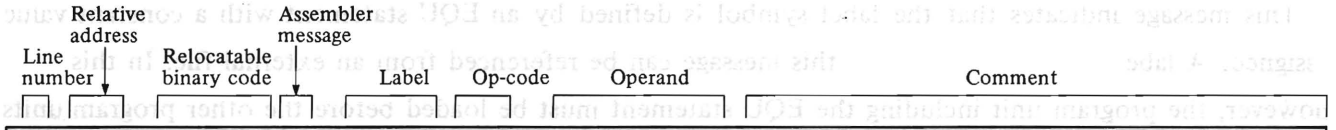
ASSEMBLY LISTING AND ASSEMBLER MESSAGES

The assembly listing is ouput to the CRT screen or printer when a DOS system command ASM is executed with $CRT/L or $LPT/L specified as an argument. Examining the assembly listing is one of the most important procedures in assembly programming since this is when a check is made for errors in the source program.

The assembler translates the specified source program and outputs the assembly listing, which includes line numbers, relative addresses, relocatable binary codes, assembler messages and the source program list (including label symbols, Z80 instruction mnemonic codes and comments). The assembly listing is pages every 60 lines.

The comment column is displayed when the number of characters per line is set to 80, but is not displayed when it is set to 40.

The assembly listing format is shown below. Tabs are set at the beginnings of labels, op-codes, operands and comment columns.




```
    **  Z80 ASSEMBLER SB-7201  <A>  PAGE 01  ??/??/??   ] This message is output at the top of each page.
01  0000                ;
02  0000                ; ASSEMBLER LIST SAMPLE
03  0000                ;
04  0000  P             LETNL:  EQU   0762H
05  0000  P             MSG:    EQU   06B3H
06  0000                ;
07  0000                START:  ENT                   ; ENTRY FROM UNIT#1
08  0000                MAIN:   ENT                   ; ENTRY FROM UNIT#2
09  0000  310000            MAIN0:  LD    SP, START   ; INITIAL STACK POINTER
10  0003  210000    E       MAIN1:  LD    HL, TEMP0
11  0006  DD210000  E       MAIN2:  LD    IX, TEMP1
12  000A  DD360000  EE      MAIN3:  LD    (IX+CONST0), CONST1
13  000E  00        Q       MAIN4:  XOA   A             ; A<--00
 :      :       :   :       :   :       :             :
47  005A  1A            MAIN7:  LD    A, (DE)
48  005B  B7                    OR    A
49  005C  2000      V           JR    NZ, COMP
50  005E  EB            MAIN8:  EX    DE, HL          ; EXCHANGE DE, HL

    **  Z80 ASSEMBLER SB-7201  <A>  PAGE 02  ??/??/??  ] A new page is started when the number of lines
                                                         on the preceding page reaches 60.
```

Errors detected during assembly and definition conditions are indicated with assembler messages.

—Definition Condition Messages—

E (External)

This message indicates that an external symbol reference is being made; i.e., the label symbol by the operand is not defined in the assembly source program unit assembled.

The label symbol indicated must be defined as a global symbol in another assembly program unit for linkage with the current unit by the linker. (See "Assembler Directive ENT" on page 10.)

An undefined byte of data is treated as "00"; 2 undefined bytes of data (or an address) are uncertain.

```
Example:  E     LD      B, CONST0
          └──── The byte of data "CONST0" is not defined in the program unit.
          E     CALL    SORT
          └──── Address SORT is not defined in the program unit.
          EE    BIT     TOP, (IY+FLAG)
          ├└─── The byte of data "FLAG" is not defined in the program unit.
          └──── The byte of data "TOP" is not defined in the program unit.
```

P (Phase)

This message indicates that the label symbol is defined by an EQU statement with a constant value assigned. A label symbol indicated by this message can be referenced from an external file. In this case, however, the program unit including the EQU statement must be loaded before the other program units which are to be linked with it.

The P message is displayed when a label symbol different from those stored in the symbol table during PASS 1 is found.

```
Example:  P     LETNL:  EQU  0762H
          P     DATA1:  EQU  3
          └──── Indicates that LETNL and DATA1 are defined by EQU.
```

The P message is displayed in the relocatable binary code column rather than in the assembler message column.

—Error Messages—

C (illegal Character error)

This message indicates that an illegal character has been used as an operand.

```
Example:  C JP  +1000–3
```

F (Format error)

This message indicates that the instruction format is incorrect.

