PART 2 _____ **ASSEMBLER**

The standard processor ASM (Assembler) assembles source statements, written in the P800M Assembly Language described in Part 1, into an object module of relocatable machine code.

The source input may be read from a disc or non-disc file. The output is written to a temporary object file /D5.

By specifying parameters in the obligatory control statement OPT, which must follow the command ASM, the user can define the Assembler's processing and listing.

The size of the Assembler processor is 6 pages.

The Assembler processor is called by the BCL command input from the device assigned to /EO or /EE:

    ASM [DUMP={ALL | PROG | NO}][,SIZE={MAX | <n>}]

The parameter DUMP indicates whether a dump must be made after an abort or after an exit (LKM 3).

    ALL   Dump the Monitor and background machine in case of an abort, or if
          bit 8 is set in register A7 for LKM 3.
    PROG Dump only the background machine.
    NO   No dump required. (Default.)

The parameter SIZE permits to reserve a work area of <n> pages for the Assembler. It is only useful when the parameter SIZE is not specified in the 'Declare Batch Processing Machine' command DCB.

    MAX   The system will reserve 32K words (16 pages) of work area for the
          Assembler.
    <n>   A number, ranging from 0 through 16, specifying the number of
          additional pages required as work area. Default = 0 pages.

ERROR MESSAGES

    PARAM. NOT VALID   The parameter is   1) erroneous
                                                   2) <n> greater than 16

    PROCESSOR NOT CATALOGUED
    DAD ASSIGN ERROR
    I/O ERROR ON DISK
    SEARCH DIRECT. NOT POSSIBLE

If the ASM command is accepted and /EO is assigned to an interactive device, such as console keyboard or display, the message:
    ASM:

is output to that device. The user must now input the OPT statement described in Chapter 3.

If the OPT command is rejected, then:

—   If /EO is assigned to an interactive device an error message explaining the
    error is output on this device, followed by the message:
        ASM:

    requesting the user to enter the correct OPT command.

—   If /EO is assigned to a non-interactive device (such as the card reader),
    an error message is output on the ERR device, followed by the message:
        ASM:

requesting the user to enter the correct command from the device assigned to ERR.

- If /E0 is assigned to a non-interactive device and there is no ERR device defined for this Job, the error message is output to the device assigned to /02 and the Assembler processor exits. The BCP is reloaded and reads all subsequent commands on /E0 until one of the commands :EOJ, :EOB, or :STP is encountered.

The ASM OPT statement must be given immediately after having called the Assembler with the ASM command, and must be present on the device assigned to /EO, or /EE for catalogued procedure input.

The OPT statement may take one of the formats described below, depending on how the source file to be assembled is assigned.

SOURCE FILE

If the source file is a catalogued disc file, its filecode may be assigned either before the Assembler starts or by coding the Type 3 OPT control statement, but not in both ways.

In case of a Type 3 OPT control statement, the Assembler will assign filecode /D4 to the catalogued disc file. This filecode is removed from the background machine filecode table by an LKM 24 issued by the Assembler before it exits.

When the source file has been read it is assembled immediately, followed by an exit to BCP when assembling is terminated.

OBJECT FILE

The object file may be explicitly assigned to /D5 before the Assembler starts. Otherwise it is assigned to /D5 by default.

The filecode is not removed from the background machine filecode table when ASM exits. This is to allow several executions of the Assembler to add new object modules to an existing (temporary) object file, which will finally be input to the Linkage Editor.

Type 1) Source File Filecode = /E1

Sequential source file records are to be read from a device assigned to /E1. This filecode must have been assigned before calling the Assembler. /E1 is usually assigned to the card reader, but may be assigned to another device.

    OPT [LIST={YES | NO}][,COND={YES | NO}]

LIST=   YES: all source records are printed on the assembly listing, which is output on filecode /02.
           NO: only the IDENT, END and any rejected source records are printed on the assembly listing, which is output on filecode /02.
           Default = YES.

COND=   YES: the source records preceded by a $ sign, % sign, or # sign in the first position are assembled.
           NO: the source records preceded by a $ sign, % sign or # sign in the first position are not Assembled, but the line with one of these signs is printed on the listing if LIST=YES or defaulted. These lines are preceded on the listing by a $ sign in front of the line number and followed behind the comments field by eight $ signs. Default = NO.

