

High Level Assembler for MVS® & VM & VSE



Language Reference

Release 4

High Level Assembler for MVS® & VM & VSE



Language Reference

Release 4

Note!

Before using this information and the product it supports, be sure to read the general information under "Notices" on page 381.

Fourth Edition (September 2000)

This edition applies to IBM High Level Assembler for MVS & VM & VSE, Release 4, Program Number 5696-234 and to any subsequent releases until otherwise indicated in new editions. Make sure you are using the correct edition for the level of the product.

Order publications through your IBM representative or the IBM branch office serving your locality. Publications are not stocked at the address below.

A form for reader's comments is provided at the back of this publication. If the form has been removed, address your comments to:

IBM Corporation, Department BWE/H3
P.O.Box 49023
SAN JOSE, CA 95161-9023
United States of America

When you send information to IBM, you grant IBM a nonexclusive right to use or distribute the information in any way it believes appropriate without incurring any obligation to you.

© **Copyright International Business Machines Corporation 1982, 2000. All rights reserved.**

US Government Users Restricted Rights – Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

Contents

About this Manual	x
Who Should Use this Manual	x
Programming Interface Information	x
Organization of this Manual	xi
IBM High Level Assembler for MVS & VM & VSE Publications	xii
Hardcopy Publications	xii
Online Publications	xiii
Related Publications	xiii
Syntax Notation	xiii
Double-Byte Character Set Notation	xv
 Summary of Changes	 xvi

Part 1. Assembler Language—Structure and Concepts	1
 Chapter 1. Introduction	 3
Language Compatibility	4
Assembler Language	4
Assembler Program	5
Relationship of Assembler to Operating System	7
Coding Made Easier	9
 Chapter 2. Coding and Structure	 11
Character Set	11
Standard Character Set	11
Double-Byte Character Set	12
Translation Table	14
Assembler Language Coding Conventions	14
Field Boundaries	14
Continuation Lines	15
Blank Lines	18
Comment Statement Format	18
Instruction Statement Format	19
Assembler Language Structure	21
Overview of Assembler Language Structure	22
Machine Instructions	23
Assembler Instructions	24
Conditional Assembly Instructions	25
Macro Instructions	26
Terms, Literals, and Expressions	27
Terms	27
Literals	39
Expressions	42
 Chapter 3. Addressing, Program Sectioning, and Linking	 47
Addressing	47
Addressing within Source Modules: Establishing Addressability	47
Base Register Instructions	48
Qualified Addressing	48

Dependent Addressing	49
Relative Addressing	49
Program Sectioning and Linking	49
Source Module	50
Control Sections	51
Executable Control Sections	51
Reference Control Sections	54
Location Counter Setting	56
Literal Pools In Control Sections	58
External Symbol Dictionary Entries	58
Establishing Residence and Addressing Mode	59
Symbolic Linkages	60
Association of Code and Data Areas (MVS and CMS)	62

Part 2. Machine and Assembler Instruction Statements 65

Chapter 4. Machine Instruction Statements	68
General Instructions	68
Decimal Instructions	69
Floating-Point Instructions	69
Control Instructions	69
Input/Output Operations	70
Branching with Extended Mnemonic Codes	70
Statement Formats	72
Symbolic Operation Codes	73
Operand Entries	74
Registers	74
Addresses	76
Lengths	79
Immediate Data	79
Examples of Coded Machine Instructions	79
RI Format	80
RR Format	81
RS Format	81
RSI Format	82
RX Format	83
SI Format	84
SS Format	85
Chapter 5. Assembler Instruction Statements	87
64-bit Addressing Mode	88
*PROCESS Statement	89
ACONTROL Statement	90
ADATA Instruction	93
AINsert Instruction	94
ALIAS Instruction	95
AMODE Instruction	96
CATTR Instruction (MVS and CMS)	98
CCW and CCW0 Instructions	100
CCW1 Instruction	101
CEJECT Instruction	103
CNOP Instruction	103
COM Instruction	105

COPY Instruction	106
CSECT Instruction	108
CXD Instruction	109
DC Instruction	110
Rules for DC Operand	112
General Information About Constants	113
Padding and Truncation of Values	114
Subfield 1: Duplication Factor	116
Subfield 2: Type	117
Subfield 3: Type Extension	118
Subfield 4: Modifier	119
Subfield 5: Nominal Value	123
DROP Instruction	152
DS Instruction	155
DSECT Instruction	158
DXD Instruction	160
EJECT Instruction	161
END Instruction	162
ENTRY Instruction	163
EQU Instruction	164
Using Conditional Assembly Values	166
EXITCTL Instruction	166
EXTRN Instruction	167
ICTL Instruction	168
ISEQ Instruction	169
LOCTR Instruction	170
LTOrg Instruction	171
Literal Pool	172
Addressing Considerations	173
Duplicate Literals	173
MNOTE Instruction	174
OPSYN Instruction	176
ORG Instruction	178
POP Instruction	181
PRINT Instruction	181
Process Statement	184
PUNCH Instruction	184
PUSH Instruction	186
REPRO Instruction	187
RMODE Instruction	187
RSECT Instruction	189
SPACE Instruction	190
START Instruction	190
TITLE Instruction	191
USING Instruction	194
How to Use the USING Instruction	195
Base Registers for Absolute Addresses	196
Ordinary USING Instruction	196
Labeled USING Instruction	199
Dependent USING Instruction	202
WXTRN Instruction	204
XATTR Instruction (MVS and CMS)	205

Part 3. Macro Language	209
Chapter 6. Introduction to Macro Language	212
Using Macros	212
Macro Definition	212
Model Statements	213
Processing Statements	214
Comment Statements	214
Macro Instruction	215
Source and Library Macro Definitions	215
Macro Library	216
System Macro Instructions	216
Conditional Assembly Language	216
Chapter 7. How to Specify Macro Definitions	217
Where to Define a Macro in a Source Module	217
Format of a Macro Definition	218
Macro Definition Header and Trailer	218
MACRO Statement	218
MEND Statement	219
Macro Instruction Prototype	219
Body of a Macro Definition	221
Model Statements	221
Variable Symbols as Points of Substitution	222
Listing of Generated Fields	222
Rules for Concatenation	223
Rules for Model Statement Fields	225
Symbolic Parameters	227
Positional Parameters	228
Keyword Parameters	229
Combining Positional and Keyword Parameters	229
Subscripted Symbolic Parameters	229
Processing Statements	229
Conditional Assembly Instructions	229
Inner Macro Instructions	230
AEJECT Instruction	230
AINsert Instruction	231
AREAD Instruction	231
ASPACE Instruction	233
COPY Instruction	234
MEXIT Instruction	234
Comment Statements	235
Ordinary Comment Statements	235
Internal Macro Comment Statements	235
System Variable Symbols	235
Scope and Variability of System Variable Symbols	236
&SYSADATA_DSN System Variable Symbol	237
&SYSADATA_MEMBER System Variable Symbol	238
&SYSADATA_VOLUME System Variable Symbol	238
&SYSASM System Variable Symbol	239
&SYSCLOCK System Variable Symbol	239
&SYSDATC System Variable Symbol	240
&SYSDATE System Variable Symbol	240

&SYSECT System Variable Symbol	241
&SYSIN_DSN System Variable Symbol	243
&SYSIN_MEMBER System Variable Symbol	244
&SYSIN_VOLUME System Variable Symbol	245
&SYSJOB System Variable Symbol	245
&SYSLIB_DSN System Variable Symbol	246
&SYSLIB_MEMBER System Variable Symbol	246
&SYSLIB_VOLUME System Variable Symbol	247
&SYSLIN_DSN System Variable Symbol	247
&SYSLIN_MEMBER System Variable Symbol	249
&SYSLIN_VOLUME System Variable Symbol	249
&SYSLIST System Variable Symbol	250
&SYSLOC System Variable Symbol	252
&SYSMAC System Variable Symbol	253
&SYSM_HSEV System Variable Symbol	253
&SYSM_SEV System Variable Symbol	253
&SYSNDX System Variable Symbol	254
&SYSNEST System Variable Symbol	257
&SYSOPT_DBCS System Variable Symbol	258
&SYSOPT_OPTABLE System Variable Symbol	258
&SYSOPT_RENT System Variable Symbol	258
&SYSOPT_XOBJECT System Variable Symbol	259
&SYSPARM System Variable Symbol	259
&SYSPRINT_DSN System Variable Symbol	260
&SYSPRINT_MEMBER System Variable Symbol	261
&SYSPRINT_VOLUME System Variable Symbol	261
&SYSPUNCH_DSN System Variable Symbol	262
&SYSPUNCH_MEMBER System Variable Symbol	263
&SYSPUNCH_VOLUME System Variable Symbol	264
&SYSSEQF System Variable Symbol	264
&SYSSTEP System Variable Symbol	265
&SYSSTMT System Variable Symbol	265
&SYSSTYP System Variable Symbol	266
&SYSTEM_ID System Variable Symbol	266
&SYSTEM_DSN System Variable Symbol	267
&SYSTEM_MEMBER System Variable Symbol	268
&SYSTEM_VOLUME System Variable Symbol	268
&SYSTIME System Variable Symbol	269
&SYSVER System Variable Symbol	270
Chapter 8. How to Write Macro Instructions	271
Macro Instruction Format	271
Alternative Ways of Coding a Macro Instruction	272
Name Entry	273
Operation Entry	273
Operand Entry	274
Sublists in Operands	278
Values in Operands	281
Omitted Operands	281
Unquoted Operands	282
Special Characters	282
Nesting Macro Instruction Definitions	285
Inner and Outer Macro Instructions	286
Levels of Macro Call Nesting	286

General Rules and Restrictions	286
Passing Values through Nesting Levels	287
System Variable Symbols in Nested Macros	289
Chapter 9. How to Write Conditional Assembly Instructions	291
SET Symbols	292
Subscripted SET Symbols	292
Scope of SET Symbols	292
Scope of Symbolic Parameters	292
SET Symbol Specifications	293
Subscripted SET Symbols Specifications	295
Created SET Symbols	296
Data Attributes	296
Combining Attributes with Symbols	299
Type Attribute (T')	300
Length Attribute (L')	304
Scaling Attribute (S')	305
Integer Attribute (I')	306
Count Attribute (K')	306
Number Attribute (N')	307
Defined Attribute (D')	308
Operation Code Attribute (O')	308
Sequence Symbols	310
Lookahead	311
Open Code	313
Conditional Assembly Instructions	314
Declaring SET Symbols	314
GBLA, GBLB, and GBLC Instructions	315
LCLA, LCLB, and LCLC Instructions	316
Assigning Values to SET Symbols	318
SETA Instruction	318
SETB Instruction	328
SETC Instruction	333
Extended SET Statements	341
SETAF Instruction	342
SETCF Instruction	343
Substring Notation	344
Branching	346
AIF Instruction	346
AGO Instruction	349
ACTR Instruction	350
ANOP Instruction	351
Chapter 10. MHELP Instruction	353

Part 4. Appendixes	357
Appendix A. Assembler Instructions	358
Appendix B. Summary of Constants	363
Appendix C. Macro and Conditional Assembly Language Summary	365

Appendix D. Standard Character Set Code Table	377
Notices	381
Trademarks	382
Bibliography	383
High Level Assembler Publications	383
Toolkit Feature Publications	383
Related Publications (Architecture)	383
Related Publications for MVS	383
Related Publications for VM	384
Related Publications for VSE	384
General Publications	384
Index	385

About this Manual

This manual describes the syntax of assembler language statements, and provides information about writing source programs that are to be assembled by IBM* High Level Assembler for MVS & VM & VSE, Licensed Program 5696-234, hereafter referred to as High Level Assembler, or simply the assembler. It is meant to be used in conjunction with *HLASM Programmer's Guide*.

Detailed definitions of machine instructions are not included in this manual. See "Bibliography" on page 383 for a list of manuals that provide this information.

Throughout this book, we use these indicators to identify platform-specific information:

- Prefix the text with platform-specific text (for example, "Under CMS...")
- Add parenthetical qualifications (for example, "(CMS only)")
- Bracket the text with icons. The following are some of the icons that we use:

 Informs you of information specific to MVS 

 Informs you of information specific to CMS 

 Informs you of information specific to VSE 

MVS is used in this manual to refer to Multiple Virtual Storage/Enterprise Systems Architecture (MVS/ESA™) and to OS/390®.

CMS is used in this manual to refer to Conversational Monitor System on Virtual Machine/Enterprise Systems Architecture (VM/ESA®).

VSE is used in this manual to refer to Virtual Storage Extended/Enterprise Systems Architecture (VSE/ESA®).

Who Should Use this Manual

HLASM Language Reference is for application programmers coding in the High Level Assembler language. It is not intended to be used for tutorial purposes, but is for reference only. If you are interested in learning more about assemblers, most libraries have tutorial books on the subject. It assumes you are familiar with the functional details of the Enterprise Systems Architecture, and the role of machine-language instructions in program execution.

Programming Interface Information

This manual is intended to help the customer create application programs. This manual documents General-Use Programming Interface and Associated Guidance Information provided by IBM High Level Assembler for MVS & VM & VSE.

General-use programming interfaces allow the customer to write programs that obtain the services of IBM High Level Assembler for MVS & VM & VSE.

Organization of this Manual

This manual is organized as follows:

Part 1, Assembler Language—Structure and Concepts

- **Chapter 1, Introduction**, describes the assembler language and how the assembler processes assembler language source statements. It also describes the relationship between the assembler and the operating system, and suggests ways to make the task of coding easier.
- **Chapter 2, Coding and Structure**, describes the coding rules for and the structure of the assembler language. It also describes the language elements in a program.
- **Chapter 3, Addressing, Program Sectioning, and Linking** describes the concepts of addressability and symbolic addressing. It also describes control sections and the linkage between control sections.

Part 2, Machine and Assembler Instruction Statements

- **Chapter 4, Machine Instruction Statements**, describes the machine instruction types and their formats.
- **Chapter 5, Assembler Instruction Statements**, describes the assembler instructions in alphabetical order.

Part 3, Macro Language

- **Chapter 6, Introduction to Macro Language**, describes the macro facility concepts including macro definitions, macro instruction statements, source and library macro definitions, and conditional assembly language.
- **Chapter 7, How to Specify Macro Definitions**, describes the components of a macro definition.
- **Chapter 8, How to Write Macro Instructions**, describes how to call macro definitions using macro instructions.
- **Chapter 9, How to Write Conditional Assembly Instructions**, describes the conditional assembly language including SET symbols, sequence symbols, data attributes, branching, and the conditional assembly instructions.
- **Chapter 10, MHELP Instruction**, describes the MHELP instruction that you can use to control a set of macro trace and dump facilities.

Appendixes

- **Appendix A, Assembler Instructions**, summarizes the assembler instructions and assembler statements, and the related name and operand entries.
- **Appendix B, Summary of Constants**, summarizes the types of constants and related information.
- **Appendix C, Macro and Conditional Assembly Language Summary**, summarizes the macro language described in Part 3. This summary also includes a summary table of the system variable symbols.
- **Appendix D, Standard Character Set Code Table**, shows the code table for the assembler's standard character set.

IBM High Level Assembler for MVS & VM & VSE Publications

High Level Assembler runs under OS/390®, MVS, VM and VSE. Its publications for the OS/390, MVS, VM and VSE operating systems are described in this section.

Hardcopy Publications

The books in the High Level Assembler library are shown in Figure 1. This figure shows which books can help you with specific tasks, such as application programming.

Figure 1. IBM High Level Assembler for MVS & VM & VSE Publications

Task	Publication	Order Number
Evaluation and Planning	General Information	GC26-4943
Installation and Customization	Installation and Customization Guide	SC26-3494
	Programmer's Guide	SC26-4941
	Toolkit Feature Installation Guide	GC26-8711
Application Programming	Programmer's Guide	SC26-4941
	Language Reference	SC26-4940
	General Information	GC26-4943
	Toolkit Feature User's Guide	GC26-8710
	Toolkit Feature Interactive Debug Facility User's Guide	GC26-8709
Diagnosis	Installation and Customization Guide	SC26-3494
Warranty	Licensed Program Specifications	GC26-4944

General Information

Introduces you to the High Level Assembler product by describing what it does and which of your data processing needs it can fill. It is designed to help you evaluate High Level Assembler for your data processing operation and to plan for its use.

Installation and Customization Guide

Contains the information you need to install and customize, and diagnose failures in, the High Level Assembler product.

The diagnosis section of the book helps users determine if a correction for a similar failure has been documented previously. For problems not documented previously, the book helps users to prepare an APAR. This section is for users who suspect that High Level Assembler is not working correctly because of some defect.

Language Reference

Presents the rules for writing assembler language source programs to be assembled using High Level Assembler.

Licensed Program Specifications

Contains a product description and product warranty information for High Level Assembler.

Programmer's Guide

Describes how to assemble, debug, and run High Level Assembler programs.

Toolkit Feature Installation Guide

Contains the information you need to install and customize, and diagnose failures in, the High Level Assembler Toolkit Feature.

Toolkit Feature User's Guide

Describes how to use the High Level Assembler Toolkit Feature.

Toolkit Feature Debug Reference Summary

Contains a reference summary of the High Level Assembler Interactive Debug Facility.

Toolkit Feature Interactive Debug Facility User's Guide

Describes how to use the High Level Assembler Interactive Debug Facility.

Online Publications

The High Level Assembler publications are available in the following softcopy formats:

- *MVS Collection* CD-ROM, SK2T-0710
- *OS/390 Collection* CD-ROM, SK2T-6700
- *VM/ESA Collection* CD-ROM, SK2T-2067
- *VSE Collection* CD-ROM, SK2T-0060

For more information about High Level Assembler, see the High Level Assembler web site, at

<http://www.ibm.com/software/ad/hlasm>

Related Publications

See "Bibliography" on page 383 for a list of publications that supply information you might need while you are using High Level Assembler.

Syntax Notation

Throughout this book, syntax descriptions use the structure defined below.

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.

The ► symbol indicates the beginning of a statement.

The → symbol indicates that the statement syntax is continued on the next line.

The ► symbol indicates that a statement is continued from the previous line.

The →◀ indicates the end of a statement.

Diagrams of syntactical units other than complete statements start with the ► symbol and end with the —► symbol.

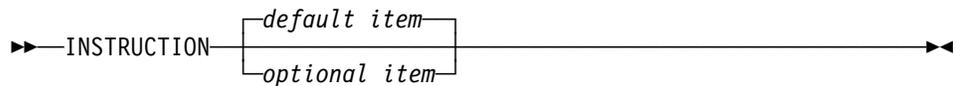
- **Keywords** appear in uppercase letters (for example, ASPACE) or upper and lower case (for example, PATHFile). They must be spelled exactly as shown. Lower case letters are optional (for example, you could enter the PATHFile keyword as PATHF, PATHFI, PATHFIL or PATHFILE).

Variables appear in all lowercase letters in a special typeface (for example, *integer*). They represent user-supplied names or values.

- If punctuation marks, parentheses, or such symbols are shown, they must be entered as part of the syntax.
- Required items appear on the horizontal line (the main path).

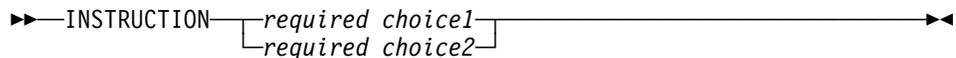


- Optional items appear below the main path. If the item is optional and is the default, the item appears above the main path.

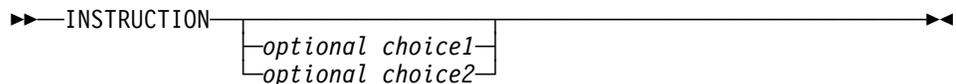


- When you can choose from two or more items, they appear vertically in a stack.

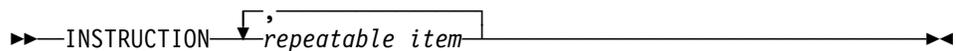
If you **must** choose one of the items, one item of the stack appears on the main path.



If choosing one of the items is optional, the whole stack appears below the main path.

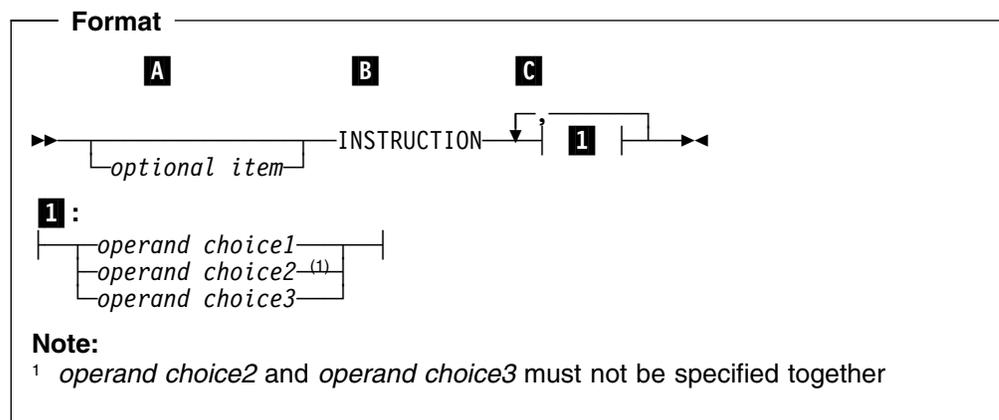


- An arrow returning to the left above the main line indicates an item that can be repeated. When the repeat arrow contains a separator character, such as a comma, you must separate items with the separator character.



A repeat arrow above a stack indicates that you can make more than one choice from the stacked items, or repeat a single choice.

The following example shows how the syntax is used.



- A** The item is optional, and can be coded or not.
- B** The INSTRUCTION key word must be specified and coded as shown.
- C** The item referred to by **1** is a required operand. Allowable choices for this operand are given in the fragment of the syntax diagram shown below **1** at the bottom of the diagram. The operand can also be repeated. That is, more than one choice can be specified, with each choice separated by a comma.

Double-Byte Character Set Notation

Double-byte character set (DBCS) characters in terms, expressions, character strings, and comments are delimited by shift-out and shift-in characters. In this manual, the shift-out delimiter is represented pictorially by the < character, and the shift-in delimiter is represented pictorially by the > character. The EBCDIC codes for the shift-out and shift-in delimiters are X'0E' and X'0F', respectively.

The following figure summarizes the DBCS notation used throughout this manual.

Character(s)	Represents
<	Shift-out (SO)
>	Shift-in (SI)
D1D2D3...	Double-byte characters
DaDbDc...	Double-byte characters
.A.B.C.'.&.,	EBCDIC characters in double-byte form: A, B, C, single quotation mark, ampersand, and comma. The dots separating the letters represent the hexadecimal value X'42'. A double-byte character that contains the value of an EBCDIC ampersand or single quotation mark in either byte is not recognized as a delimiter when enclosed by SO and SI.
eeeeeee	Single-byte (EBCDIC) characters
abcd...	Single-byte (EBCDIC) characters
XXX	Extended continuation indicator for macro-generated statements
+++	Alternative extended continuation indicator for macro-generated statements

Summary of Changes

Date of Publication September 2000

Form of Publication Fourth Edition, SC26-4940-03

Assembler options changes

- Options file allows options to be specified via an external file.
- *PROCESS OVERRIDE
- New options:
 - THREAD
 - CODEPAGE

New assembler statement

- XATTR statement allows attributes of external symbols to be specified.

Changed assembler statements

- DC new constant types:
 - R** PSECT address constant
 - CU** Unicode character constants
 - AD** Doubleword aligned 8-byte address
 - FD** Doubleword aligned 8-byte fixed point constant
 - Floating point symbolic value DMIN added
- AMODE
 - ANY31 operand added
 - 64 operand documented
- RMODE
 - 31 operand added
 - 64 operand documented

Miscellany

- Literals now always entered in literal pool
- Predefined absolute symbols may no longer be used in conditional assembly character expressions.

Part 1. Assembler Language—Structure and Concepts

Chapter 1. Introduction	3
Language Compatibility	4
Assembler Language	4
Machine Instructions	5
Assembler Instructions	5
Macro Instructions	5
Assembler Program	5
Basic Functions	6
Associated Data	6
Controlling the Assembly	6
Processing Sequence	7
Relationship of Assembler to Operating System	7
Coding Made Easier	9
Symbolic Representation of Program Elements	9
Variety in Data Representation	9
Controlling Address Assignment	9
Relocatability	9
Sectioning a Program	9
Linkage between Source Modules	10
Program Listings	10
 Chapter 2. Coding and Structure	 11
Character Set	11
Standard Character Set	11
Double-Byte Character Set	12
Translation Table	14
Assembler Language Coding Conventions	14
Field Boundaries	14
Statement Field	14
Continuation-Indicator Field	15
Identification-Sequence Field	15
Continuation Lines	15
Alternative Statement Format	16
Continuation of double-byte data	16
Blank Lines	18
Comment Statement Format	18
Instruction Statement Format	19
Statement Coding Rules	19
Assembler Language Structure	21
Overview of Assembler Language Structure	22
Machine Instructions	23
Assembler Instructions	24
Conditional Assembly Instructions	25
Macro Instructions	26
Terms, Literals, and Expressions	27
Terms	27
Symbols	28
Self-Defining Terms	32
Location Counter Reference	35
Symbol Length Attribute Reference	37

Part 1. Assembler Language—Structure and Concepts

Other Attribute References	39
Literals	39
Literals, Constants, and Self-Defining Terms	39
General Rules for Using Literals	40
Literal Pool	42
Expressions	42
Rules for Coding Expressions	42
Evaluation of Expressions	44
Absolute and Relocatable Expressions	44
Chapter 3. Addressing, Program Sectioning, and Linking	47
Addressing	47
Addressing within Source Modules: Establishing Addressability	47
How to Establish Addressability	47
Base Register Instructions	48
Qualified Addressing	48
Dependent Addressing	49
Relative Addressing	49
Program Sectioning and Linking	49
Source Module	50
Beginning of a Source Module	50
End of a Source Module	50
Control Sections	51
Executable Control Sections	51
First Control Section	52
Unnamed Control Section	53
Reference Control Sections	54
Dummy Control Sections	54
Common Control Sections	55
External Dummy Sections	55
Location Counter Setting	56
Use of Multiple Location Counters	57
Literal Pools In Control Sections	58
External Symbol Dictionary Entries	58
Establishing Residence and Addressing Mode	59
Symbolic Linkages	60
Establishing symbolic linkage	60
Referring to external data	60
Branching to an external address	61
Establishing an external symbol alias	62
Association of Code and Data Areas (MVS and CMS)	62

Chapter 1. Introduction

A computer can understand and interpret only machine language. Machine language is in binary form and, thus, very difficult to write. The assembler language is a symbolic programming language that you can use to code instructions instead of coding in machine language.

Because the assembler language lets you use meaningful symbols made up of alphabetic and numeric characters, instead of just the binary digits 0 and 1 used in machine language, you can make your coding easier to read, understand, and change. The assembler must translate the symbolic assembler language into machine language before the computer can run your program. The specific procedures followed to do this may vary according to the system you are using. However, the method is basically the same for all systems:

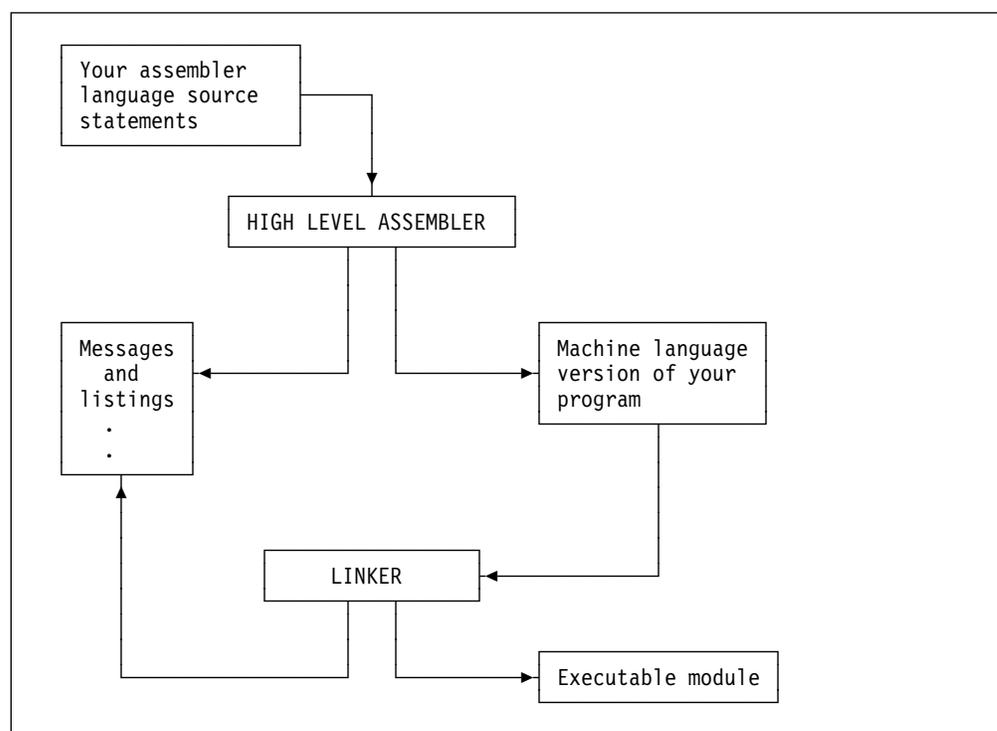


Figure 2. Assembling and Link-Editing Your Assembler Language Program

Your program, written in the assembler language, becomes the source module that is input to the assembler. The assembler processes your source module and produces an object module in machine language (called object code). The object module can be used as input to be processed by the linker or the binder. The linker or binder produces a load module (MVS and CMS), or a phase (VSE), that can be loaded later into the main storage of the computer. When your program is loaded, it can then be run. Your source module and the object code produced are printed, along with other information, on a program listing.

Language Compatibility

The assembler language supported by High Level Assembler has functional extensions to the languages supported by Assembler H Version 2 and DOS/VSE Assembler. High Level Assembler uses the same language syntax, function, operation, and structure as Assembler H Version 2. Similarly, the functions provided by the Assembler H Version 2 macro facility are all provided by High Level Assembler.

Migration from Assembler H Version 2 or DOS/VSE Assembler to High Level Assembler requires an analysis of existing assembler language programs to ensure that they do not contain:

- Macro instructions with names that conflict with High Level Assembler symbolic operation codes
- SET symbols with names that conflict with the names of High Level Assembler system variable symbols
- Dependencies on the type attribute values of certain variable symbols or macro instruction operands

With the exception of these possible conflicts, and with the appropriate High Level Assembler option values, source language source programs written for Assembler H Version 2 or DOS/VSE Assembler, that assemble without warning or error diagnostic messages, should assemble correctly using High Level Assembler.

VSE An E-Deck refers to a macro source book of type E that can be used as the name of a macro definition to process in a macro instruction. E-Decks are stored in edited format, and High Level Assembler requires that library macros be stored in source statement format. A library input exit can be used to analyze a macro definition, and, in the case of an E-Deck, call the VSE/ESA ESERV program to change, the E-Deck definition, line by line, back into source format required by the assembler, without modifying the original library file.

See the section titled *Using the High Level Assembler Library Exit for Processing E-Decks* in the *IBM VSE/ESA Guide to System Functions* manual. This section describes how to set up the exit and how to use it. **VSE**

Assembler Language

The assembler language is the symbolic programming language that lies closest to the machine language in form and content. You will, therefore, find the assembler language useful when:

- You need to control your program closely, down to the byte and even the bit level.
- You must write subroutines for functions that are not provided by other symbolic programming languages, such as COBOL, FORTRAN, or PL/I.

The assembler language is made up of statements that represent either instructions or comments. The instruction statements are the working part of the language and are divided into the following three groups:

- Machine instructions
- Assembler instructions

- Macro instructions

Machine Instructions

A machine instruction is the symbolic representation of a machine language instruction of the following instruction sets:

- IBM System/370™
- IBM System/370 Extended Architecture (370-XA)
- Enterprise Systems Architecture/370™ (ESA/370)
- Enterprise Systems Architecture/390® (ESA/390™)

It is called a machine instruction because the assembler translates it into the machine language code that the computer can run. Machine instructions are described in Chapter 4, “Machine Instruction Statements.”

Assembler Instructions

An assembler instruction is a request to the assembler to do certain operations during the assembly of a source module; for example, defining data constants, reserving storage areas, and defining the end of the source module. Except for the instructions that define constants, and the instruction used to generate no-operation instructions for alignment, the assembler does not translate assembler instructions into object code. The assembler instructions are described in Chapter 3, “Addressing, Program Sectioning, and Linking,” Chapter 5, “Assembler Instruction Statements,” and Chapter 9, “How to Write Conditional Assembly Instructions.”

Macro Instructions

A macro instruction is a request to the assembler program to process a predefined sequence of instructions called a *macro definition*. From this definition, the assembler generates machine and assembler instructions, which it then processes as if they were part of the original input in the source module.

IBM supplies macro definitions for input/output, data management, and supervisor operations that you can call for processing by coding the required macro instruction. (These IBM-supplied macro instructions are described in the applicable *Macro Instructions* manual.)

You can also prepare your own macro definitions, and call them by coding the corresponding macro instructions. Rather than code all of this sequence each time it is needed, you can create a macro instruction to represent the sequence and then, each time the sequence is needed, simply code the macro instruction statement. During assembly, the sequence of instructions represented by the macro instruction is inserted into the source program.

A complete description of the macro facility, including the macro definition, the macro instruction, and the conditional assembly language, is given in Part 3, “Macro Language.”

Assembler Program

The *assembler program*, also referred to as the *assembler*, processes the machine, assembler, and macro instructions you have coded (source statements) in the assembler language, and produces an object module in machine language.

Basic Functions

Processing involves the translation of source statements into machine language, assignment of storage locations to instructions and other elements of the program, and performance of auxiliary assembler functions you have designated. The output of the assembler program is the object program, a machine language translation of the source program. The assembler produces a printed listing of the source statements and object program statements and additional information, such as error messages, that are useful in analyzing the program. The object program is in the format required by the linker.

Associated Data

The assembler can produce an associated data file that contains information about the source program and the assembly environment. The ADATA information includes information such as:

- Data sets used by the assembler
- Program source statements
- Macros used by the assembler
- Program symbols
- Program object code
- Assembly error messages

Different subsets of this information are needed by various consumers, such as configuration managers, debuggers, librarians, metrics collectors, and many more.

Controlling the Assembly

You can control the way the assembler produces the output from an assembly, using assembler options and assembler language instructions.

Assembler options are described in the *HLASM Programmer's Guide*. A subset of assembler options can be specified in your source program using the *PROCESS statement described on page 89.

Assembler language instructions are assembler language source statements that cause the assembler to perform a specific operation. Some assembler language instructions, such as the DC instruction, generate object code. Assembler language instructions are categorized as follows:

Assembler Instructions

These include instructions for:

- Producing associated data
- Assigning base registers
- Defining data constants
- Controlling listing output
- Redefining operation codes
- Sectioning and linking programs
- Defining symbols

These instructions are described in Chapter 5, Assembler Instruction Statements.

Macro Instructions

These instructions let you define macros for generating a sequence of assembler language statements from a single instruction. These instructions are described in Part 3, Macro Language.

Conditional Assembly Instructions

These instructions let you perform general arithmetic and logical computations, and condition tests that can vary the output generated by the assembler. These instructions are described under “Conditional Assembly Instructions” on page 314.

Processing Sequence

The assembler processes the machine and assembler language instructions at different times during its processing sequence. You should be aware of the assembler's processing sequence in order to code your program correctly.

The assembler processes most instructions twice, first during conditional assembly and, later, at assembly time. However, as shown below, it does some processing only during conditional assembly.

Conditional Assembly and Macro Instructions: The assembler processes conditional assembly instructions and macro processing instructions during conditional assembly. During this processing the assembler evaluates arithmetic, logical, and character conditional assembly expressions. Conditional assembly takes place before assembly time.

The assembler processes the machine and ordinary assembler instructions generated from a macro definition called by a macro instruction at assembly time.

Machine Instructions: The assembler processes all machine instructions, and translates them into object code at assembly time.

Assembler Instructions: The assembler processes ordinary assembler instructions at assembly time. During this processing:

- The assembler evaluates absolute and relocatable expressions (sometimes called assembly-time expressions)
- Some instructions, such as ADATA, ALIAS, CATTR and XATTR (MVS and CMS), DC, DS, ENTRY, EXTRN, PUNCH, and REPRO, produce output for later processing by programs such as the linker.

The assembler prints in a program listing all the information it produces at the various processing times discussed above. The assembler also produces information for other processors. The linker uses such information at link-edit time to combine object modules into load modules. At program fetch time, the load module produced by the linker is loaded into virtual storage. Finally, at execution time, the computer runs the load module.

Relationship of Assembler to Operating System

High Level Assembler operates under the OS/390 operating system, the MVS/ESA operating system, the CMS component of the VM/ESA operating system, and the VSE/ESA operating system. These operating systems provide the assembler with services for:

- Assembling a source module
- Running the assembled object module as a program

Relationship of Assembler to Operating System

In writing a source module, you must include instructions that request any required service functions from the operating system.

MVS: MVS provides the following services:

- For assembling the source module:
 - A control program
 - Sequential data sets to contain source code
 - Libraries to contain source code and macro definitions
 - Utilities
- For preparing for the execution of the assembler program as represented by the object module:
 - A control program
 - Storage allocation
 - Input and output facilities
 - Linker or binder
 - Loader

CMS: CMS provides the following services:

- For assembling the source module:
 - An interactive control program
 - Files to contain source code
 - Libraries to contain source code and macro definitions
 - Utilities
- For preparing for the execution of the assembler program as represented by the object modules:
 - An interactive control program
 - Storage allocation
 - Input and output facilities
 - Linker
 - A loader

VSE: VSE provides the following services:

- For assembling the source module:
 - A control program
 - Sequential data sets to contain source code
 - Libraries to contain source code and macro definitions
 - Utilities
- For preparing for the execution of the assembler program as represented by the object module:
 - A control program
 - Storage allocation
 - Input and output facilities
 - Linker

Coding Made Easier

It can be very difficult to write an assembler language program using only machine instructions. The assembler provides additional functions that make this task easier. They are summarized below.

Symbolic Representation of Program Elements

Symbols greatly reduce programming effort and errors. You can define symbols to represent storage addresses, displacements, constants, registers, and almost any element that makes up the assembler language. These elements include operands, operand subfields, terms, and expressions. Symbols are easier to remember and code than numbers; moreover, they are listed in a symbol cross reference table, which is printed in the program listings. Thus, you can easily find a symbol when searching for an error in your code. See page 28 for details about symbols, and how you can use them in your program.

Variety in Data Representation

You can use decimal, binary, hexadecimal, or character representation of machine language binary values in writing source statements. You select the representation best suited to the purpose. The assembler converts your representations into the binary values required by the machine language.

Controlling Address Assignment

If you code the correct assembler instruction, the assembler computes the displacement from a base address of any symbolic addresses you specify in a machine instruction. It inserts this displacement, along with the base register assigned by the assembler instruction, into the object code of the machine instruction.

At execution time, the object code of address references must be in base-displacement form. The computer obtains the required address by adding the displacement to the base address contained in the base register.

Relocatability

The assembler produces an object module that is independent of the location it is initially assigned in virtual storage. That is, it can be loaded into any suitable virtual storage area without affecting program execution. This is made easier because most addresses are assembled in their base-displacement form.

Sectioning a Program

You can divide a source module into one or more control sections. After assembly, you can include or delete individual control sections from the resulting object module before you load it for execution. Control sections can be loaded separately into storage areas that are not contiguous. A discussion of sectioning is contained in "Program Sectioning and Linking" on page 49.

Linkage between Source Modules

You can create symbolic linkages between separately assembled source modules. This lets you refer symbolically from one source module to data and instructions defined in another source module. You can also use symbolic addresses to branch between modules.

A discussion of sectioning and linking is contained in “Program Sectioning and Linking” on page 49.