N (Non label error)

This message indicates that ENT or EQU has no label symbol.

```
Example:  N           EQU  0012H
          ──────
          No label symbol
```

L (erroneous Label error)

This message indicates that an illegal label symbol is used.

Example:
```
L       JR   XYZ
```
XYZ is not defined in the current source program.

No externally defined global symbol can be used as an operand of the JR or DJNZ commands. The L message is displayed if such a label symbol is specified.

M (Multiple label error)

This message indicates that a label symbol is defined two or more times.

Example:
```
M   ABC: LD DE, BUFFER
         ⌇
M   ABC: ENT
```
Indicates that ABC is defined more than once.

O (erroneous Operand)

This message indicates that an illegal operand has been specified.

Q (Questionable mnemonic)

This message indicates that a mnemonic code is incorrect.

Example:
```
Q   CAL XYZ
```
CALL XYZ is correct.
```
Q   PSH B
```
PUSH BC is correct.

S (String error)

This message indicates that single quotation mark(s) are omitted from a DEFM statement.

Example:
```
S   DEFM GAME OVER
```
DEFM 'GAME OVER' is correct.

V (Value over)

This message indicates that the value of the operand is out of the prescribed range.

Example:
```
V   LD A, FF8H
V   SET 8, A
V   JR -130
```

ASSEMBLER DIRECTIVES

Assembler directives (also sometimes referred to as "pseudo instructions") control assembly, but are not converted into machine language. However, in the DEFB, DEFW and DEFM directives, their operands are sometimes converted into machine language.

—ENT (entry)—

This assembler directive defines a label symbol as a global symbol. Label symbols which are referenced by two or more programs when multiple programs are linked must be defined by the entry directive.

Label symbols defined by the entry directive are included in the relocatable file so that the linker can identify them The symbolic debugger can performs symbolic addressing using these label symbols.

Label symbols which are not defined by the entry directive contribute only to assembly of the current source program unit, and are not included in the relocatable file output by the assembler. However, labels defined by the EQU directive are exceptions since they are defined as global symbols and entry definition is not necessary.

The example below shows label symbols being referenced between program units GAUSS-MAIN and GAUSS-SR. The E message in the assembler message column indicates that a label symbol which is not defined in the current program unit is being referenced externally.

Program unit 1
"GAUSS-MAIN"

```
                    ; GAUSS-MAIN
                    ;
                    MAIN0:  ENT              ← Entry definition of label symbol
                                                MAIN0
                            :
                            CALL  CMPLX
                            :
Address undefined           :
  CD0000  E                 CALL  CMPLX+2    ← No offset can be added to a label symbol
     E message              :                   which is defined externally.
                            :
                            END              ← END is always required at the end of a
                                                program unit.
```

Program unit 2
"GAUSS-SR"

```
                    ; GAUSS-SR
                    ;
                    CMPLX:  ENT              ← Entry definition of label symbol
                            :                   CMPLX
                            RET
                            :
Address undefined           :
  C30000  E                 JP    MAIN0
     E message              :
                            END
```

—EQU (equate)—

This assembler directive defines a label symbol with a numeric value (or address) assigned. The numeric value must be a decimal or hexadecimal constant. Any numeric value can be added to or subtracted from a label ymbol once it is defined with a numeric value assigned; this allows a new label symbol to be defined.

The label symbol used as an address in the operand is generally treated as a relative address. However, when a specific address is assigned to the label symbol with an EQU directive, the address is not changed during assembly.

The EQU directive also defines a label symbol as a global symbol. A label defined by the EQU directive can be referenced by an external program unit. **However, program units including such directives must be loaded before other program units to be linked.**