Type 2) Source File Filecode Pre-Assigned

Sequential source records are read from a file, whose filecode has already been
assigned; this may or may not be filecode /E1.

If a source file is created by the UPD processor, filecode /D4 must be
specified.

        OPT PROG=<fc>[,LIST={YES | NO}][,COND={YES | NO}]

<fc>   A filecode assigned to a disc or non-disc file.

LIST=   YES: all source records are printed on the assembly listing, which is
              output on filecode /02.
         NO: only the IDENT, END and any rejected source records are printed
              on the assembly listing, which is output on filecode /02.
         Default = YES.

COND=   YES: the source records preceded by a $ sign, % sign, or # sign in the
              first position are assembled.
         NO: the source records preceded by a $ sign, % sign or # sign in the
              first position are not included in the object, but the line with
              one of these signs is printed on the listing if LIST=YES or
              defaulted. These lines are preceded on the listing by a $ sign in
              front of the line number and followed behind the comments field
              by eight $ signs. Default = NO.

Type 3) Source File Filecode Not Given

Sequential source records are read from a catalogued disc file which has not
been assigned to a filecode. The assembler issues an LKM 23 to assign the file
to filecode /D4.

        OPT PROG=<fn>[,VERS=<v>][,USID=<u>][,DAD=<d>][,LIST={YES| NO}]
             [,COND={YES | NO}]

<fn>   Name of the source file in the directory of the userid <u> in the
         catalogue for the DAD code <d>.
<v>   the version number of the source file to be assembled, ranging from 0
         (most recent) to 7 (oldest). Default = 0.
<u>   User identification. Default = :JOB USID.

<d>   DAD code, previously assigned by an SCL FCD command. Default = :JOB
         DAD.

LIST=   YES: all source records are printed on the assembly listing, which is
              output on filecode /02.
         NO: only the IDENT, END and any rejected source records are printed
              on the assembly listing, output on filecode /02.
         Default = YES.

COND=   YES: the source records preceded by a $ sign, % sign, or # sign in the
              first position are assembled.
         NO: the source records preceded by a $ sign, % sign or # sign in the
              first position are not included in the object, but the line with
              one of these signs is printed on the listing if LIST=YES or
              defaulted. These lines are preceded on the listing by a $ sign in
              front of the line number and followed behind the comments field
              by eight $ signs. Default = NO.

ERROR MESSAGES

The following error messages are output by the Assembler on filecodes /01 and
/02 if an erroneous parameter is given in the OPT control command. After having
printed the error message, the Assembler will wait until a new OPT command is
given on the command input device.

    IO ERROR <fc> <status>
    KEYWORD OCCURRENCE ERROR   The source file cannot be assigned, due to
                                        keywords which canot be used together.
    INCORRECT /D4 ASSIGNMENT   1) erroneous source input filecode
                                        2) disc overflow

    OPTION STATEMENT MISSING
    INVALID KEYWORD
    TWICE THE SAME KEYWORD
    = NOT FOLLOWING THE KEYWORD
    , NOT FOLLOWING THE PARAMETER
    INVALID OPTION STATEMENT
    INVALID FILECODE
    INVALID ASSIGNMENT   1) the output filecode cannot be assigned
                                        2) disc overflow

    INVALID VERSION NUMBER
    INVALID DAD NUMBER
    INVALID DAD OCCURRENCE
    INVALID USID VALUE
    FILE NOT -SC-TYPE
    INCORRECT /D5 ASSIGNMENT
    PARAMETER VALUE MISSING
    INVALID INTEGER
    INVALID PROGRAM NAME
    YES OR NO NOT FOUND

The assembly listing is usually assigned to be printed on the line printer
(/02). The listing, depending on the parameters given in the OPT control
statement, consists of the following elements:

LISTING

1) The very first line printed identifies the Assembler version performing the
    assembly.

2) The actual listing of the source file statements:

Column	Position	Length	
1	1	2	Error code.
2	3	5	Decimal line number, starting at 00000 and increasing by increments of 1.
3	30	4	A four-digit hexadecimal number being the location counter value. The field remains blank for all directives except RES and DATA.
4	16	4	A four-digit hexadecimal representation of the generated code.
5	22	1	Reference code:
			F = forward reference
			R = relocatable
			X = external reference (to be matched by the Linkage Editor)
			blank = no or backward reference.
6	27	56	The contents of this source line.