Program Listings

The assembler produces a listing of your source module, including any generated statements, and the object code assembled from the source module. You can control the form and content of the listing using assembler listing control instructions, assembler options, and user I/O exits. The listing control instructions are described in Chapter 5, “Assembler Instruction Statements” on page 87, and in “Processing Statements” on page 229. Assembler options and user I/O exits are discussed in the *HLASM Programmer's Guide*.

The assembler also prints messages about actual errors and warnings about potential errors in your source module.

Chapter 2. Coding and Structure

This chapter provides information about assembler language coding conventions and assembler language structure.

Character Set

High Level Assembler provides support for both standard single-byte characters and double-byte characters.

Standard Character Set

The standard character set used by High Level Assembler is a subset of the EBCDIC character set. This subset consists of letters of the alphabet, national characters, the underscore character, digits, and special characters. The complete set of characters that make up the standard assembler language character set is shown in Figure 3.

Figure 3. Standard Character Set

Alphabetic characters	a through z A through Z national characters @, \$, and # underscore character _
Digits	0 through 9
Special characters	+ - , = . * () ' / & blank

For a description of the binary and hexadecimal representations of the characters that make up the standard character set, see Appendix D, “Standard Character Set Code Table” on page 377.

When you code terms and expressions (see “Terms, Literals, and Expressions” on page 27) in assembler language statements, you can only use the set of characters described above. However, when you code remarks, comments or character strings between paired single quotation marks, you can use any character in the EBCDIC character set.

The term *alphanumeric characters* includes both alphabetic characters and digits, but not special characters. Normally, you would use strings of alphanumeric characters to represent terms, and special characters as:

- Arithmetic operators in expressions
- Data or field delimiters
- Indicators to the assembler for specific handling

Whenever a lowercase letter (a through z) is used, the assembler considers it to be identical to the corresponding uppercase character (A through Z), except when it is used within a character string enclosed in single quotation marks, or within the positional and keyword operands of macro instructions.

Compatibility with Earlier Assemblers: You can specify the COMPAT(MACROCASE) assembler option to instruct the assembler to maintain uppercase alphabetic character set compatibility with earlier assemblers for unquoted macro operands. The assembler converts lowercase alphabetic characters (a through z) in unquoted macro operands to uppercase alphabetic characters (A through Z).

Double-Byte Character Set

In addition to the standard EBCDIC set of characters, High Level Assembler accepts double-byte character set (DBCS) data. The double-byte character set consists of the following:

Figure 4. Double-Byte Character Set (DBCS)

Double-byte blank	X'4040'
Double-byte characters	Each double-byte character contains two bytes, each of which must be in the range X'41' to X'FE'. The first byte of a double-byte character is known as the <i>ward</i> byte. For example, the ward character for the double-byte representation of EBCDIC characters is X'42'.
Shift codes	Shift-out (SO) - X'0E' Shift-in (SI) - X'0F'

Note:

1. SO and SI delimit DBCS data only when the DBCS assembler option is specified. The DBCS assembler option is described in the *HLASM Programmer's Guide*.
2. When the DBCS assembler option is specified, double-byte characters may be used anywhere that EBCDIC characters enclosed by single quotation marks can be used.
3. Regardless of the invocation option, double-byte characters may be used in remarks, comments, and the statements processed by AREAD and REPRO statements.

Examples showing the use of EBCDIC characters and double-byte characters are given in Figure 5. For a description of the DBCS notation used in the examples, see "Double-Byte Character Set Notation" on page xv.

Figure 5 (Page 1 of 2). Examples Using Character Set

Characters	Usage	Example	Constituting
Alphanumeric	In ordinary symbols	Label FIELD#01 Save_Tota1	Terms
	In variable symbols	&EASY-TO-READ	
Digits	As decimal	1	Terms
	self-defining terms	9	

Figure 5 (Page 2 of 2). Examples Using Character Set

Characters	Usage	Example	Constituting
Special Characters	As operators		
+	Addition	NINE+FIVE	Expressions
-	Subtraction	NINE-5	Expressions
*	Multiplication	9*FIVE	Expressions
/	Division	TEN/3	Expressions
+ or -	(Unary)	+NINE -FIVE	Terms
	As delimiters		
Blanks	Between fields	LABEL AR 3,4	Statement
Comma	Between operands	OPND1,OPND2	Operand field
Single Quotation Marks	Enclosing character strings	'STRING'	String
	Attribute operator	L'OPND1	Term
Parentheses	Enclosing subfields or subexpressions	MOVE MVC TO(80),FROM(A+B*(C-D))	Statement Expression
SO and SI	Enclosing double-byte data	C'<.A.B.C>abc' G'<D1D2D3D4>'	Mixed string Pure DBCS
	As indicators for		
Ampersand	Variable symbol	&VAR	Term
Period	Symbol qualifier	QUAL.SYMBOL	Term
	Sequence symbol	.SEQ	(label)
	Comment statement in macro definition	.*THIS IS A COMMENT	Statement
	Concatenation	&VAR.A	Term
	Bit-length specification	DC CL.7'AB'	Operand
	Decimal point	DC F'1.7E4'	Operand
Asterisk	Location counter reference	**72	Expression
	Comment statement	*THIS IS A COMMENT	Statement
Equal sign	Literal reference	L 6,=F'2'	Statement
	Keyword	&KEY=D	Keyword parameter

Translation Table

In addition to the standard EBCDIC set of characters, High Level Assembler can use a user-specified translation table to convert the characters contained in character (C-type) data constants (DCs) and literals. High Level Assembler provides a translation table to convert the EBCDIC character set to the ASCII character set. You can supply a translation table using the TRANSLATE assembler option described in the *docid=asma100.HLASM Programmer's Guide*.

Self-defining Terms: Self-defining terms are not translated when a translation table is used. See “How to Generate a Translation Table” in the *HLASM Programmer's Guide*.

Assembler Language Coding Conventions

Figure 6 shows the standard format used to code an assembler language statement.

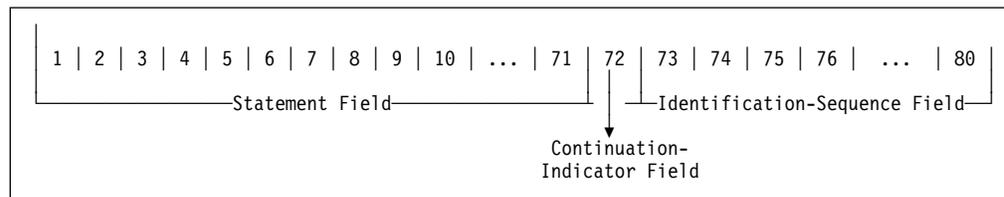


Figure 6. Standard Assembler Coding Format

Field Boundaries

Assembler language statements usually occupy one 80-character record, or line. For information about statements that occupy more than 80 characters, see “Continuation Lines” on page 15. Each line is divided into three main fields:

- Statement field
- Continuation-indicator field
- Identification-sequence field

If it can be printed, any character coded into any column of a line, or otherwise entered as a position in a source statement, is reproduced in the listing printed by the assembler. Whether it can be printed or not depends on the printer.

Uppercase Printing: Use the FOLD assembler option to instruct the assembler to convert lowercase alphabetic characters to uppercase alphabetic characters before they are printed.

Statement Field

The instructions and comment statements must be written in the statement field. The statement field starts in the *begin* column and ends in the *end* column. The continuation-indicator field always lies in the column after the *end* column, unless the *end* column is column 80, in which case no continuation is possible. The identification-sequence field usually lies in the field after the continuation-indicator field. Any continuation lines needed must start in the *continue* column and end in the *end* column.

The assembler assumes the following standard values for these columns:

- The *begin* column is column 1
- The *end* column is column 71
- The *continue* column is column 16

These standard values can be changed by using the Input Format Control (ICTL) assembler instruction. The ICTL instruction can, for example, be used to reverse the order of the statement field and the identification-sequence field by changing the standard *begin*, *end*, and *continue* columns. However, all references to the *begin*, *end*, and *continue* columns in this manual refer to the standard values described above.

Continuation-Indicator Field

The continuation-indicator field occupies the column after the end column. Therefore, the standard position for this field is column 72. A non-blank character in this column indicates that the current statement is continued on the next line. This column must be blank on the last (or only) line of a statement. If this column is not blank, the assembler treats the statement that follows on the next line as a continuation line of the current statement.

If the DBCS assembler option is specified, then:

- When an SI is placed in the end column of a continued line, and an SO is placed in the continue column of the next line, the SI and SO are considered redundant and are removed from the statement before statement analysis is done.
- An extended continuation-indicator provides the ability to extend the end column to the left on a line-by-line basis, so that any alignment of double-byte data in a source statement can be supported.
- The double-byte delimiters SO and SI cannot be used as continuation-indicators.

Identification-Sequence Field

The identification-sequence field can contain identification characters or sequence numbers or both. If the ISEQ instruction has been specified to check this field, the assembler verifies whether or not the source statements are in the correct sequence.

The columns checked by the ISEQ function are not restricted to columns 73 through 80, or by the boundaries determined by any ICTL instruction. The columns specified in the ISEQ instruction can be anywhere on the input statement, including columns that are occupied by the statement field.

Continuation Lines

To continue a statement on another line, follow these rules:

1. Enter a non-blank character in the continuation-indicator field (column 72). This non-blank character must not be part of the statement coding. When more than one continuation line is needed, enter a non-blank character in column 72 of each line that is to be continued.
2. Continue the statement on the next line, starting in the continue column (column 16). Columns to the left of the continue column must be blank. Comment statements may be continued after column 16.

Assembler Language Coding Conventions

If an operand is continued after column 16, it is taken to be a comment. Also, if the continuation-indicator field is filled in on one line and you try to start a new statement after column 16 on the next line, this statement is taken as a comment belonging to the previous statement.

Specify the FLAG(CONT) assembler option to instruct the assembler to issue warning messages when it suspects a continuation error in a macro call instruction. Refer to the FLAG option description in the *HLASM Programmer's Guide* for details about the situations that might be flagged as continuation errors.

Unless it is one of the statement types listed below, nine continuation lines are allowed for a single assembler language statement.

Alternative Statement Format

The alternative statement format, which allows as many continuation lines as are needed, can be used for the following instructions:

- AGO conditional assembly statement, see “Alternative Format for AGO Statement” on page 350
- AIF conditional assembly statement, see “Alternative Format for AIF Statement” on page 349
- GBLA, GBLB, and GBLC conditional assembly statements, see “Alternative Format for GBLx Statements” on page 316
- LCLA, LCLB, and LCLC conditional assembly statements, see “Alternative Format for LCLx Statements” on page 318
- Macro instruction statement, see “Alternative Ways of Coding a Macro Instruction” on page 272
- Prototype statement of a macro definition, see “Alternative Ways of Coding the Prototype Statement” on page 220
- SETA, SETB, SETAF, SETCF and SETC conditional assembly statements, see “Alternative Statement Format” on page 342

Examples of the alternative statement format for each of these instructions are given with the description of the individual instruction.

Continuation of double-byte data

No special considerations apply to continuation:

- Where double-byte data is created by a code-generation program, and
- There is no requirement for double-byte data to be readable on a device capable of presenting DBCS characters

A double-byte character string may be continued at any point, and SO and SI must be balanced within a field, but not within a statement line.

Where double-byte data is created by a workstation that has the capability of presenting DBCS characters, such as the IBM 5550 multistation, or where readability of double-byte data in High Level Assembler source input or listings is required, special features of the High Level Assembler language may be used. When the DBCS assembler option is specified, High Level Assembler provides the flexibility to cater for any combination of double-byte data and single-byte data. The special features provided are:

- Removal of redundant SI/SO at continuation points. When an SI is placed in the end column of a continued line, and an SO is placed in the continue

column of the next line, the SI and SO are considered redundant and are removed from the statement before statement analysis.

- An extended continuation-indicator provides a flexible end column on a line-by-line basis to support any alignment of double-byte data in a source statement. The end column of continued lines may be shifted to the left by extending the continuation-indicator.
- To guard against accidental continuation caused by double-byte data ending in the continuation-indicator column, neither SO nor SI is regarded as a continuation-indicator. If either is used, the following warning message is issued:

```
ASMA201W SO or SI in continuation column - no continuation
assumed
```

The examples below show the use of these features. Refer to “Double-Byte Character Set Notation” on page xv for the notation used in the examples.

Source Input Considerations

- Extended continuation-indicators may be used in any source statement, including macro statements and statements included by the COPY instruction. This feature is intended for source lines containing double-byte data.
- On a line with a nonblank continuation-indicator, the end column is the first column to the left of the continuation-indicator which has a value different from the continuation-indicator.
- When converting existing programs for assembly with the DBCS option, ensure that continuation-indicators are different from the adjacent data in the end column.
- The extended continuation-indicators must not be extended into the continue column, otherwise the extended continuation-indicators are treated as data, and the assembler issues the following error message:

```
ASMA205E Extended continuation column must not extend into continue
column
```

- For SI and SO to be removed at continuation points, the SI must be in the end column, and the SO must be in the continue column of the next line.

Examples:

Name	Operation	Operand	Continuation
DBCS1	DC	C'<D1D2D3D4D5D6D7D8D9>XXXXXXXXXXXXXXXXXXXXX <DaDb>'	↓
DBCS2	DC	C'abcdefghijklmnopqrstuvwxy0123456789XXXX <DaDb>'	
DBCS3	DC	C'abcdefghijklmnopqrstuv<D1D2D3D4D5D6D7>XX <DaDb>'	

DBCS1: The DBCS1 constant contains 11 double-byte characters bracketed by SO and SI. The SI and SO at the continuation point are not assembled into the operand. The assembled value of DBCS1 is:

```
<D1D2D3D4D5D6D7D8D9DaDb>
```

Assembler Language Coding Conventions

DBCS2: The DBCS2 constant contains an EBCDIC string which is followed by a double-byte string. Because there is no space for any double-byte data on the first line, the end column is extended three columns to the left and the double-byte data started on the next line. The assembled value of DBCS2 is:

```
abcdefghijklmnopqrstuvwxy0123456789<DaDb>
```

DBCS3: The DBCS3 constant contains 22 EBCDIC characters followed by 9 double-byte characters. Alignment of the double-byte data requires that the end column be extended one column to the left. The SI and SO at the continuation point are not assembled into the operand. The assembled value of DBCS3 is:

```
abcdefghijklmnopqrstuv<D1D2D3D4D5D6D7DaDb>
```

Source Listing Considerations

- For source that does not contain substituted variable symbols, the listing exactly reflects the source input.
- Double-byte data input from code-generation programs, that contain no substituted variables, are not readable in the listing if the source input was not displayable on a device capable of presenting DBCS characters.
- Refer to “Listing of Generated Fields Containing Double-Byte Data” on page 223 for details of extended continuation and macro-generated statements.

| **Blank Lines**

| Blank lines are accepted in source programs. In **open code**, each blank line is
| treated as equivalent to a SPACE 1 statement. In the body of a **macro definition**,
| each blank line is treated as equivalent to an ASPACE 1 statement.

Comment Statement Format

Comment statements are not assembled as part of the object module, but are only printed in the assembly listing. You can write as many comment statements as you need, provided you follow these rules:

- Comment statements require an asterisk in the begin column. Internal macro definition comment statements require a period in the begin column, followed by an asterisk. Internal macro comments are accepted as comment statements in open code.
- Any characters of the EBCDIC character set, or double-byte character set can be used (see “Character Set” on page 11).
- Comment statements must lie within the statement field. If the comment extends into the continuation-indicator field, the statement following the comment statement is considered a continuation line of that comment statement.
- Comment statements must not appear between an instruction statement and its continuation lines.

Instruction Statement Format

Instruction statements must consist of one to four entries in the statement field. They are:

- A name entry
- An operation entry
- An operand entry
- A remarks entry

These entries must be separated by one or more blanks, and must be written in the order stated.

Statement Coding Rules

The following general rules apply to the coding of an instruction statement:

- The entries must be written in the following order: name, operation, operand, and remarks.
- The entries must be contained in the begin column (1) through the end column (71) of the first line and, if needed, in the continue column (16) through the end column (71) of any continuation lines.
- The entries must be separated from each other by one or more blanks.
- If used, a name entry must start in the begin column.
- The name and operation entries, each followed by at least one blank, must be contained in the first line of an instruction statement.
- The operation entry must begin at least one column to the right of the begin column.

Statement Example: The following example shows the use of name, operation, operand, and remarks entries. The symbol COMP names a compare instruction, the operation entry (CR) is the mnemonic operation code for a register-to-register compare operation, and the two operands (5,6) designate the two general registers whose contents are to be compared. The remarks entry reminds readers that this instruction compares NEW SUM to OLD.

```
COMP      CR              5,6                NEW SUM TO OLD
```

Descriptions of the name, operation, operand, and remarks entries follow:

Name Entry: The name entry is a symbol created by you to identify an instruction statement. A name entry is usually optional. Except for two instances, the name entry, when provided, must be a valid symbol at assembly time (after substituting variable symbols, if specified). For a discussion of the exceptions to this rule, see “TITLE Instruction” on page 191 and “Macro Instruction Format” on page 271.

The symbol must consist of 63 or less alphanumeric characters, the first of which must be alphabetic. It must be entered with the first character appearing in the begin column. If the begin column is blank, the assembler program assumes no name has been entered. No blanks or double-byte data may appear in the symbol.

Operation Entry: The operation entry is the symbolic operation code specifying the machine, assembler, or macro instruction operation. The following rules apply to the operation entry:

- An operation entry is mandatory.

Assembler Language Coding Conventions

- For machine and assembler instructions, it must be a valid symbol at assembly time (after substitution for variable symbols, if specified), consisting of 63 or less alphanumeric characters, the first which must be alphabetic. Most standard symbolic operation codes are five characters or less. For a description of machine instructions, see the applicable *Principles of Operation* manual. For a summary of assembler instructions, see Appendix A, “Assembler Instructions.”

The standard set of codes can be changed by OPSYN instructions (see “OPSYN Instruction” on page 176).

- For macro instructions, the operation entry can be any valid symbol.
- An operation entry cannot be continued on the next statement.

Operand Entries: Operand entries contain zero or more operands that identify and describe data to be acted upon by the instruction, by indicating such information as storage locations, masks, storage area lengths, or types of data. The following rules apply to operands:

- One or more operands are usually required, depending on the instruction.
- Operands must be separated by commas. No blanks are allowed between the operands and the commas that separate them.
- A blank normally indicates the end of the operand entry, unless the operand is in single quotes. This applies to machine, assembler, and macro instructions.

The following instruction is correctly coded:

```
LA          R1,4+5          No blank
```

The following instruction may appear to be the same, but is not:

```
LA          R1,4 + 5          Blanks included
```

In this example, the embedded blank means that the operand finishes after “4.” There is no assembler error, but the result is a LA R1,4, which may not be what you intended.

A blank inside unquoted parentheses is an error, and leads to a diagnostic. The following instruction is correctly coded:

```
DC          CL(L'STRLEN)' '   Blank within quotes
```

The following instruction, with an extra blank, is not correct:

```
DC          CL(L'STRLEN )' '   Blank not within quotes
```

The following example shows a blank enclosed in quotes, as part of a string. This blank is properly accounted for:

```
MVC        AREA1,=C'This Area' Blank inside quotes
```

If parentheses are quoted, then blanks can be included:

```
LA          R1,=C'This is OK (isn't it)'
```

Remarks Entries: Remarks are used to describe the current instruction. The following rules apply to remarks:

- Remarks are optional.

- They can contain any character from the EBCDIC character set, or the double-byte characters set.
- They can follow any operand entry.
- In statements in which an optional operand entry is omitted, but you want to code a comment, indicate the absence of the operand by a comma preceded and followed by one or more blanks, as shown below:

```
END           ,           End of Program
```

Assembler Language Structure

This section describes the structure of the assembler language, including the statements that are allowed in the language, and the elements that make up those statements.

“Statement Coding Rules” on page 19 describes the composition of an assembler language source statement.

The figures in this section show the overall structure of the statements that represent the assembler language instructions, and are not specifications for these instructions. The individual instructions, their purposes, and their specifications are described in other sections of this manual.

Model statements, used to generate assembler language statements, are described in Chapter 7, “How to Specify Macro Definitions.”

The remarks entry in a source statement is not processed by the assembler, but it is printed in the assembler listing. For this reason, it is only shown in the overview of the assembler language structure in Figure 7 on page 22, and not in the other figures.

The machine instruction statements are described in Figure 8 on page 23, discussed in Chapter 4, “Machine Instruction Statements,” and summarized in the applicable *Principles of Operation* manual.

Assembler instruction statements are described in Figure 9 on page 24, discussed in Chapter 3, “Addressing, Program Sectioning, and Linking” and Chapter 5, “Assembler Instruction Statements,” and are summarized in Appendix A, “Assembler Instructions.”

Conditional assembly instruction statements and the macro processing statements (MACRO, MEND, MEXIT, MNOTE, AREAD, ASPAGE, and AEJECT) are described in Figure 10 on page 25. The conditional assembly instructions are discussed in Chapter 9, “How to Write Conditional Assembly Instructions,” and macro processing instructions in Chapter 7, “How to Specify Macro Definitions.” Both types are summarized in Appendix A, “Assembler Instructions.”

Macro instruction statements are described in Figure 11 on page 26, and discussed in Chapter 8, “How to Write Macro Instructions” on page 271.

Overview of Assembler Language Structure

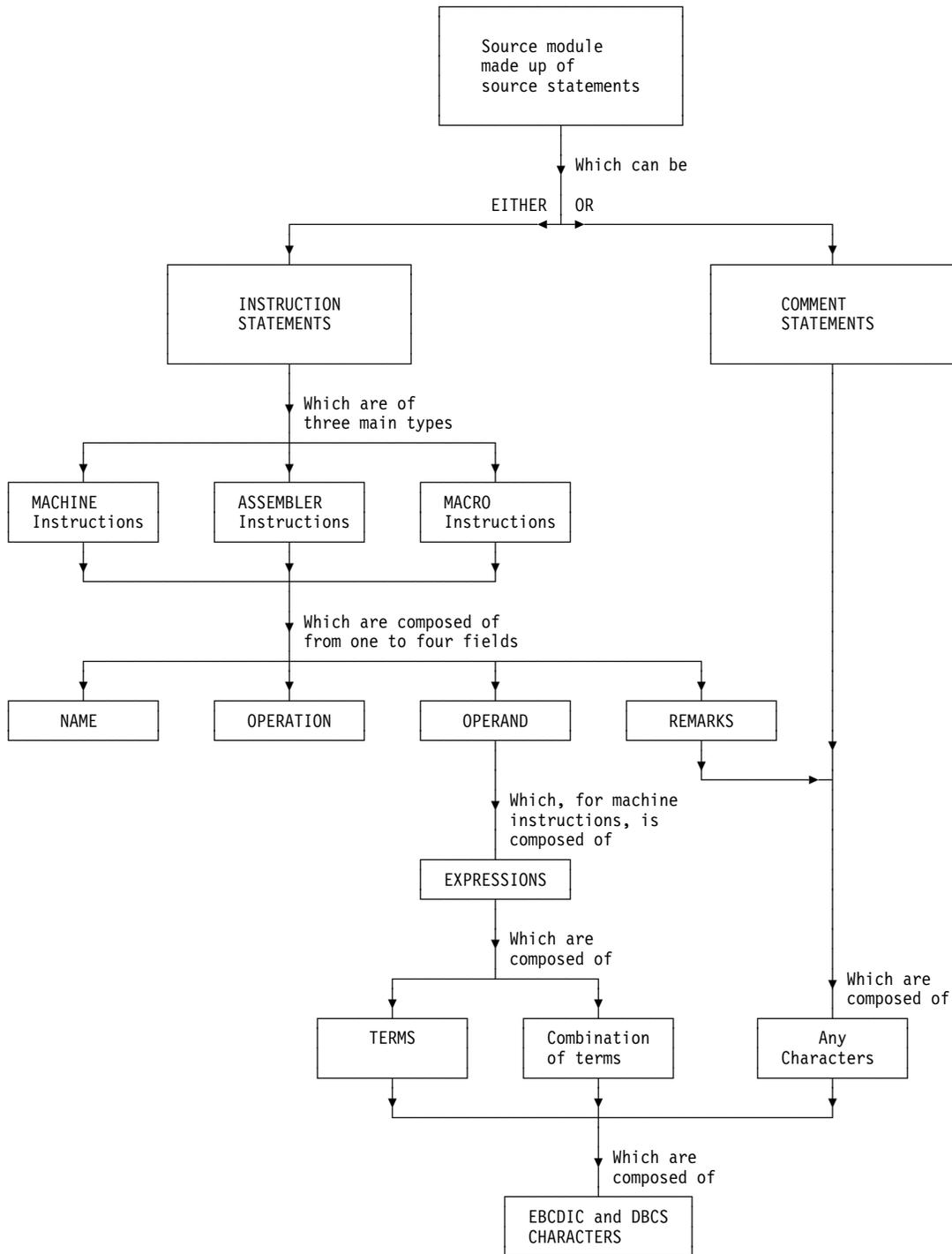
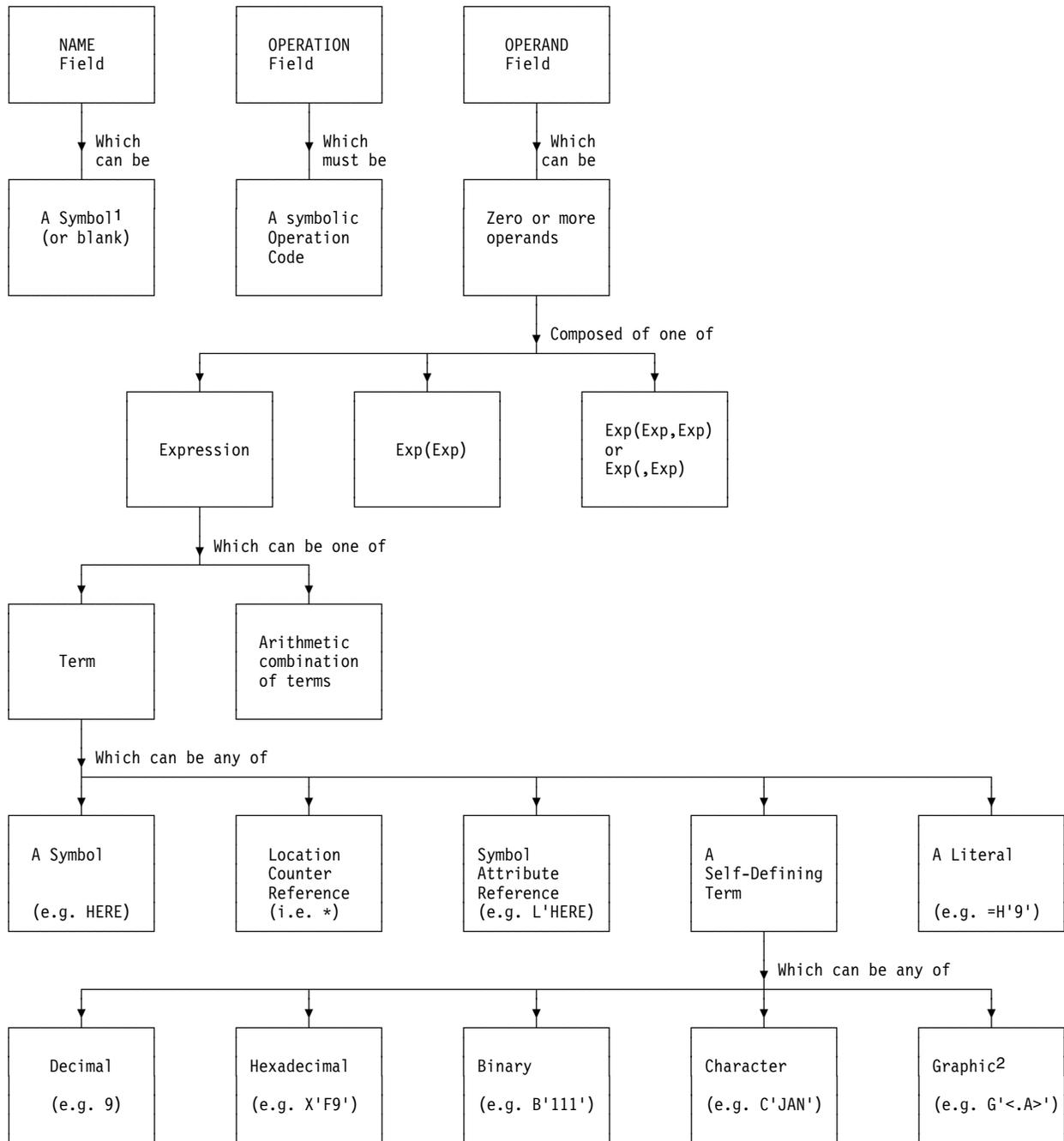


Figure 7. Overview of Assembler Language Structure

Machine Instructions

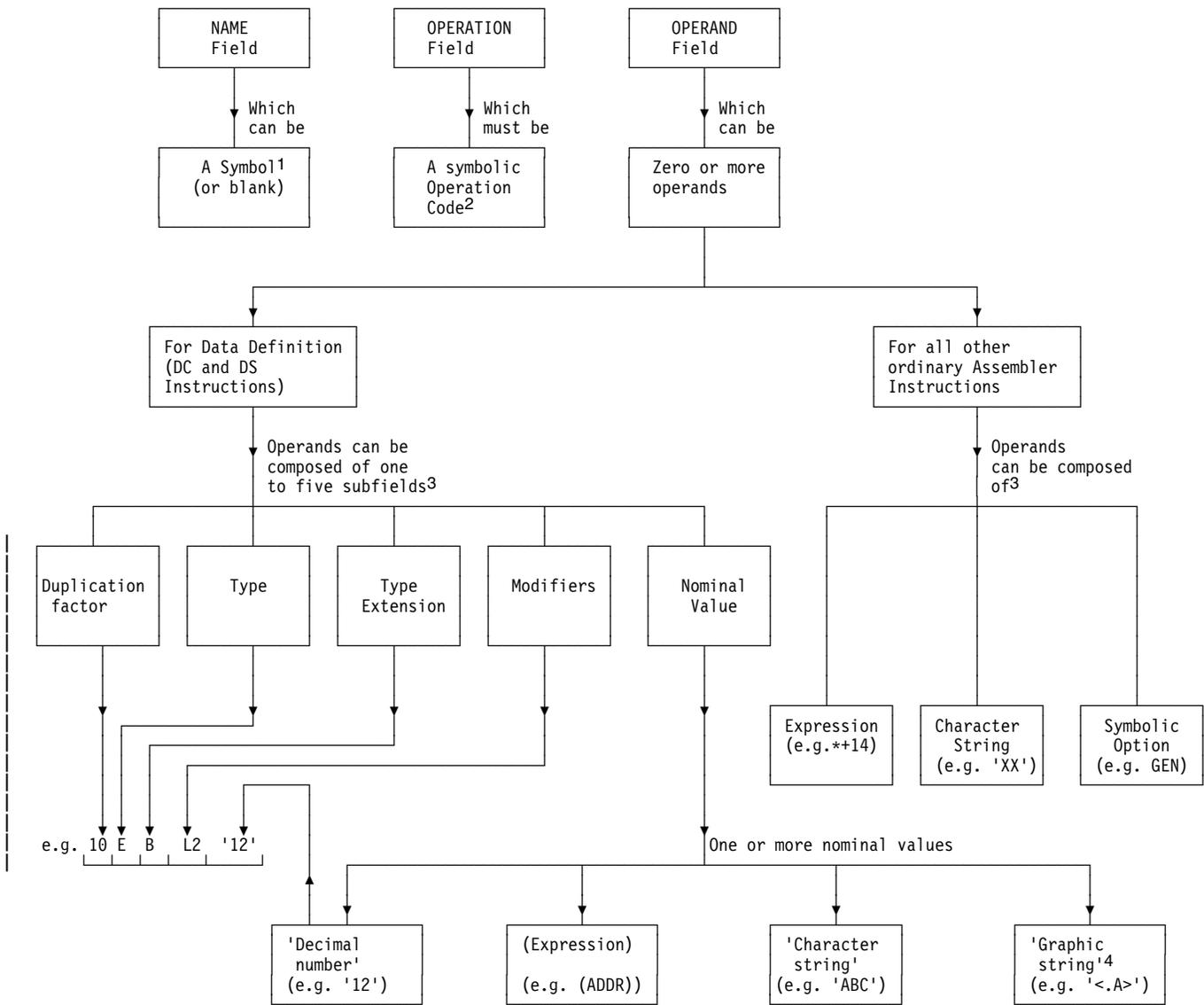


¹ Can be an ordinary symbol, a variable symbol, or a sequence symbol

² With DBCS option only

Figure 8. Machine Instructions

Assembler Instructions



1 Can be an ordinary symbol, a variable symbol, or a sequence symbol
 2 Includes symbolic operation codes of macro definitions
 3 Discussed more fully where individual instructions are described
 4 With DBCS option only

Figure 9. Ordinary Assembler Instruction Statements

Conditional Assembly Instructions

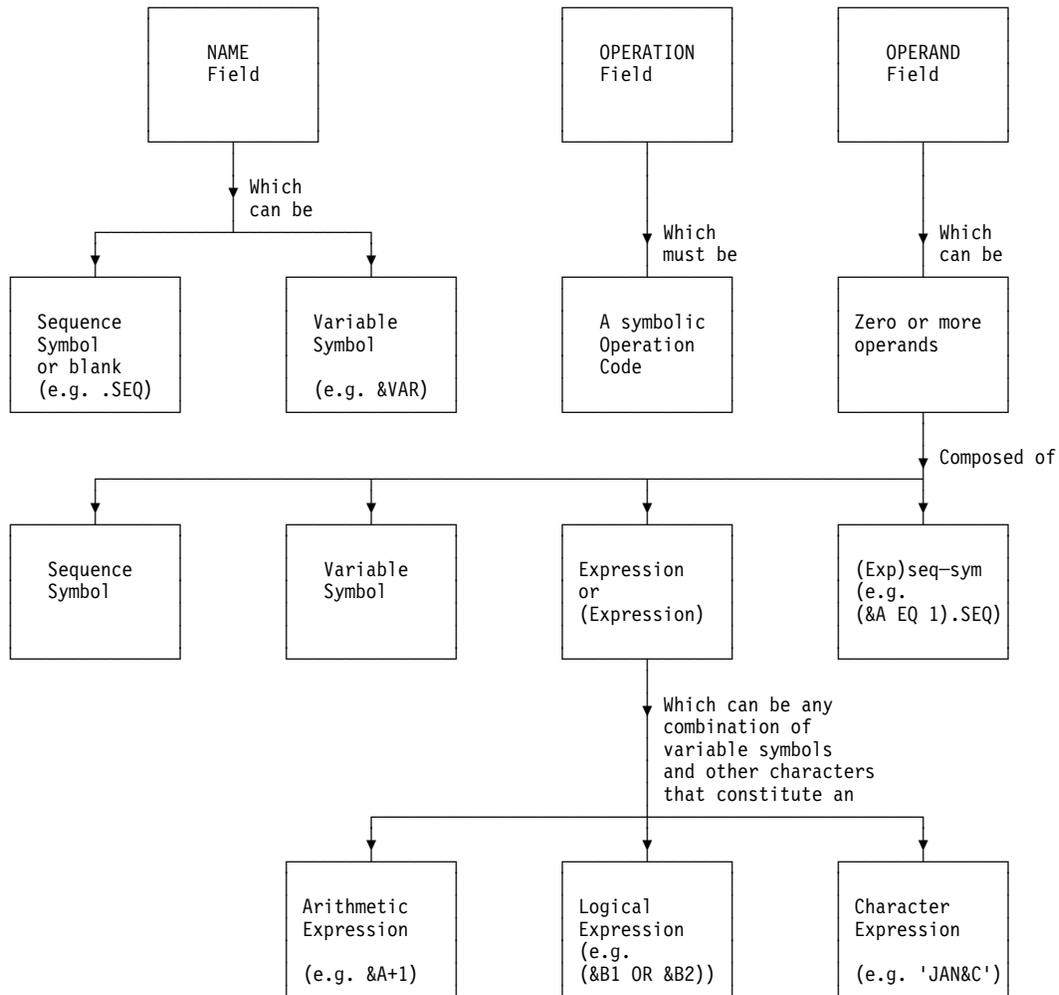


Figure 10. Conditional Assembly Instructions

Macro instruction statements are described in Figure 11 on page 26.

Macro Instructions

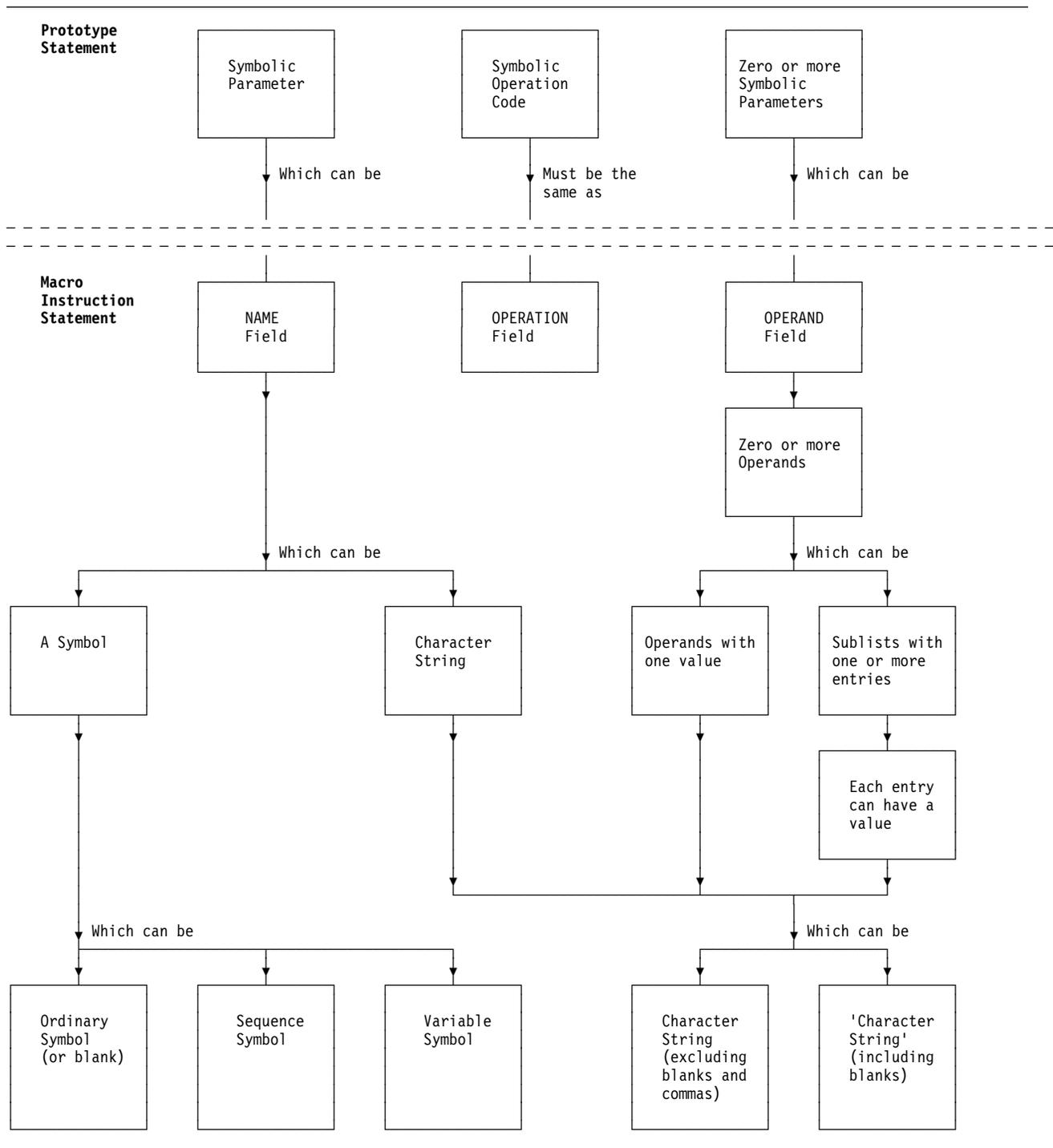


Figure 11. Macro Instructions

Terms, Literals, and Expressions

The most basic element of the assembler language is the *term*. Terms may be used alone, or in combination with other terms in expressions. This section describes the different types of terms used in the assembler language, and how they can be used.