The following example illustrates use of the EQU directive to define label symbols as monitor subroutine addresses and I/O port numbers for a specific device. The P messages indicate that the EQU directives define the label symbols as global symbols.

```
    **  Z80 ASSEMBLER SB-7201  <A>  PAGE 01          ??/??/??
01  0000                ;
02  0000                ; MONITOR SUBROUTINE
03  0000                ;
04  0000  P             BRKEY:    EQU    0527H
05  0000  P             GETKY:    EQU    0610H
06  0000  P             PRNTS:    EQU    063AH
07  0000  P             PRNT:     EQU    063CH
08  0000  P             MSG:      EQU    06B5H
09  0000  P             NL:       EQU    0757H
10  0000  P             LETNL:    EQU    0764H
11  0000  P             GETL:     EQU    0BE5H
12  0000                SKP       3


16  0000                ;
17  0000                ; SET PORT#: PRINTER
18  0000                ;
19  0000  P             POTFE:    EQU    FEH
20  0000  P             POTFF:    EQU    POTFE+1      ; POTFF is defined with FF (hexadecimal)
21  0000                ;                                assigned.
22  0000  P             CON1:     EQU    1
23  0000  P             CON2:     EQU    2
24  0000  P             CON3:     EQU    CON1+CON2    ; This results in assigned of 3 to CON 3. In this
                                                        case, CON1 and CON2 must be defined in
                                                        advance.
```

—ORG (origin)—

This assembler directive determines the object program loading address. For example, when

ORG 2000H

is placed at the beginning of the program to be assembled, the assembler assembles the program with a loading address of 2000H specified.

When a relocatable binary file generated with the loading address specified with the ORG directive is linked with other programs by the linker, the loading address specified with the ORG directive is effective and that specified with the linker is not.

When relocatable files with loading addresses specified with ORG directives are linked, or when more than one ORG directives is used in a program, the loading addresses specified must not overlap and must appear in the sequential order.

When a relocatable file with a loading address specified with an ORG assembler directive is converted into a system file using the LINK/S command, the specified loading address is ignored.

```
**  Z80 ASSEMBLER SB-7201  <ORG>  PAGE 01          ??/??/??
01  0000                ; TYPE COMMAND
02  0000                ;
03  2000                        ORG     2000H
04  2000                .TYPE:  ENT
05  2000  116220                LD      DE, SWTBL       ; DE: = SWITCH TABLE
06  2003  CD0000    E           CALL    ?GSW            ; CHECK GLOBAL SWITCH
07  2006  D8                   RET     C
08  2007  CD0000    E           CALL    C&L1            ; SELECT CRT OR LPT
09  200A  CD0000    E           CALL    ?SEP            ; CHECK SEPARATOR
10  200D  D8                   RET     C
11  200E  FE2C                  CP      2CH             ; SEPARATOR = "," ?
12  2010  3E03                  LD      A, 3            ; 3 IS ERR CODE
13  2012  37                    SCF
14  2013  C0                    RET     NZ              ; NO, ERR RETURN
15  2014  CD0000    E   TYPE0:  CALL    ?LSW            ; CHECK LOCAL SWITCH
16  2017  D8                    REC     C
17  2018  3E08                  LD      A, 8            ; 8 IS ERR CODE
18  201A  37                    SCF
19  201B  C0                    RET     NZ              ; ERROR, LSW EXIST
20  201C  0E80                  LD      C, 128          ; LU#: = 128
21  201E  D9                    EXX
22  201F  0604                  LD      B, 4            ; DEFAULT MODE = ASC
23  2021  D9                    EXX
 :   :    :                     :       :                :
55  2062  88            SWTBL: DEFB    88H             ; /P
56  2063  FF                   DEFB    FFH             ; END OF SWTBL
57  2064                BUFFER: DEFS    128             ; 128 BYTE BUFFER
58  20E4                        END

**  Z80 ASSEMBLER SB-7021  <ORG>  PAGE 02          ??/??/??
.TYPE   2000    BUFFER  2064    SWTBL  2062    TYPE0  2014    TYPE10  203C
TYPE20  2048    TYPEER  2058
```

—DEFB n (define byte)—

This directive sets constant n (1 byte) in the address of the line on which the directive is specified. A label symbol defined with a constant (1 byte) assigned may be used in place of n.

This directive (as well as DEFW and DWFM) is used to form message data or a graphic data group for a code conversion table or other table.

The following example forms the message "ERROR" in ASCII code. Since it uses 0DH as an end mark, monitor subroutine 06B5H can be used to output the message.

```
13  1FF3  B7              OR      A
14  1FF4  CA0000   E      JP      Z, READY
15  1FF7  110020          LD      DE, MESGO
16  1FFA  CDB506          CALL    MSG
17  1FFD  C30000   E      JP      MAIN2
18  2000   P      MSG:    EQU     06B5H
19  2000                 ;
20  2000                 ; MESSAGE GROUP
21  2000                 ;
22  2000                 MESGO:  ENT                     ;"ERROR"
23  2000  45              DEFB    45H
24  2001  52              DEFB    52H
25  2002  52              DEFB    52H
26  2003  4F              DEFB    4FH
27  2004  52              DEFB    52H
28  2005  0D              DEFB    0DH
```

—DEFB 'S', DEFB "S" (define byte)—

This directive sets the ASCII code corresponding to the character enclosed in single or double quotation marks in the address of the line on which the directive is specified.