SYMBOL TABLE

A symbol table, containing all external, relocatable, absolute and undefined
symbols encountered in the module, is printed after processing the END
directive. The table is listed four symbols to a line in the order encountered.

Each symbol is listed with its location counter value and an indication of the
type of symbol:

    A   the symbol is absolute
    R   the symbol is relocatable
    X   the symbol is an external reference
    **   the symbol is not defined.

The Symbol Table may be included in the generated object module when a STAB
directive immediately precedes the END directive; in this case, the END
directive must specify the name given to the Symbol Table.

ERROR INDICATIONS

Erroneous statements are indicated by an asterisk followed by an error code,
and on the next line seven consecutive asterisks, followed by an asterisk
underneath the place where a fault is detected. For a description of the error
codes see Chapter 5.

The symbol table is followed by one of the following messages:

UND.ENT. *****	indicating the number of undefined entry points
UND.LAB. *****	indicating the number of undefined labels
FOR.O/R. *****	the forward reference with address ***** contained one of the following errors:
	- the value is greater than 255 for the least significant bits of a short instruction
	- the value specified is not absolute.
ASS.ERR. *****	indicating the number of assembly errors in this module.

Severe Errors

If a severe error occurs during the assembly, one of the lines shown below will be output:

***** O   Overflow; too many symbols or forward references, or insufficient memory space available for the Assembler.

***** E   No END directive encountered before the :EOF on the source file.

***** I   No IDENT directive encountered at the beginning of the source file.

If one of these errors has occurred, no object code will be produced.

SEVERITY CODES

An ASM severity code is output when the Assembler's processing is terminated. It is printed on the listing device and can be:

0   No error or trivial error. The object code is produced on /D5.

/40   The object file has not been produced. An error message from the processor will have been output.

/60   The processor was unable to start because of an invalid OPT statement, disc overflow, no source program, or one or more of the filecodes were not assigned. An error message will have been output from the processor.

The following Assembler messages are output on the listing device /02 when the Assembler detects an erroneous source statement.

The code is printed in front of the line number of the erroneous line.

Error Code   Meaning and Description

*C   A constant is:
- missing
- too long
- not allowed here
- when hexadecimal, not preceded by the proper hexadecimal indicator (`X` or /).

*E   An address not even for:
- start address
- AORG or RORG directive.

*F   A FORM or XFORM directive is invalid:
- more than 16 fields
- negative field lengthe
- value too big for 16 bits
- more than 8 words
- field specified twice
- displacement value not allowed when the predefinition concerns an external name
- predefinition using a colon only allowed for 16-bit fields
- negative value only allowed for 16-bit fields
- displacement too large
- invalid field number
- an XFORM declared symbol must be linked to a FORM defined pseudo whose name is the first parameter of the operand.
- the division of the current word of an XFORM declaration is not the same as the corresponding word of the linked FORM symbol
- more than the number of words described by the linked FORM symbol are described by an XFORM declaration.

*I   An identifier does not have a letter as the first character.

*L   A label is:
- missing
- not allowed
- the same as a previous label; the first 6 characters, excluding full stops, are the same.

*M   Unknown mnemonic.

*O   Offset (displacement) too large.

*P   Parameter error:
       -    too many
       -    missing
       -    DATA value longer than 16 words
       -    STAB parameter must not be an entry point, forward reference or a
            common name
       -    illegal use of a register name in a standard instruction operand
       -    '' is not a character string.

*R   A relocation error:
       -    too many relocatable symbols in the expression
       -    expression involves the subtraction of a relocatable part from an
            absolute part
       -    displacement from an external reference must be absolute
       -    EQU value not absolute
       -    an absolute predefined expression is requested
       -    a relocatable predefined expression is requested.

*S   A statement is invalid:
       -    operand not allowed
       -    operand missing
       -    invalid character
       -    invalid indirect addressing
       -    invalid condition specification
       -    label not followed by operation
       -    open parenthesis '(' not matched by close parenthesis ')'
       -    RES operand value causes the location counter value to become
            negative
       -    ENTRY, EXTRN, or COMN directive no longer acceptable.

*X   An expression contains:
       -    more than two symbols
       -    more than three terms
       -    an external and a forward reference
       -    a negative external reference
       -    a plus or minus not followed by a term
       -    a register expression of more than one term
       -    a forward or external reference specified in a requested
            predefined expression.