Terms

A term is the smallest element of the assembler language that represents a distinct and separate value. It can, therefore, be used alone or in combination with other terms to form expressions. Terms are classified as absolute or relocatable, depending on the effect of program relocation upon them. *Program relocation* is the loading of the object program into storage locations other than those originally assigned by the assembler. Terms have absolute or relocatable values that are assigned by the assembler or that are inherent in the terms themselves.

A term is absolute if its value does not change upon program relocation. A term is relocatable if its value changes by n if the origin of the control section in which it appears is relocated by n bytes.

Terms in Parentheses: Terms in parentheses are reduced to a single value; thus the terms in parentheses, in effect, become a single term.

You can use arithmetically combined terms, enclosed in parentheses, in combination with terms outside the parentheses, as follows:

$14+BETA-(GAMMA-LAMBDA)$

When the assembler encounters terms in parentheses in combination with other terms, it first reduces the combination of terms inside the parentheses to a single value which may be absolute or relocatable, depending on the combination of terms. This value is then used in reducing the rest of the combination to another single value.

You can include terms in parentheses within a set of terms in parentheses:

$A+B-(C+D-(E+F)+10)$

The innermost set of terms in parentheses is evaluated first. Any number of levels of parentheses are allowed. A *level of parentheses* is a left parenthesis and its corresponding right parenthesis. An arithmetic combination of terms is evaluated as described in “Expressions” on page 42. Figure 12 summarizes the various types of terms, and gives a reference to the page number that discusses the term and the rules for using it.

Figure 12 (Page 1 of 2). Summary of Terms

Terms	Term can be absolute	Term can be relocatable	Value is assigned by assembler	Value is inherent in term	Page reference
Symbols	X	X	X		28
Self-defining terms	X			X	32

Figure 12 (Page 2 of 2). Summary of Terms

Terms	Term can be absolute	Term can be relocatable	Value is assigned by assembler	Value is inherent in term	Page reference
Location counter reference		X	X		35
Symbol length attribute	X		X		37
Other data attributes ¹	X		X		39

Notes:

1. Other valid data attributes are S and I.

Symbols

You can use a symbol to represent storage locations or arbitrary values. If you write a symbol in the name field of an instruction, you can then specify this symbol in the operands of other instructions and thus refer to the former instruction symbolically. This symbol represents a relocatable address.

You can also assign an absolute value to a symbol by coding it in the name field of an EQU instruction with an operand whose value is absolute. This lets you use this symbol in instruction operands to represent:

- Registers
- Displacements in explicit addresses
- Immediate data
- Lengths
- Implicit addresses with absolute values

For details of these program elements, see “Operand Entries” on page 74.

The advantages of symbolic over numeric representation are:

- Symbols are easier to remember and use than numeric values, thus reducing programming errors and increasing programming efficiency.
- You can use meaningful symbols to describe the program elements they represent. For example, INPUT can name a field that is to contain input data, or INDEX can name a register to be used for indexing.
- You can change the value of one symbol that is used in many instructions (through an EQU instruction) more easily than you can change several numeric values in many instructions.
- Symbols are entered into a cross reference table that is printed in the *Ordinary Symbol and Literal Cross Reference* section of the assembler listing. The cross reference helps you find a symbol in the *source and object* section of the listing because it shows:
 - The number of the statement that defines the symbol. A symbol is defined when it appears in the name entry of a statement.
 - The number of all the statements in which the symbol is used as an operand.

Symbol Table: When the assembler processes your source statements for the first time, it assigns an absolute or relocatable value to every symbol that appears in the name field of an instruction. The assembler enters this value, which normally reflects the setting of the location counter, into the symbol table. It also enters the attributes associated with the data represented by the symbol. The values of the symbol and its attributes are available later when the assembler finds this symbol or attribute reference used as a term in an operand or expression. See “Symbol Length Attribute Reference” and “Self-Defining Terms” in this chapter for more details. The three types of symbols recognized by the assembler are:

- Ordinary symbols
- Variable symbols
- Sequence symbols

Ordinary Symbols: Ordinary symbols can be used in the name and operand fields of machine and assembler instruction statements. Code them to conform to these rules:

- The symbol must not consist of more than 63 alphanumeric characters. The first character must be an alphabetic character. An *alphabetic character* is a letter from A through Z, or from a through z, or \$, _, #, or @. The other characters in the symbol may be alphabetic characters, digits, or a combination of the two.
- No other special characters may be included in an ordinary symbol.
- No blanks are allowed in an ordinary symbol.
- No double-byte data is allowed in an ordinary symbol.

In the following sections, the term *symbol* refers to the ordinary symbol.

The following examples are valid ordinary symbols:

ORDSYM#435A	HERE	\$OPEN
K4	#0123	X
B49467LITTLENAIL	@33	_TOTAL_SAVED

Variable Symbols: Variable symbols must begin with an & followed by an alphabetic character and, optionally, up to 61 alphanumeric characters. Variable symbols can only be used in macro processing and conditional assembly instructions, and to provide substitution in machine and assembler instructions. They allow different values to be assigned to one symbol. A complete discussion of variable symbols appears in Chapter 7, “How to Specify Macro Definitions” on page 217.

The following examples are valid variable symbols:

&VARYINGSYMABC	&@ME
&F346944	&A
&EASY_TO_READ	

System Variable Symbol Prefix: A variable symbol should not begin with the characters &SYS as they are used to prefix System Variable Symbols. See “System Variable Symbols” on page 235 for a list of the System Variable Symbols provided with High Level Assembler.

Sequence Symbols: Sequence symbols consist of a period (.) followed by an alphabetic character, and up to 61 additional alphanumeric characters. Sequence symbols can be used only in macro processing and conditional assembly instructions. They are used to indicate the position of statements within the source program or macro definition. Use them to vary the sequence in which statements are processed by the assembler program. (See the complete discussion in Chapter 9, “How to Write Conditional Assembly Instructions.”)

The following examples are valid sequence symbols:

```
.BLABEL04          .#359
.BRANCHTOMEFIRST  .A
```

Symbol Definition: An ordinary symbol is defined in:

- The name entry in a machine or assembler instruction of the assembler language
- One of the operands of an EXTRN or WXTRN instruction

Ordinary symbols can also be defined in instructions generated from model statements during conditional assembly.

In Figure 13 on page 31, the assembler assigns a value to the ordinary symbol in the name entry according to the following rules:

1. The symbol is assigned a relocatable address value if the first byte of the storage field contains one of the following:
 - Any machine or assembler instruction, except the EQU or OPSYN instruction (see **1** in Figure 13)
 - A storage area defined by the DS instruction (see **2** in Figure 13)
 - Any constant defined by the DC instruction (see **3** in Figure 13)
 - A channel command word defined by the CCW, CCW0, or CCW1 instruction

The address value assigned is relocatable, because the object code assembled from these items is relocatable. The relocatability of addresses is described in “Addresses” on page 76.

2. The symbol is assigned the value of the first or only expression specified in the operand of an EQU instruction. This expression can have a *relocatable* (see **4** in Figure 13) or *absolute* (see **5** in Figure 13) value, which is then assigned to the ordinary symbol.

The value of an ordinary symbol must lie in the range -2^{31} through $+2^{31}-1$.

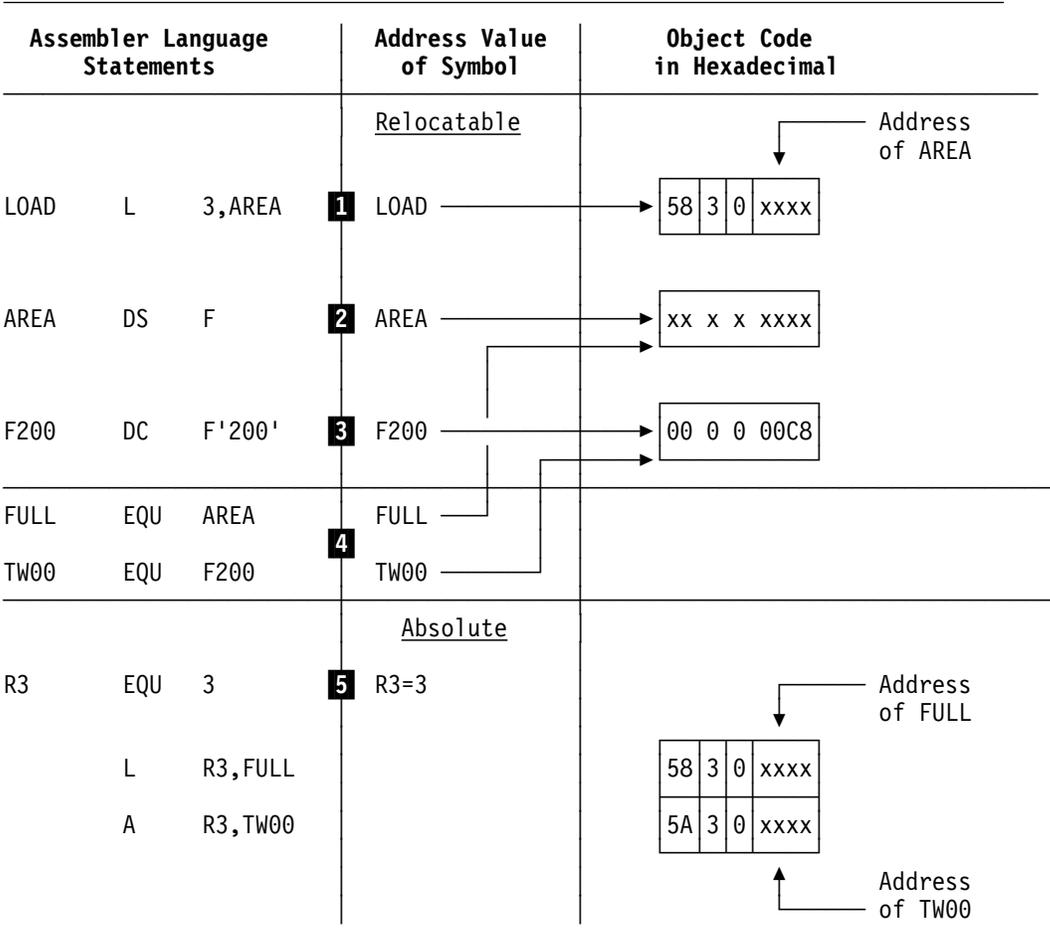


Figure 13. Transition from Assembler Language Statement to Object Code

Restrictions on Symbols: A symbol must be defined only once in a source module with one or more control sections, with the following exceptions:

- The symbol in the name field of a CSECT, RSECT, DSECT, or COM instruction can be the same as the name of previous CSECT, RSECT, DSECT, or COM instruction, respectively. It identifies the resumption of the control section specified by the name field.
- **CMS, MVS** The symbol in the name field of a CATTR instruction can be the same as the name of a previous CATTR instruction. It identifies the resumption of the class specified by the name field. **CMS, MVS**
- The symbol in the name field of a LOCTR instruction can be the same as the name of a previous START, CSECT, RSECT, DSECT, COM, or LOCTR instruction. It identifies the resumption of the location counter specified by the name field.
- The symbol in the name field of a labeled USING instruction can be the same as the name of a previous labeled USING instruction. It identifies the termination of the domain of the previous labeled USING instruction with the specified name.
- A symbol can be used as an operand of a V-type constant and as an ordinary label, without duplication.

An ordinary symbol is not defined when:

Terms, Literals, and Expressions

- It is used in the name field of an OPSYN or TITLE instruction. It can, therefore, be used in the name field of any other statement in a source module.
- It is only used in the name field of a macro instruction and does not appear in the name field of a macro-generated assembler statement. It can, therefore, be used in the name field of any other statement in a source module.
- It is only used in the name field of an ALIAS instruction and does not appear in one of the following:
 - The name field of a START, CSECT, RSECT, COM, or DXD instruction.
 - The name field of a DSECT instruction and the nominal value of a Q-type address constant.
 - The operand of an ENTRY, EXTRN or WXTRN instruction.
 - The nominal value of a V-type address constant.

Previously Defined Symbols: An ordinary symbol is *previously defined* if the statement that defines it is processed before the statement in which the symbol appears in the operand.

An ordinary symbol must be defined by the time the END statement is reached, however, it need not be previously defined when it is used as follows:

- In operand expressions of certain instructions such as CNOP instructions and some ORG instructions
- In modifier expressions of DC, DS, and DXD instructions
- In the first operand of an EQU instruction
- In Q-type constants

When using the forward-reference capability of the assembler, avoid the following types of errors:

- Circular definition of symbols, such as:

```
X      EQU      Y
Y      EQU      X
```

- Circular location-counter dependency, as in this example:

```
A      DS      (B-A)C
B      LR      1,2
```

The first statement in this example cannot be resolved because the value of the duplication factor is dependent on the location of B, which is, in turn, dependent upon the length and duplication factor of A.

Literals may contain symbolic expressions in modifiers, but any ordinary symbols used must have been previously defined.

Self-Defining Terms

A self-defining term lets you specify a value explicitly. With self-defining terms, you can also specify decimal, binary, hexadecimal, or character data. If the DBCS assembler option is specified, you can specify a graphic self-defining term that contains pure double-byte data, or include double-byte data in character self-defining terms. These terms have absolute values and can be used as absolute terms in expressions to represent bit configurations, absolute addresses, displacements, length or other modifiers, or duplication factors.

Using Self-Defining Terms: Self-defining terms represent machine language *binary values* and are absolute terms. Their values do not change upon program relocation. Some examples of self-defining terms and the binary values they represent are given below:

Self-Defining Term	Decimal Value	Binary Value
15	15	1111
241	241	1111 0001
B'1111'	15	1111
B'11110001'	241	1111 0001
B'100000001'	257	0001 0000 0001
X'F'	15	1111
X'F1'	241	1111 0001
X'101'	257	0001 0000 0001
C'1'	241	1111 0001
C'A'	193	1100 0001
C'AB'	49,602	1100 0001 1100 0010
G'<.A>'	17,089	0100 0010 1100 0001

The assembler carries the values represented by self-defining terms to 4 bytes or 32 bits, the high-order bit of which is the sign bit. (A '1' in the sign bit indicates a negative value; a '0' indicates a positive value.)

The use of a self-defining term is distinct from the use of data constants or literals. When you use a self-defining term in a machine instruction statement, its value is used to determine the binary value that is assembled into the instruction. When a data constant is referred to or a literal is specified in the operand of an instruction, its address is assembled into the instruction. Self-defining terms are always right-justified. Truncation or padding with zeros, if necessary, occurs on the left.

Decimal Self-Defining Term: A decimal self-defining term is simply an unsigned decimal number written as a sequence of decimal digits. High-order zeros may be used (for example, 007). Limitations on the value of the term depend on its use. For example, a decimal term that designates a general register should have a value between 0 and 15. A decimal term that represents an address should not exceed the size of storage. In any case, a decimal term may not consist of more than 10 digits, nor exceed 2,147,483,647 ($2^{31}-1$). A decimal self-defining term is assembled as its binary equivalent. Some examples of decimal self-defining terms are: 8, 147, 4092, and 00021.

Hexadecimal Self-Defining Term: A hexadecimal self-defining term consists of 1-to-8 hexadecimal digits enclosed in single quotation marks and preceded by the letter X; for example, X'C49'.

Each hexadecimal digit is assembled as its 4-bit binary equivalent. Thus, a hexadecimal term used to represent an 8-bit mask would consist of 2 hexadecimal digits. The maximum value of a hexadecimal term is X'FFFFFFFF'; this allows a range of values from -2,147,483,648 through 2,147,483,647.

The hexadecimal digits and their bit patterns are as follows:

Terms, Literals, and Expressions

0 - 0000	4 - 0100	8 - 1000	C - 1100
1 - 0001	5 - 0101	9 - 1001	D - 1101
2 - 0010	6 - 0110	A - 1010	E - 1110
3 - 0011	7 - 0111	B - 1011	F - 1111

When used as an absolute term in an expression, a hexadecimal self-defining term has a negative value if the high-order bit is 1.

Binary Self-Defining Term: A binary self-defining term is written as an unsigned sequence of 1s and 0s enclosed in single quotation marks and preceded by the letter B; for example, B'10001101'. A binary term may have up to 32 bits. This allows a range of values from -2,147,483,648 through 2,147,483,647.

When used as an absolute term in an expression, a binary self-defining term has a negative value if the term is 32 bits long and the high-order bit is 1.

Binary representation is used primarily in designating bit patterns of masks or in logical operations.

The following shows a binary term used as a mask in a Test Under Mask (TM) instruction. The contents of GAMMA are to be tested, bit by bit, against the pattern of bits represented by the binary term.

```
ALPHA    TM          GAMMA,B'10101101'
```

Character Self-Defining Term: A character self-defining term consists of 1-to-4 characters enclosed in single quotation marks, and must be preceded by the letter C. All letters, decimal digits, and special characters may be used in a character self-defining term. In addition, any of the remaining EBCDIC characters may be designated in a character self-defining term. Examples of character self-defining terms are:

```
C '/'  
C ' ' (blank)  
C 'ABC'  
C '13'
```

Because of the use of single quotation marks in the assembler language and ampersands in the macro language as syntactic characters, the following rule must be observed when using these characters in a character self-defining term:

For each single quotation mark or ampersand you want in a character self-defining term, two single quotation marks or ampersands must be written. For example, the character value A'# would be written as 'A' '#', while a single quotation mark followed by a blank and another single quotation mark would be written as ''' '''.

Each character in the character sequence is assembled as its 8-bit code equivalent (see Appendix D, "Standard Character Set Code Table" on page 377). The two single quotation marks or ampersands that must be used to represent a single quotation mark or ampersand within the character sequence are assembled as a single quotation mark or ampersand. Double-byte data may appear in a character self-defining term, if the DBCS assembler option is specified. The assembled value includes the SO and SI delimiters. Hence a character self-defining term containing double-byte data is limited to one double-byte character delimited by SO and SI. For example, C'<.A>'.

Since the SO and SI are stored, the null double-byte character string, C'<>', is also a valid character self-defining term.

Note: The assembler will not support character self-defining terms of the form CU'x' because self-defining terms are required by definition of the Assembler Language to have fixed values.

Graphic Self-Defining Term: If the DBCS assembler option is specified, a graphic self-defining term can be specified. A graphic self-defining term consists of 1 or 2 double-byte characters delimited by SO and SI, enclosed in single quotation marks and preceded by the letter G. Any valid double-byte characters may be used. Examples of graphic self-defining terms are:

```
G'<.A>'
G'<.A.B>'
G'<Da>'
G'<.A><.B>'
```

The SO and SI are not represented in the assembled value of the self-defining term, hence the assembled value is pure double-byte data. A redundant SI/SO pair can be present between two double-byte characters, as shown in the last of the above examples. However, if SO and SI are used without an intervening double-byte character, this error is issued:

ASMA148E Self-defining term lacks ending quote or has bad character

Location Counter Reference

The assembler maintains a location counter to assign storage addresses to your program statements. It is the assembler's equivalent of the instruction counter in the computer. You can refer to the current value of the location counter at any place in a source module by specifying an asterisk as a term in an operand.

As the instructions and constants of a source module are being assembled, the location counter has a value that indicates a location in the program. The assembler increments the location counter according to the following:

1. After an instruction or constant has been assembled, the location counter indicates the *next available location*.
2. Before assembling the current instruction or constant, the assembler checks the boundary alignment required for it and *adjusts the location counter*, if necessary, to the correct boundary.
3. While the instruction or constant is being assembled, the location counter value does not change. It indicates the location of the current data after boundary alignment and is the *value assigned to the symbol*, if present, in the name field of the statement.
4. After assembling the instruction or constant, the assembler increments the location counter by the length of the assembled data to *indicate the next available location*.

These rules are shown below:

Terms, Literals, and Expressions

Location in Hexadecimal		Source Statements
000004	DONE	DC CL3'ABC'
000007	BEFORE	EQU *
000008	DURING	DC F'200'
00000C	AFTER	EQU *
000010	NEXT	DS D

You can specify multiple location counters for each control section in a source module; for more details about the location counter setting in control sections, see “Location Counter Setting” on page 56.

Maximum Location Counter Value: The assembler carries internal location counter values as 4-byte (32-bit) values. When you specify the NOG OFF assembler option, the assembler uses only the low-order 3 bytes for the location counter, and prints only the low-order 3 bytes in the assembly listings. In this case the maximum valid location counter value is $2^{24}-1$.

CMS, MVS When you specify the G OFF assembler option, the assembler uses the entire 4-byte value for the location counter and prints the 4-byte value in the assembly listings. In this case the maximum valid location counter value is $2^{31}-1$.

CMS, MVS

If the location counter exceeds its valid maximum value the assembler issues error message

ASMA039S Location counter error

Controlling the Location Counter Value: You can control the setting of the location counter in a particular control section by using the START or ORG instruction, described in Chapter 3, “Addressing, Program Sectioning, and Linking” and Chapter 5, “Assembler Instruction Statements,” respectively. The counter affected by either of these assembler instructions is the counter for the control section in which they appear.

Referring to the Location Counter: You can refer to the current value of the location counter at any place in a program by using an asterisk as a term in an operand. The asterisk is a relocatable term, specified according to the following rules:

- The asterisk can be specified only in the operands of:
 - Machine instructions
 - DC and DS instructions
 - EQU, ORG, and USING instructions
- It can also be specified in *literal constants*. See “Literals” on page 39. For example:

```
THERE L 3,=A(*)
```

The value of the location counter reference (*) is the current value of the location counter of the control section in which the asterisk (*) is specified as a term. The asterisk has the same value as the *address of the first byte of the instruction* in which it appears. For example:

```
HERE B **8
```

where the value of * is the value of HERE.

For the value of the asterisk in address constants with duplication factors, see “Subfield 1: Duplication Factor” on page 116 of “DC Instruction” on page 110, and “Address Constants—A and Y” on page 135.

Symbol Length Attribute Reference

The length attribute of a symbol may be used as a term. Reference to the attribute is made by coding L' followed by the symbol, as in:

L'BETA

The length attribute of BETA is substituted for the term. When you specify a symbol length attribute reference, you obtain the length of the instruction or data named by a symbol. You can use this reference as a term in instruction operands to:

- Specify assembler-determined storage area lengths
- Cause the assembler to compute length specifications for you
- Build expressions to be evaluated by the assembler

The symbol length attribute reference must be specified according to the following rules:

- The format must be L' immediately followed by a valid symbol or the location counter reference (*).
- The symbol must be defined in the same source module in which the symbol length attribute reference is specified.
- The symbol length attribute reference can be used in the operand of any instruction that requires an absolute term. However, it cannot be used in the form L'* in any instruction or expression that requires a previously defined symbol.

The value of the length attribute is normally the length in bytes of the storage area required by an instruction, constant, or field represented by a symbol. The assembler stores the value of the length attribute in the symbol table along with the address value assigned to the symbol.

When the assembler encounters a symbol length attribute reference, it substitutes the value of the attribute from the symbol table entry for the symbol specified.

The assembler assigns the length attribute values to symbols in the name field of instructions as follows:

- For machine instructions (see **1** in Figure 14 on page 38), it assigns either 2, 4, or 6, depending on the format of the instruction.
- For the DC and DS instructions (see **2** in Figure 14), it assigns either the implicitly or explicitly specified length of the first or only operand. The length attribute is not affected by a duplication factor.
- For the EQU instruction, it assigns the length attribute value of the first or only term (see **3** in Figure 14) of the first expression in the first operand, unless a specific length attribute is supplied in a second operand.

Note the length attribute values of the following terms in an EQU instruction:

- Self-defining terms (see **4** in Figure 14)
- Location counter reference (see **5** in Figure 14)

Terms, Literals, and Expressions

– L'* (see **6** in Figure 14)

For assembler instructions such as DC, DS, and EQU, the length attribute of the location counter reference (L'* — see **6** in Figure 14) is equal to 1. For machine instructions, the length attribute of the location counter reference (L'* — see **7** in Figure 14) is equal to the length attribute of the instruction in which the L'* appears.

Figure 14. Assignment of Length Attribute Values to Symbols in Name Fields

Source Module		Length Attribute Reference	Value of Symbol Length Attribute At Assembly Time
MACHA	MVC TO, FROM	L'MACHA	6 1
MACHB	L 3,ADCON	L'MACHB	4 1
MACHC	LR 3,4	L'MACHC	2 1
TO	DS CL80	L'TO	80 2
FROM	DS CL240	L'FROM	240 2
ADCON	DC A(OTHER)	L'ADCON	4 2
CHAR	DC C'YUKON'	L'CHAR	5 2
DUPL	DC 3F'200'	L'DUPL	4 2
RELOC1	EQU TO 3	L'RELOC1	80
RELOC2	EQU TO+80 3	L'RELOC2	80
ABSOL1	EQU FROM-TO 3	L'ABSOL1	240
ABSOL2	EQU ABSOL1 3	L'ABSOL2	240
SDT1	EQU 102 3	L'SDT1	1 4
SDT2	EQU X'FF'+A-B 3	L'SDT2	1 4
SDT3	EQU C'YUK' 3	L'SDT3	1 4
ASTERISK	EQU **+10 3	L'ASTERISK	1 5
LOCTREF	EQU L'* 3	L'LOCTREF	1 6
LENGTH1	DC A(L'*)	L'*	1 6
		L'LENGTH1	4
LENGTH2	MVC TO(L'*), FROM	L'*	6 7
LENGTH3	MVC TO(L'TO-20), FROM	L'TO	80

The following example shows how to use the length attribute to move a character constant into either the high-order or low-order end of a storage field.

```

A1      DS          CL8
B2      DC          CL2'AB'
HIORD   MVC        A1(L'B2),B2
LOORD   MVC        A1+L'A1-L'B2(L'B2),B2
    
```

A1 names a storage field 8 bytes in length and is assigned a length attribute of 8. B2 names a character constant 2 bytes in length and is assigned a length attribute of 2. The statement named HIORD moves the contents of B2 into the first 2 bytes of A1. The term L'B2 in parentheses provides the length specification required by the instruction.

The statement named LOORD moves the contents of B2 into the extreme right 2 bytes of A1. The combination of terms A1+L'A1-L'B2 adds the length of A1 to the beginning address of A1, and subtracts the length of B2 from this value. The result is the address of the seventh byte in field A1. The constant represented by B2 is

moved into A1 starting at this address. L'B2 in parentheses provides the length specification in both instructions.

For ease in following the preceding example, the length attributes of A1 and B2 are specified explicitly in the DS and DC statements that define them. However, keep in mind that the L'symbol term makes coding such as this possible in situations where lengths are unknown. For example:

```
C3          DC          C'This is too long a string to be worth counting'
STRING     MVC         BUF(L'C3),C3
```

Other Attribute References

Other attributes describe the characteristics and structure of the data you define in a program; for example, the kind of constant you specify or the number of characters you need to represent a value. These other attributes are:

- Count (K')
- Defined (D')
- Integer (I')
- Number (N')
- Operation code (O')
- Scaling (S')
- Type (T')

You can refer to the count (K'), defined (D'), number (N'), and operation code (O') attributes only in conditional assembly instructions and expressions. For full details, see "Data Attributes" on page 296.

Literals

You can use literals as operands in order to introduce data into your program. The literal is a special type of relocatable term. It behaves like a symbol in that it represents data. However, it is a special kind of term because it also is used to define the constant specified by the literal. This is convenient because:

- The data you enter as numbers for computation, addresses, or messages to be printed is visible in the instruction in which the literal appears.
- You avoid the added effort of defining constants elsewhere in your source module and then using their symbolic names in machine instruction operands.

The assembler assembles the data item specified in a literal into a *literal pool* (See "Literal Pool" on page 42). It then assembles the address of this literal data item in the pool into the object code of the instruction that contains the literal specification. Thus, the assembler saves you a programming step by storing your literal data for you. The assembler also organizes literal pools efficiently, so that the literal data is aligned on the correct boundary alignment and occupies a minimum amount of space.

Literals, Constants, and Self-Defining Terms

Literals, constants, and self-defining terms differ in three important ways:

- Where you can specify them in machine instructions, that is, whether they represent data or an address of data
- Whether they have relocatable or absolute values
- What is assembled into the object code of the machine instruction in which they appear

Terms, Literals, and Expressions

Figure 15 on page 40 shows examples of the differences between literals, constants, and self-defining terms.

1. A literal with a relocatable address:

```
L    3,=F'33'    Register 3 set to 33.  See note 1
L    3,F33      Register 3 set to 33.  See note 2
.
.
.
F33  DC    F'33'
```

2. A literal with a self-defining term and a symbol with an absolute value

```
MVC  FLAG,=X'00'  FLAG set to X'00'.  See note 1
MVI  FLAG,X'00'  FLAG set to X'00'.  See note 3
MVI  FLAG,ZERO   FLAG set to X'00'.  See note 4
.
.
.
FLAG DS    X
ZERO EQU  X'00'
```

3. A symbol having an absolute address value specified by a self-defining term

```
LA   4,LOCORE   Register 4 set to 1000.  See note 4
LA   4,1000     Register 4 set to 1000.  See note 3
.
.
.
LOCORE EQU  1000
```

Notes:

1. A literal both defines data and represents data. The address of the literal is assembled into the object code of the instruction in which it is used. The constant specified by the literal is assembled into the object code, in the literal pool.
2. A constant is represented by a symbol with a relocatable value. The address of a constant is assembled into the object code.
3. A self-defining term has an absolute value. In this example, the absolute value of the self-defining term is assembled into the object code.
4. A symbol with an absolute value does not represent the address of a constant, but represents either immediate data or an absolute address. When a symbol with an absolute value represents immediate data, it is the absolute value that is assembled into the object code.

Figure 15. Differences between Literals, Constants, and Self-Defining Terms

General Rules for Using Literals

You can specify a literal as either a complete operand in a machine instruction, or as part of an expression in the operand of a machine instruction. A literal can also be specified as the name field on a macro call instruction.

Because literals define *read-only* data, they must not be used in operands that represent the receiving field of an instruction that modifies storage.

The assembler requires a description of the type of literal being specified as well as the literal itself. This descriptive information assists the assembler in assembling the literal correctly. The descriptive portion of the literal must indicate the format of the constant. It can also specify the length of the constant.

The method of describing and specifying a constant as a literal is nearly identical to the method of specifying it in a single operand of a DC assembler instruction. The only difference is that the literal must start with an equal sign (=), which indicates to the assembler that a literal follows.

A literal may be coded as indicated here:

```
=10XL5'F3'
```

where the subfields are:

```
Duplication factor 10
Type                X
Modifiers           L5
Nominal value      'F3'
```

The following instruction shows one use of a literal:

```
GAMMA    L                10,=F'274'
```

The statement GAMMA is a load instruction using a literal as the second operand. When assembled, the second operand of the instruction refers to the relative address at which the value F'274' is stored.

In general, literals can be used wherever a storage address is permitted as an operand, including in conjunction with an index register in instructions with the RX format. For example:

```
DELTA    LH                5,=H'11,23,39,48,64'(6)
```

is equivalent to:

```
DELTA    LH                5,LENGTHS(6)
          .
          .
          .
LENGTHS  DC                H'11,23,39,48,64'
```

See “DC Instruction” on page 110 for a description of how to specify the subfields in a literal.

Literals cannot be used in any assembler instruction where a previously defined symbol is required. Literals are relocatable terms because the address of the literal, rather than the literal-generated constant itself, is assembled in the statement that references a literal. The assembler generates the literals, collects them, and places them in a specific area of storage, as explained under “Literal Pool” on page 42. Because the assembler determines the order in which literals are placed in the literal pool, the effect of using two literals as paired relocatable terms (see “Paired Relocatable Terms” on page 44) is unpredictable.

“Referring to the Location Counter” on page 36 describes how you can use the current location counter in a literal.

Contrast with Immediate Data: You should not confuse a literal with the *immediate data* in an SI instruction. Immediate data is assembled into the instruction.

Literal Pool

The literals processed by the assembler are collected and placed in a special area called the literal pool. You can control the positioning of the literal pool. Unless otherwise specified, the literal pool is placed at the end of the first control section.

You can also specify that multiple literal pools be created. However, the assembler controls the sequence in which literals are ordered within the pool. Further information on positioning literal pools is in “LTORG Instruction” on page 171.

Expressions

This section discusses the expressions used in coding operand entries for source statements. You can use an expressions to specify:

- An address
- An explicit length
- A modifier
- A duplication factor
- A complete operand

Expressions have absolute and relocatable values. Whether an expression is absolute or relocatable depends on the value of the terms it contains. The assembler evaluates relocatable and absolute expressions at assembly time. Figure 16 shows examples of valid expressions.

There are three types of expression that you can use only in conditional assembly instructions: arithmetic, logical, and character expressions. They are evaluated during conditional assembly.

An expression is composed of a single term or an arithmetic combination of terms. The assembler reduces multiterm expressions to single values. Thus, you do not have to compute these values yourself. The following are examples of valid expressions:

*	BETA*10
AREA1+X'2D'	B'101'
*+32	C'ABC'
N-25	29
FIELD+332	L'FIELD
FIELD	LAMBDA+GAMMA
(EXIT-ENTRY+1)+G0	TEN/TWO
ALPHA-BETA/(10+AREA*L'FIELD)-100	=F'1234'
=A(100,133,175,221)+8	

Figure 16. Examples of Valid Expressions

Rules for Coding Expressions

The rules for coding an absolute or relocatable expression are:

- Both unary (operating on one value) and binary (operating on two values) operators are allowed in expressions.
- An expression can have one or more unary operators preceding any term in the expression or at the beginning of the expression.
- An expression must not begin with a binary operator, nor can it contain two binary operators in succession.

- An expression must not contain two terms in succession.
- No blanks are allowed between an operator and a term, nor between two successive operators.
- An expression can contain any number of unary and binary operators, and any number of levels of parentheses.
- A single relocatable term is not allowed in a multiply or divide operation. Note that paired relocatable terms have absolute values and can be multiplied and divided if they are enclosed in parentheses. See “Paired Relocatable Terms” on page 44.

Figure 17 shows the definitions of absolute and relocatable expressions.

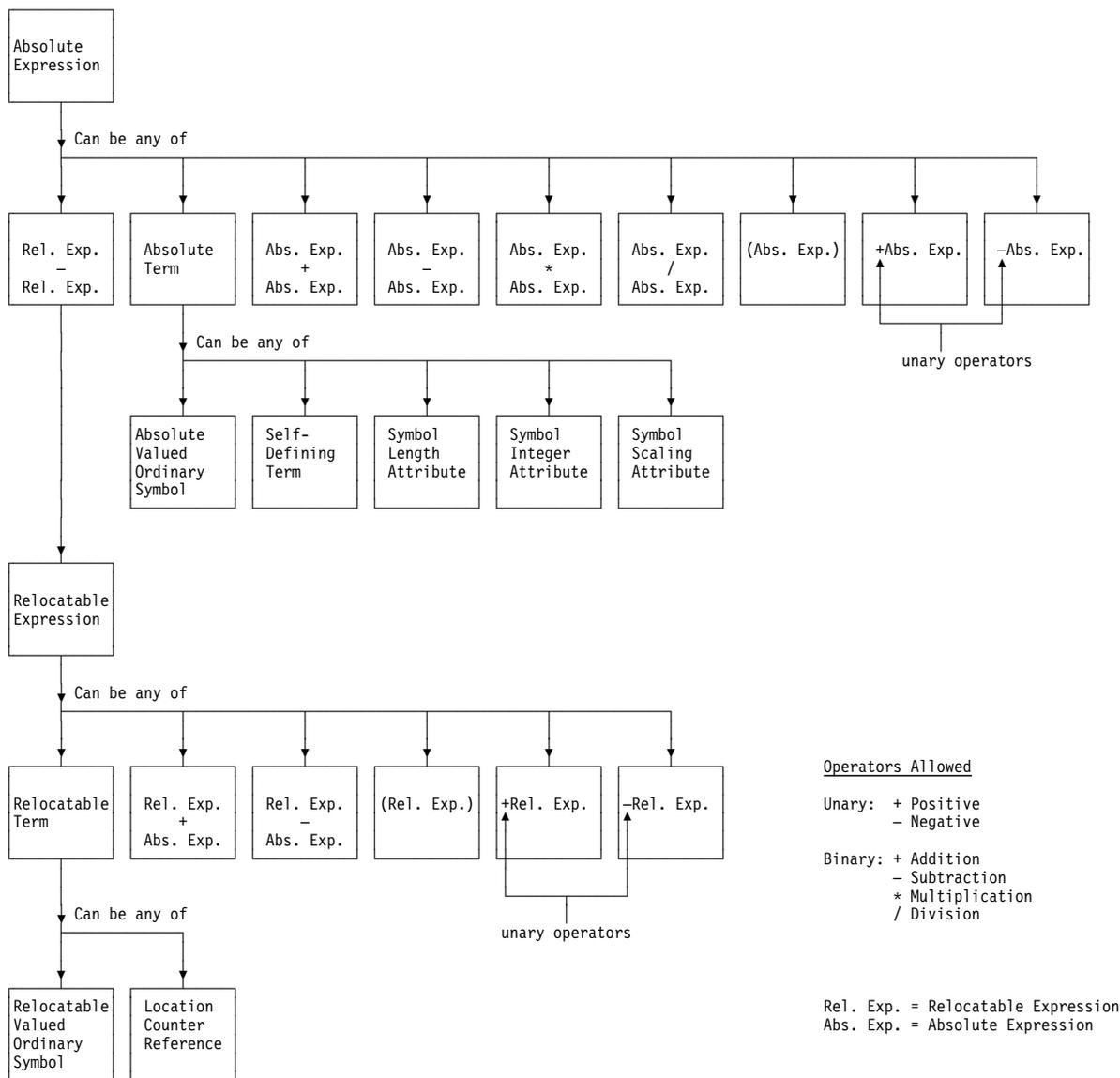


Figure 17. Definitions of Absolute and Relocatable Expressions

Evaluation of Expressions

A single-term expression, like 29 or BETA, has the value of the term involved. The assembler reduces a multiterm expression, like $25*10+A/B$ or $BETA+10$, to a single value, as follows:

1. It evaluates each term.
2. It does arithmetic operations from left to right. However:
 - a. It does unary operations before binary operations.
 - b. It does binary operations of multiplication and division before the binary operations of addition and subtraction.
3. In division, it gives an integer result; any fractional portion is dropped. Division by zero gives 0.
4. In parenthesized expressions, the assembler evaluates the innermost expressions first and then considers them as terms in the next outer level of expressions. It continues this process until the outermost expression is evaluated.
5. A term or expression's intermediate value and computed result must lie in the range of -2^{31} through $+2^{31}-1$.

The assembler evaluates paired relocatable terms at each level of expression nesting.

Absolute and Relocatable Expressions

An expression is *absolute* if its value is unaffected by program relocation. An expression is *relocatable* if its value depends upon program relocation. The two types of expressions, absolute and relocatable, take on these characteristics from the term or terms composing them. A description of the factors that determine whether an expression is absolute or relocatable follows.

Absolute Expression: An absolute expression is one whose value remains the same after program relocation. The value of an absolute expression is called an *absolute value*.

An expression is absolute, and is reduced to a single absolute value if the expression:

1. Comprises a symbol with an absolute value, a self-defining term, or a symbol length attribute reference, or any arithmetic combination of absolute terms.
2. Contains relocatable terms alone or in combination with absolute terms, and if all these relocatable terms are paired.

Relocatability Attribute: The relocatability attribute describes the attribute of a relocatable term. If a pair of terms are defined in the same control section, they are characterized as having the same relocatability attribute.