Since this directive converts characters to ASCII code, the above example can be rewritten as follows.

```
21  2000                 MESGO:  ENT                     ;"ERROR"
22  2000  45              DEFB    'E'
23  2001  52              DEFB    'R'
24  2002  52              DEFB    'R'
25  2003  4F              DEFB    'O'
26  2004  52              DEFB    'R'
27  2005  0D              DEFB    0DH
28  2006  06              DEFB    '©'
29  2007  03              DEFB    '⇨'
30  2008  0D              DEFB    0DH
31  2009  27              DEFB    "'"
32  200A  22              DEFB    '"'
```

—DEFW nn' (define word)—

This directive sets n' in the address of the line on which the directive is specified and n in the following address; in other words, it sets two bytes of data. A label symbol may be used in place of nn'.

```
39  5FF1                CMDT:   ENT             ; COMMAND TABLE
40  5FF1  41                    DEFB    41H
41  5FF2  0053                  DEFW    CMDA
42  5FF4  42                    DEFB    42H
43  5FF5  1E53                  DEFW    CMDB+3
44  5FF7  53                    DEFB    53H
45  5FF8  0000          E       DEFW    CMDS
46  5FFA  0D                    DEFB    0DH
47  5FFB                CONST0: ENT
48  5FFB  0F01                  DEFW    010FH
49  5FFD                CONST1: ENT
50  5FFD  660D                  DEFW    0D66H
```

—DEFM 'S', DEFM "S" (define message)—

This directive sets the character string enclosed in single or double quotation marks in ASCII code in addresses starting at that of the line on which the directive is specified. The number of characters must be within the range from 1 to 64. On the assembly listing, codes for 4 characters are output on each line.

The example on the preceding page can be written as follows with this directive.

```
21  2000                MESGO:  ENT             ;"ERROR"
22  2000  4552524F              DEFM    'ERROR'
23  2004  52
24  2005  0D                    DEFB    0DH
25  2006  06034142              DEFM    '©⇨AB'
26  200A  0D                    DEFB    0DH
27  200B  41274247              DEFM    "A'B'C'"
28  200F  4327
29  2011  0D                    DEFB    0DH
```

—DEFS nn' (define storage)—

This directive reserves nn' bytes of memory area starting at the address of the line on which the directive is specified.

This directive adds nn' to the reference counter contents; the contents of addresses skipped are not defined.

The following example reserves buffer areas.

```
02  4BB8              TEMP0:   ENT              ; BUFFER A
03  4BB8                       DEFS   1
04  4BB9              TEMP1:   ENT              ; BUFFER B
05  4BB9                       DEFS   2
06  4BBB              TEMP2:   ENT              ; BUFFER C
07  4BBB                       DEFS   2
08  4BBD              TEMP3:   ENT              ; BUFFER D
09  4BBD                       DEFS   128
10  4C3D              BFFR:    ENT              ; BUFFER E
11  4C3D                       DEFS   A
12  4C47              BUFFER:  ENT              ; BUFFER F
13  4C47                       DEFS   2
```

The addresses are increased by amounts corresponding to the values indicated by the respective DEFS statements.

—SKP n (skip n lines)—

This directive advances the assembly listing by n lines to make the list easy to read.

```
30                      COMMON:  ENT              ; NORMAL RETURN
31  3BB8  AF                     XOR     A        ; A<- -00
32  3BB9  32B84B                 LD      (TEMPO), A ; CLEAR CMD BUFFER
33  3BBC  110020                 LD      DE, MESGO ; "READY"
34  3BBF  C9                     RET
35  3BC0                         SKP     3
                                                   } 3 line feeds are made.
39  3BC0                 ;
40  3BC0                 ; ABNORMAL RETURN
41  3BC0                 ;
42  3BC0                 ABNRET:  ENT              ; SET INVALID MODE
```

—SKP H (skip home)—

This directive advances the page during output of the assembly listing.

—END (end)—

This directive declares the end of the source program. All source programs must be ended with this directive. Assembly operation is not completed if this directive is omitted.