Paired Relocatable Terms: An expression can be absolute even though it contains relocatable terms, provided that all the relocatable terms are paired. The pairing of relocatable terms cancels the effect of relocation.

The assembler reduces paired terms to single absolute terms in the intermediate stages of evaluation. The assembler considers relocatable terms as paired under the following conditions:

- The paired terms must have the same relocatability attribute.
- The paired terms must have opposite signs after all unary operators are resolved. In an expression, the paired terms do not have to be contiguous (that is, other terms can come between the paired terms).
- The value represented by the paired terms is absolute.

The following examples show absolute expressions. A is an absolute term; X and Y are relocatable terms with the same relocatability:

```
A-Y+X
A
A*A
X-Y+A
```

A reference to the location counter must be paired with another relocatable term from the same control section; that is, with the same relocatability. For example:

```
*-Y
```

Relocatable Expression: A relocatable expression is one whose value changes by n if the origin of the control section in which it appears is relocated n bytes.

A relocatable expression can be a single relocatable term. The assembler reduces a relocatable expression to a single relocatable value if the expression:

1. Is composed of a single relocatable term, or
2. Contains relocatable terms, alone or in combination with absolute terms, and
 - a. All the relocatable terms but one are paired. Note that the unpaired term gives the expression a relocatable value; the paired relocatable terms and other absolute terms constitute increments or decrements to the value of the unpaired term.
 - b. The relocatability attribute of the whole expression is that of the unpaired term.
 - c. The sign preceding the unpaired relocatable term must be positive, after all unary operators have resolved.

The following examples show relocatable expressions. A is an absolute term, W and X are relocatable terms with the same relocatability attribute, and Y is a relocatable term with a different relocatability attribute.

Y-32*A	W-X**	=F'1234' (literal)
* (reference to	W-X+W	Y
location counter)	W-X+Y	A*A+W-W+Y

Complex Relocatable Expressions: Complex relocatable expressions, unlike relocatable expressions, can contain:

- Two or more unpaired relocatable terms
- An unpaired relocatable term preceded by a negative sign

Complex relocatable expressions are used in A-type and Y-type address constants to generate address constant values. For more details, refer to “Complex Relocatable Expressions”, and “Address Constants—A and Y” on page 135. V-type and S-type constants may not contain complex relocatable expressions.

Terms, Literals, and Expressions

You can assign a complex relocatable value to a symbol using the EQU instruction, as described on page 164.

Chapter 3. Addressing, Program Sectioning, and Linking

This chapter describes how you use symbolic addresses to refer to data in your assembler language program, and how you divide a large program into smaller parts and use symbolic addresses in one part to refer to data in another part.

Addressing

This part of the chapter describes the techniques and introduces the instructions that let you use symbolic addresses when referring to data. You can address data that is defined within the same source module, or data that is defined in another source module. Symbolic addresses are more meaningful and easier to use than the corresponding object code addresses required for machine instructions. Also, the assembler can convert the symbolic addresses you specify into their object code form.

The System/390® architecture has two ways of resolving addresses in your program, depending on the machine instruction type:

- **base-displacement**, where the address is computed by adding the displacement to a base register.
- **relative-branch**, where the address is computed by adding the signed immediate field to the instruction's address (refer to “RI Format” on page 80 and “RSI Format” on page 82).

Addressing within Source Modules: Establishing Addressability

You can use symbolic addresses, defined in a control section, in machine instructions and certain assembler instructions. This is much easier than explicitly coding the addresses in the form required by the hardware. Symbolic addresses you code in the instruction operands are *implicit addresses*, and addresses in which you specify the base-displacement or intermediate form are *explicit addresses*.

The assembler converts your implicit addresses into the explicit addresses required for the assembled object code of the machine instruction. However, for base-displacement operands, you must first establish the addressability of the control section, as described below.

Base Address Definition: The term *base address* is used throughout this manual to mean the location counter value within a control section from which the assembler can compute displacements to locations, or *addresses*, within the control section. The base address is not always the storage address of a control section when it is loaded into storage at execution time.

How to Establish Addressability

To establish the addressability of a control section (see “Control Sections” on page 51), you must:

- Specify a base address from which the assembler can compute displacements to the addresses within the control section.
- Assign the base registers to contain this base address.
- Write the instructions that loads the base registers with the base address.

Addressing

The following example shows the base address at MYPROG, that is assigned by register 12. Register 12 is loaded with the value in register 15, which contains the storage address of the control section (CSECT) when the program is loaded into storage at execution time.

MYPROG	CSECT	The base address
	USING MYPROG,12	Assign the base register
	LR 12,15	Load the base address

During assembly, the implicit addresses you code are converted into their explicit base-displacement form; then, they are assembled into the object code of the machine instructions in which they have been coded.

During execution, the base address is loaded into the base register.

Base Register Instructions

The USING and DROP assembler instructions enable you to use expressions representing implicit addresses as operands of machine instruction statements, leaving the assignment of base registers and the calculation of displacements to the assembler.

In order to use symbols in implicit addresses in the operand field of machine instruction statements, you must:

- Code a USING instruction to assign one or more base registers to a base address
- Code machine instructions to load each base register with the base address

Having the assembler determine base registers and displacements relieves you of the need to separate each address into an explicit displacement value and an explicit base register value. This feature of the assembler eliminates a likely source of programming errors, thus reducing the time required to write and test programs. You use the USING and DROP instructions to take advantage of this feature. For information about how to use these instructions, see “USING Instruction” on page 194 and “DROP Instruction” on page 152.

Qualified Addressing

Qualified addressing lets you use the same symbol to refer to data in different storage locations. Qualified symbols are simply ordinary symbols prefixed by a symbol qualifier and a period. A symbol qualifier is used to specify which base register the assembler should use when converting an implicit address into its explicit base-displacement form. Before you use a symbol qualifier, you must have previously defined it in the name entry of a labeled USING instruction. For information about labeled USING instructions, see “USING Instruction” on page 194. When defined, you can use a symbol qualifier to qualify any symbol that names a storage location within the range of the labeled USING. Qualified symbols may be used anywhere a relocatable term may be used.

The following examples show the use of qualified symbols. SOURCE and TARGET are both symbol qualifiers previously defined in two labeled USING instructions. X and Y are both symbols that name storage locations within the range of both labeled USING instructions.

MVC	TARGET.X, SOURCE.X
MVC	TARGET.Y+5(3), SOURCE.Y+5
XC	TARGET.X+10(L'X-10), TARGET.X+10
LA	2, SOURCE.Y

Dependent Addressing

Dependent addressing lets you minimize the number of base registers required to refer to data by making greater use of established addressability. For example, you may want to describe the format of a table of data defined in your source module with a dummy control section (see “Dummy Control Sections” on page 54). To refer to the data in the table using the symbols defined in the dummy section, you need to establish the addressability of the dummy section. To do this you must:

- Code a USING instruction to assign one or more base registers to a base address
- Code machine instructions to load each base register with the base address

However, as the following discussion explains, dependent addressing offers an alternative means of establishing addressability of the dummy section.

When you have established addressability of the control section in which the table is defined, you can establish addressability of the dummy section by simply coding a USING statement which specifies the name of the dummy section and the address of the table. When you subsequently refer to the symbols in the dummy section, the assembler makes use of the already established addressability of the control section when converting the symbolic addresses into their base-displacement form.

Relative Addressing

Relative addressing is the technique of addressing instructions and data areas by designating their location in relation to the location counter or to some symbolic location. This type of addressing is always in bytes—never in bits, words, or instructions. Thus, the expression `*+4` specifies an address that is 4 bytes greater than the current value of the location counter. In the sequence of instructions in the following example, the location of the CR machine instruction can be expressed in two ways, `ALPHA+2`, or `BETA-4`, because all the machine instructions in the example are for 2-byte instructions.

ALPHA	LR	3,4
	CR	4,6
	BCR	1,14
BETA	AR	2,3

Program Sectioning and Linking

This part of the chapter explains how to subdivide a large program into smaller parts that are easier to understand and maintain. It also explains how to divide these smaller parts into convenient sections, for example, one section to contain executable instructions, and another section to contain data constants and areas.

You should consider two different subdivisions when writing an assembler language program:

- The source module
- The control section

Program Sectioning and Linking

You can divide a program into two or more source modules. Each source module is assembled into a separate object module. The object modules can then be combined to form an executable program.

You can also divide a source module into two or more control sections. Each control section is assembled as part of the same object module. By writing the correct link-edit control statements, you can select a complete object module or any individual control section of the object module to be link-edited and later loaded as an executable program.

Size of Program Parts: If a source module becomes so large that its logic is not easily understood, divide it into smaller modules.

Unless you have special programming reasons, you should write each control section so that the resulting object code is not larger than 4096 bytes. This is the largest number of bytes that can be addressed by one base register.

Communication between Program Parts: You must be able to communicate between the parts of your program; that is, be able to refer to data in a different part or branch to another part.

To communicate between two or more source modules, you must link them together with applicable symbolic references.

To communicate between two or more control sections within a source module, you must establish the addressability of each control section correctly from one section to another.

Source Module

A source module is composed of source statements in the assembler language. You can include these statements in the source module in two ways:

- You can enter them directly into the file that contains your source program.
- You specify one or more COPY instructions among the source statements being entered. When the assembler encounters a COPY instruction, it replaces the COPY instruction with a predetermined set of source statements from a library. These statements then become a part of the source module. See “COPY Instruction” on page 106 for more details.

Beginning of a Source Module

The first statement of a source module can be any assembler language statement, except MEXIT and MEND. You can initiate the first control section of a source module by using the START instruction. However, you can write some source statements before the beginning of the first control statement. See “First Control Section” on page 52 for more details.

End of a Source Module

The END instruction usually marks the end of a source module. However, you can code several END instructions. The assembler stops assembling when it processes the first END instruction. If no END instruction is found, the assembler generates one. See “END Instruction” on page 162 for more details.

Conditional Assembly: Conditional assembly processing can determine which of several coded or substituted END instructions is to be processed.

Control Sections

A *control section* is the smallest subdivision of a program that can be relocated as a unit. The assembled control sections contain the object code for machine instructions, data constants, and areas.

Consider the concept of a control section at different processing times:

At coding time: You create a control section when you write the instructions it contains. In addition, you establish the addressability of each control section within the source module, and provide any symbolic linkages between control sections that lie in different source modules. You also write the linker control statements to combine control sections into a load module, and to provide an entry point address for the beginning of program execution.

At assembly time: The assembler translates the source statements in the control section into object code. Each source module is assembled into one object module. The whole object module and each of the control sections it contains are relocatable.

At linking time: As specified by linker or binder control statements, the linker or binder combines the object code of one or more control sections into one load module. It also calculates the addresses needed to accommodate common sections and external dummy sections from different object modules. In addition, it calculates the space needed to accommodate external dummy sections.

At program fetch time: The control program loads the load module into virtual storage. All the relocatable addresses are converted to fixed locations in storage.

At execution time: The control program passes control to the load module now in virtual storage, and your program is run.

You can specify the relocatable address of the starting point for program execution in a link-edit control statement or in the operand field of an assembler END statement.

Executable Control Sections

An *executable control section* is one you initiate by using the START, CSECT, or RSECT instruction, as described below:

- The START instruction can be used to initiate the first or only control section of a source module. For more information about the START instruction, see “START Instruction” on page 190.
- The CSECT instruction can be used anywhere in a source module to initiate or continue an executable control section. For more information about the CSECT instruction, see “CSECT Instruction” on page 108.
- Like the CSECT instruction, the RSECT instruction can be used anywhere in a source module to initiate or continue an executable control section. Unlike the CSECT instruction, however, the RSECT instruction causes the assembler to check the coding in the control section for possible violations of reenterability. For more information about the RSECT instruction, see “RSECT Instruction” on page 189.

An executable control section can also be initiated as an unnamed control section, or *private code*, without using the START, CSECT, or RSECT instruction. For more information, see “Unnamed Control Section” on page 53.

At assembly time, an executable control section is assembled into object code. At execution time, an executable control section contains the binary data assembled from your coded instructions and constants.

First Control Section

Before you initiate the first executable control section in your source module, you may code only certain instructions. The following information lists those instructions that initiate the first control section, and those instructions that may precede the first control section.

Instructions that establish the first control section: Any instruction that affects the location counter, or uses its current value, establishes the beginning of the first executable control section. The instructions that establish the first control section include any machine instruction and the following assembler instructions:

CCW	DC	ORG
CCW0	DROP	RSECT
CCW1	DS	START
CNOP	END	USING
CSECT	EQU	
CXD	LTOrg	

These instructions are always considered a part of the control section in which they appear.

The statements copied into a source module by a COPY instruction determine whether it initiates the first control section. The PROFILE option causes the assembler to generate a COPY statement as the first statement after any ICTL or *PROCESS statements.

The DSECT, COM, and DXD instructions initiate reference control sections and do not establish the first executable control section.

What must come before the first control section: The ICTL instruction, if specified, must be the first statement in a source module.

*PROCESS statements must precede all other statements in a source module, except the ICTL instruction. There is a limit of 10 *PROCESS statements allowed in a source module. Additional *PROCESS statements are treated as assembler comment statements. See 89 for a description of the *PROCESS statement.

What can optionally come before the first control section: The instructions or groups of instructions that can optionally be specified before the first control section are:

- The following assembler instructions:

ACONTROL	ENTRY	PRINT
ADATA	EXITCTL	PUNCH
AINsert	EXTRN	PUSH
ALIAS	ISEQ	REPRO
CEJECT	MACRO	SPACE
COPY	MEND	TITLE
DXD	MEXIT	WXTRN
EJECT	POP	XATTR

- Comments statements, including macro format comment statements
- Any statement which is part of an inline macro definition
- Common control sections
- Dummy control sections
- External dummy control sections
- Any conditional assembly instruction
- Macro instructions

The above instructions or groups of instructions belong to a source module, but are not considered part of an executable control section.

Any instructions copied by a COPY instruction, or generated by the processing of a macro instruction before the first control section, must belong exclusively to one of the groups of instructions shown above. Any other instructions cause the assembler to establish the first control section.

All the instructions or groups of instructions listed above can also appear as part of a control section.

If you specify the PROFILE assembler option the assembler generates a COPY statement as the first statement in the assembly after any ICTL or *PROCESS statements. The copy member should not contain any ICTL or *PROCESS statements.

Unnamed Control Section

The *unnamed control section* is an executable control section that can be initiated in one of the following two ways:

- By coding a START, CSECT, or RSECT instruction without a name entry
- By coding any instruction, other than the START, CSECT, or RSECT instruction, that initiates the first executable control section

The unnamed control section is sometimes referred to as *private code*.

All control sections should be given names so they can be referred to symbolically:

- Within a source module
- In EXTRN and WXTRN instructions and in linker control statements for linkage between source modules

Unnamed common control sections or dummy control sections can be defined if the name entry is omitted from a COM or DSECT instruction.

If you include an AMODE or RMODE instruction in the assembly and leave the name field blank, you must provide an unnamed control section.

Reference Control Sections

A *reference control section* is one you initiate by using the DSECT, COM, or DXD instruction, as follows:

- You can use the DSECT instruction to initiate or continue a dummy control section. For more information about dummy sections, see “Dummy Control Sections.”
- You can use the COM instruction to initiate or continue a common control section. For more information about common sections, see “Common Control Sections” on page 55.
- You can use the DXD instructions to define an external dummy section. For more information about external dummy sections, see “External Dummy Sections” on page 55.

At assembly time, reference control sections are not assembled into object code. You can use a reference control section either to reserve storage areas or to describe data to which you can refer from executable control sections. These reference control sections are considered empty at assembly time, and the actual binary data to which they refer is not available until execution time.

Dummy Control Sections

A *dummy control section* is a reference control section that describes the layout of data in a storage area without actually reserving any virtual storage.

You may want to describe the format of an area whose storage location is not determined until the program is run. You can do so by describing the format of the area in a dummy section, and using symbols defined in the dummy section in the operands of machine instructions.

The DSECT instruction initiates a dummy control section or indicates its continuation. For more information about the DSECT instruction, see “DSECT Instruction” on page 158.

How to use a dummy control section: A dummy control section (dummy section) lets you write a sequence of assembler language statements to describe the layout of data located elsewhere in your source module. The assembler produces no object code for statements in a dummy control section, and it reserves no storage in the object module for it. Rather, the dummy section provides a symbolic format that is empty of data. However, the assembler assigns location values to the symbols you define in a dummy section, relative to its beginning.

Therefore, to use a dummy section, you must:

- Reserve a storage area for the data
- Ensure that the locations of the symbols in the dummy section actually correspond to the locations of the data being described
- Establish the addressability of the dummy section in combination with the storage area

You can then refer to the data symbolically by using the symbols defined in the dummy section.

Common Control Sections

A *common control section* is a reference control section that lets you reserve a storage area that can be used by one or more source modules. One or more common sections can be defined in a source module.

The COM instruction initiates a common control section, or indicates its continuation. For more information about the COM instruction, see “COM Instruction” on page 105.

How to use a common control section: A common control section (common section) lets you describe a common storage area in one or more source modules.

When the separately assembled object modules are linked as one program, the required storage space is reserved for the common control section. Thus, two or more modules may share the common area.

Only the storage area is provided; the assembler does not assemble the source statements that make up a common control section into object code. You must provide the data for the common area at execution time.

The assembler assigns locations to the symbols you define in a common section relative to the beginning of that common section. This lets you refer symbolically to the data that is placed in the common section at execution time. If you want to refer to data in a common control section, you must establish the addressability of the common control section in each source module that contains references to it. If you code identical common sections in two or more source modules, you can communicate data symbolically between these modules through this common section.

Communicating with FORTRAN Modules: You can code a common control section in a source module written in the FORTRAN language. This lets you communicate between assembler language modules and FORTRAN modules.

External Dummy Sections

An *external dummy section* is a reference control section that lets you describe storage areas for one or more source modules, to be used as:

- Work areas for each source module
- Communication areas between two or more source modules

When the assembled object modules are linked and loaded, you can dynamically allocate the storage required for all your external dummy sections at one time from one source module (for example, by using the MVS GETMAIN macro instruction). This is not only convenient, but it saves space and reduces fragmentation of virtual storage.

To generate and use the external dummy sections, you need to specify a combination of the following:

- DXD or DSECT instruction
- Q-type address constant
- CXD instruction

For more information about the DXD and CXD instructions, see “DXD Instruction” on page 160 and “CXD Instruction” on page 109.

Generating an external dummy section: An external dummy section is generated when you specify a DXD instruction or a DSECT instruction in combination with a Q-type address constant that contains the name of the DXD instruction or the DSECT instruction.

Use the Q-type address constant to reserve storage for the offset to the external dummy section whose name is specified in the operand. This offset is the distance in bytes from the beginning of the area allocated for all the external dummy sections to the beginning of the external dummy section specified. You can use this offset value to address the external dummy section.

Using external dummy sections: To use an external dummy section, you must do the following:

1. Identify and define the external dummy section. The assembler computes the length and alignment required.
2. Provide a Q-type constant for each external dummy section defined.
3. Use the CXD instruction to reserve a fullword area into which the linker or loader inserts the total length of all the external dummy sections that are specified in the source modules of your program. The linker computes this length from the accumulated lengths of the individual external dummy sections supplied by the assembler.
4. Allocate a storage area using this computed total length.
5. Load the address of the allocated area into a register.
6. Add to the address in the register the offset into the allocated area of the applicable external dummy section. The linker inserts this offset into the area reserved by the associated Q-type address constant.
7. Establish the addressability of the external dummy section in combination with the portion of the allocated area reserved for the external dummy section.

You can now refer symbolically to the locations in the external dummy section. Note that the source statements in an external dummy section are not assembled into object code. Thus, you must create the data described by external dummy sections at execution time.

Location Counter Setting

The assembler maintains a separate *location counter* for each control section. The location counter setting for each control section starts at 0, except when an initial control section is started with a START statement that specifies a non-zero location counter value. The location values assigned to the instructions and other data in a control section are, therefore, relative to the location counter setting at the beginning of that control section.

However, for executable control sections, the location values that appear in the listings do not restart at 0 for each subsequent executable control section. They continue, after suitable alignment, from the end of the previous control section. Your executable control sections are usually loaded into storage in the order in which you write them. You can, therefore, match the source statements and object code produced from them with the contents of a dump of your program.

For reference control sections, the location values that appear in the listings always start from 0.

You can continue a control section that has been discontinued by another control section, and, thereby, intersperse code sequences from different control sections. Note that the location values that appear in the listings for a control section, divided into segments, follow from the end of one segment to the beginning of the subsequent segment.

The location values, listed for the next control section defined, begin after the last location value assigned to the preceding control section.

On VSE, or on MVS and CMS when you specify the NOGOFF assembler option, the maximum value of the location counter and the maximum length of a control section is $2^{24}-1$, or X'FFFFFF' bytes.

CMS, MVS When you specify the GOFF assembler option, the maximum value of the location counter and the maximum length of a control section is $2^{31}-1$, or X'7FFFFFFF' bytes. **CMS, MVS**

The *length counter* for an executable control section increments until it reaches its maximum value. The counter is then locked and remains at that value for the control section. No error condition or message is issued by High Level Assembler when the length counter exceeds its maximum. However, when the control section location counter exceeds its maximum it issues one of the following messages:

- Message ASMA039S Location counter error is issued for an executable control section location counter that exceeds its maximum.
- Message ASMA067S Illegal duplication factor is issued for a duplication factor on a DS or DC statement that exceeds the maximum.

The location counter setting is relative to the beginning of the location it represents, and the length counter represents the cumulative length of the control section. This means that the length counter is nearly always greater than the location counter, and can exceed its maximum value before the location counter.

Use of Multiple Location Counters

High Level Assembler lets you use multiple location counters for each individual control section. Use the LOCTR instruction (see “LOCTR Instruction” on page 170) to assign different location counters to different parts of a control section. The assembler then rearranges and assembles the coding together, according to the different location counters you have specified: All coding using the first location counter is assembled together, then the coding using the second location counter is assembled together, and so forth.

An example of the use of multiple location counters is shown in Figure 18 on page 58. In the example, executable instructions and data areas have been interspersed throughout the coding in their logical sequence, each group of instructions preceded by a LOCTR instruction identifying the location counter under which it is to be assembled. The assembler rearranges the control section so that the executable instructions are grouped together and the data areas are grouped together. Symbols are not resolved in the order they appear in the source program, but in location counter sequence.

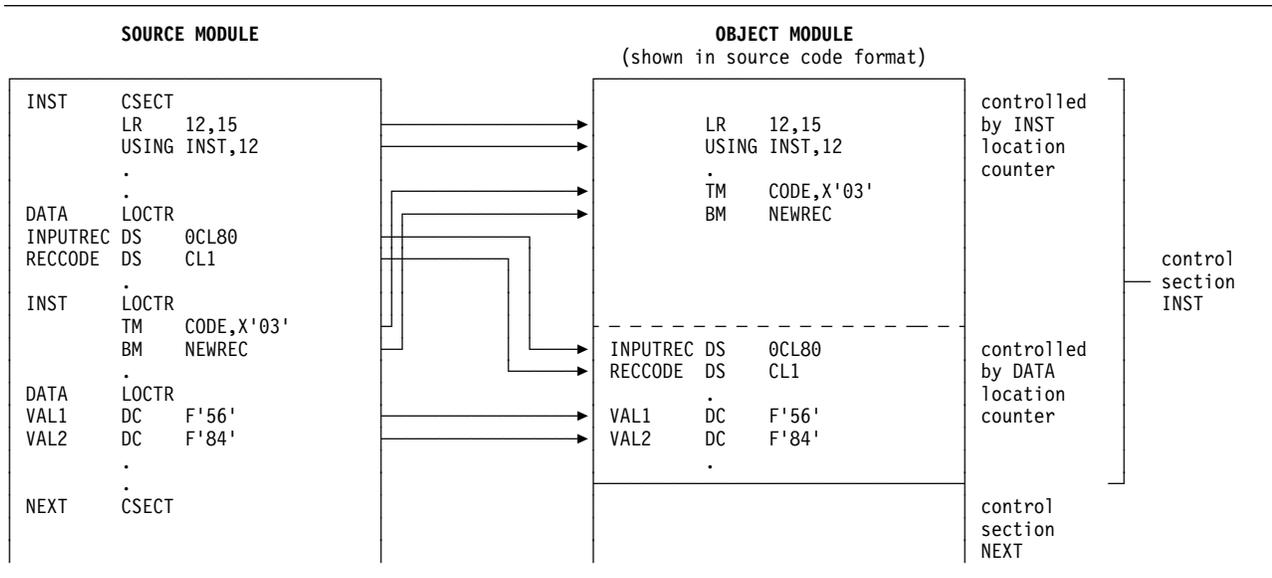


Figure 18. Use of Multiple Location Counters

Literal Pools In Control Sections

Literals, collected into pools by the assembler, are assembled as part of the executable control section to which the pools belong. If a LTORG instruction is specified at the end of each control section, the literals specified for that section are assembled into the pool starting at the LTORG instruction. If no LTORG instruction is specified, a literal pool containing all the literals used in the whole source module is assembled at the end of the first control section. This literal pool appears in the listings after the END instruction. For more information about the LTORG instruction, see "LTORG Instruction" on page 171.

Independently Addressed Segments: If any control section is divided into independently addressed segments, a LTORG instruction should be specified at the end of each segment to create a separate literal pool for that segment.

External Symbol Dictionary Entries

For each control section, the assembler keeps a record of the following external symbol dictionary (ESD) information:

- Symbolic name, if one is specified
- Type code
- Individual identification
- Starting address
- Length
- Alias, if one is specified

Figure 19 lists the assembler instructions that define control sections and dummy control sections, or identify entry and external symbols, and tells their associated type codes. You can define up to 65535 individual control sections and external symbols in a source module.

Figure 19. Defining CSECTs, DSECTs, and Symbols

Name Entry	Instruction	Coding Entered into External Symbol Dictionary	
		NOGOFF or NOXOBJECT	GOFF or XOBJECT
If present	START, CSECT, or RSECT	SD	SD, EDs, LD
If omitted	START, CSECT, or RSECT	PC	SD
Instruction-dependent	Any instruction that initiates the unnamed control section	PC	SD
Optional	COM	CM	CM
Optional	DSECT	None	None
Mandatory	DXD or external DSECT	XD	XD
Mandatory	CATTR	Not applicable	ED
Not applicable	ENTRY	LD	LD
Not applicable	EXTRN	ER	ER
Not applicable	DC (V-type address constant)	ER	ER
Not applicable	WXTRN	WX	WX

Refer to *Appendix C Object Deck Output* in the *HLASM Programmer's Guide*, SC26-4941 for details about the ESD entries produced when you specify the NOGOFF or NOXOBJECT assembler option.

CMS, MVS Refer to *DFSMS/MVS Program Management*, SC26-4916 for details about the ESD entries produced when you specify the GOFF or XOBJECT assembler option. **CMS, MVS**

Establishing Residence and Addressing Mode

The AMODE and RMODE instructions specify the addressing mode (AMODE) and the residence mode (RMODE) to be associated with control sections in the object deck. These modes may be specified for the following types of control sections:

- Control section (for example START, CSECT)
- Unnamed control section
- Common control section (COM instruction)

The assembler sets the AMODE and RMODE indicators in the ESD record for each applicable control section in an assembly. The linker stores the AMODE and RMODE values in the load module. They are subsequently used by the loader program that brings the load module into storage. The loader program uses the RMODE value to determine where it loads the load module, and passes the AMODE value to the operating system to establish the addressing mode.

For more information about the AMODE and RMODE instructions, see “AMODE Instruction” on page 96 and “RMODE Instruction” on page 187.

Symbolic Linkages

Symbols can be defined in one module and referred to in another, which results in symbolic linkages between independently assembled program sections. These linkages can be made only if the assembler can provide information about the linkage symbols to the linker, which resolves the linkage references at link-edit time.

Establishing symbolic linkage

You must establish symbolic linkage between source modules so that you can refer or branch to symbolic locations defined in the control sections of external source modules. You do this by using external symbol definitions, and external symbol references. To establish symbolic linkage with an external source module, you must do the following:

- In the current source module, you must identify the symbols that are not defined in that source module, if you want to use them in instruction operands. These symbols are called external symbols, because they are defined in another (external) source module. You identify external symbols in the EXTRN or WXTRN instruction, or the V-type address constant. For more information about the EXTRN and WXTRN instructions, see “EXTRN Instruction” on page 167 and “WXTRN Instruction” on page 204.
- In the external source modules, you must identify the symbols that are defined in those source modules, and that you refer to from the current source module. The two types of definitions that you can use are control section names (defined by the CSECT, RSECT, and START instructions), and entry symbols. Entry symbols are so called because they provide points of entry to a control section in a source module. You identify entry symbols with the ENTRY instruction. For more information about the ENTRY instruction, see “ENTRY Instruction” on page 163.
- You must provide the A-type or V-type address constants needed by the assembler to reserve storage for the addresses represented by the external symbols.

The assembler places information about entry and external symbols in the external symbol dictionary. The linker uses this information to resolve the linkage addresses identified by the entry and external symbols.

Referring to external data

Use the EXTRN instruction to identify the external symbol that represents data in an external source module, if you want to refer to this data symbolically.

For example, you can identify the address of a data area as an external symbol and load the address constant specifying this symbol into a base register. Then, you use this base register when establishing the addressability of a dummy section that describes this external data. You can now refer symbolically to the data that the external area contains.

You must also identify, in the source module that contains the data area, the address of the data as an entry symbol.

Branching to an external address

Use the V-type address constant to identify the external symbol that represents the address in an external source module that you want to branch to.

For example, you can load into a register the V-type address constant that identifies the external symbol. Using this register, you can then branch to the external address represented by the symbol.

If the symbol is the name entry of a START, CSECT, or RSECT instruction in the other source module, and thus names an executable control section, it is automatically identified as an entry symbol. If the symbol represents an address in the middle of a control section, you must identify it as an entry symbol for the external source module.

You can also use a combination of an EXTRN instruction to identify, and an A-type address constant to contain, the external branch address. However, the V-type address constant is more convenient because:

- You do not have to use an EXTRN instruction.
- The external symbol you specify, can be used in the name entry of any other statement in the same source program.

The following example shows how you use an A-type address constant to contain the address of an external symbol that you identify in an EXTRN instruction. You cannot use the external symbol name EXMOD1 in the name entry of any other statement in the source program.

```

      .
      .
      L    15,EX_SYM      Load address of external symbol
      BASR 14,15         Branch to it
      .
      .
EX_SYM DC A(EXMOD1)     Address of external symbol
      EXTRN EXMOD1      Identify EXMOD1 as external symbol
      .
      .
    
```

The following example shows how you use the symbol EXMOD1 as both the name of an external symbol and a name entry on another statement.

```

      .
      .
      L    15,EX_SYM      Load address of external symbol
      BASR 14,15         Branch to it
      .
      .
EXMOD1 DS    0H          Using EXMOD1 as a name entry
      .
      .
EX_SYM DC V(EXMOD1)     Address of external symbol
      .
      .
    
```

If the external symbol that represents the address to which you want to branch is to be part of an overlay-structured module, you should identify it with a V-type address constant, not with an EXTRN instruction and an A-type address constant. You can

Program Sectioning and Linking

use the supervisor CALL macro instruction to branch to the address represented by the external symbol. The CALL macro instruction generates the necessary V-type address constant.

Establishing an external symbol alias

You can instruct the assembler to use an alias for an external symbol in place of the external symbol itself, when it generates the object module. To do this you must code an ALIAS instruction which specifies the external symbol and the alias you want the assembler to use. The external symbol must be defined in a START, CSECT, RSECT, ENTRY, COM, DXD, external DSECT, EXTRN, or WXTRN instruction, or in a V-type address constant.

The following example shows how you use the ALIAS instruction to specify an alias for the external symbol EXMOD1.

```
      .
      .
      L    15,EX_SYM          Load address of external symbol
      BASR 14,15             Branch to it
      .
      .
EXMOD1 DS    0H              Using EXMOD1 as a name entry
      .
      .
EX_SYM  DC V(EXMOD1)         Address of external symbol
EXMOD1  ALIAS C'XMD1PGM'     XMD1PGM is the real external name
      .
      .
```

See “ALIAS Instruction” on page 95 for information about the ALIAS instruction.

Association of Code and Data Areas (MVS and CMS)

To provide support for application program reentrancy and dynamic binding, the assembler provides a way to associate code and data areas. This is done by defining and accessing “associated data areas” which are referred to as PSECTs. A PSECT (Prototype Control Section) when instantiated, becomes the non-shared working storage for an invocation of a shared reentrant program.

In the Program Object model, a PSECT is *not* a section: it is an element within the *same section* as the element containing the shared code to which it belongs. The two classes defining these elements will have attributes appropriate to their respective uses.

The following example illustrates how V-type and R-type address constants are used to provide code and data addressability with PSECTs for a reentrant program.

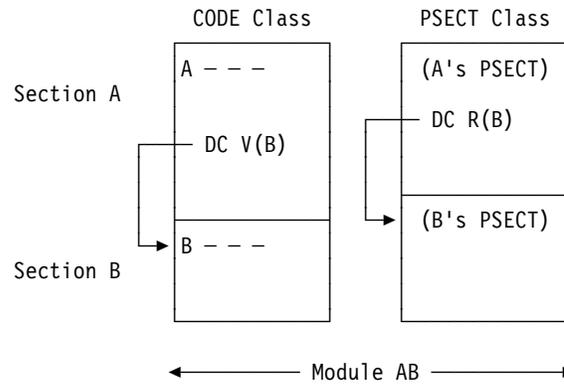


Figure 20. Program Object with PSECTs, Example 1

In this figure, there are two sections A and B, each with a PSECT. When the module AB containing A and B is instantiated, a copy of the PSECT class belonging to AB is loaded into storage, and R-type address constants pointing to PSECTs in that class are relocated. The invoker of A is responsible for defining R(A), the address of A's PSECT, and for providing that address on entry to A so that A can address its own PSECT. (Note that the V-type address constant in A referring to the entry point of B was resolved at the time the CODE class was loaded.) Later instantiations of AB would load new copies of the PSECT class, and any address constants in the newly-loaded class would be relocated.

In Figure 20, the V-type address constant referring to B was in the CODE class; it could also be in the PSECT class, as shown in Figure 21. (This technique could be used if B is a dynamically loaded module requiring that V(B) be relocated during execution.)

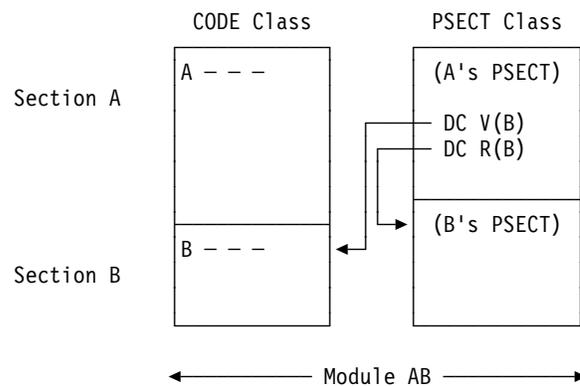


Figure 21. Program Object with PSECTs, Example 2

Part 2. Machine and Assembler Instruction Statements

Chapter 4. Machine Instruction Statements	68
General Instructions	68
Decimal Instructions	69
Floating-Point Instructions	69
Control Instructions	69
Input/Output Operations	70
Branching with Extended Mnemonic Codes	70
Statement Formats	72
Symbolic Operation Codes	73
Operand Entries	74
Registers	74
Register Usage by Machine Instructions	75
Register Usage by System	76
Addresses	76
Implicit Address	77
Explicit Address	77
Relative Address	77
Relocatability of Addresses	77
Machine or Object Code Format	78
Lengths	79
Immediate Data	79
Examples of Coded Machine Instructions	79
RI Format	80
RR Format	81
RS Format	81
RSI Format	82
RX Format	83
SI Format	84
SS Format	85
 Chapter 5. Assembler Instruction Statements	 87
64-bit Addressing Mode	88
*PROCESS Statement	89
ACONTROL Statement	90
ADATA Instruction	93
AINsert Instruction	94
ALIAS Instruction	95
AMODE Instruction	96
CATTR Instruction (MVS and CMS)	98
CCW and CCW0 Instructions	100
CCW1 Instruction	101
CEJECT Instruction	103
CNOP Instruction	103
COM Instruction	105
COPY Instruction	106
CSECT Instruction	108
CXD Instruction	109
DC Instruction	110
Rules for DC Operand	112
General Information About Constants	113

Part 2. Machine and Assembler Instruction Statements

Length Attribute Value of Symbols Naming Constants	113
Alignment of Constants	113
Padding and Truncation of Values	114
Padding	115
Truncation	116
Subfield 1: Duplication Factor	116
Subfield 2: Type	117
Subfield 3: Type Extension	118
Subfield 4: Modifier	119
Length Modifier	120
Scale Modifier	121
Exponent Modifier	122
Subfield 5: Nominal Value	123
Binary Constant—B	124
Character Constant—C	125
Graphic Constant—G	128
Hexadecimal Constant—X	129
Fixed-Point Constants—F and H	130
Decimal Constants—P and Z	133
Address Constants	135
Hexadecimal Floating-Point Constants—E, EH, D, DH, L, LH	141
Binary Floating-Point Constants—EB, DB, LB	146
Floating-Point Special Values	149
Offset Constant—Q	150
Length Constant—J	151
Literal Constants	152
DROP Instruction	152
DS Instruction	155
How to Use the DS Instruction	156
DSECT Instruction	158
DXD Instruction	160
EJECT Instruction	161
END Instruction	162
ENTRY Instruction	163
EQU Instruction	164
Using Conditional Assembly Values	166
EXITCTL Instruction	166
EXTRN Instruction	167
ICTL Instruction	168
ISEQ Instruction	169
LOCTR Instruction	170
LTORG Instruction	171
Literal Pool	172
Addressing Considerations	173
Duplicate Literals	173
MNOTE Instruction	174
OPSYN Instruction	176
Redefining Conditional Assembly Instructions	177
ORG Instruction	178
POP Instruction	181
PRINT Instruction	181
Process Statement	184
PUNCH Instruction	184
PUSH Instruction	186

Part 2. Machine and Assembler Instruction Statements

REPRO Instruction	187
RMODE Instruction	187
RSECT Instruction	189
SPACE Instruction	190
START Instruction	190
TITLE Instruction	191
Deck ID in Object Records	192
Printing the Heading	192
Printing the TITLE Statement	193
Sample Program Using the TITLE Instruction	193
Page Ejects	193
Valid Characters	194
USING Instruction	194
How to Use the USING Instruction	195
Base Registers for Absolute Addresses	196
Ordinary USING Instruction	196
Range of an Ordinary USING Instruction	198
Domain of an Ordinary USING Instruction	199
Labeled USING Instruction	199
Range of a Labeled USING Instruction	201
Domain of a Labeled USING Instruction	201
Dependent USING Instruction	202
Range of a Dependent USING Instruction	203
Domain of a Dependent USING Instruction	204
WXTRN Instruction	204
XATTR Instruction (MVS and CMS)	205

I

Chapter 4. Machine Instruction Statements

This chapter introduces a sample of the more common instruction formats and provides general rules for coding them in their symbolic assembler language format.

For the complete specifications of machine instructions, their object code format, their coding specifications, and their use of registers and virtual storage areas, see the applicable *Principles of Operation* manual for your processor. If your program requires vector facility instructions, see the applicable *Vector Operations* manual for the complete specifications of vector-facility instructions.

At assembly time, the assembler converts the symbolic assembler language representation of the machine instructions to the corresponding object code. The computer processes this object code at execution time. Thus, the functions described in this section can be called execution-time functions.

Also at assembly time, the assembler creates the object code of the data constants and reserves storage for the areas you specify in your data definition assembler instructions, such as DC and DS (see Chapter 5, “Assembler Instruction Statements”). At execution time, the machine instructions can refer to these constants and areas, but the constants themselves are not normally processed.

As defined in the applicable *Principles of Operation* manual, there are five categories of machine instructions:

- General instructions
- Decimal instructions
- Floating-Point instructions
- Control instructions
- Input/Output operations

Each is discussed in the following sections.

General Instructions

Use general instructions to manipulate data that resides in general registers or in storage, or that is introduced from the instruction stream. General instructions include fixed-point, logical, and branching instructions. In addition, they include unprivileged status-switching instructions. Some general instructions operate on data that resides in the PSW or the TOD clock.

The general instructions treat data as four types: signed binary integers, unsigned binary integers, unstructured logical data, and decimal data. Data is treated as decimal by the conversion, packing, and unpacking instructions.

For further information, see “General Instructions” in the applicable *Principles of Operation* manual.

Decimal Instructions

Use the decimal instructions when you want to do arithmetic and editing operations on data that has the binary equivalent of decimal representation.

Decimal data may be represented in either zoned or packed format. In the *zoned format*, the rightmost four bits of a byte are called the numeric bits and normally consist of a code representing a decimal digit. The leftmost four bits of a byte are called the zone bits, except for the rightmost byte of a decimal operand, where these bits may be treated either as a zone or as a sign.

In the *packed format*, each byte contains two decimal digits, except for the rightmost byte, which contains a sign to the right of a decimal digit.

Decimal instructions treat all numbers as integers. For example, 3.14, 31.4, and 314 are all processed as 314. You must keep track of the decimal point yourself. The integer and scaling attributes discussed in “Data Attributes” on page 296 can help you do this.

Additional operations on decimal data are provided by several of the instructions in “General Instructions” in the applicable *Principles of Operation* manual. Decimal operands always reside in storage.

For further information, see “Decimal Instructions” in the applicable *Principles of Operation* manual.

Floating-Point Instructions

Use floating-point instructions when you want to do arithmetic operations on data in the floating-point representation. Thus, you do not have to keep track of the decimal point in your computations. Floating-point instructions also let you do arithmetic operations on both very large numbers and very small numbers, usually providing greater precision than fixed-point decimal instructions.

For further information, see “Floating-Point Instructions” in the applicable *Principles of Operation* manual.

Control Instructions

Control instructions include all privileged and semiprivileged machine instructions, except the input/output instructions described on page 70.

Privileged instructions may be processed only when the processor is in the supervisor state. An attempt to process an installed privileged instruction in the problem state generates a privileged-operation exception.

Semiprivileged instructions are those instructions that can be processed in the problem state when certain authority requirements are met. An attempt to process an installed semiprivileged instruction in the problem state when the authority requirements are not met generates a privileged-operation exception or some other program-interruption condition depending on the particular requirement that is violated.

For further details, see “Control Instructions” in the applicable *Principles of Operation* manual.

Input/Output Operations

Use the input/output instructions (instead of the IBM-supplied system macro instructions) when you want to control your input and output operations more closely.

The input or output instructions let you identify the channel or the device on which the input or output operation is to be done. For information about how and when you can use these instructions, see the applicable system manual.

For more information, see “Input/Output Operations” in the applicable *Principles of Operation* manual and the applicable system manuals.

Branching with Extended Mnemonic Codes

Branch instructions let you specify an *extended mnemonic code* for the condition on which a branch is to occur. Thus, you avoid having to specify the mask value, that represents the condition code, required by the BC, BCR, and BRC machine instructions. The assembler translates the extended mnemonic code into the mask value, and then assembles it into the object code of the BC, BCR, or BRC machine instruction.

The extended mnemonic codes are given in Figure 22 on page 71. They can be used as operation codes for branching instructions, replacing the BC, BCR, and BRC machine instruction codes (see **1** in Figure 22). Note that the first operand (see **2** in Figure 22) of the BC, BCR, and BRC instructions must not be present in the operand field (see **3** in Figure 22) of the extended mnemonic branching instructions.

Extended Code	Meaning	Format	(Symbolic) Machine Instruction Equivalent
<div style="display: flex; justify-content: space-around; margin-bottom: 5px;"> 3 4 </div> <div style="margin-left: 20px;"> </div>	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>B $D_2(X_2, B_2)$] Unconditional Branch</p> <p>BR R_2]</p> <p>J label] Unconditional Jump</p> <p>NOP $D_2(X_2, B_2)$] No Operation</p> <p>NOPR R_2]</p> <p>JNOP label]</p> </div> <div style="width: 45%;"> <p>RX</p> <p>RR</p> <p>RI</p> <p>RX</p> <p>RR</p> <p>RI</p> </div> </div>	<div style="display: flex; justify-content: space-around; margin-bottom: 5px;"> 1 2 </div> <div style="margin-left: 20px;"> </div>	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>BC $15, D_2(X_2, B_2)$</p> <p>BCR $15, R_2$</p> <p>BRC $15, label$</p> <p>BC $0, D_2(X_2, B_2)$</p> <p>BCR $0, R_2$</p> <p>BRC $0, label$</p> </div> <div style="width: 45%;"> <p>RX</p> <p>RR</p> <p>RI</p> <p>RX</p> <p>RR</p> <p>RI</p> </div> </div>
Used After Compare Instructions			
<p>BH $D_2(X_2, B_2)$] Branch on High</p> <p>BHR R_2]</p> <p>JH label] Jump on High</p> <p>BL $D_2(X_2, B_2)$] Branch on Low</p> <p>BLR R_2]</p> <p>JL label] Jump on Low</p> <p>BE $D_2(X_2, B_2)$] Branch on Equal</p> <p>BER R_2]</p> <p>JE label] Jump on Equal</p> <p>BNH $D_2(X_2, B_2)$] Branch on Not High</p> <p>BNHR R_2]</p> <p>JNH label] Jump on Not High</p> <p>BNL $D_2(X_2, B_2)$] Branch on Not Low</p> <p>BNLR R_2]</p> <p>JNL label] Jump on Not Low</p> <p>BNE $D_2(X_2, B_2)$] Branch on Not Equal</p> <p>BNER R_2]</p> <p>JNE label] Jump on Not Equal</p>	<p>RX</p> <p>RR</p> <p>RI</p>	<p>BC $2, D_2(X_2, B_2)$</p> <p>BCR $2, R_2$</p> <p>BRC $2, label$</p> <p>BC $4, D_2(X_2, B_2)$</p> <p>BCR $4, R_2$</p> <p>BRC $4, label$</p> <p>BC $8, D_2(X_2, B_2)$</p> <p>BCR $8, R_2$</p> <p>BRC $8, label$</p> <p>BC $13, D_2(X_2, B_2)$</p> <p>BCR $13, R_2$</p> <p>BRC $13, label$</p> <p>BC $11, D_2(X_2, B_2)$</p> <p>BCR $11, R_2$</p> <p>BRC $11, label$</p> <p>BC $7, D_2(X_2, B_2)$</p> <p>BCR $7, R_2$</p> <p>BRC $7, label$</p>	
Used After Arithmetic Instructions			
<p>BP $D_2(X_2, B_2)$] Branch on Plus</p> <p>BPR R_2]</p> <p>JP label] Jump on Plus</p> <p>BM $D_2(X_2, B_2)$] Branch on Minus</p> <p>BMR R_2]</p> <p>JM label] Jump on Minus</p> <p>BZ $D_2(X_2, B_2)$] Branch on Zero</p> <p>BZR R_2]</p> <p>JZ label] Jump on Zero</p> <p>BO $D_2(X_2, B_2)$] Branch on Overflow</p> <p>BOR R_2]</p> <p>JO label] Jump on Overflow</p> <p>BNP $D_2(X_2, B_2)$] Branch on Not Plus</p> <p>BNPR R_2]</p> <p>JNP label] Jump on Not Plus</p> <p>BNM $D_2(X_2, B_2)$] Branch on Not Minus</p> <p>BNMR R_2]</p> <p>JNM label] Jump on Not Minus</p> <p>BNZ $D_2(X_2, B_2)$] Branch on Not Zero</p> <p>BNZR R_2]</p> <p>JNZ label] Jump on Not Minus</p> <p>BNO $D_2(X_2, B_2)$] Branch on No Overflow</p> <p>BNOR R_2]</p> <p>JNO label] Jump on No Overflow</p>	<p>RX</p> <p>RR</p> <p>RI</p>	<p>BC $2, D_2(X_2, B_2)$</p> <p>BCR $2, R_2$</p> <p>BRC $2, label$</p> <p>BC $4, D_2(X_2, B_2)$</p> <p>BCR $4, R_2$</p> <p>BRC $4, label$</p> <p>BC $8, D_2(X_2, B_2)$</p> <p>BCR $8, R_2$</p> <p>BRC $8, label$</p> <p>BC $1, D_2(X_2, B_2)$</p> <p>BCR $1, R_2$</p> <p>BRC $1, label$</p> <p>BC $13, D_2(X_2, B_2)$</p> <p>BCR $13, R_2$</p> <p>BRC $13, label$</p> <p>BC $11, D_2(X_2, B_2)$</p> <p>BCR $11, R_2$</p> <p>BRC $11, label$</p> <p>BC $7, D_2(X_2, B_2)$</p> <p>BCR $7, R_2$</p> <p>BRC $7, label$</p> <p>BC $14, D_2(X_2, B_2)$</p> <p>BCR $14, R_2$</p> <p>BRC $14, label$</p>	

Figure 22 (Part 1 of 2). Extended Mnemonic Codes

Statement Formats

Used After Test Under Mask Instructions

BO	D ₂ (X ₂ ,B ₂)	]	Branch if Ones	RX	BC	1,D ₂ (X ₂ ,B ₂)
BOR	R ₂	]		RR	BCR	1,R ₂
BM	D ₂ (X ₂ ,B ₂)	]	Branch if Mixed	RX	BC	4,D ₂ (X ₂ ,B ₂)
BMR	R ₂	]		RR	BCR	4,R ₂
BZ	D ₂ (X ₂ ,B ₂)	]	Branch if Zero	RX	BC	8,D ₂ (X ₂ ,B ₂)
BZR	R ₂	]		RR	BCR	8,R ₂
BNO	D ₂ (X ₂ ,B ₂)	]	Branch if Not Ones	RX	BC	14,D ₂ (X ₂ ,B ₂)
BNOR	R ₂	]		RR	BCR	14,R ₂
BNM	D ₂ (X ₂ ,B ₂)	]	Branch if Not Mixed	RX	BC	11,D ₂ (X ₂ ,B ₂)
BNMR	R ₂	]		RR	BCR	11,R ₂
BNZ	D ₂ (X ₂ ,B ₂)	]	Branch if Not Zero	RX	BC	7,D ₂ (X ₂ ,B ₂)
BNZR	R ₂	]		RR	BCR	7,R ₂

Notes:

1. D₂=displacement, X₂=index register, B₂=base register, R₂=register containing branch address
2. The addresses represented are explicit address (see [4](#)). However, implicit addresses can also be used in this type of instruction.
3. Avoid using BM, BNM, JM, and JNM after the TMH or TML instruction.

Figure 22 (Part 2 of 2). Extended Mnemonic Codes

Statement Formats

Machine instructions are assembled into 2, 4, or 6 bytes of object code according to the format of each instruction. Machine instruction formats include the following (ordered by length attribute):

Length	Attribute Basic Formats
2	RR
4	RI, RS, RSI, RX, SI
6	SS

See the applicable *Principles of Operation* manual for complete details about machine instruction formats. See also “Examples of Coded Machine Instructions” on page 79.

When you code machine instructions, you use symbolic formats that correspond to the actual machine language formats. Within each basic format, you can also code variations of the symbolic representation, divided into groups according to the basic formats shown below.

The assembler converts only the operation code and the operand entries of the assembler language statement into object code. The assembler assigns to a name entry symbol the value of the address of the first byte of the assembled instruction. When you use this same symbol in the operand of an assembler language statement, the assembler uses this address value in converting the symbolic operand into its object code form. The length attribute assigned to the symbol depends on the basic machine language format of the instruction in which the symbol appears as a name entry.

A remarks entry is not converted into object code.

An example of a typical assembler language statement follows:

```
LABEL    L                4,256(5,10)        LOAD INTO REG4
```

where:

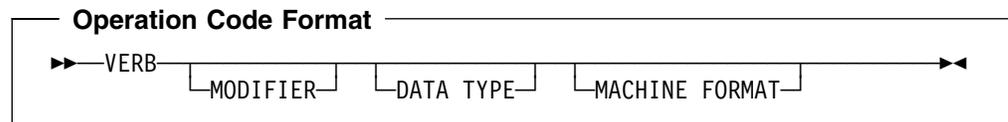
LABEL is the name entry
 L is the operation code mnemonic (converted to hex 58)
 4 is the register operand (converted to hex 4)
 256(5,10) are the storage operand entries (converted to hex 5A100)
 LOAD INTO REG4 are remarks not converted into object code

The object code of the assembled instruction, in hexadecimal, is:
 5845A100 (4 bytes in RX format)

Symbolic Operation Codes

You must specify an operation code for each machine instruction statement. The symbolic operation code, or mnemonic code as it is also called, indicates the type of operation to be done; for example, A indicates the addition operation. See the applicable *Principles of Operation* for a complete list of symbolic operation codes and the formats of the corresponding machine instructions.

The general format of the machine instruction operation code is:



Verb: The verb must always be present. It usually consists of one or two characters and specifies the operation to be done. The verb is underscored in the following examples:

<u>A</u> 3,AREA	A indicates an add operation
<u>MV</u> C TO,FROM	MV indicates a move operation

The other items in the operation code are not always present. They include the following (underscores are used to indicate modifiers, data types, and machine formats in the examples below):

Modifier: Modifier, which further defines the operation:

<u>A</u> L 3,AREA	L indicates a logical operation
-------------------	---------------------------------

Data Type: Type qualifier, which indicates the type of data used by the instruction in its operation:

<u>CV</u> B 3,BINAREA	B indicates binary data
<u>MV</u> C TO,FROM	C indicates character data
<u>A</u> E 2,FLTSHRT	E indicates normalized short floating-point data
<u>A</u> D 2,FLTLONG	D indicates normalized long floating-point data

Machine Format: Format qualifier, R indicating a register operand, or I indicating an immediate operand. For example:

Operand Entries

<code>ADR 2,4</code>	R indicates a register operand
<code>MVI FIELD,X'A1'</code>	I indicates an immediate operand
<code>AHI 7,123</code>	

Operand Entries

You may specify one or more operands in each machine instruction statement to provide the data or the location of the data upon which the machine operation is to be done. The operand entries consist of one or more fields or subfields, depending on the format of the instruction being coded. They can specify a register, an address, a length, or immediate data. You can omit length fields or subfields, which the assembler computes for you from the other operand entries. You can code an operand entry either with symbols or with self-defining terms.

The rules for coding operand entries are:

- A comma must separate operands.
- Parentheses must enclose subfields.
- A comma must separate subfields enclosed in parentheses.
- If a subfield is omitted because it is implicit in a symbolic address, the parentheses that would have enclosed the subfield must be omitted.
- If two subfields are enclosed in parentheses and separated by commas, the following applies:
 - If both subfields are omitted because they are implicit in a symbolic entry, the separating comma and the parentheses that would have been needed must also be omitted.
 - If the first subfield is omitted, the comma that separates it from the second subfield must be written, as well as the enclosing parentheses.
 - If the second subfield is omitted, the comma that separates it from the first subfield must be omitted; however, the enclosing parentheses must be written.
- Blanks must not appear within the operand field, except as part of a character self-defining term, or in the specification of a character literal.

Registers

You can specify a register in an operand for use as an arithmetic accumulator, a base register, an index register, and as a general depository for data to which you want to refer repeatedly.

You must be careful when specifying a register whose contents have been affected by the execution of another machine instruction, the control program, or an IBM-supplied system macro instruction.

For some machine instructions, you are limited in which registers you can specify in an operand.

The expressions used to specify registers must have absolute values; in general, registers 0 through 15 can be specified for machine instructions. However, the following restrictions on register usage apply:

- If the NOAFPR assembler option is specified, then only the floating-point registers (0, 2, 4, or 6) may be specified for floating-point instructions.

- The even-numbered registers (0, 2, 4, 6, 8, 10, 12, 14) must be specified for the following groups of instructions:
 - The double-shift instructions
 - The fullword multiply and divide instructions
 - The move long and compare logical long instructions
- If the AFPR assembler option is specified, then one of the floating-point registers 0, 1, 4, 5, 8, 9, 12 or 13 can be specified for the instructions that use extended floating-point data in pairs of registers, such as AXR, SXR, LTXBR, and SQEBR.
- If the NOAFPR assembler option is specified, then either floating-point register 0 or 4 must be specified for these instructions.
- For a processor with a vector facility, the even-numbered vector registers (0, 2, 4, 6, 8, 10, 12, 14) must be specified in vector-facility instructions that are used to manipulate long floating-point data or 64-bit signed binary data in vector registers.

The assembler checks the registers specified in the instruction statements of the above groups. If the specified register does not comply with the stated restrictions, the assembler issues a diagnostic message and does not assemble the instruction. Binary zeros are generated in place of the machine code.

Register Usage by Machine Instructions

Registers that are not explicitly coded in symbolic assembler language representation of machine instructions, but are nevertheless used by assembled machine instructions, are divided into two categories:

- Base registers that are implicit in the symbolic addresses specified. (See “Addresses” on page 76.) The registers can be identified by examining the object code or the USING instructions that assign base registers for the source module.
- Registers that are used by machine instructions, but don't appear in assembled object code.
 - For double shift and fullword multiply and divide instructions, the odd-numbered register, whose number is one greater than the even-numbered register specified as the first operand.
 - For Move Long and Compare Logical Long instructions, the odd-numbered registers, whose number is one greater than even-numbered registers specified in the two operands.
 - For Branch on Index High (BXH) and the Branch on Index Low or Equal (BXLE) instructions, if the register specified for the second operand is an even-numbered register, the next higher odd-numbered register is used to contain the value to be used for comparison.
 - For Load Multiple (LM) and Store Multiple (STM) instructions, the registers that lie between the registers specified in the first two operands.
 - For extended-precision floating point instructions, the second register of the register pair.
 - For Compare and Form Codeword (CFC) instruction, registers 1, 2 and 3 are used.
 - For Translate and Test (TRT) instruction, registers 1 and 2 are used.

Operand Entries

- For Update Tree (UPT) instruction, registers 0-5 are used.
- For Edit and Mark (EDMK) instruction, register 1 is used.
- For certain control instructions, one or more of registers 0-4 and register 14 are used. See “Control Instructions” in the applicable *Principles of Operation* manual.
- For certain input/output instructions, either or both registers 1 and 2 are used. See “Input/Output Instructions” in the applicable *Principles of Operation* manual.
- On a processor with a vector facility:
 1. For instructions that manipulate long floating-point data in vector registers, the odd-numbered vector registers, whose number is one greater than the even-numbered vector registers specified in each operand.
 2. For instructions that manipulate 64-bit signed binary data in vector registers, the odd-numbered vector registers, whose number is one greater than the even-numbered vector registers specified in each operand.

Register Usage by System

The programming interface of the system control programs uses registers 0, 1, 13, 14, and 15.

Addresses

You can code a symbol in the name field of a machine instruction statement to represent the address of that instruction. You can then refer to the symbol in the operands of other machine instruction statements. The object code for the IBM System/370 and IBM System/390 requires that addresses be assembled in a numeric base-displacement format. This format lets you specify addresses that are relocatable or absolute. Chapter 3, “Addressing, Program Sectioning, and Linking” on page 47 describes how you use symbolic addresses to refer to data in your assembler language program.

Defining Symbolic Addresses: Define relocatable addresses by either using a symbol as the label in the name field of an assembler language statement, or equating a symbol to a relocatable expression.

Define absolute addresses (or values) by equating a symbol to an absolute expression.

Referring to Addresses: You can refer to relocatable and absolute addresses in the operands of machine instruction statements. (Such address references are also called addresses in this manual.) The two ways of coding addresses are:

- Implicitly—in a form that the assembler must first convert into an explicit base-displacement form before it can be assembled into object code.
- Explicitly—in a form that can be directly assembled into object code.

Implicit Address

An implicit address is specified by coding one expression. The expression can be relocatable or absolute. The assembler converts all implicit addresses into their base-displacement form before it assembles them into object code. The assembler converts implicit addresses into explicit addresses only if a USING instruction has been specified, or for small absolute expressions, where the address is resolved without a USING. The USING instruction assigns both a base address, from which the assembler computes displacements, and a base register, which is assumed to contain the base address. The base register must be loaded with the correct base address at execution time. For more information, refer to “Addressing” on page 47.

Explicit Address

An explicit address is specified by coding two absolute expressions as follows:

- The first is an absolute expression for the displacement, whose value must lie in the range 0 through 4095 (4095 is the maximum value that can be represented by the 12 binary bits available for the displacement in the object code).
- The second (enclosed in parentheses) is an absolute expression for the base register, whose value must lie in the range 0 through 15.

An explicit base register designation must not accompany an implicit address. However, in RX-format instructions, an index register can be coded with an implicit address as well as with an explicit address. When two addresses are required, each address can be coded as an explicit address or as an implicit address.

Relative Address

A relative address is specified by coding one expression. The expression may be relocatable or absolute. If a relocatable expression is used, then the assembler converts the value to a 16-bit signed number of halfwords relative to the current location counter, and then uses that value in the object code. An absolute value may be used for a relative address, but the assembler issues a warning message, as it uses the supplied value, and this may cause unpredictable results.

Relocatability of Addresses

If the value of an address expression changes when the assumed origin of the program is changed, and changes by the same amount, then the address is simply relocatable. If the addressing expression does not change when the assumed origin of the program is changed, then that address is absolute. If the addressing expression changes by some other amount, the address may be complexly relocatable.

Addresses in the base-displacement form are relocatable, because:

- Each relocatable address is assembled as a displacement from a base address and a base register.
- The base register contains the base address.
- If the object module assembled from your source module is relocated, only the contents of the base register need reflect this relocation. This means that the location in virtual storage of your base has changed, and that your base register must contain this new base address.

Operand Entries

- Addresses in your program have been assembled as relative to the base address; therefore, the sum of the displacement and the contents of the base register point to the correct address after relocation.

Absolute addresses are also assembled in the base-displacement form, but always indicate a fixed location in virtual storage. This means that the contents of the base register must always be a fixed absolute address value regardless of relocation.

Machine or Object Code Format

All addresses assembled into the object code of the IBM System/370 and IBM System/390 machine instructions have the format given in Figure 23. Not all of the instruction formats are shown in Figure 23.

The addresses represented have a value that is the sum of a displacement (see **1** in Figure 23) and the contents of a base register (see **2** in Figure 23).

Index Register: In RX-format instructions, the address represented has a value that is the sum of a displacement, the contents of a base register, and the contents of an index register (see **3** in Figure 23).

Format	Coded or Symbolic Representation of Explicit Address	Object Code Representation of Addresses						
		8 bits Operation Code	4 bits	4 bits	4 bits Base Reg.	12 bits Displacement	4 bits	12 bits Displacement
					2 ↓	1 ↓		
RS	$D_2(B_2)$	OP CODE	R_1	R_3	B_2	D_2		
				3 (Index Register) ↓				
RX	$D_2(X_2, B_2)$	OP CODE	R_1	X_2	B_2	D_2		
SI	$D_1(B_1)$	OP CODE		I_2	B_1	D_1		
							2 ↓	1 ↓
SS	$D_1(, B_1), D_2(B_2)$	OP CODE		L	B_1	D_1	B_2	D_2

I_2 represents an immediate value

L represents a length

B_2, R_1 and R_3 represent registers

Figure 23. Format of Addresses in Object Code

Lengths

You can specify the length field in an SS-format instruction. This lets you indicate explicitly the number of bytes of data at a virtual storage location that is to be used by the instruction. However, you can omit the length specification, because the assembler computes the number of bytes of data to be used from the expression that represents the address of the data.

See page 85 for more information about SS-format instructions.

Implicit Length: When a length subfield is omitted from an SS-format machine instruction, an implicit length is assembled into the object code of the instruction. The implicit length is either of the following:

- For an *implicit address*, it is the length attribute of the first or only term in the expression representing the *implicit address*.
- For an *explicit address*, it is the length attribute of the first or only term in the expression representing the *displacement*.

Explicit Length: When a length subfield is specified in an SS-format machine instruction, the explicit length always overrides the implicit length.

An implicit or explicit length is the *effective length*. The length value assembled is always one less than the effective length. If you want an assembled length value of 0, an explicit length of 0 or 1 can be specified.

In the SS-format instructions requiring one length value, the allowable range for explicit lengths is 0 through 256. In the SS-format instructions requiring two length values, the allowable range for explicit lengths is 0 through 16.

Immediate Data

In addition to registers, numeric values, relative addresses, and lengths, some machine instruction operands require immediate data. Such data is assembled directly into the object code of the machine instructions. Use immediate data to specify the bit patterns for masks or other absolute values you need.

Specify immediate data only where it is required. Do not confuse it with address references to constants and areas, or with any literals you specify as the operands of machine instructions.

Immediate data must be specified as absolute expressions whose range of values depends on the machine instruction for which the data is required. The immediate data is assembled into its binary representation.

Examples of Coded Machine Instructions

The examples that follow are grouped according to machine instruction format, and the groups are shown in order of the instruction length. They show the various ways in which you can code the operands of machine instructions. Both symbolic and numeric representation of fields and subfields are shown in the examples. Therefore, assume that all symbols used are defined elsewhere in the same source module.

Examples of Coded Machine Instructions

The object code assembled from at least one coded statement per group is also included. A complete summary of machine instruction formats with the coded assembler language variants can be found in the applicable *Principles of Operation* manual.

The examples that follow show the various instruction formats, and are not meant to show how the machine instructions should be used.

RI Format

The operand fields of RI-format instructions designate a register and a 16-bit immediate operand, with the following exception:

- In BRC branching instructions, a 4-bit branching mask with a value between 0 and 15 inclusive replaces the register designation.

Symbols used to represent registers (such as REG1 in the example) are assumed to be equated to absolute values between 0 and 15. The 16-bit immediate operand has two different interpretations, depending on whether the instruction is a branching instruction or not.

There are two types of non-branching RI-format instructions.

- For most, the immediate value is treated as a 16-bit signed binary integer (a value between -32768 and $+32767$). This value may be specified using self-defining terms or equated symbols.
- For logical instructions such as TMH, the immediate field is a 16 bit mask.

Examples:

```
ALPHA1  AHI          REG1,2000
ALPHA2  MHI          3,1234
BETA1   TMH          7,X'8001'
```

When assembled, the object code for the instruction labeled BETA1, in hexadecimal, is

```
A7708001
```

where:

```
A7.0 is the operation code
7    is register R1
8001 is the immediate data I2
```

For branching RI-format instructions, the immediate value is treated as a 16-bit signed binary integer representing the number of halfwords to branch relative to the current location.

The branch target may be specified as a relocatable expression, in which case the assembler performs some checking, and calculates the immediate value.

The branch target may also be specified as an absolute value in which case the assembler issues a warning before it assembles the instruction.

Examples:

ALPHA1	BRAS	1,BETA1
ALPHA2	BRC	3,ALPHA1
BETA1	BRCT	7,ALPHA1

When assembled, the object code for the instruction labeled BETA1, in hexadecimal, is

A776FFFC

where:

A7.6 is the operation code

7 is register R₁

FFFC is the immediate data I2; a value of -4 decimal

RR Format

The operand fields of RR-format instructions designate two registers, with the following exceptions:

- In BCR branching instructions, when a 4-bit branching mask replaces the first register specification (see 8 in the instruction labeled GAMMA1 below)
- In SVC instructions, where an immediate value (between 0 and 255) replaces both registers (see 200 in the instruction labeled DELTA1 below)

Symbols used to represent registers in RR-format instructions (see INDEX and REG2 in the instruction labeled ALPHA2 below) are assumed to be equated to absolute values between 0 and 15.

Symbols used to represent immediate values in SVC instructions (see TEN in the instruction labeled DELTA2 below) are assumed to be equated to absolute values between 0 and 255.

Examples:

ALPHA1	LR	1,2
ALPHA2	LR	INDEX,REG2
GAMMA1	BCR	8,12
DELTA1	SVC	200
DELTA2	SVC	TEN

When assembled, the object code of the instruction labeled ALPHA1, in hexadecimal, is:

1812

where:

18 is the operation code

1 is register R₁

2 is register R₂

RS Format

The operand fields of RS-format instructions designate two registers, and a virtual storage address (coded as an implicit address or an explicit address).

In the Insert Characters under Mask (ICM) and the Store Characters under Mask (STCM) instructions, a 4-bit mask (see X'E' and MASK in the instructions labeled

Examples of Coded Machine Instructions

DELTA1 and DELTA2 below), with a value between 0 and 15, replaces the second register specifications.

Symbols used to represent registers (see REG4, REG6, and BASE in the instruction labeled ALPHA2 below) are assumed to be equated to absolute values between 0 and 15.

Symbols used to represent implicit addresses (see AREA and IMPLICIT in the instructions labeled BETA1 and DELTA2 below) can be either relocatable or absolute.

Symbols used to represent displacements (see DISPL in the instruction labeled BETA2 below) in explicit addresses are assumed to be equated to absolute values between 0 and 4095.

Examples:

ALPHA1	LM	4,6,20(12)
ALPHA2	LM	REG4,REG6,20(BASE)
BETA1	STM	4,6,AREA
BETA2	STM	4,6,DISPL(BASE)
GAMMA1	SLL	2,15
DELTA1	ICM	3,X'E',1024(10)
DELTA2	ICM	REG3,MASK,IMPLICIT

When assembled, the object code for the instruction labeled ALPHA1, in hexadecimal, is:

9846C014

where:

98 is the operation code
4 is register R₁
6 is register R₃
C is base register B₁
014 is displacement D₁ from base register B₁

When assembled, the object code for the instruction labeled DELTA1, in hexadecimal, is:

BF3EA400

where:

BF is the operation code
3 is register R₁
E is mask M₃
A is base register B₁
400 is displacement D₁ from base register B₁

RSI Format

The operand fields of RSI-format instructions designate two registers and a 16-bit immediate operand.

Symbols used to represent registers (See REG1 below) are assumed to be equated to absolute values between 0 and 15.

The immediate value is treated as a 16-bit signed binary integer representing the number of halfwords to branch relative to the current location.

The branch target may be specified as a label in which case the assembler calculates the immediate value and performs some checking of the value.

The branch target may also be specified as an absolute value in which case the assembler issues a warning before it assembles the instruction.

Examples:

```
ALPHA1  BRXH          REG1,REG3,BETA1
BETA1   BRXLE        1,2,ALPHA1
```

When assembled, the object code for the instruction labeled ALPHA1, in hexadecimal, is

84130002

where:

84 is the operation code
 1 is register REG1
 3 is register REG3
 0002 is the immediate data I2

RX Format

The operand fields of RX-format instructions designate one or two registers, including an index register, and a virtual storage address (coded as an implicit address or an explicit address), with the following exception:

In BC branching instructions, a 4-bit branching mask (see 7 and TEN in the instructions labeled LAMBDA_n below) with a value between 0 and 15, replaces the first register specification.

Symbols used to represent registers (see REG1, INDEX, and BASE in the ALPHA2 instruction below) are assumed to be equated to absolute values between 0 and 15.

Symbols used to represent implicit addresses (see IMPLICIT in the instructions labeled GAMMA_n below) can be either relocatable or absolute.

Symbols used to represent displacements (see DISPL in the instructions labeled BETA2 and LAMBDA1 below) in explicit addresses are assumed to be equated to absolute values between 0 and 4095.

Examples:

```
ALPHA1  L           1,200(4,10)
ALPHA2  L           REG1,200(INDEX,BASE)
BETA1   L           2,200(,10)
BETA2   L           REG2,DISPL(,BASE)
GAMMA1  L           3,IMPLICIT
GAMMA2  L           3,IMPLICIT(INDEX)
DELTA1  L           4,=F'33'
LAMBDA1 BC         7,DISPL(,BASE)
LAMBDA2 BC        TEN,ADDRESS
```

When assembled, the object code for the instruction labeled ALPHA1, in hexadecimal, is:

Examples of Coded Machine Instructions

5814A0C8

where:

58 is the operation code
1 is register R₁
4 is index register X₂
A is base register B₂
0C8 is displacement D₂ from base register B₂

When assembled, the object code for the instruction labeled GAMMA1, in hexadecimal, is:

5824xyyy

where:

58 is the operation code
2 is register R₁
4 is the index register X₂
x is base register B₂
yyy is displacement D₂ from base register B₂

SI Format

The operand fields of SI-format instructions designate immediate data and a virtual storage address.

Symbols used to represent immediate data (see HEX40 and TEN in the instructions labeled ALPHA2 and BETA1 below) are assumed to be equated to absolute values between 0 and 255.

Symbols used to represent implicit addresses (see IMPLICIT and KEY in the instructions labeled BETA1 and BETA2) can be either relocatable or absolute.

Symbols used to represent displacements (see DISPL40 in the instruction labeled ALPHA2 below) in explicit addresses are assumed to be equated to absolute values between 0 and 4095.

Examples:

ALPHA1	CLI	40(9),X'40'
ALPHA2	CLI	DISPL40(NINE),HEX40
BETA1	CLI	IMPLICIT,TEN
BETA2	CLI	KEY,C'E'

When assembled, the object code for the instruction labeled ALPHA1, in hexadecimal, is:

95409028

where

95 is the operation code.
40 is the immediate data.
9 is the base register.
028 is the displacement from the base register

SS Format

The operand fields and subfields of SS-format instructions designate two virtual storage addresses (coded as implicit addresses or explicit addresses) and, optionally, the explicit data lengths you want to include. However, note that, in the Shift and Round Decimal (SRP) instruction, a 4-bit immediate data field (see 3 in SRP instruction below), with a value between 0 and 9, is specified as a third operand.

Symbols used to represent base registers (see BASE8 and BASE7 in the instruction labeled ALPHA2 below) in explicit addresses are assumed to be equated to absolute values between 0 and 15.

Symbols used to represent explicit lengths (see NINE and SIX in the instruction labeled ALPHA2 below) are assumed to be equated to absolute values between 0 and 256 for SS-format instructions with one length specification, and between 0 and 16 for SS-format instructions with two length specifications.

Symbols used to represent implicit addresses (see FIELD1 and FIELD2 in the instruction labeled ALPHA3, and FIELD1,X'8' in the SRP instructions below) can be either relocatable or absolute.

Symbols used to represent displacements (see DISP40 and DISP30 in the instruction labeled ALPHA5 below) in explicit addresses are assumed to be equated to absolute values between 0 and 4095.

See page 79 for more information about the lengths of SS-format instructions.

Examples:

ALPHA1	AP	40(9,8),30(6,7)
ALPHA2	AP	40(NINE,BASE8),30(SIX,BASE7)
ALPHA3	AP	FIELD1,FIELD2
ALPHA4	AP	AREA(9),AREA2(6)
ALPHA5	AP	DISP40(,8),DISP30(,7)
BETA1	MVC	0(80,8),0(7)
BETA2	MVC	DISP0(,8),DISP0(7)
BETA3	MVC	TO,FROM
	SRP	FIELD1,X'8',3

When assembled, the object code for the instruction labeled ALPHA1, in hexadecimal, is:

FA858028701E

where:

FA is the operation code.
 8 is length L₁
 5 is length L₂
 8 is base register B₁
 028 is displacement D₁ from base register B₁
 7 is base register B₂
 01E is displacement D₂ from base register B₂

When assembled, the object code for the instruction labeled BETA1, in hexadecimal, is:

D24F80007000

Examples of Coded Machine Instructions

where:

D2 is the operation code

4F is length L

8 is base register B₁

000 is displacement D₁ from base register B₁

7 is base register B₂

000 is displacement D₂ from base register B₂

Chapter 5. Assembler Instruction Statements

This chapter describes, in detail, the syntax and usage rules of each assembler instruction. The following table lists the assembler instructions by type, and provides the page number where the instruction is described.

Figure 24 (Page 1 of 2). Assembler Instructions

Type of Instruction	Instruction	Page No.
Program Control	AINsert	94
	CNOp	103
	COPY	106
	END	162
	EXITCTL	166
	ICTL	168
	ISEQ	169
	LTORG	171
	ORG	178
	POP	181
	PUNCH	184
	PUSH	186
	REPRO	187
Listing Control	CEJECT	103
	EJECT	161
	PRINT	181
	SPACE	190
	TITLE	191
Operation Code Definition	OPSYN	176

64-bit Addressing Mode

Figure 24 (Page 2 of 2). Assembler Instructions

Type of Instruction	Instruction	Page No.
Program Section and Linking	ALIAS	95
	AMODE	96
	CATTR (MVS and CMS)	98
	COM	105
	CSECT	108
	CXD	109
	DSECT	158
	DXD	160
	ENTRY	163
	EXTRN	167
	LOCTR	170
	RMODE	187
	RSECT	189
	START	190
WXTRN	204	
	XATTR (MVS and CMS)	205
Base Register	DROP	152
	USING	194
Data Definition	CCW	100
	CCW0	100
	CCW1	101
	DC	110
	DS	155
Symbol Definition	EQU	164
Associated Data	ADATA	93
Assembler Options	*PROCESS	89
	ACONTROL	90

64-bit Addressing Mode

Some instructions have an operand or operands that pertain to 64-bit addressing mode (for example, 64 for AMODE). This operand is accepted and processed by the assembler. However, other operating system components and utility programs may not be able to accept and process information related to this operand.

*PROCESS Statement

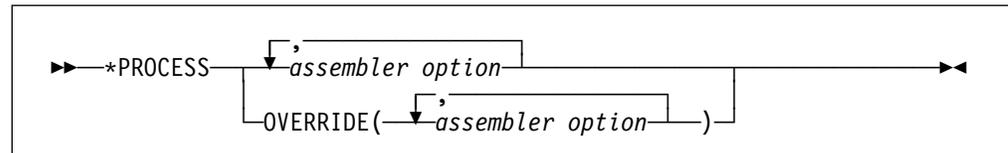
Process (*PROCESS) statements specify assembler options in an assembler source program. You can include them in the primary input data set or provide them from a SOURCE user exit.

To ensure that certain assembler options cannot be changed for a given source file, put the OVERRIDE keyword as the first and only keyword on the process statement, followed by a list of options. This means that default and invocation options cannot override the specified options.

You can specify up to 10 process statements in each source program. Except for the ICTL instruction, process statements must be the first statements in your source program. If you include process statements anywhere else in your source program the assembler treats them as comments.

A process statement has a special coding format, unlike any other assembler instruction, although it is affected by the column settings of the ICTL instruction. You must code the characters *PROCESS starting in the begin column of the source statement, followed by one or more blanks. You can code as many assembler options that can fit in the remaining columns up to, and including the end column of the source statement.

You cannot continue a process statement on to the next statement.



assembler_option
is any assembler option.

A number of options are not accepted from a process statement. If the option is specified on a process override statement and differs from the option in effect at the time of processing the statement, the assembler issues a warning message.

These options are:

ADATA	LANGUAGE	SIZE
ASA	LINECOUNT	SYSPARM
DECK	LIST	TERM
EXIT	OBJECT	TRANSLATE
GOFF	OPTABLE	XOBJECT

When the assembler detects an error in a process statement, it produces an error message in the *High Level Assembler Option Summary* section of the assembler listing. If the installation default option PESTOP is set then the assembler stops after it finishes processing any remaining process statements.

The assembler lists the options from process statements in the *High Level Assembler Option Summary* section of the assembler listing. The process statements are also shown as comment lines in the *Source and Object* section of the assembler listing.

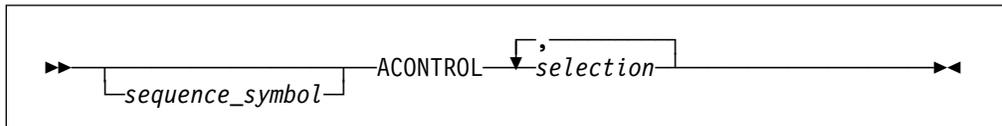
ACONTROL Statement

The ACONTROL instruction can change these HLASM options within a program:

- AFPR
- COMPAT
- FLAG (except the RECORD/NORECORD and the PUSH/NOPUSH suboptions)
- LIBMAC
- RA2

Note: The AFPR option is not available as an assembler option at invocation of the assembler.