The assembly outputs

END?

when it reads a source file which doesn't include an END directive.

MESSAGE TABLE

Definition status message	Meaning	Example
E (External)	Indicates that a label symbol is being referenced externally; that is, the label is not defined in the current source program unit.	E LD B, CONST0 ↑—The data byte "CONST0" is undefined. E CALL SORT ↑—The address "SORT" is undefined. EE BIT TOP, (IY+FLAG) ↑↑—The data byte "FLAG" is undefined. └—The data byte "TOP" is undefined.
P (Phase)	Defines a label symbol with a constant assigned. This message is also output when a label symbol is encountered during pass 2 which was not encountered during pass 1.	P LETNL : EQU 0762H P DATA1 : EQU 3 ↑—LETNL and DATA1 are defined by EQU. The P message is displayed in the relocatable binary code column rather than in the assembler message column.

Error message	Meaning	Example
C (illegal Character error)	Indicates that an illegal character is used in the operand.	C JP +1000–3
F (Format error)	Indicates that the instruction format is incorrect.	
N (Non label error)	Indicates that no label symbol is specified for ENT or EQU.	N EQU 0012H ↑—No label symbol
L (erroneous Label error)	Indicates that an illegal label symbol is used.	L JR XYZ ↑—XYZ is not defined in the current program. No externally defined global symbol can be used as the operand of a JR or DJNZ command. If such a label symbol is specified, the L message is displayed.
M (Multiple label error)	Indicates that a label symbol is defined two or more times.	M ABC : LD DE, BUFFER ≀ M ABC : ENT ↑—ABC is defined twice.
O (erroneous Operand)	Indicates that an illegal operand is specified.	
Q (Questionable mnemonic)	Indicates that the mnemonic code is incorrect.	Q CAL XYZ CALL XYZ is correct.
S (String error)	Indicates that single or double quotation mark(s) are omitted.	S DEFM GAME OVER DEFM 'GAME OVER' is correct.
V (Value over)	Indicates that the value of the operand is out of the prescribed range.	V LD A, FF8H V SET 8, A V JR –130
END?	Indicates that the END directive is missing from the source program.	

Note: Refer to the System Error Messages in the System Command manual for other system errors.

MESSAGE TABLE

Definition error message	Meaning	Example
E (External)	Indicates that a label symbol is being referenced externally; that is, the label is not defined in the current source program unit.	E LD B, CONST0 ↑ The data byte "CONST0" is undefined E CALL SORT ↑ The address "SORT" is undefined. E BIT TOP, (IY+FLAG) ↑ ↑ The data byte "FLAG" is undefined. The data byte "TOP" is undefined.
P (Phase)	Defines a label symbol with a constant assigned. This message is also output when a label symbol is encountered during pass 2 which was not encountered during pass 1.	P LETTNL : EQU 076ZH P DATA1 : EQU 3 ↑ LETTNL and DATA1 are defined by EQU. The P message is displayed in the relocatable binary code column rather than in the assembler message column

Error message	Meaning	Example
C (Illegal Character error)	Indicates that an illegal character is used in the operand.	C JP +1000-3
F (Format error)	Indicates that the instruction format is incorrect.	
N (Non label error)	Indicates that no label symbol is specified for ENT or EQU.	N EQU 0012H ↑ No label symbol
L (erroneous Label error)	Indicates that an illegal label symbol is used.	L JR XYZ ↑ XYZ is not defined in the current program. No externally defined global symbol can be used as the operand of a JR or DJNZ command. If such a label symbol is specified, the L message is displayed.
M (Multiple label error)	Indicates that a label symbol is defined two or more times.	M ABC : LD DE, BUFFER ↓ M ABC : ENT ↑ ABC is defined twice.
O (erroneous Operand)	Indicates that an illegal operand is specified.	
O (Questionable mnemonic)	Indicates that the mnemonic code is incorrect.	O CAL XYZ CALL XYZ is correct.
S (String error)	Indicates that single or double quotation mark(s) are omitted.	S DEFM 'GAME OVER DEFM 'GAME OVER' is correct.
V (Value over)	Indicates that the value of the operand is out of the prescribed range.	V LD A, FFSH V SET 8, A V JR -130
END?	Indicates that the END directive is missing from the source program.	

Note: Refer to the System Error Messages in the System Command manual for other system errors.