The selections which can be specified are documented here for completeness.



sequence_symbol
is a sequence symbol.

selection
is one or more selections from the group of selections described below.

Because ACONTROL is making changes to existing values, there are no default values for the ACONTROL statement.



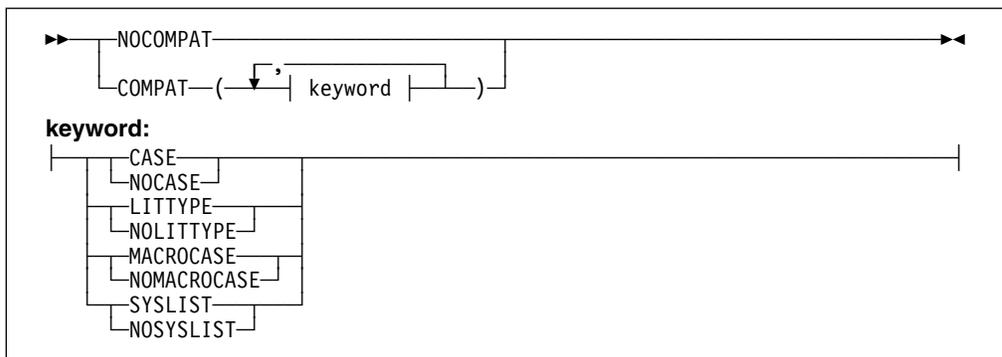
AFPR

instructs the assembler that the additional floating point registers 1, 3, 5 and 7 through 15 may be specified in the program.

Note: The assembler starts with AFPR enabled.

NOAFPR

instructs the assembler that no additional floating point registers, that is, only floating point registers 0, 2, 4 and 6 may be specified in the program.



COMPAT(CASE), abbreviation CPAT(CASE)

instructs the assembler to maintain uppercase alphabetic character set compatibility with earlier assemblers.

COMPAT(NOCASE), abbreviation CPAT(NOCASE)

instructs the assembler to allow mixed case alphabetic character set.

COMPAT(LITTYPE), abbreviation CPAT(LIT)

instructs the assembler to return 'U' as the type attribute for all literals.

COMPAT(NOLITTYPE), abbreviation CPAT(NOLIT)

instructs the assembler to return the correct type attribute for literals.

COMPAT(MACROCASE), abbreviation CPAT(MC)

instructs the assembler to convert internally lowercase lowercase alphabetic characters in unquoted macro operands to uppercase alphabetic characters prior to macro expansion. (The source statement is unchanged).

COMPAT(NOMACROCASE), abbreviation CPAT(NOMC)

instructs the assembler not to convert lowercase alphabetic characters (a through z) in unquoted macro operands.

COMPAT(SYSLIST), abbreviation CPAT(SYSL)

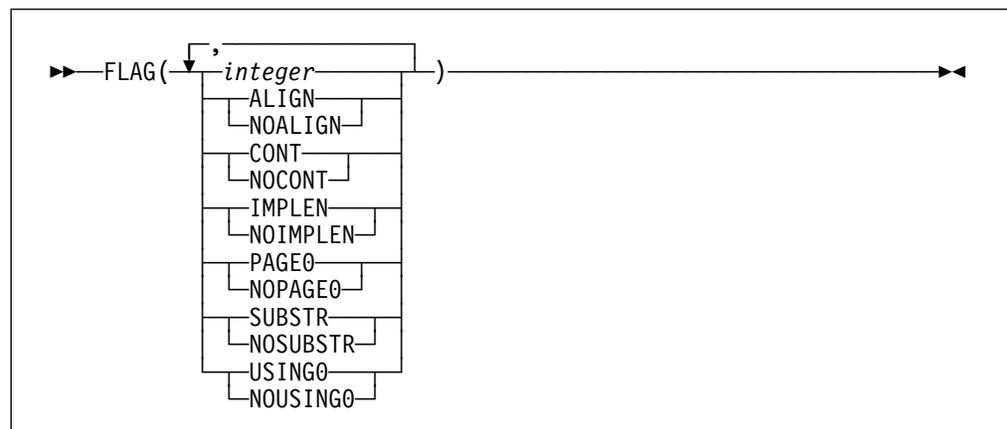
instructs the assembler to treat sublists in SETC symbols as compatible with earlier assemblers.

COMPAT(NOSYSLIST), abbreviation CPAT(NOSYSL)

instructs the assembler not to treat sublists in SETC symbols as character strings, when passed to a macro definition in an operand of a macro instruction.

NOCOMPAT, abbreviation NOCPAT

instructs the assembler to allow lowercase alphabetic characters in all language elements, to treat sublists in SETC symbols as sublists when passed to a macro definition in the operand of a macro instruction, and to return the correct type attribute for literals.



integer

specifies that error diagnostic messages with this or a higher severity code are printed in the source and object section of the assembly listing.

FLAG(ALIGN), abbreviation FLAG(AL)

instructs the assembler to issue diagnostic message ASMA033W when an inconsistency is detected between the operation code and the alignment of addresses in machine instructions.

FLAG(NOALIGN), abbreviation FLAG(NOAL)

instructs the assembler not to issue diagnostic message ASMA033W when an inconsistency is detected between the operation code and the alignment of addresses in machine instructions.

FLAG(CONT)

specifies that the assembler is to issue diagnostic messages ASMA430W through ASMA433W when an inconsistent continuation is encountered in a statement.

FLAG(NOCONT)

specifies that the assembler is not to issue diagnostic messages ASMA430W through ASMA433W when an inconsistent continuation is encountered in a statement.

FLAG(IMPLEN)

instructs the assembler to issue diagnostic message ASMA169I when an explicit length subfield is omitted from an SS-format machine instruction.

FLAG(NOIMPLEN)

instructs the assembler not to issue diagnostic message ASMA169I when an explicit length subfield is omitted from an SS-format machine instruction.

FLAG(PAGE0)

instructs the assembler to issue diagnostic message ASMA309W when an operand is resolved to a baseless address and a base and displacement is expected.

FLAG(NOPAGE0)

instructs the assembler not to issue diagnostic message ASMA309W when an operand is resolved to a baseless address and a base and displacement is expected.

FLAG(SUBSTR), abbreviation FLAG(SUB)

instructs the assembler to issue warning diagnostic message ASMA094 when the second subscript value of the substring notation indexes past the end of the character expression.

FLAG(NOSUBSTR), abbreviation FLAG(NOSUB)

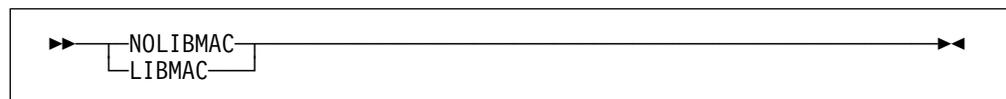
instructs the assembler not to issue warning diagnostic message ASMA094 when the second subscript value of the substring notation indexes past the end of the character expression.

FLAG(USING0), abbreviation FLAG(US0)

instructs the assembler to issue diagnostic warning message ASMA306W for a USING that is coincident with or overlaps the implied USING 0,0, when the USING(WARN) suboption includes the condition numbers 1 and/or 4.

FLAG(NOUSING0), abbreviation FLAG(NOUS0)

instructs the assembler to suppress diagnostic warning message ASMA306W

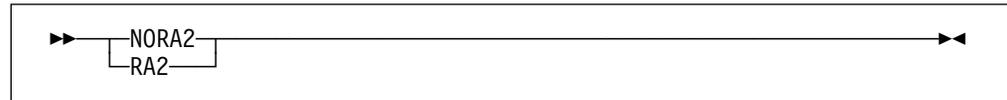


LIBMAC, abbreviation LMAC

specifies that, for each macro, macro definition statements read from a macro library are to be imbedded in the input source program immediately preceding the first invocation of that macro.

NOLIBMAC, abbreviation NOLMAC

specifies that macro definition statements read from a macro library are not to be included in the input source program.



RA2

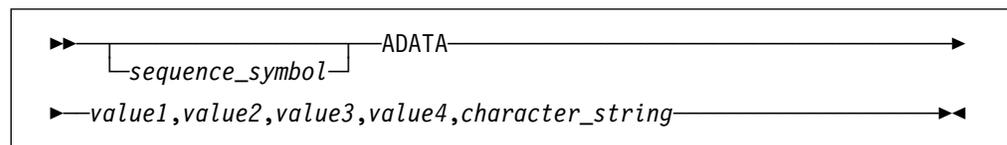
instructs the assembler to suppress error diagnostic message ASMA066 when 2-byte relocatable address constants are defined in the source

NORA2

instructs the assembler to issue error diagnostic message ASMA066 when 2-byte relocatable address constants are defined in the source

ADATA Instruction

The ADATA instruction writes records to the associated data file.



sequence_symbol
is a sequence symbol.

value1-value4
up to four values may be specified, separated by commas. If a value is omitted, the field written to the associated data file contains binary zeros. You must code a comma in the operand for each omitted value. If specified, *value1* through *value4* must be a decimal self-defining term with a value in the range -2^{31} to $+2^{31}-1$.

character_string
is a character string up to 255 bytes long, enclosed in single quotes. If omitted, the length of the user data field in the associated data file is set to zero.

Notes:

1. All operands may be omitted to produce a record containing binary zeros in all fields except the user data field.
2. The record written to the associated data file is described under "User-Supplied Information Record X'0070'," in Appendix D, "Associated Data File Output" of the *HLASM Programmer's Guide*.
3. If you do not specify the ADATA assembler option, or the GOFF(ADATA) or the XOBJECT(ADATA) assembler option (MVS or CMS), the assembler only

AININSERT Instruction

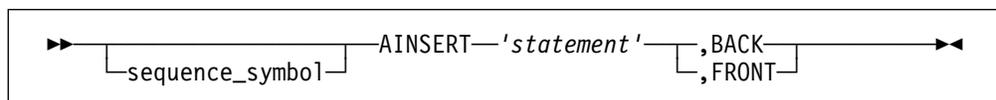
checks the syntax of an ADATA instruction, and prints it in the assembler listing.

4. The assembler writes associated data records to the SYSADATA (MVS or CMS), or the SYSADAT (VSE) file.

AININSERT Instruction

The AININSERT instruction inserts statements into the input stream. These statements are queued in an internal buffer until the macro generator has completed. At that point the internal buffer queue provides the next statement or statements. An operand controls the sequence of the statements within the internal buffer queue.

Note: While inserted statements may be placed at either end of the buffer queue, the statements are removed only from the front of the buffer queue.



sequence_symbol
is a sequence symbol.

statement

is the statement stored in the internal buffer. It may be any characters enclosed in single quotation marks.

The rules that apply to this character string are:

- Variable symbols are allowed.
- The string may be up to 80 characters in length. If the string is longer than 80 characters, only the first 80 characters are used. The rest of the string is ignored.

BACK

The statement is placed at the back of the internal buffer.

FRONT

The statement is placed at the front of the internal buffer.

Notes:

1. The ICTL instruction does not affect the format of the stored statements. The assembler processes these statements according to the standard begin, end and continue columns.
2. The assembler does not check the stored statements, even when the ISEQ instruction is active.

Example:

```

MACRO
MAC1
.
.A  AINSERT 'INSERT STATEMENT NUMBER ONE',FRONT      Insert record into the input stream
.B  AINSERT 'INSERT STATEMENT NUMBER TWO',FRONT      Insert record at the top of the input stream
.C  AINSERT 'INSERT STATEMENT NUMBER THREE',BACK     Insert record at the bottom of the input stream
.
.
&FIRST AREAD                                         Retrieve record TWO from the top of the input stream
.
.D  AINSERT 'INSERT STATEMENT NUMBER FOUR',FRONT     Insert record at the top of the input stream
&SECOND AREAD                                        Retrieve record FOUR from the top of the input stream
.
MEND
CSECT
.
MAC1
.
END

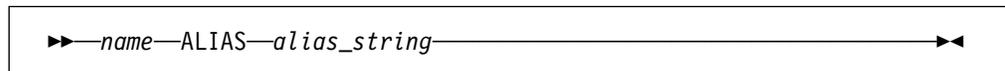
```

In this example the variable `&FIRST` receives the operand of the `AINsert` statement created at `.B`. `&SECOND` receives the operand of the `AINsert` statement created at `.D`. The operand of the `AINsert` statements at `.A` and `.C` are in the internal buffer in the sequence `.A` followed by `.C` and are the next statements processed when the macro generator has finished processing.

Figure 62 on page 236 shows code using `AINsert` in statements 16, 22, and 23.

ALIAS Instruction

The `ALIAS` instruction specifies alternate names for the external symbols that identify control sections, entry points, and external references. The instruction has nothing to do with the link-time aliases in libraries.



name

is an external symbol that is represented by one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

alias_string

is the alternate name for the external symbol, represented by one of the following:

- A character constant in the form `C'aaaaaaaa'`, where `aaaaaaaa` is a string of characters each of which has a hexadecimal value of `X'42'` to `X'FE'` inclusive
- A hexadecimal constant in the form `X'xxxxxxxx'`, where `xxxxxxxx` is a string of hexadecimal digits, each pair of which is in the range `X'42'` to `X'FE'` inclusive

AMODE Instruction

The ordinary symbol denoted by *name* must also appear in one of the following in this assembly:

- The name entry field of a START, CSECT, RSECT, COM, or DXD instruction
- The name entry field of a DSECT instruction and the nominal value of a Q-type offset constant
- The operand of an ENTRY, EXTRN or WXTRN instruction
- The nominal value of a V-type address constant

The assembler uses the string denoted by *alias_string* to replace the external symbol denoted by *name* in the external symbol dictionary records in the object module. If the string is shorter than 8 characters, or 16 hexadecimal digits, it is padded on the right with EBCDIC spaces (X'40'). If the string is longer than 8 characters, it is truncated. Some programs that process object modules do not support external symbols longer than 8 characters.

CMS, MVS If the extended object format is being generated (GOFF assembler option), the *alias_string* can be up to 64 characters, or 128 hexadecimal digits.

CMS, MVS

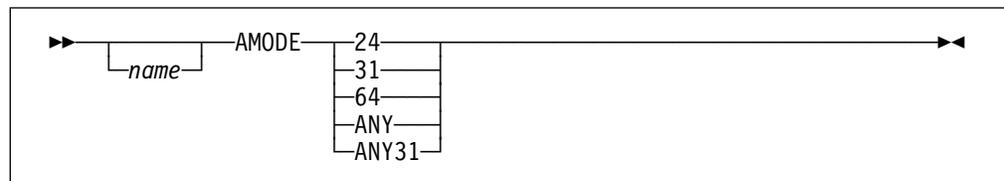
The following examples are of the ALIAS instruction, and show both formats of the alternate name denoted by *alias_string*. In both examples the alternate name is the lowercase equivalent of the external symbol.

```
EXTSYM1 ALIAS          C'extsym1'  
EXTSYM2 ALIAS          X'85A7A3A2A894F2'
```

This example is a special case where the *alias_string* is the lower case equivalent of the external symbol. However, dummy external section (DXD) aliases are only compared with other DXDs. In all other cases, the *alias_string* must not match any external symbol, regardless of case.

AMODE Instruction

The AMODE instruction specifies the addressing mode associated with control sections in the object deck.



name Is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

- **CMS, MVS** If the extended object format is being generated (GOFF assembler option), a relocatable symbol that names an entry point specified on an ENTRY instruction. **CMS, MVS**

- 24** Specifies that 24-bit addressing mode is to be associated with a control section, or entry point.
- 31** Specifies that 31-bit addressing mode is to be associated with a control section, or entry point.
- 64** Specifies that 64-bit addressing mode is to be associated with a control section, or entry point (see “64-bit Addressing Mode” on page 88).
- ANY** The same as ANY31.
- ANY31** The control section or entry point is not sensitive to whether it is entered in AMODE 24 or AMODE 31.

Any field of this instruction may be generated by a macro, or by substitution in open code.

If *name* denotes an ordinary symbol, the ordinary symbol associates the addressing mode with a control section. The ordinary symbol must also appear in the name field of a START, CSECT, RSECT, or COM instruction in this assembly.

If *name* is not specified, or if *name* is a sequence symbol, there must be an unnamed control section in this assembly.

Notes:

1. AMODE can be specified anywhere in the assembly. It does not initiate an unnamed control section.
2. An assembly can have multiple AMODE instructions; however, two AMODE instructions cannot have the same name field.
3. The valid and invalid combinations of AMODE and RMODE are shown in the following table. Note that combinations involving AMODE 64 and RMODE 64 are subject to the support outlined in “64-bit Addressing Mode” on page 88.

Figure 25. AMODE/RMODE Combinations

	RMODE 24	RMODE 31	RMODE 64
AMODE 24	OK	invalid	invalid
AMODE 31	OK	OK	invalid
AMODE ANY|ANY31	OK	OK	invalid
AMODE 64	OK	OK	OK

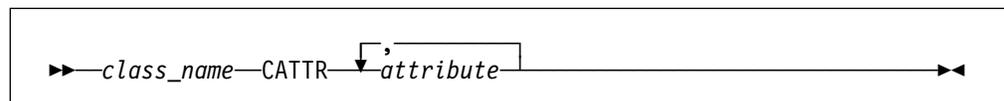
4. AMODE or RMODE cannot be specified for an unnamed common control section.
5. The defaults used when zero or one MODE is specified are shown in the following table. Note that combinations involving AMODE 64 and RMODE 64 are subject to the support outlined in “64-bit Addressing Mode” on page 88.

Figure 26. AMODE/RMODE Defaults

Specified	Default
Neither	AMODE 24, RMODE 24
AMODE 24	RMODE 24
AMODE 31	RMODE 24
AMODE ANYIANY31	RMODE 24
RMODE 24	AMODE 24
RMODE 31 (was ANY)	AMODE 31
AMODE 64	RMODE 31
RMODE 64	AMODE 64

CATTR Instruction (MVS and CMS)

The CATTR instruction establishes a program object external class name, and assigns binder attributes for the class. This instruction is only valid when you specify the GOFF or XOBJECT assembler option.



class_name

is a valid program object external class name. The class name must follow the rules for naming external symbols, except that:

- Class names are restricted to a maximum of 16 characters
- Class names with an underscore (`_`) in the second character are reserved for IBM use; for example `B_TEXT`. If you use a class name of this format, it might conflict with an IBM-defined binder class.

attribute

is one or more binder attributes that are assigned to the text in this class:

ALIGN(*n*)

Aligns the text on a 2^n boundary. *n* is an integer in the range from 0 to 12.

EXECUTABLE

The text can be branched to or executed—it is instructions, not data.

DEFLOAD

The text is not loaded when the program object is brought into storage, but will probably be requested, and therefore should be partially loaded, for fast access.

MERGE

The text has the merge binding property. For example, pseudo-registers or external dummy sections have the “merge” binding property.

Merge classes can contain initial text. If they do contain initial text, they must have a class name beginning with `C_`.

MOVABLE

The text can be moved, and is reenterable (that is, it is free of location-dependent data such as address constants, and executes normally if moved to a properly aligned boundary).

NOLOAD

The text for this class is not loaded when the program object is brought into storage. An external dummy section is an example of a class which is defined in the source program but not loaded.

NOTEXECUTABLE

The text cannot be branched to or executed (that is, it is data, not instructions).

NOTREUS

The text is marked not reusable.

READONLY

The text is storage-protected.

REFR

The text is marked refreshable.

RENT

The text is marked reenterable.

REUS

The text is marked reusable.

RMODE(24)

The text has a residence mode of 24.

RMODE(31)

The text has a residence mode of 31.

RMODE(ANY)

The text may be placed in any addressable storage.

Refer to the *DFSMS/MVS Program Management*, SC26-4916 for details about the binder attributes.

Default Attributes: When you don't specify attributes on the CATTR instruction the defaults are:

ALIGN(3),EXECUTABLE,NOTREUS,RMODE(24)

Where to Use the CATTR Instruction: Use the CATTR instruction anywhere in a source module after any ICTL or *PROCESS statements. The CATTR instruction must be preceded by a START, CSECT, or RSECT statement, otherwise the assembler issues diagnostic message ASMA190.

If several CATTR instructions within a source module have the same class name, the first occurrence establishes the class and its attributes, and the rest indicate the continuation of the text for the class. If you specify attributes on subsequent CATTR instructions having the same class name as a previous CATTR instruction, the assembler ignores the attributes and issues diagnostic message ASMA191.

CCW and CCW0 Instructions

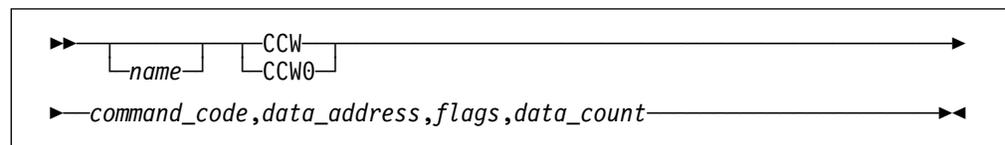
If you specify conflicting attributes, the assembler uses the last one specified. In the following example, the assembler uses RMODE(ANY):

```
MYCLASS CATTR RMODE(24),RMODE(ANY)
```

Syntax Checking Only: If you code a CATTR instruction but don't specify the GOFF or XOBJECT option, the assembler checks the syntax of the instruction statement and does not process the attributes.

CCW and CCW0 Instructions

The CCW and CCW0 instructions define and generate an 8-byte, format-0 channel command word for input/output operations. A format-0 channel command word allows a 24-bit data address. The CCW and CCW0 instructions have identical functions.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

command_code

is an absolute expression that specifies the command code. This expression's value is right-justified in byte 0 of the generated channel command word.

data_address

is a relocatable or absolute expression that specifies the address of the data to operate upon. This value is treated as a 3-byte, A-type address constant. The value of this expression is right-justified in bytes 1 to 3 of the generated channel command word.

flags

is an absolute expression that specifies the flags for bits 32 to 37, and zeros for bits 38 and 39, of the generated channel command word. The value of this expression is right-justified in byte 4 of the generated channel command word. Byte 5 is set to zero by the assembler.

data_count

is an absolute expression that specifies the byte count or length of data. The value of this expression is right-justified in bytes 6 and 7 of the generated channel command word.

The generated channel command word is aligned at a doubleword boundary. Any skipped bytes are set to zero.

The internal machine format of a channel command word is shown in Figure 27.

Figure 27. Channel Command Word, Format 0

Byte	Bits	Usage
0	0-7	Command code
1-3	8-31	Address of data to operate upon
4	32-37	Flags
	38-39	Must be specified as zeros
5	40-47	Set to zeros by assembler
6-7	48-63	Byte count or length of data

If *symbol* is an ordinary symbol or a variable symbol that has been assigned an ordinary symbol, the ordinary symbol is assigned the value of the address of the first byte of the generated channel command word. The length attribute value of the symbol is 8.

The following are examples of CCW and CCW0 statements:

```
WRITE1  CCW          1,DATADR,X'48',X'50'
WRITE2  CCW0         1,DATADR,X'48',X'50'
```

The object code generated (in hexadecimal) for either of the above examples is:

```
01 xxxxxx 48 00 0050
```

where xxxxxx contains the address of DATADR, and DATADR must reside below 16 megabytes.

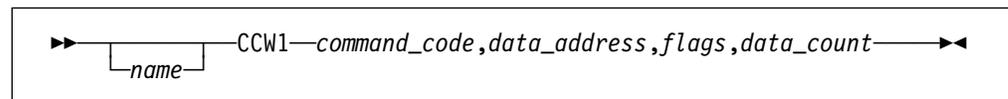
MVS ➤

Using EXCP or EXCPVR access methods: If you use the EXCP or EXCPVR access method, you must use CCW or CCW0, because EXCP and EXCPVR do not support 31-bit data addresses in channel command words. ◀ **MVS**

Specifying RMODE: Use RMODE 24 with CCW or CCW0 to ensure that valid data addresses are generated. If you use RMODE ANY with CCW or CCW0, an invalid data address in the channel command word can result at execution time.

CCW1 Instruction

The CCW1 instruction defines and generates an 8-byte format-1 channel command word for input/output operations. A format-1 channel command word allows 31-bit data addresses. A format-0 channel command word generated by a CCW or CCW0 instruction allows only a 24-bit data address.



name

is one of the following:

- An ordinary symbol

- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

command_code

is an absolute expression that specifies the command code. This expression's value is right-justified in byte 0 of the generated channel command word.

data_address

is a relocatable or absolute expression that specifies the address of the data to operate upon. This value is treated as a 4-byte, A-type address constant. The value of this expression is right-justified in bytes 4 to 7 of the generated channel command word.

flags

is an absolute expression that specifies the flags for bits 8 to 15 of the generated channel command word. The value of this expression is right-justified in byte 1 of the generated channel command word.

data_count

is an absolute expression that specifies the byte count or length of data. The value of this expression is right-justified in bytes 2 and 3 of the generated channel command word.

The generated channel command word is aligned at a doubleword boundary. Any skipped bytes are set to zero.

The internal machine format of a channel command word is shown in Figure 28.

Figure 28. Channel Command Word, Format 1

Byte	Bits	Usage
0	0-7	Command code
1	8-15	Flags
2-3	16-31	Count
4	32	Must be zero
4-7	33-63	Data address

The expression for the data address should be such that the address is within the range 0 to $2^{31}-1$, inclusive, after possible relocation. This is the case if the expression refers to a location within one of the control sections that are link-edited together. An expression such as `*-1000000000` yields an acceptable value only when the value of the location counter (*) is 1000000000 or higher at assembly time.

If *symbol* is an ordinary symbol or a variable symbol that has been assigned an ordinary symbol, the ordinary symbol is assigned the value of the address of the first byte of the generated channel command word. The length attribute value of the symbol is 8.

The following is an example of a CCW1 statement:

```
A      CCW1      X'0C',BUF1,X'00',L'BUF1
```

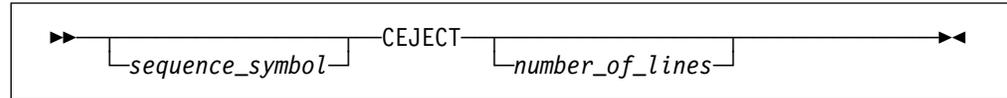
The object code generated (in hexadecimal) for the above examples is:

```
0C 00 yyyy xxxxxxxx
```

where *yyyy* is the length of BUF1 and *xxxxxxx* is the address of BUF1. BUF1 can reside anywhere in virtual storage.

CEJECT Instruction

The CEJECT instruction conditionally stops the printing of the assembler listing on the current page, and continues the printing on the next page.



sequence_symbol
is a sequence symbol.

number_of_lines
is an absolute value that specifies the minimum number of lines that must be remaining on the current page to prevent a page eject. If the number of lines remaining on the current page is less than the value specified by *number_of_lines*, the next line of the assembler listing is printed at the top of a new page.

You may use any absolute expression to specify *number_of_lines*.

If number of lines is omitted, the CEJECT instruction behaves as an EJECT instruction.

If zero, a page is ejected unless the current line is at the top of a page.

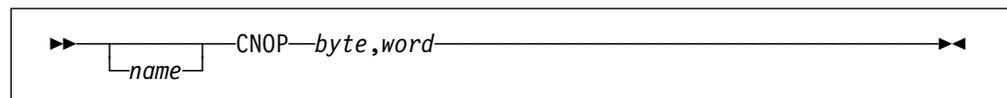
If the line before the CEJECT statement appears at the bottom of a page, the CEJECT statement has no effect. A CEJECT instruction without an operand immediately following another CEJECT instruction or an EJECT instruction is ignored.

Notes:

1. The CEJECT statement itself is not printed in the listing unless a variable symbol is specified as a point of substitution in the statement, in which case the statement is printed before substitution occurs.
2. The PRINT DATA and PRINT NODATA instructions can alter the effect of the CEJECT instruction, depending on the number of assembler listing lines that are required to print the generated object code for each instruction.

CNOP Instruction

The CNOP instruction aligns any instruction or other data on a specific halfword boundary. This ensures an unbroken flow of executable instructions, since the CNOP instruction generates no-operation instructions to fill the bytes skipped to achieve specified alignment.



|

name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

byte

is an absolute expression that specifies at which even-numbered byte in a fullword or doubleword the location counter is set. The value of the expression must be 0, 2, 4, or 6.

word

is an absolute expression that specifies the byte specified by *byte* is in a fullword or a doubleword. A value of 4 indicates the byte is in a fullword. A value of 8 indicates the byte is in a doubleword.

Figure 29 shows valid pairs of *byte* and *word*.

Figure 29. Valid CNOP Values

Values	Specify
0,4	Beginning of a word
2,4	Middle of a word
0,8	Beginning of a doubleword
2,8	Second halfword of a doubleword
4,8	Middle (third halfword) of a doubleword
6,8	Fourth halfword of a doubleword

Figure 30 shows the position in a doubleword that each of these pairs specifies. Note that both 0,4 and 2,4 specify two locations in a doubleword.

Doubleword							
Fullword				Fullword			
Halfword		Halfword		Halfword		Halfword	
Byte	Byte	Byte	Byte	Byte	Byte	Byte	Byte
0,4		2,4		0,4		2,4	
0,8		2,8		4,8		6,8	

Figure 30. CNOP Alignment

Use the CNOP instruction, for example, when you code the linkage to a subroutine, and you want to pass parameters to the subroutine in fields immediately following the branch and link instructions. These parameters—for example, channel command words—can require alignment on a specific boundary. The subroutine can then address the parameters you pass through the register with the return address, as in the following example:

```

LINK   CNOP           6,8
        BALR          2,10
        CCW           1,DATADR,X'48',X'50'

```

Assume that the location counter is aligned at a doubleword boundary. Then the CNOP instruction causes three no-operations to be generated, thus aligning the BALR instruction at the last halfword in a doubleword as follows:

```

        BCR           0,0
        BCR           0,0
        BCR           0,0
        BALR          2,10
LINK   CCW           1,DATADR,X'48',X'50'

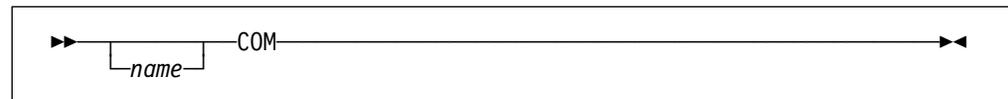
```

After the BALR instruction is generated, the location counter is at a doubleword boundary, thereby ensuring that the CCW instruction immediately follows the branch and link instruction.

The CNOP instruction forces the alignment of the location counter to a halfword, fullword, or doubleword boundary. It does not affect the location counter if the counter is already correctly aligned. If the specified alignment requires the location counter to be incremented, one-to-three no-operation instructions (BCR 0,0 occupying two bytes each) are generated to fill the skipped bytes. Any single byte skipped to achieve alignment to the first no-operation instruction is filled with zeros.

COM Instruction

The COM instruction identifies the beginning or continuation of a common control section.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

The COM instruction can be used anywhere in a source module after the ICTL instruction.

If *name* denotes an ordinary symbol, the ordinary symbol identifies the common control section. If several COM instructions within a source module have the same symbol in the name field, the first occurrence initiates the common section and the rest indicate the continuation of the common section. The ordinary symbol denoted by *name* represents the address of the first byte in the common section, and has a length attribute value of 1.

If *name* is not specified, or if *name* is a sequence symbol, the COM instruction initiates, or indicates the continuation of, the unnamed common section.

COPY Instruction

| See “CSECT Instruction” on page 108 for a discussion on the interaction between
| COM and the GOFF assembler option.

The location counter for a common section is always set to an initial value of 0. However, when an interrupted common control section is continued using the COM instruction, the location counter last specified in that control section is continued.

If a common section with the same name (or unnamed) is specified in two or more source modules, the amount of storage reserved for this common section is equal to that required by the longest common section specified.

The source statements that follow a COM instruction belong to the common section identified by that COM instruction.

Notes:

1. The assembler language statements that appear in a common control section are not assembled into object code.
2. When establishing the addressability of a common section, the symbol in the name field of the COM instruction, or any symbol defined in the common section, can be specified in a USING instruction.

In the following example, addressability to the common area of storage is established relative to the named statement XYZ.

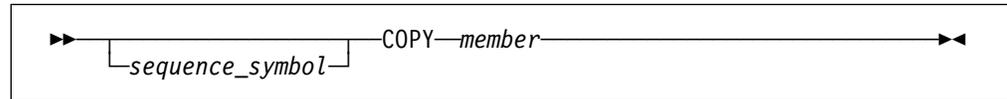
```
      .  
      .  
      L           1,=A(XYZ)  
      USING      XYZ,1  
      MVC       PDQ(16),=4C'ABCD'  
      .  
      .  
      COM  
XYZ   DS         16F  
PDQ   DS         16C  
      .  
      .
```

A common control section may include any assembler language instructions, but no object code is generated by the assembly of instructions or constants appearing in a common control section. Data can only be placed in a common control section through execution of the program.

If the common storage is assigned in the same manner by each independent assembly, reference to a location in common by any assembly results in the same location being referenced.

COPY Instruction

Use the COPY instruction to obtain source statements from a source language library and include them in the program being assembled. You can thereby avoid writing the same, often-used sequence of code over and over.

*sequence_symbol*

is a sequence symbol. Refer to page 30 for a description of sequence symbols.

member

is an ordinary symbol that identifies a source language library member to be copied from either a system macro library or a user macro library. In open code it can also be a variable symbol that has been assigned a valid ordinary symbol.

The source statements that are copied into a source module:

- Are inserted immediately after the COPY instruction.
- Are inserted and processed according to the standard instruction statement coding format, even if an ICTL instruction has been specified.
- Must not contain either an ICTL or ISEQ instruction.
- Can contain other COPY statements. There are no restrictions on the number of levels of nested copy instructions. However, the COPY nesting must not be recursive. For example, assume that the source program contains the statement:

```
COPY A
```

and library member A contains the statement:

```
COPY B
```

In this case, the library member B must not contain a COPY A or COPY B statement.

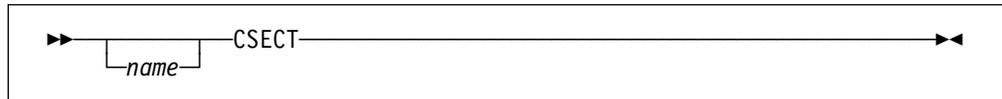
- Can contain macro definitions. Note, however, that if a source macro definition is copied into a source module, both the MACRO and MEND statements that delimit the definition must be contained in the same level of copied code.

Notes:

1. The COPY instruction can also be used to copy statements into source macro definitions.
2. The rules that govern the occurrence of assembler language statements in a source module also govern the statements copied into the source module.
3. Whenever the assembler processes a COPY statement, whether it is in open code or in a macro definition, the assembler attempts to read the source language library member specified in the COPY statement. This means that all source language library members specified by COPY statements in a source program, including those specified in macro definitions, must be available during the assembly. The *HLASM Programmer's Guide* describes how to specify the libraries when you run the assembler.
4. If an END instruction is encountered in a member during COPY processing, the assembly is ended. Any remaining statements in the COPY member are discarded.

CSECT Instruction

The CSECT instruction initiates an executable control section or indicates the continuation of an executable control section.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

The CSECT instruction can be used anywhere in a source module after any ICTL or *PROCESS statements. If it is used to initiate the first executable control section, it must not be preceded by any instruction that affects the location counter and thereby causes a control section to be initiated.

If *name* denotes an ordinary symbol, the ordinary symbol identifies the control section. If several CSECT instructions within a source module have the same symbol in the name field, the first occurrence initiates the control section and the rest indicate the continuation of the control section. The ordinary symbol denoted by *name* represents the address of the first byte in the control section, and has a length attribute value of 1.

If *name* is not specified, or if *name* is a sequence symbol, the CSECT instruction initiates, or indicates the continuation of the unnamed control section.

If the first control section is initiated by a START instruction, the CSECT instruction which continues the section must have the same name as the START instruction.

When the GOFF option is not specified a control section is initiated or resumed by the CSECT, RSECT, and COM statements. Any machine language text created by statements that follow such control section declarations belongs to the control section, and is manipulated during program linking and binding as an indivisible unit.

When the GOFF option is specified, the behavior of CSECT, RSECT, and COM statements is somewhat different. By default, the assembler creates a definition of a text class named B_TEXT, to which subsequent machine language text belongs if no other classes are declared. If you specify other class names using the CATTR statement, machine language text following such CATTR statements belongs to that class.

The combination of a section name and a class name defines an *element*, which is the indivisible unit manipulated during linking and binding. All elements with the same section name are “owned” by that section, and binding actions (such as section replacement) act on all elements owned by a section.

| When the GOFF option is specified, and if no CATTR statements are present, then
 | all machine language text is placed in the default class B_TEXT, and the behavior
 | of the elements in the bound module is essentially the same as the behavior of
 | control sections when the OBJECT option is specified. However, if additional
 | classes are declared, a section name can best be thought of as a “handle” by
 | which elements within declared classes are owned.

The beginning of a control section is aligned on a doubleword boundary. However, when an interrupted control section is continued using the CSECT instruction, the location counter last specified in that control section is continued. Consider the coding in Figure 31:

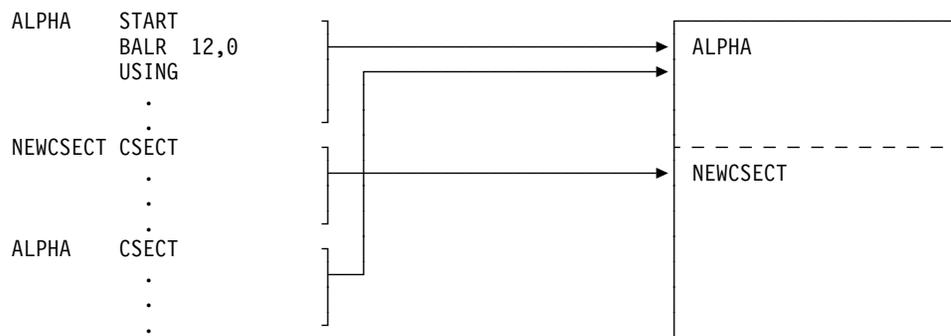


Figure 31. How the Location Counter Works

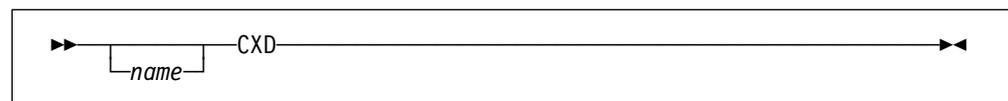
The source statements following a CSECT instruction that either initiate or indicate the continuation of a control section are assembled into the object code of the control section identified by that CSECT instruction.

The end of a control section or portion of a control section is marked by:

- Any instruction that defines a new or continued control section
- The END instruction

CXD Instruction

The CXD instruction reserves a fullword area in storage. The linker or loader inserts into this area the total length of all external dummy sections specified in the source modules that are assembled and linked into one program.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

DC Instruction

The linker or loader inserts into the fullword-aligned fullword area reserved by the CXD instruction the total length of storage required for all the external dummy sections specified in a program. If the GOFF assembler option is specified, CXD returns the length of the B_PRV class. If *name* denotes an ordinary symbol, the ordinary symbol represents the address of the fullword area. The ordinary symbol denoted by *name* has a length attribute value of 4.

The following examples shows how external dummy sections may be used:

ROUTINE A

```
ALPHA   DXD           2DL8
BETA    DXD           4FL4
OMEGA   CXD
        .
        .
        DC           Q(ALPHA)
        DC           Q(BETA)
        .
        .
```

ROUTINE B

```
GAMMA   DXD           5D
DELTA   DXD           10F
        .
        .
        DC           Q(GAMMA)
        DC           Q(DELTA)
        .
        .
```

ROUTINE C

```
EPSILON DXD           4H
        .
        .
        DC           Q(EPSILON)
        .
        .
```

Each of the three routines is requesting an amount of work area. Routine A wants 2 doublewords and 4 fullwords; Routine B wants 5 doublewords and 10 fullwords; Routine C wants 4 halfwords. At the time these routines are brought into storage, the sum of the individual lengths is placed in the location of the CXD instruction labeled OMEGA. Routine A can then allocate the amount of storage that is specified in the CXD location.

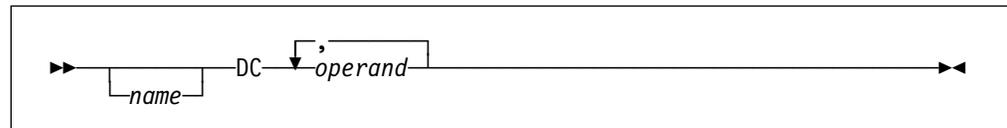
DC Instruction

You specify the DC instruction to define the data constants you need for program execution. The DC instruction causes the assembler to generate the binary representation of the data constant you specify into a particular location in the assembled source module; this is done at assembly time.

The DC instruction can generate the following types of constants:

Figure 32. Types of Data Constants

Type of Constant	Function	Example		
Address	Defines address mainly for the use of fixed-point and other instructions	ADCON	L DC	5,ADCON A(SOMWHERE)
Binary	Defines bit patterns	FLAG	DC	B'00010000'
Character	Defines character strings or messages	CHAR	DC	C'string of characters'
Decimal	Used by decimal instructions	PCON AREA	AP DC DS	AREA,PCON P'100' P
Fixed-point	Used by the fixed-point and other instructions	FCON	L DC	3,FCON F'100'
Floating-point	Used by floating-point instructions	ECON	LE DC	2,ECON E'100.50'
Graphic	Defines character strings or messages that contain pure double-byte data	DBCS	DC	G'<.D.B.C.S. .S.T.R.I.N.G>'
Hexadecimal	Defines large bit patterns	PATTERN	DC	X'FF00FF00'



name

is one of the following:

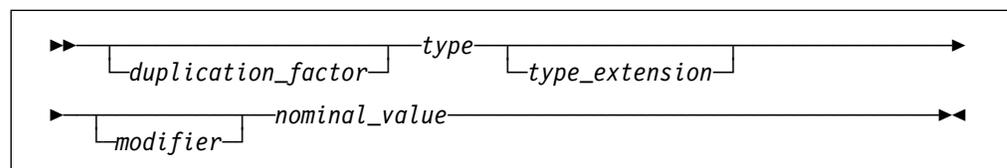
- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

If *symbol* denotes an ordinary symbol, the ordinary symbol represents the address of the first byte of the assembled constant. If several operands are specified, the first constant defined is addressable by the ordinary symbol. The other constants can be reached by relative addressing.

operands

An operand of five subfields. The first four subfields describe the constant. The fifth subfield provides the nominal values for the constants.

A DC operand has this format:



DC Instruction

duplication_factor

causes the *nominal_value* to be generated the number of times indicated by this factor. See “Subfield 1: Duplication Factor” on page 116.

type

further determines the type of constant the *nominal_value* represents. See “Subfield 2: Type” on page 117.

type_extension

determines some of the characteristics of the constant. See “Subfield 3: Type Extension” on page 118.

modifier

describes the length, the scaling, and the exponent of the *nominal_value*. See “Subfield 4: Modifier” on page 119.

nominal_value

defines the value of the constant. See “Subfield 5: Nominal Value” on page 123.

For example, in:

10EBL2'12'

the five subfields are:

- Duplication factor is 10
- Type is E
- Type extension is B
- Modifier is L2
- Nominal value is 12

If all subfields are specified, the order given above is required. The first, third and fourth subfields can be omitted, but the second and fifth must be specified in that order.

Rules for DC Operand

1. The type subfield and the nominal value must always be specified unless the duplication factor is zero. If the duplication factor is zero, only the type must be specified.
2. The duplication factor, type extension and modifier subfields are optional.
3. When multiple operands are specified, they can be of different types.
4. When multiple nominal values are specified in the fifth subfield, they must be separated by commas and be of the same type. Multiple nominal values are not allowed for character or graphic constants.
5. The descriptive subfields apply to all the nominal values. Separate constants are generated for each separate operand and nominal value specified.
6. No blanks are allowed:
 - Between subfields
 - Between multiple operands
 - Within any subfields, unless they occur within a quoted nominal value.

General Information About Constants

Constants defined by the DC instruction are assembled into an object module at the location at which the instruction is specified. However, the type of constant being defined, and the presence or absence of a length modifier, determines whether the constant is to be aligned on a particular storage boundary or not (see “Alignment of Constants”).

Symbolic Addresses of Constants: The value of the symbol that names the DC instruction is the address of the first byte (after alignment) of the first or only constant.

Length Attribute Value of Symbols Naming Constants

The length attribute value assigned to the symbols in the name field of the constants is equal to:

- The implicit length (see “Implicit Length” in Figure 33) of the constant when no explicit length is specified in the operand of the constant, or
- The explicit length (see “Value of Length Attribute” in Figure 33) of the constant.

If more than one operand is present, the length attribute value of the symbol is the length in bytes of the first constant specified, according to its implicit or explicit length.

Alignment of Constants

The assembler aligns constants on different boundaries according to the following:

- On boundaries implicit to the type of constant (see “Implicit Boundary Alignment” in Figure 34 on page 114) when no length is specified.
- On byte boundaries (see “Boundary Alignment” in Figure 34) when an explicit length is specified.

Bytes that are skipped to align a constant at the correct boundary are not considered part of the constant. They are filled with zeros.

Notes:

1. The automatic alignment of constants and areas does not occur if the NOALIGN assembler option has been specified.
2. Alignment can be forced to any boundary by a preceding DS or DC instruction with a zero duplication factor. This occurs whether or not the ALIGN option is set.

Figure 33 (Page 1 of 2). Length Attribute Value of Symbol Naming Constants

Type of constant	Implicit Length	Examples	Value of Length Attribute ¹
B	as needed	DC B'10010000'	1
C	as needed	DC C'ABC' DC CL8'WOW'	3 8
CU	as needed	DC CU'ABC' DC CUL4'XX'	6 4

Figure 33 (Page 2 of 2). Length Attribute Value of Symbol Naming Constants

Type of constant	Implicit Length	Examples	Value of Length Attribute ¹
G	as needed	DC G'<DaDb>'	4
		DC GL8'<DaDb>'	8
X	as needed	DC X'COFFEE'	3
		DC XL2'FFEE'	2
H	2	DC H'32'	2
F	4	DC FL3'32'	3
FD	8	DC FD'32'	8
P	as needed	DC P'123'	2
		DC PL4'123'	4
Z	as needed	DC Z'123'	3
		DC ZL10'123'	10
E	4	DC E'565.40'	4
D	8	DC DL6'565.40'	6
L	16	DC LL12'565.40'	12
Y	2	DC Y(HERE)	2
A	4	DC AL1(THERE)	1
AD	8	DC AD(WHERE)	8
S	2	DC S(THERE)	2
V	4	DC VL3(OTHER)	3
J	4	DC J(CLASS)	4
Q	4	DC QL1(LITTLE)	1
R	4	DC R(APSECT)	4

Note:

1. Depends on whether or not an explicit length is specified in the constant.

Padding and Truncation of Values

The nominal values specified for constants are assembled into storage. The amount of space available for the nominal value of a constant is determined:

- By the explicit length specified in the second operand subfield, or
- If no explicit length is specified, by the implicit length according to the type of constant defined (see Appendix B, “Summary of Constants” on page 363).

Figure 34 (Page 1 of 2). Alignment of Constants

Type of constant	Implicit Boundary Alignment	Examples	Boundary Alignment ¹
B	byte	DC B'1011'	byte
C	byte	DC C'Character string'	byte
CU	byte	DC CU'Character string'	byte
G	byte	DC G'<.D.B.C.S .S.T.R.I.N.G>	byte
X	byte	DC X'20202021202020'	byte

Figure 34 (Page 2 of 2). Alignment of Constants

Type of constant	Implicit Boundary Alignment	Examples	Boundary Alignment ¹
H	halfword	DC H'25'	halfword
F	fullword	DC HL3'25'	byte
	fullword	DC F'225'	fullword
FD	doubleword	DC FL7'225'	byte
		DC FD'225'	doubleword
P	byte	DC P'2934'	byte
Z	byte	DC Z'1235'	byte
		DC ZL2'1235'	byte
E	fullword	DC E'1.25'	fullword
		DC EL5'1.25'	byte
D	doubleword	DC 8D'95'	doubleword
		DC 8DL7'95'	byte
L	doubleword	DC L'2.57E65'	doubleword
Y	halfword	DC Y(HERE)	halfword
A	fullword	DC AL1(THERE)	byte
AD	doubleword	DC AD(WHERE)	doubleword
S	halfword	DC S(LABEL)	halfword
		DC SL2(LABEL)	byte
V	fullword	DC V(EXTERNAL)	fullword
		DC VL3(EXTERNAL)	byte
J	fullword	DC J(CLASS)	fullword
Q	fullword	DC QL1(DUMMY)	byte
R	fullword	DC R(APSECT)	fullword

Note:

1. Depends on whether or not an explicit length is specified in the constant.

Padding

If more space is specified than is needed to accommodate the binary representation of the nominal value, the extra space is padded:

- With binary zeros on the left for the binary (B), hexadecimal (X), fixed-point (H,F), packed decimal (P), and all address (A,Y,S,V,J,Q,R) constants
- With EBCDIC zeros on the left (X'F0') for the zoned decimal (Z) constants
- With EBCDIC blanks on the right (X'40') for the character (C) constants
- With EBCDIC blanks on the right (X'40') for the Unicode character (CU) constant prior to translation
- With double-byte blanks on the right (X'4040') for the graphic (G) constants

Notes:

1. In floating-point constants (E,D,L), the fraction is extended to fill the extra space available.
2. Padding is on the left for all constants except the character constant and the graphic constant.

Truncation

If less space is available than is needed to accommodate the nominal value, the nominal value is truncated and part of the constant is lost. Truncation of the nominal value is:

- On the left for the binary (B), hexadecimal (X), fixed-point (H and F), decimal (P and Z), and address (A and Y) constants
- On the right for the character (C) constant, the Unicode character (CU) constant, and the graphic (G) constant
- On the left for the external address (V), offset (Q), length (J) and PSECT address (R) constants. The actual value stored and any possible truncation is dependent on the values inserted by the linker/binder and the length of the constant.

Notes:

1. If significant bits are lost in the truncation of fixed-point constants, error diagnostic message ASMA072E Data item too large is issued.
2. Floating-point constants (E, D, L) are not truncated. They are rounded to fit the space available.
3. The above rules for padding and truncation also apply when using the bit-length modifier (see “Subfield 4: Modifier” on page 119).
4. Double-byte data in C-type constants cannot be truncated because truncation creates incorrect double-byte data. Error ASMA208E Truncation into double-byte data is not permitted is issued if such truncation is attempted.
5. Truncation of double-byte data in CU-type and G-type constants is permitted because the length modifier restrictions (see “Subfield 4: Modifier” on page 119) ensure that incorrect double-byte data cannot be created by truncation.

Subfield 1: Duplication Factor

The syntax for coding the *duplication factor* is shown in the subfield format on page 111.

You may omit the duplication factor. If specified, it causes the nominal value or multiple nominal values specified in a constant to be generated the number of times indicated by the factor. It is applied after the nominal value or values are assembled into the constant. Symbols used in subfield 1 need not be previously defined. This does not apply to literals.

The duplication factor can be specified by an unsigned decimal self-defining term or by an absolute expression enclosed in parentheses.

The expression must have a positive value or be equal to zero.

Notes:

1. The value of a location counter reference in a duplication factor is the value before any alignment to boundaries is done, according to the type of constant specified.
2. A duplication factor of zero is permitted, except for literals with the following results:

- No value is assembled.
- Alignment is forced according to the type of constant specified, if no length attribute is present (see “Alignment of Constants” on page 113).
- The length attribute of the symbol naming the constant is established according to the implicitly or explicitly specified length.

When the duplication factor is zero, the nominal value may be omitted. The alignment is forced, even if the NOALIGN option is specified.

When the duplication factor is zero for a literal, the assembler issues message ASMA067S Illegal duplication factor.

3. If duplication is specified for an address constant whose nominal value contains a location counter reference, the value of the location counter reference is incremented by the length of the constant before each duplication is done (see “Address Constants—A and Y” on page 135).

However, if duplication is specified for an address-type literal constant containing a location counter reference, the value of the location counter reference is not incremented by the length of the literal before each duplication is done. The value of the location counter reference is the location of the first byte of the literal in the literal pool, and is the same for each duplication.

4. The maximum value for the duplication factor is $2^{24}-1$, or X'FFFFFF' bytes. If the maximum value for the duplication factor is exceeded, the assembler issues message ASMA067S Illegal duplication factor.

Subfield 2: Type

The syntax for coding the *type* is shown in the subfield format on page 111.

You must specify the type subfield. From the type specification, the assembler determines how to interpret the constant and translate it into the correct format. The type is specified by a single-letter code as shown in Figure 35.

Further information about these constants is provided in the discussion of the constants themselves under “Subfield 5: Nominal Value” on page 123.

Figure 35 (Page 1 of 2). Type Codes for Constants

Code	Constant Type	Machine Format
C	Character	8-bit code for each character
CU	Unicode character	16-bit code for each character
G	Graphic	16-bit code for each character
X	Hexadecimal	4-bit code for each hexadecimal digit
B	Binary	Binary format
F	Fixed-point	Signed, fixed-point binary format; normally a fullword
FD	Fixed-Point	Signed, fixed-point binary format; normally a doubleword
H	Fixed-point	Signed, fixed-point binary format; normally a halfword
E	Floating-point	Short floating-point format; normally a fullword
D	Floating-point	Long floating-point format; normally a doubleword
L	Floating-point	Extended floating-point format; normally two doublewords

Figure 35 (Page 2 of 2). Type Codes for Constants

Code	Constant Type	Machine Format
P	Decimal	Packed decimal format
Z	Decimal	Zoned decimal format
A	Address	Value of address; normally a fullword
AD	Address	Value of address; normally a doubleword
Y	Address	Value of address; normally a halfword
S	Address	Base register and displacement value; a halfword
V	Address	Space reserved for external symbol addresses; normally a fullword
J	Address	Space reserved for length of class or DXD; normally a fullword
Q	Address	Space reserved for external dummy section offset
R	Address	Space reserved for PSECT addresses; normally a fullword

The type in conjunction with an optional type extension specification indicates to the assembler:

1. How to assemble the nominal value(s) specified in subfield 5; that is, which binary representation or machine format the object code of the constant must have.
2. At what boundary the assembler aligns the constant, if no length modifier is present.
3. How much storage the constant occupies, according to the implicit length of the constant, if no explicit length modifier is present (for details, see “Padding and Truncation of Values” on page 114).

Subfield 3: Type Extension

The syntax for coding the *type extension* is shown in the subfield format on page 111.

You may omit the type extension subfield. If specified, the assembler, using this field in conjunction with the type subfield, determines how to interpret the constant and translate it into the correct format. The type extension is specified by a single-letter code as shown in Figure 36.

Figure 36 (Page 1 of 2). Type Extension Codes for Constants

Type	Type Extension	Description
C	U	Unicode character constant
E	H	New hexadecimal floating-point constant
	B	Binary floating-point constant
D	H	New hexadecimal floating-point constant
	B	Binary floating-point constant
L	H	New hexadecimal floating-point constant
	B	Binary floating-point constant

Figure 36 (Page 2 of 2). Type Extension Codes for Constants

Type	Type Extension	Description
F	D	Doubleword fixed-point constant
A	D	Doubleword address constant

The type extension specification, in conjunction with the type subfield, indicates to the assembler:

1. How to assemble the nominal value(s) specified in subfield 5; that is, which binary representation or machine format the object code of the constant must have.
2. At what boundary the assembler aligns the constant, if no length modifier is present.
3. How much storage the constant occupies, according to the implicit length of the constant, if no explicit length modifier is present (for details, see “Padding and Truncation of Values” on page 114).

Subfield 4: Modifier

The syntax for coding the *modifier* is shown in the subfield format on page 111.

You may omit the modifier subfield. Modifiers describe the length in bytes you want for a constant (in contrast to an implied length), and the scaling and exponent for the constant.

The three modifiers are:

- The length modifier (L), that explicitly defines the length in bytes you want for a constant. For example:

```
LENGTH DC XL10'FF'
```

- The scale modifier (S), that is only used with the fixed-point or floating-point constants (for details, see “Scale Modifier” on page 121). For example:

```
SCALE DC FS8'35.92'
```

- The exponent modifier (E), that is only used with fixed-point or floating-point constants, and indicates the power of 10 by which the constant is to be multiplied before conversion to its internal binary format. For example:

```
EXPON DC EE3'3.414'
```

If multiple modifiers are used, they must appear in this sequence: length, scale, exponent. For example:

```
ALL3 DC DL7S3E50'2.7182'
```

Symbols used in subfield 3 need not be previously defined, except in literals. For example:

```
SYM DC FS(X)'35.92'
X EQU 7
```

Length Modifier

The length modifier indicates the number of bytes of storage into which the constant is to be assembled. It is written as L_n , where n is either a decimal self-defining term or an absolute expression enclosed by parentheses. It must have a positive value.

When the length modifier is specified:

- Its value determines the number of bytes of storage allocated to a constant. It therefore determines whether the nominal value of a constant must be padded or truncated to fit into the space allocated (see “Padding and Truncation of Values” on page 114).
- No boundary alignment, according to constant type, is provided (see “Alignment of Constants” on page 113).
- Its value must not exceed the maximum length allowed for the various types of constant defined.
- The length modifier must not truncate double-byte data in a C-type constant.
- The length modifier must be a multiple of 2 in a G-type or CU-type constant.

When no length is specified, for character and graphic constants (C and G), hexadecimal constants (X), binary constants (B), and decimal constants (P and Z), the whole constant is assembled into its implicit length.

Bit-Length Modifier: The length modifier can be specified to indicate the number of bits into which a constant is to be assembled. The bit-length modifier is written as $L.n$ where n is either a decimal self-defining term, or an absolute expression enclosed in parentheses. It must have a positive value.

The value of n must lie between 1 and the number of bits (a multiple of 8) that are required to make up the maximum number of bytes allowed in the type of constant being defined. The bit-length modifier can never be used with the CU-, G-, S-, V-, R- and Q-type constants, and cannot be used with the A-type constant if the operand is simply or complexly relocatable.

When only one operand and one nominal value are specified in a DC instruction, the following rules apply:

1. The bit-length modifier allocates a field into which a constant is to be assembled. The field starts at a byte boundary and can run over one or more byte boundaries, if the bit length is greater than 8.
If the field does not end at a byte boundary and if the bit length is not a multiple of 8, the remainder of the last byte is filled with binary zeros.
2. The nominal value of the constant is assembled into the field:
 - a. Starting at the high order end for the C-, E-, D-, and L-type constants
 - b. Starting at the low-order end for the remaining types of constants that support a bit-length modifier
3. The nominal value is padded or truncated to fit the field (see “Padding and Truncation of Values” on page 114).

Character constants are padded with hexadecimal blanks, X'40'; other constant types are padded with zeros.

The length attribute value of the symbol naming a DC instruction with a specified bit length is equal to the minimum number of integral bytes needed to contain the bit length specified for the constant. Consider the following example:

```
TRUNCF   DC           FL.12'276'
```

L'TRUNCF is equal to 2. Thus, a reference to TRUNCF addresses both the two bytes that are assembled.

When more than one operand is specified in a DC instruction, or more than one nominal value in a DC operand, the above rules about bit-length modifiers also apply, except:

1. The first field allocated starts at a byte boundary, but the succeeding fields start at the next available bit.
2. After all the constants have been assembled into their respective fields, the bits remaining to make up the last byte are filled with zeros.

If duplication is specified, filling with zeros occurs once at the end of all the fields occupied by the duplicated constants.

3. The length attribute value of the symbol naming the DC instruction is equal to the number of integral bytes needed to contain the bit length specified for the first constant to be assembled.

For Double-Byte Data in C-Type Constants: If bit-lengths are specified, with a duplication factor greater than 1, and a bit-length which is not a multiple of 8, then the double-byte data is no longer valid for devices capable of presenting DBCS characters. No error message is issued.

Storage Requirement for Constants: The total amount of storage required to assemble a DC instruction is the sum of:

1. The requirements for the individual DC operands specified in the instruction.
The requirement of a DC operand is the product of:
 - The sum of the lengths (implicit or explicit) of each nominal value
 - The duplication factor, if specified
2. The number of bytes skipped for the boundary alignment between different operands

Scale Modifier

The scale modifier specifies the amount of internal scaling that you want for:

- Binary digits for fixed-point constants (H, F)
- Hexadecimal digits for floating-point constants (E, D, L)

The scale modifier can be used only with the above types of constants. It cannot be used with EB, DB, and LB floating point constants.

The range for each type of constant is:

Fixed-point constant H	-187 to 15
Fixed-point constant F	-187 to 30
Floating-point constant E	0 to 5
Floating-point constant D	0 to 13
Floating-point constant L	0 to 27

The scale modifier is written as S_n , where n is either a decimal self-defining term, or an absolute expression enclosed in parentheses. Both forms of the modifier's value n can be preceded by a sign; if no sign is present, a plus sign is assumed.

Scale Modifier for Fixed-Point Constants: The scale modifier for fixed-point constants specifies the power of two by which the fixed-point constant must be multiplied after its nominal value has been converted to its binary representation, but before it is assembled in its final *scaled* form. Scaling causes the binary point to move from its assumed fixed position at the right of the extreme right bit position.

Notes:

1. When the scale modifier has a positive value, it indicates the number of binary positions occupied by the fractional portion of the binary number.
2. When the scale modifier has a negative value, it indicates the number of binary positions deleted from the integer portion of the binary number.
3. When low-order positions are lost because of scaling (or lack of scaling), rounding occurs in the extreme left bit of the lost portion. The rounding is reflected in the extreme right position saved.

Scale Modifier for Hexadecimal Floating-Point Constants: The scale modifier for hexadecimal floating-point constants must have a positive value. It specifies the number of hexadecimal positions that the fractional portion of the binary representation of a floating-point constant is shifted to the right. The hexadecimal point is assumed to be fixed at the left of the extreme left position in the fractional field. When scaling is specified, it causes an unnormalized hexadecimal fraction to be assembled (unnormalized means the leftmost positions of the fraction contain hexadecimal zeros). The magnitude of the constant is retained, because the exponent in the characteristic portion of the constant is adjusted upward accordingly. When non-zero hexadecimal positions are lost, rounding occurs in the extreme left hexadecimal position of the lost portion. The rounding is reflected in the extreme right position saved.

Exponent Modifier

The exponent modifier specifies the power of 10 by which the nominal value of a constant is to be multiplied before it is converted to its internal binary representation. It can only be used with the fixed-point (H and F) and floating-point (E, D, and L) constants. The exponent modifier is written as E_n , where n can be either a decimal self-defining term, or an absolute expression enclosed in parentheses.

The decimal self-defining term or the expression can be preceded by a sign: If no sign is present, a plus sign is assumed. The range for the exponent modifier is -85 to $+75$. If using the type extension to define a floating-point constant, the exponent modifier can be in the range -2^{31} to $2^{31}-1$. If the nominal value cannot be represented exactly, a warning message is issued.

Notes:

1. Don't confuse the exponent modifier with the exponent that can be specified in the nominal value subfield of fixed-point and floating-point constants.

The exponent modifier affects each nominal value specified in the operand, whereas the exponent written as part of the nominal value subfield only affects the nominal value it follows. If both types of exponent are specified in a DC

operand, their values are added together before the nominal value is converted to binary form. However, this sum must lie within the permissible range of –85 to +75, unless a type extension is specified.

2. The value of the constant, after any exponents have been applied, must be contained in the implicitly or explicitly specified length of the constant to be assembled.

Subfield 5: Nominal Value

The syntax for coding the *nominal value* is shown in the subfield format on page 111.

You must specify the nominal value subfield unless a duplication value of zero is specified. It defines the value of the constant (or constants) described and affected by the subfields that precede it. It is this value that is assembled into the internal binary representation of the constant. Figure 37 shows the formats for specifying constants.

Figure 37. Specifying Constant Values

Constant Type	Single Nominal Value	Multiple Nominal Value	Page No.
C	'value'	not allowed	125
G	'<.v.a.l.u.e>'	not allowed	128
B	'value'	'value,value,...value'	124
X			129
H			130
F			130
P			133
Z			133
E			141, 146
D			141, 146
L			141, 146
A	(value)	(value,value,...value)	135
Y			135
S			135
V			135
R			135
Q	(value)	(value,value,...value)	150
J	(value)	(value,value,...value)	151

As the above list shows:

- A data constant value (any type except A, Y, S, Q, J, R and V) is enclosed by single quotation marks.
- An address constant value (type A, Y, S, V, R) or an offset constant (type Q) or a length constant (type J) is enclosed by parentheses.
- To specify two or more values in the subfield, the values must be separated by commas, and the whole sequence of values must be enclosed by the correct delimiters; that is, single quotation marks or parentheses.
- Multiple values are not permitted for character constants.

DC Instruction—Binary Constant

Blanks are allowed and ignored in nominal values for the quoted constant types (BDEFHLPXZ). Blanks are significant for C and G constant types.

How nominal values are specified and interpreted by the assembler is explained in each of the subsections that follow. There is a subsection for each of the following types of constant:

- Binary
- Character
- Graphic
- Hexadecimal
- Fixed-Point
- Decimal
- Packed Decimal
- Zoned Decimal
- Address
- Floating-Point

Literal constants are described on page 152.

Binary Constant—B

The binary constant specifies the precise bit pattern assembled into storage. Each binary constant is assembled into the integral number of bytes (see **1** in Figure 38) required to contain the bits specified, unless a bit-length modifier is specified.

The following example shows the coding used to designate a binary constant. BCON has a length attribute of 1.

```
BCON      DC          B'11011101'
BTRUNC    DC          BL1'100100011'
BPAD      DC          BL1'101'
```

BTRUNC assembles with the extreme left bit truncated, as follows:

```
00100011
```

BPAD assembles with five zeros as padding, as follows:

```
00000101
```

Figure 38 (Page 1 of 2). Binary Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	B		
3. <u>Type Extension</u>	Not Allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	As needed	B DC B'10101111' C DC B'101'	L'B = 1 1 L'C = 1 1
Alignment:	Byte		

Figure 38 (Page 2 of 2). Binary Constants

Subfield	Value	Example	Result
Range for length:	1 to 256 (byte length)		
	.1 to .2048 (bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. Nominal value			
Represented by:	Binary digits (0 or 1)		
Enclosed by:	Single quotation marks		
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	With zeros at left		
Truncation of assembled value:	At left		

Character Constant—C

The character constant specifies character strings, such as error messages, identifiers, or other text, that the assembler converts into binary (EBCDIC) representations.

Any of the 256 characters from the EBCDIC character set may be designated in a character constant. Each character specified in the nominal value subfield is assembled into one byte (see **1** in Figure 39).

A null nominal value is permitted if a length is specified. For example:

```
DC          CL3'
```

is assembled as three EBCDIC blanks with object code X'404040'

Multiple nominal values are not allowed because if a comma is specified in the nominal value subfield, the assembler considers the comma a valid character (see **2** in Figure 39) and, therefore, assembles it into its binary (EBCDIC) representation (see Appendix D, “Standard Character Set Code Table” on page 377). For example:

```
DC          C'A,B'
```

is assembled as A,B with object code C16BC2.

Give special consideration to representing single quotation marks and ampersands as characters. Each single quotation mark or ampersand you want as a character in the constant must be represented by a pair of single quotation marks or ampersands. Each pair of single quotation marks is assembled as one single quotation mark, and each pair of ampersands is assembled as one ampersand (see **3** in Figure 39).

DC Instruction—Character Constant

Figure 39. Character Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	C		
3. <u>Type Extension</u>	U	C DC CU'UNICODE'	L'C = 14
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	Evaluate as an even number, if Type Extension of U is specified	C DC C'LENGTH'	L'C = 6 1
Alignment:	Byte		
Range for length:	1 to 256 (byte length)		
	.1 to .2048 (bit length) (Not permitted if Type Extension of U is specified.)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			Object code
Represented by:	Characters (all 256 8-bit combinations)	DC C'A'B' DC CU'AA'	X'C17DC2' 3 X'00410041' 3
Enclosed by:	Single quotation marks		
Exponent allowed:	No (would be interpreted as character data)		
Number of values per operand:	One	DC C'A,B'	Object code X'C16BC2' 2
Padding:	With blanks at right (X'40')		
Truncation of assembled value:	At right		

In the following example, the length attribute of FIELD is 12:

```
FIELD DC C'TOTAL IS 110'
```

However, in this next example, the length attribute is 15, and three blanks appear in storage to the right of the zero:

```
FIELD DC CL15'TOTAL IS 110'
```

In the next example, the length attribute of FIELD is 12, although 13 characters appear in the operand. The two ampersands are paired, and so count as only one byte.

```
FIELD DC C'TOTAL IS &&10'
```

In the next example, a length of 4 has been specified, but there are five characters in the constant.

```
FIELD    DC          3CL4'ABCDE'
```

The generated constant would be:

```
ABCDABCDABCD
```

The same constant could be specified as a literal.

```
                MVC          AREA(12),=3CL4'ABCDE'
```

On the other hand, if the length had been specified as 6 instead of 4, the generated constant would have been:

```
ABCDE ABCDE ABCDE
```

Unicode data in character constants: For Character Unicode (CU) constants the value is converted to Unicode using the code page identified via the CODEPAGE assembler option. Any paired occurrences of ampersands and apostrophes are converted to a single occurrence of such a character prior to conversion. If necessary the value is padded with EBCDIC spaces on the right (X'40'). The assembler then maps each EBCDIC character into its 2-byte Unicode equivalent.

Double-byte data in character constants: When the DBCS assembler option is specified, double-byte data may be used in a character constant. The start of double-byte data is delimited by SO, and the end by SI. All characters between SO and SI must be valid double-byte characters. No single-byte meaning is drawn from the double-byte data. Hence, special characters such as the single quotation mark and ampersand are not recognized between SO and SI. The SO and SI are included in the assembled representation of a character constant containing double-byte data.

If a duplication factor is used, SI/SO pairs at the duplication points are not removed. For example, the statement:

```
DBCS    DC          3C'<D1>'
```

results in the assembled character string value of:

```
<D1><D1><D1>
```

Null double-byte data (SO followed immediately by SI) is acceptable and is assembled into the constant value.

The following examples of character constants contain double-byte data:

```
DBCS1    DC          C'<.D.B.C.S>'
DBCS2    DC          C'abc<.A.B.C>'
DBCS3    DC          C'abc<.A.B.C>def'
```

The length attribute includes the SO and SI. For example, the length attribute of DBCS2 is 11. No truncation of double-byte character strings within C-type constants is allowed, since incorrect double-byte data would be created.

Graphic Constant—G

When the DBCS assembler option is specified, the graphic (G-type) constant is supported. This constant type allows the assembly of pure double-byte data. The graphic constant differs from a character constant containing only double-byte data in that the SO and SI delimiting the start and end of double-byte data are not present in the assembled value of the graphic constant. Because SO and SI are not assembled, if a duplication factor is used, no redundant SI/SO characters are created. For example, the statement:

```
DBCS    DC          3G'<D1>'
```

results in the assembled character string value of:

```
D1D1D1
```

Examples of graphic constants are:

```
DBCS1   DC          G'<.A.B.C>'  
DBCS2   DC          GL10'<.A.B.C>'  
DBCS3   DC          GL4'<.A.B.C>'
```

Because the length attribute does not include the SO and SI, the length attribute of DBCS1 is 6. The length modifier of 10 for DBCS2 causes padding of 2 double-byte blanks at the right of the nominal value. The length modifier of 4 for DBCS3 causes truncation after the first 2 double-byte characters. The length attribute of a graphic constant must be a multiple of 2.

Type Attribute of G-Type Constant: Don't confuse the G-type constant character with the type (data) attribute of a graphic constant. The type attribute of a graphic constant is @, not G. See the general discussion about data attributes on page 296, and “Type Attribute (T’)” on page 300.

Figure 40 (Page 1 of 2). Graphic Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed	DC 3G'<.A>'	Object code X'42C142C142C1'
2. <u>Type</u>	G		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	As needed (twice the number of DBCS characters)	GC DC G'<.A.B>'	L'GC = 4
Alignment:	Byte		
Range for length:	2 to 256, must be multiple of 2 (byte length) bit length not allowed		
5. <u>Nominal value</u>			
Represented by:	DBCS characters delimited by SO and SI	DC G'<.&.'> DC G'<.A><.B>'	Object code X'4250427D' X'42C142C2'

Figure 40 (Page 2 of 2). Graphic Constants

Subfield	Value	Example	Result
Enclosed by:	Single quotation marks		
Number of values per operand:	One	DC G'<.A.,.B>'	Object code X'42C1426B42C2'
Padding:	With DBCS blanks at right (X'4040')	DC GL6'<.A>'	Object code X'42C140404040'
Truncation of assembled value:	At right	DC GL2'<.A.B>'	Object code X'42C1'

Hexadecimal Constant—X

Hexadecimal constants generate large bit patterns more conveniently than binary constants. Also, the hexadecimal values you specify in a source module let you compare them directly with the hexadecimal values generated for the object code and address locations printed in the program listing.

Each hexadecimal digit (see **1** in Figure 41) specified in the nominal value subfield is assembled into four bits (their binary patterns can be found in “Self-Defining Terms” on page 32). The implicit length in bytes of a hexadecimal constant is then half the number of hexadecimal digits specified (assuming that a high-order hexadecimal zero is added to an odd number of digits). See **2** and **3** in Figure 41.

An 8-digit hexadecimal constant provides a convenient way to set the bit pattern of a full binary word. The constant in the following example sets the first and third bytes of a word with all 1 bits.

```

DS          0F
TEST       DC          X'FF00FF00'
```

The DS instruction sets the location counter to a fullword boundary. (See “DS Instruction” on page 155.)

The next example uses a hexadecimal constant as a literal and inserts a byte of all 1 bits into bits 24 to 31 of register 5.

```
IC          5,=X'FF'
```

In the following example, the digit A is dropped, because 5 hexadecimal digits are specified for a length of 2 bytes:

```
ALPHACON DC          3XL2'A6F4E'          Generates 6F4E 3 times
```

The resulting constant is 6F4E, which occupies the specified 2 bytes. It is duplicated three times, as requested by the duplication factor. If it had been specified as:

```
ALPHACON DC          3X'A6F4E'          Generates 0A6F4E 3 times
```

the resulting constant would have a hexadecimal zero in the extreme left position.
0A6F4E0A6F4E0A6F4E

Figure 41. Hexadecimal Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	X		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	As needed	X DC X'FF00A2' Y DC X'F00A2'	L'X = 3 2 L'Y = 3 2
Alignment:	Byte		
Range for length:	1 to 256 (byte length)		
	.1 to .2048 (bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			Object code
Represented by:	Hexadecimal digits (0 to 9 and A to F)	DC X'1F' DC X'91F'	X'1F' 1 X'091F' 3
Enclosed by:	Single quotation marks		
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	With zeros at left		
Truncation of assembled value:	At left		

Fixed-Point Constants—F and H

Fixed-point constants let you introduce data that is in a form suitable for the arithmetic operations of the fixed-point machine instructions. The constants you define can also be automatically aligned to the correct fullword or halfword boundary for the instructions that refer to addresses on these boundaries (unless the NOALIGN option has been specified; see “General Information About Constants” on page 113). You can do algebraic operations using this type of constant because they can have positive or negative values.

A fixed-point constant is written as a decimal number, which can be followed by a decimal exponent. The format of the constant is as follows:

1. The nominal value can be a signed (see **1** in Figure 42 on page 131) integer, fraction, or mixed number (see **2** Figure 42) followed by a signed exponent (see **3** in Figure 42). If a sign is not specified for either the number or exponent, + is assumed.
2. The exponent must lie within the permissible range (see **4** in Figure 42). If an exponent modifier is also specified, the algebraic sum (see **5** in Figure 42)

of the exponent and the exponent modifier must lie within the permissible range.

Some examples of the range of values that can be assembled into fixed-point constants are given below:

Length	Range of values that can be assembled
8	-2^{63} to $2^{63}-1$
4	-2^{31} to $2^{31}-1$
2	-2^{15} to $2^{15}-1$
1	-2^7 to 2^7-1

The range of values depends on the implicitly or explicitly specified length (if scaling is disregarded). If the value specified for a particular constant does not lie within the allowable range for a given length, the constant is not assembled, but flagged as an error.

A fixed-point constant is assembled as follows:

1. The specified number, multiplied by any exponents, is converted to a binary number.
2. Scaling is done, if specified. If a scale modifier is not provided, the fractional portion of the number is lost.
3. The binary value is rounded, if necessary. The resulting number does not differ from the exact number specified by more than one in the least significant bit position at the right.
4. A negative number is carried in two's-complement form.
5. Duplication is applied after the constant has been assembled.

The statement below generates 3 fullwords of data. The location attribute of CONWRD is the address of the first byte of the first word, and the length attribute is 4, the implied length for a fullword fixed-point constant. The expression CONWRD+4 could be used to address the second constant (second word) in the field.

```
CONWRD DC 3F'658474'
```

Figure 42 (Page 1 of 2). Fixed-Point Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	F and H		
3. <u>Type Extension</u>	D permitted with type F		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	Doubleword: 8 bytes Fullword: 4 bytes Halfword: 2 bytes		
Alignment: (Length modifier not present)	Doubleword, fullword or halfword		

DC Instruction—Fixed-Point Constants

Figure 42 (Page 2 of 2). Fixed-Point Constants

Subfield	Value	Example	Result
Range for length:	1 to 8 (byte length)		
	.1 to .64 (bit length)		
Range for scale:	F: -187 to +30 H: -187 to +15		
Range for exponent:	-85 to +75 4	DC HE+75'2E-73' 5	value=2x10 ²
5. Nominal value			
Represented by:	Decimal digits (0 to 9)	Doubleword DC FD'-200' 1	
		Fullword DC FS4'2.25' 2	
		Halfword: DC H'+200' DC HS4'.25'	
Enclosed by:	Single quotation marks		
Exponent allowed:	Yes	Doubleword: DC FD'2E6'	
		Fullword: DC F'2E6' 3	
		Halfword: DC H'2E-6'	
Number of values per operand:	Multiple		
Padding:	With sign bits at left		
Truncation of assembled value:	At left (error message issued)		

In the following example, the DC statement generates a 2-byte field containing a negative constant. Scaling has been specified in order to reserve 6 bits for the fractional portion of the constant.

```
HALFCON DC HS6'-25.46'
```

In the following example, the constant (3.50) is multiplied by 10 to the power -2 before being converted to its binary format. The scale modifier reserves 12 bits for the fractional portion.

```
FULLCON DC HS12'3.50E-2'
```

The same constant could be specified as a literal:

```
AH 7,=HS12'3.50E-2'
```

The final example specifies three constants. The scale modifier requests 4 bits for the fractional portion of each constant. The 4 bits are provided whether or not the fraction exists.

```
THRECON DC          FS4'10,25.3,100'
```

Decimal Constants—P and Z

The decimal constants let you introduce data in a form suitable for the operations of the decimal feature machine instructions. The packed decimal constants (P-type) are used for processing by the decimal instructions. The zoned decimal constants (Z-type) are in the form (EBCDIC representation) you can use as a print image, except for the digits in the extreme right byte.

The nominal value can be a signed (plus is assumed if the number is unsigned) decimal number. A decimal point may be written anywhere in the number, or it may be omitted. The placement of a decimal point in the definition does not affect the assembly of the constant in any way, because the decimal point is not assembled into the constant; it only affects the integer and scaling attributes of the symbol that names the constant.

The specified digits are assumed to constitute an integer (see **1** in Figure 43). You may determine correct decimal point alignment either by defining data so that the point is aligned or by selecting machine instructions that operate on the data correctly (that is, shift it for purposes of alignment).

Decimal constants are assembled as follows:

Packed Decimal Constants: Each digit is converted into its 4-bit binary coded decimal equivalent (see **2** in Figure 43). The sign indicator (see **3** in Figure 43) is assembled into the extreme right four bits of the constant.

Zoned Decimal Constants: Each digit is converted into its 8-bit EBCDIC representation (see **4** in Figure 43). The sign indicator (see **5** in Figure 43) replaces the first four bits of the low-order byte of the constant.

The range of values that can be assembled into a decimal constant is shown below:

Type of decimal constant	Range of values that can be specified
Packed	$10^{31}-1$ to -10^{31}
Zoned	$10^{16}-1$ to -10^{16}

For both packed and zoned decimals, a plus sign is translated into the hexadecimal digit C, a minus sign into the digit D. The packed decimal constants (P-type) are used for processing by the decimal instructions.

If, in a constant with an implicit length, an even number of packed decimal digits is specified, one digit is left unpaired because the extreme right digit is paired with the sign. Therefore, in the extreme left byte, the extreme left four bits are set to zeros and the extreme right four bits contain the odd (first) digit.

Figure 43. Decimal Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	P and Z		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	As needed	Packed: P DC P'+593'	L'P = 2
		Zoned: Z DC Z'-593'	L'Z= 3
Alignment:	Byte		
Range for length:	1 to 16 (byte length)		
	.1 to .128 (bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			
Represented by:	Decimal digits (0 to 9)	Packed: DC P'5.5' 1 DC P'55' 1 DC P'+555' 2	Object code X'055C' X'055C' X'555C' 3
		Zoned: DC Z'-555' 4	Object code X'F5F5D5' 5
Enclosed by:	Single quotation marks		
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	Packed: with binary zeros at left		
	Zoned: with EBCDIC zeros (X'F0') at left		
Truncation of assembled value:	At left		

In the following example, the DC statement specifies both packed and zoned decimal constants. The length modifier applies to each constant in the first operand (that is, to each packed decimal constant). A literal could not specify both operands.

Cont.

```
DECIMALS DC      PL8'+25.8,-3874,
                  +2.3',Z'+80,-3.72'
```

X

The last example shows the use of a packed decimal literal.

```
UNPK          OUTAREA,=PL2'+25'
```

Address Constants

An address constant is an absolute or relocatable expression, such as a storage address, that is translated into a constant. Address constants can be used for initializing base registers to facilitate the addressing of storage. Furthermore, they provide a means of communicating between control sections of a multisection program. However, storage addressing and control section communication also depends on the USING assembler instruction and the loading of registers. See “USING Instruction” on page 194.

The nominal value of an address constant, unlike other types of constants, is enclosed in parentheses. If two or more address constants are specified in an operand, they are separated by commas, and the whole sequence is enclosed by parentheses. There are five types of address constants: A, Y, S, R and V. A relocatable address constant may not be specified with bit lengths.

Complex Relocatable Expressions: A complex relocatable expression can only specify an A-or Y-type address constant. These expressions contain two or more unpaired relocatable terms, or two or more negative relocatable terms in addition to any absolute or paired relocatable terms. A complex relocatable expression might consist of external symbols and designate an address in an independent assembly that is to be linked and loaded with the assembly containing the address constant.

The following example shows how, and why, a complex relocatable expression could be used for an A or Y address constant:

```
          EXTRN          X
B        DC              A(X-*)      Offset from B to X
```

Address Constants—A and Y: The following sections describe how the different types of address constants are assembled from expressions that usually represent storage addresses, and how the constants are used for addressing within and between source modules.

In the A-type and Y-type address constants, you can specify any of the three following types of assembly-time expressions whose values the assembler then computes and assembles into object code. Use this expression computation as follows:

- Relocatable expressions for addressing
- Absolute expressions for addressing and value computation
- Complex relocatable expressions to relate addresses in different source modules

Notes:

1. No bit-length modifier (see **1** in Figure 44 on page 136) is allowed when a relocatable or complex relocatable expression (see **2** in Figure 44) is specified. The only explicit lengths that can be specified with relocatable or complex relocatable address constants are:
 - 2 through 8 bytes for AD-type constants
 - 2, 3, or 4 bytes for A-type constants

DC Instruction—Address Constants

- 2 bytes for Y-type constants

The linkage editor/binder/loader you use determines which lengths are actually supported. Please see the appropriate product manual for more information.

- The value of the location counter reference (*) when specified in an address constant varies from constant to constant, if any of the following, or a combination of the following, are specified:

- Multiple operands
- Multiple nominal values (see **3** in Figure 44)
- A duplication factor (see **4** in Figure 44)

The location counter is incremented with the length of the previously assembled constant.

- When the location counter reference occurs in a literal address constant, the value of the location counter is the address of the first byte of the instruction.

Figure 44 (Page 1 of 2). A and Y Address Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed	A DC 5AL1(*-A) 4	Object code X'0001020304'
2. <u>Type</u>	A and Y		
3. <u>Type Extension</u>	D permitted for A type only		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	A-type: 4 bytes AD-type 8 bytes Y-type: 2 bytes		
Alignment: (Length modifier not present)	A-type: fullword AD-type: doubleword Y-type: halfword		
Range for length:	A-type: 2 to 4 1 (byte length) AD-type: 2 to 8 (byte length) Y-type: 2 only (byte length)		
Range for scale:	Not allowed		
Range for exponent	Not allowed		
5. <u>Nominal value</u>			
Represented by:	Absolute, relocatable, or complex relocatable expressions 2	A-type: DC A(ABSOL+10) Y-type: DC Y(RELOC+32) A DC Y(*-A, **4) 3	values=0,A+6
Enclosed by:	Parentheses		
Exponent allowed:	No		

Figure 44 (Page 2 of 2). A and Y Address Constants

Subfield	Value	Example	Result
Number of values per operand:	Multiple		
Padding:	With zeros at left		
Truncation of assembled value:	At left		

Take care when using Y-type address constants and 2-byte A-type address constants for relocatable addresses, as they can only address a maximum of 65,536 bytes of storage. Using these types of address constants for relocatable addresses results in message ASMA066 being issued unless the assembler option RA2 is specified.

The A-type and Y-type address constants are processed as follows: If the nominal value is an absolute expression, it is computed to its 32-bit value and then truncated on the left to fit the implicit or explicit length of the constant. If the nominal value is a relocatable or complex relocatable expression, it is not completely evaluated until linkage edit time when the object modules are transformed into load modules. The relocated address values are then placed in the fields set aside for them at assembly time by the A-type and Y-type constants.

In the following examples, the field generated from the statement named ACON contains four constants, each of which occupies four bytes. The statement containing the LM instruction shows the same set of constants specified as literals (that is, address constant literals).

```
ACON    DC          A(108,LOP,END-STRT,**+4096)
        LM          4,7,=A(108,LOP,END-STRT,**+4096)
```

A location counter reference (*) appears in the fourth constant (**+4096). The value of the location counter is the address of the first byte of the fourth constant. When the location counter reference occurs in a literal, as in the LM instruction, the value of the location counter is the address of the first byte of the instruction.

Note: It is important to remember that expression evaluation for address constants is restricted to using 32-bit internal arithmetic. The result is then sign-extended to the length of the constant. This means that certain expressions in AD-type constants may not yield expected results, especially if the resulting value is negative.

Address Constant—S: Use the S-type address constant to assemble an explicit address, that is, an address in base-displacement form. You can specify the explicit address yourself or let the assembler compute it from an implicit address, using the current base register and address in its computation.

The nominal values can be specified in two ways:

1. As one absolute or relocatable expression (see **1** in Figure 45 on page 138) representing an implicit address.
2. As two absolute expressions (see **2** in Figure 45) the first of which represents the displacement and the second, enclosed in parentheses, represents the base register.

DC Instruction—Address Constants

The address value represented by the expression in **1** in Figure 45, is converted by the assembler into the correct base register and displacement value. An S-type constant is assembled as a halfword and aligned on a halfword boundary. The extreme left four bits of the assembled constant represent the base register designation; the remaining 12 bits, the displacement value.

Notes:

1. The value of the location counter (*) when specified in an S-type address constant varies from constant to constant if one or more the following is specified:

- Multiple operands
- Multiple nominal values
- A duplication factor

In each case the location counter is incremented with the length of the previously assembled constant.

2. If a length modifier is used, only 2 bytes may be specified.
3. S-type address constants can be specified as literals. The USING instructions used to resolve them are those in effect at the place where the literal pool is assembled, and not where the literal is used.

Figure 45 (Page 1 of 2). S Address Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	S		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	2 bytes		
Alignment: (Length modifier not present)	Halfword		
Range for length:	2 only (no bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			Base Disp
Represented by:	Absolute or relocatable expression 1	DC S(RELOC) DC S(1024)	X YYY 0 400
	Two absolute expressions 2	DC S(512(12))	C 200
Enclosed by:	Parentheses		
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	Not applicable		

Figure 45 (Page 2 of 2). S Address Constants

Subfield	Value	Example	Result
Truncation of assembled value:	Not applicable		

Address Constant—V: The V-type constant reserves storage for the address of a location in a control section that lies in another source module. Use the V-type address constant only to branch to an external address, because link-time processing may cause the branch to be *indirect* (for example, an assisted linkage in an overlay module). That is, the resolved address in a V-type address constant might *not* contain the address of the referenced symbol. In contrast, to refer to external data you should use an A-type address constant whose nominal value specifies an external symbol identified by an EXTRN instruction.

Because you specify a symbol in a V-type address constant, the assembler assumes that it is an external symbol. A value of zero is assembled into the space reserved for the V-type constant; the correct relocated value of the address is inserted into this space by the linkage editor before your object program is loaded.

The symbol specified (see **1** in Figure 46) in the nominal value subfield does not constitute a definition of the symbol for the source module in which the V-type address constant appears.

The symbol specified in a V-type constant must not represent external data in an overlay program.

Figure 46 (Page 1 of 2). V Address Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	V		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	4 bytes		
Alignment: (Length modifier not present)	Fullword		
Range for length:	4 or 3 only (no bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			
Represented by:	A single external symbol	DC V(MODA) 1 DC V(EXTADR) 1	
Enclosed by:	Parentheses		
Exponent allowed:	No		

Figure 46 (Page 2 of 2). V Address Constants

Subfield	Value	Example	Result
Number of values per operand:	Multiple		
Padding:	With zeros at left		
Truncation of assembled value:	Not applicable		

In the following example, 12 bytes are reserved, because there are three symbols. The value of each assembled constant is zero until the program is link-edited.

```
VCONST DC V(SORT,MERGE,CALC)
```

PSECT Reference—R: The R-type constant reserves storage for the address of the PSECT of *symbol1* as specified in the associated XATTR statement. It is the caller's responsibility to establish the definition of the R-type address constant referencing the called routine's PSECT, and to pass that address to the called routine. This constant is only available if the GOFF option is specified.

Note: If a program is to be reentrant, R-type address constants may not appear in shared (read-only) text. They should be in the caller's PSECT, and be provided to the called routine using an appropriate convention. That is, R-type address constants referring to PSECTs should themselves reside in PSECTs. If not, there can be only a single instantiation of the PSECT work area, and the program cannot be reentrant.

Figure 47 (Page 1 of 2). R Address Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	R		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	4 bytes		
Alignment: (Length modifier not present)	Fullword		
Range for length:	4 or 3 only (no bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			
Represented by:	An ordinary symbol	DC R(PSECT1)	
Enclosed by:	Parentheses		
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	With zeros at left		

Figure 47 (Page 2 of 2). R Address Constants

Subfield	Value	Example	Result
Truncation of assembled value:	Not applicable		

Hexadecimal Floating-Point Constants—E, EH, D, DH, L, LH

Floating-point constants let you introduce data that is in the form suitable for the operations of the floating-point feature instructions. These constants have the following advantages over fixed-point constants:

- You do not have to consider the fractional portion of a value you specify, nor worry about the position of the decimal point when algebraic operations are to be done.
- You can specify both much larger and much smaller values.
- You retain greater processing precision; that is, your values are carried in more significant figures.

The nominal value can be a signed (see **1** in Figure 49) integer, fraction, or mixed number (see **2** Figure 49) followed by a signed exponent (see **3** in Figure 49). If a sign is not specified for either the number or exponent, a plus sign is assumed. If you specify the 'H' type extension you can also specify a rounding mode that is used when the nominal value is converted from decimal to its hexadecimal form. The syntax for nominal values (including the binary floating-point constants) is shown in Figure 51 on page 147. The valid rounding mode values are:

- 1** Round by adding one in the first lost bit position
- 4** Unbiased round to nearest, with tie-breaking rule
- 5** Round towards zero (that is, truncate)
- 6** Round up towards the maximum positive value
- 7** Round down towards the minimum negative value

Figure 48. Rounding Mode Values

See **4** in Figure 49.

The exponent must lie within the permissible range. If an exponent modifier is also specified, the algebraic sum of the exponent and the exponent modifier must lie within the permissible range.

Figure 49 (Page 1 of 3). Hexadecimal Floating-Point Constants

Subfield	Value	Example
1. <u>Duplication factor</u>	Allowed	
2. <u>Type</u>	E, D, and L	
3. <u>Type Extension</u>	Omitted or H	
4. <u>Modifiers</u>		
Implicit length: (length modifier not present)	E-type: 4 bytes D-type: 8 bytes L-type: 16 bytes	

DC Instruction—Hexadecimal Floating-Point Constants

Figure 49 (Page 2 of 3). Hexadecimal Floating-Point Constants

Subfield	Value	Example
Alignment: (Length modifier not present)	E-type: Fullword D-type: Doubleword L-type: Doubleword	
Range for length:	E-type: 1 to 8 (byte length) .1 to .64 (bit length) EH-type: .12 to .64 (bit length) D-type: 1 to 8 (byte length) .1 to .64 (bit length) DH-type: .12 to .64 (bit length) L-type: 1 to 16 (byte length) .1 to .128 (bit length) LH-type: .12 to .128 (bit length)	
Range for scale:	E-type: 0 to 5 D-type: 0 to 13 L-type: 0 to 27	
Range for exponent:	-85 to +75	
5. Nominal value Represented by:	Decimal digits (0 to 9)	E-type: DC E'+525' 1 DC E'5.25' 2 D-type: DC D'-525' 1 DC D'+.001' 2 L-type: DC L'525' DC L'3.414' 2
Enclosed by:	Single quotation marks	
Exponent allowed:	Yes	E-type: DC E'1E+60' 3 D-type: DC D'-2.5E10' 3 L-type: DC L'3.712E-3' 3

Figure 49 (Page 3 of 3). Hexadecimal Floating-Point Constants

Subfield	Value	Example
Rounding mode allowed if type extension specified:	Yes (see Figure 48 for values)	E-type: DC EH'1E+60R1' 4 D-type: DC DH'-2.5E10R4' 4 L-type: DC LH'3.712E-3R5' 4
Number of values per operand:	Multiple	
Padding:	Correct fraction is extended to the right and rounded	
Truncation of assembled value:	Not applicable (values are rounded)	

The format of the constant is shown in Figure 50 on page 144.

The value of the constant is represented by two parts:

- An exponent portion (see **1** in Figure 50 on page 144), followed by
- A fractional portion (see **2** in Figure 50)

A sign bit (see **3** in Figure 50) indicates whether a positive or negative number has been specified. The number specified must first be converted into a hexadecimal fraction before it can be assembled into the correct internal format. The quantity expressed is the product of the fraction (see **4** in Figure 50) and the number 16 raised to a power (see **5** in Figure 50). Figure 50 shows the external format of the three types of floating-point constants.

Here is the range of values that can be assembled into hexadecimal floating-point constants:

Type of Constant	Range of Magnitude (M) of Values (Positive and Negative)
E	$16^{-65} \leq M \leq (1-16^{-6}) \times 16^{63}$
D	$16^{-65} \leq M \leq (1-16^{-14}) \times 16^{63}$
L	$16^{-65} \leq M \leq (1-16^{-28}) \times 16^{63}$
E, D, L	$5.4 \times 10^{-79} \leq M \leq 7.2 \times 10^{75}$ (approximate)

If the value specified for a particular constant does not lie within these ranges, the constant is not assembled, but is flagged as an error.

DC Instruction—Hexadecimal Floating-Point Constants

Type	Called	Format
E EH	Short Floating- Point Number	<p>3 1 2 + 7-bit Characteristic 24-bit Fraction Bits 0 1 7 8 31</p>
D DH	Long Floating- Point Number	<p>+ 7-bit Characteristic 56-bit Fraction Bits 0 1 7 8 63</p>
L LH	Extended Floating- Point Number	<p>+ 7-bit Characteristic High-order 56 bits of 112-bit Fraction Bits 0 1 7 8 63</p> <p>+ 7-bit Characteristic Low-order 56 bits of 112-bit Fraction Bits 0 1 7 8 63</p> <p>Set in second half of L-type constant</p>
Characteristic | Hexadecimal Fraction		<p>4</p> <p>5 16^E X [$\frac{a}{16} + \frac{b}{16^2} + \frac{c}{16^3} + \dots$]</p>

where a,b,c ... are hexadecimal digits, and E is an exponent that has a positive or negative value indicated by the characteristic

Figure 50. Hexadecimal Floating-Point External Formats

Representation of Hexadecimal Floating Point: The assembler assembles a floating-point constant into its binary representation as follows: The specified number, multiplied by any exponents, is converted to the required two-part format. The value is translated into:

- A fractional portion represented by hexadecimal digits and the sign indicator. The fraction is then entered into the extreme left part of the fraction field of the constant (after rounding).
- An exponent portion represented by the excess-64 binary notation, which is then entered into the characteristic field of the constant.

The excess-64 binary notation is obtained by adding +64 to the value of the exponent (which lies between -64 and +63) to yield the characteristic (which lies between 0 and 127).

Notes:

1. The L-type floating-point constant resembles two contiguous D-type constants. The sign of the second doubleword is assumed to be the same as the sign of the first.

The characteristic for the second doubleword is equal to the characteristic for the first minus 14 (the number of hexadecimal digits in the fractional portion of the first doubleword). No indication is given if the characteristic of the second doubleword is zero.

2. If scaling has been specified, hexadecimal zeros are added to the left of the normalized fraction (causing it to become unnormalized), and the exponent in the characteristic field is adjusted accordingly. (For further details on scaling, see “Subfield 4: Modifier” on page 119.)
3. The fraction is rounded according to the implied or explicit length of the constant. The resulting number does not differ from the exact value specified by more than one in the last place.

Note: You can control rounding by using the 'H' type extension and specifying the rounding mode.

4. Negative fractions are carried in true representation, not in the two's-complement form.
5. Duplication is applied after the constant has been assembled.
6. An implied length of 4 bytes is assumed for a short (E) constant and 8 bytes for a long (D) constant. An implied length of 16 bytes is assumed for an extended (L) constant. The constant is aligned at the correct word (E) or doubleword (D and L) boundary if a length is not specified. However, any length up to and including 8 bytes (E and D) or 16 bytes (L) can be specified by a length modifier. In this case, no boundary alignment occurs.

Any of the following statements can be used to specify 46.415 as a positive, fullword, floating-point constant; the last is a machine instruction statement with a literal operand. Note that each of the last two constants contains an exponent modifier.

DC	E'46.415'
DC	E'46415E-3'
DC	E'+464.15E-1'
DC	E'+.46415E+2'
DC	EE2'.46415'
AE	6,=EE2'.46415'

The following would generate 3 doubleword floating-point constants.

```
FLOAT    DC          DE+4'+46,-3.729,+473'
```

Binary Floating-Point Constants—EB, DB, LB

Binary floating-point numbers may be represented in any of three formats: short, long or extended. The short format is 4 bytes with a sign of one bit, an exponent of 8 bits and a fraction of 23 bits. The long format is 8 bytes with a sign of one bit, an exponent of 11 bits and a fraction of 52 bits. The extended format is 16 bytes with a sign of one bit, an exponent of 15 bits and a fraction of 112 bits.

There are five classes of binary floating-point data, including numeric and related nonnumeric entities. Each data item consists of a sign, an exponent and a significand. The exponent is biased such that all exponents are nonnegative unsigned numbers, and the minimum biased exponent is zero. The significand consists of an explicit fraction and an implicit unit bit to the left of the binary point. The sign bit is zero for plus and one for minus values.

All finite nonzero numbers within the range permitted by a given format are normalized and have a unique representation. There are no unnormalized numbers, which might allow multiple representations for the same values, and there are no unnormalized arithmetic operations. Tiny numbers of a magnitude below the minimum normalized number in a given format are represented as *denormalized* numbers, because they imply a leading zero bit, but those values are also represented uniquely.

The classes are:

1. *Zeros* have a biased exponent of zero, a zero fraction and a sign. The implied unit bit is zero.
2. *Denormalized numbers* have a biased exponent of zero and a nonzero fraction. The implied unit bit is zero.
3. *Normalized numbers* have a biased exponent greater than zero but less than all ones. The implied unit bit is one and the fraction may have any value.
4. An *infinity* is represented by a biased exponent of all ones and a zero fraction.
5. A *NaN (Not-a-Number)* entity is represented by a biased exponent of all ones and a nonzero fraction. NaNs are produced in place of a numeric result after an invalid operation when there is no interruption. NaNs may also be used by the program to flag special operands, such as the contents of an uninitialized storage area. There are two types of NaNs, signaling and quiet. A signaling NaN (SNaN) is distinguished from the corresponding quiet NaN (QNaN) by the leftmost fraction bit: zero for the SNaN and one for QNaN. A special QNaN is supplied as the default result for an invalid-operation condition; it has a plus sign and a leftmost fraction bit of one, with the remaining fraction bits being set to zeros. Normally, QNaNs are just propagated during computations, so that they remain visible at the end. An SNaN operand causes an invalid operation exception.

To accommodate the definition of both hexadecimal and binary floating-point constants the syntax for coding a DC instruction is:

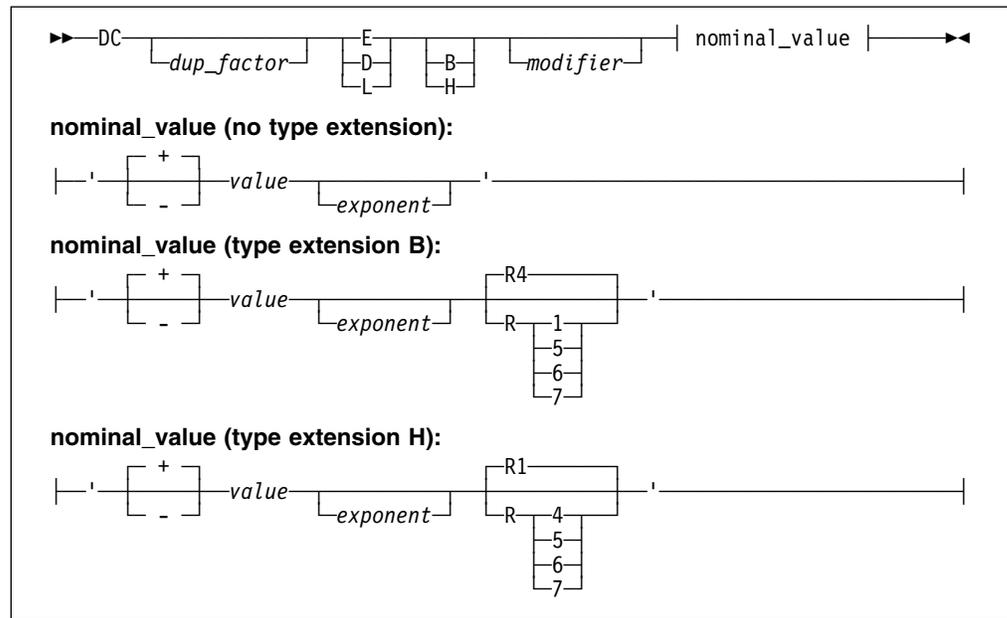


Figure 51. DC Instruction Syntax

dup_factor

causes the constant to be generated the number of times indicated by the factor.

type

indicates that the constant is either short, long or extended floating point.

type extension

the type of conversion required to assemble the constant. Valid values are:

- null** Hexadecimal floating-point constant which is converted using the Assembler H and HLASM Release 1 and Release 2 conversion logic
- B** Binary floating-point constant which is converted using the new floating-point conversion routine
- H** Hexadecimal floating-point constant which is converted using the new floating-point conversion routine

modifier

describes the length, the scaling and the exponent of the *nominal_value*. The minimum length of the 'H' hexadecimal constant is 12 bits. The minimum length in bits of the binary constant is:

- 9** Short floating-point constant
- 12** Long floating-point constant
- 16** Extended floating-point constant

This minimum length allows for the sign, exponent, the implied unit bit which is considered to be one for normalized numbers and zero for zeros and denormalized numbers.

The exponent modifier can be in the range from -2^{31} to $2^{31}-1$

DC Instruction—Binary Floating-Point Constants

nominal_value

defines the value of the constant and can include the integer, fraction or mixed number followed by an optional signed exponent and an optional explicit rounding mode.

The assembler imposes no limits on the exponent values that may be specified. The BFP architecture limits the actual values that can be represented; a warning message is issued whenever a specified value can not be represented exactly.

The rounding mode identifies the rounding required when defining a floating-point constant. The valid values are:

- 1 Round by adding one in the first lost bit position
- 4 Unbiased round to nearest, with tie-breaking rule
- 5 Round towards zero (that is, truncate)
- 6 Round up towards the maximum positive value
- 7 Round down towards the minimum negative value

Note: As binary floating-point does not support scaling, the scale modifier is ignored and a warning message issued if the scaling modifier is specified when defining a binary floating-point constant.

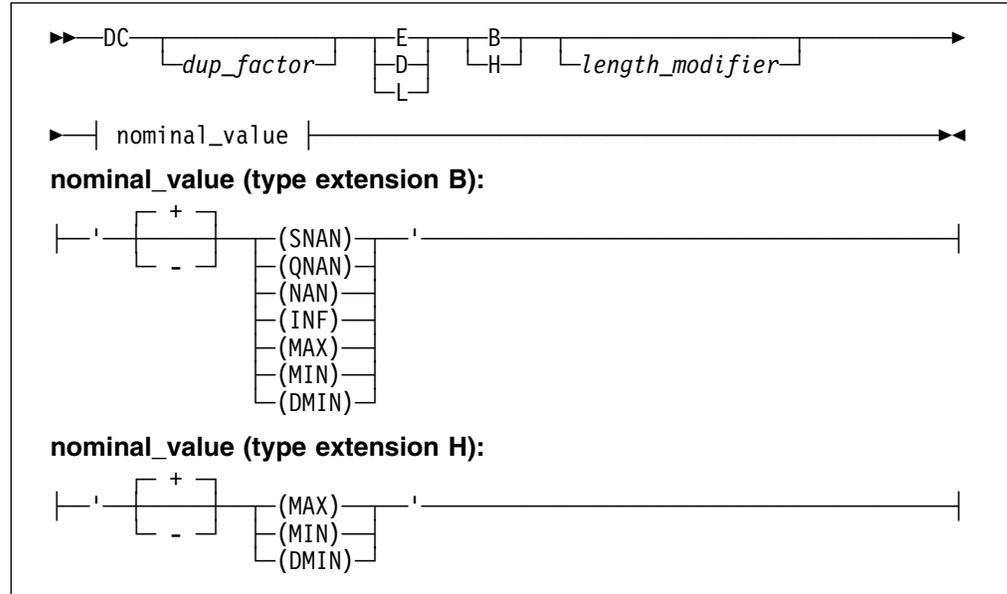
Conversion to Binary Floating-Point

For decimal to binary floating-point conversion, the assembler conforms to ANSI/IEEE Std 754-1985, IEEE Standard for Binary Floating-Point Arithmetic, dated August 12, 1985, with the following differences: exception status flags are not provided and traps are not supported.

Conversion of values outside the represented range is as follows. If the resultant value before rounding is larger in magnitude than MAX (the maximum allowed value) as represented in the specified length, then, depending on the rounding mode, either MAX or infinity is generated, along with a warning message. If the resultant nonzero value is less than Nmin (the minimum allowed value) as represented in the specified length, then, depending on the rounding mode, either Nmin or zero is generated, along with a warning message.

Floating-Point Special Values

For special values, the syntax of the DC statement is:



dup_factor

causes the constant to be generated the number of times indicated by the factor.

type

indicates that the constant is either short, long or extended floating point.

type extension

the type of conversion required to assemble the constant.

length_modifier

describes the length in bytes or bits into which the constant is to be assembled. For NANs and INF the minimum length in bits of the constant is:

- 11** Short floating-point constant
- 14** Long floating-point constant
- 18** Extended floating-point constant

This minimum length allows for the sign, exponent and two fraction bits.

nominal_value

defines the special value to be generated.

Notes:

1. The nominal value can be in mixed case.
2. SNAN assembles with an exponent of ones and 01 in the high order fraction bits with the remainder of the fraction containing zeros.
3. QNAN assembles with an exponent of ones and 11 in the high order fraction bits with the remainder of the fraction containing zeros.
4. NAN assembles with an exponent of one and 10 in the high order fraction bits with the remainder of the fraction containing zeros.

DC Instruction—Offset Constant

5. MIN assembles as a normalized minimum value, that is an exponent of one and a fraction of zeroes.
6. INF assembles with an exponent of ones and a fraction of zeros.
7. MAX assembles with an exponent of ones except for the low order bit and a fraction of ones.
8. MIN assembles as a denormalized minimum value that is an exponent of zero and a fraction with just the low order bit turned on.
9. DMIN assembles with an exponent of zeroes and a fraction of all zeroes except for a low order bit of one.

Offset Constant—Q

Use this constant to reserve storage for the offset into a storage area of an external dummy section, or the offset to a label in a class. The offset is entered into this space by the linker. When the offset is added to the address of an overall block of storage set aside for external dummy sections, it addresses the applicable section.

For a description of the use of the Q-type offset constant in combination with an external dummy section, see “External Dummy Sections” on page 55. See also Figure 52 for details.

In the following example, to access the external dummy section named VALUE, the value of A is added to the base address of the block of storage allocated for external dummy sections.

```
A      DC      Q(VALUE)
```

The DXD or DSECT names referenced in the Q-type offset constant need not be previously defined.

Figure 52 (Page 1 of 2). Q Offset Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	Q		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	4 bytes		
Alignment: (Length modifier not present)	Fullword		
Range for length:	1 to 4 bytes (no bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			
Represented by:	A single external dummy symbol	DC Q(DUMMYEXT) DC Q(DXDEXT)	
Enclosed by:	Parentheses		

Figure 52 (Page 2 of 2). Q Offset Constants

Subfield	Value	Example	Result
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	With zeros at left		
Truncation of assembled value:	At left		

Length Constant—J

Use this constant to reserve storage for the length of a DXD, class or DSECT. The length is entered into this space by the assembler. This constant is only available if the GOFF option is specified.

In the following example, the value at A is the length of CLASS.

```
A      DC          J(CLASS)
```

The DXD or DSECT names referenced in the J-type length constant need not be previously defined.

Figure 53. J Length Constants

Subfield	Value	Example	Result
1. <u>Duplication factor</u>	Allowed		
2. <u>Type</u>	J		
3. <u>Type Extension</u>	Not allowed		
4. <u>Modifiers</u>			
Implicit length: (length modifier not present)	4 bytes		
Alignment: (Length modifier not present)	Fullword		
Range for length:	2 to 4 bytes (no bit length)		
Range for scale:	Not allowed		
Range for exponent:	Not allowed		
5. <u>Nominal value</u>			
Represented by:	A single DXD, class, or DSECT name	DC J(CLASS)	
Enclosed by:	Parentheses		
Exponent allowed:	No		
Number of values per operand:	Multiple		
Padding:	With zeros at left		
Truncation of assembled value:	At left		

Literal Constants

Literal constants let you define and refer to data directly in machine instruction operands. You do not need to define a constant separately in another part of your source module. The differences between a literal, a data constant, and a self-defining term are described in “Literals” on page 39.

A literal constant is specified in the same way as the operand of a DC instruction. The general rules for the operand subfields of a DC instruction also apply to the subfield of a literal constant. Moreover, the rules that apply to the individual types of constants apply to literal constants as well.

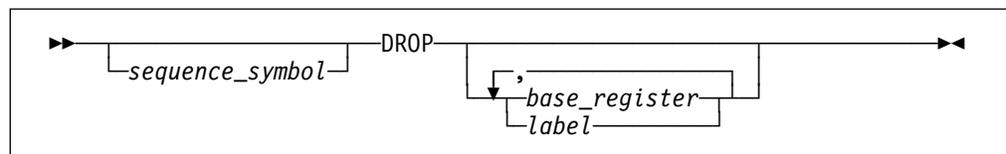
However, literal constants differ from DC operands in the following ways:

- Literals must be preceded by an equal sign.
- Multiple operands are not allowed.
- The duplication factor must not be zero.
- Symbols used in the duplication factor or length modifier must be previously defined. Scale and Exponent modifiers do not need pre-definition.
- If an address-type literal constant specifies a duplication factor greater than one and a nominal value containing the location counter reference, the value of the location counter reference is not incremented, but remains the same for each duplication.
- The assembler groups literals together by size. If you use a literal constant, the alignment of the constant can be different than might be the case for an explicit constant. See “Literal Pool” on page 42.

DROP Instruction

The DROP instruction ends the domain of a USING instruction. This:

- Frees base registers previously assigned by the USING instruction for other programming purposes
- Ensures that the assembler uses the base register you want in a particular coding situation, for example, when two USING ranges overlap or coincide



sequence_symbol
is a sequence symbol.

base_register
is an absolute expression whose value represents one of the general registers 0 through 15. The expression in *base_register* indicates a general register, previously specified in the operand of an ordinary USING statement, that is no longer to be used for base addressing.

label

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

The ordinary symbol denoted by *label* must be a symbol previously used in the name field of a labeled USING statement or a labeled dependent USING statement.

If neither *base_register* nor *label* is specified in the operand of a DROP instruction, all active base registers assigned by ordinary, labeled, and labeled dependent USING instructions are dropped.

After a DROP instruction:

- The assembler does not use the register or registers specified in the DROP instruction as base registers. A register made unavailable as a base register by a DROP instruction can be reassigned as a base register by a subsequent USING instruction.
- The label or labels specified in the DROP instruction are no longer available as symbol qualifiers. A label made unavailable as a symbol qualifier by a DROP instruction can be reassigned as a symbol qualifier by a subsequent labeled USING instruction.

The following statements, for example, stop the assembler using registers 7 and 11 as base registers, and the label FIRST as a symbol qualifier:

```
DROP      7,11
DROP      FIRST
```

Labeled USING: You cannot end the domain of a labeled USING instruction by coding a DROP instruction which specifies the same registers as were specified in the labeled USING instruction. If you want to end the domain of a labeled USING instruction, you must code a DROP instruction with an operand that specifies the label of the labeled USING instruction.

Dependent USING: To end the domain of a dependent USING instruction, you must end the domain of the corresponding ordinary USING instruction. In the following example, the DROP instruction prevents the assembler from using register 12 as a base register. The DROP instruction causes the assembler to end the domain of the ordinary USING instruction and the domains of the two dependent USING instructions. The storage areas represented by INREC and OUTREC are both within the range of the ordinary USING instruction (register 12).

```
        USING      *,12
        USING      RECMAP,INREC
        USING      RECMAP,OUTREC
        .
        .
        DROP      12
        .
        .
INREC   DS         CL156
OUTREC  DS         CL156
```

DROP Instruction

To end the domain of a labeled dependent USING instruction, you can code a DROP instruction with the USING label in the operand. The following example shows this:

```
        USING          *,12
PRIOR   USING          RECMAP,INREC
POST    USING          RECMAP,OUTREC
        .
        .
        DROP          PRIOR,POST
        .
        .
INREC   DS             CL156
OUTREC  DS             CL156
```

In the above example, the DROP instruction makes the labels PRIOR and POST unavailable as symbol qualifiers.

When a labeled dependent USING domain is dropped, none of any subordinate USING domains are dropped. In the following example the labeled dependent USING BLBL1 is not dropped, even though it is dependent on the USING ALBL2 that is dropped:

```
        USING          DSECTA,14
ALBL1   USING          DSECTA,14
        USING          DSECTB,ALBL1.A
        .
        .
ALBL2   USING          DSECTA,ALBL1.A
        .
        .
BLBL1   USING          DSECTA,ALBL2
        .
        DROP          ALBL2
        .
        .
DSECTA  DSECT
A       DS             A
DSECTB  DSECT
B       DS             A
```

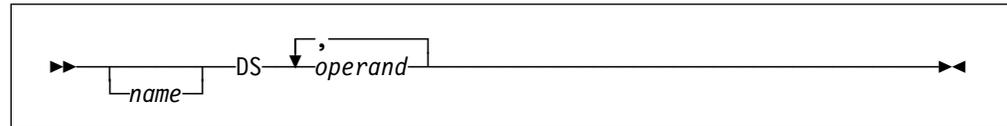
A DROP instruction is not needed:

- If the base address is being changed by a new ordinary USING instruction, and the same base register is assigned. However, the new base address must be loaded into the base register by an appropriate sequence of instructions.
- If the base address is being changed by a new labeled USING instruction or a new labeled dependent USING instruction, and the same USING label is assigned; however, the correct base address must be loaded into the base register specified in the USING instruction by an appropriate sequence of instructions.
- At the end of a source module

DS Instruction

The DS instruction:

- Reserves areas of storage
- Provides labels for these areas
- Uses these areas by referring to the symbols defined as labels



name

is one of the following:

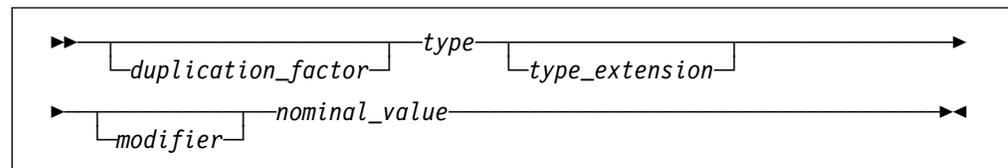
- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

If *symbol* denotes an ordinary symbol, the ordinary symbol represents the address of the first byte of the storage area reserved. If several operands are specified, the first storage area defined is addressable by the ordinary symbol. The other storage areas can be reached by relative addressing.

operand

is an operand of five subfields. The first four subfields describe the attributes of the symbol. The fifth subfield provides the nominal values that determine the implicit lengths; however no constants are generated.

A DS operand has this format:



The format of the DS operand is identical to that of the DC operand; exactly the same subfields are used and are written in exactly the same sequence as they are in the DC operand. For more information about the subfields of the DC instruction, see “DC Instruction” on page 110.

Unlike the DC instruction, the DS instruction causes no data to be assembled. Therefore, you do not have to specify the nominal value (fifth subfield) of a DS instruction operand. The DS instruction is the best way of symbolically defining storage for work areas, input/output buffers, etc.

Although the formats are identical, there are two differences in the specification of subfields. They are:

- The nominal value subfield is optional in a DS operand, but it is mandatory in a DC operand. If a nominal value is specified in a DS operand, it must be valid.

DS Instruction

- The maximum length that can be specified for the character (C) and hexadecimal (X) type areas is 65,535 bytes rather than 256 bytes for the same DC operands. The maximum length for the graphic (G) type is 65,534 bytes.

If *symbol* denotes an ordinary symbol, the ordinary symbol, as with the DC instruction:

- Has an address value of the first byte of the area reserved, after any boundary alignment is done
- Has a length attribute value, depending on the implicit or explicit length of the type of area reserved

If the DS instruction is specified with more than one operand or more than one nominal value in the operand, the label addresses the area reserved for the field that corresponds to the first nominal value of the first operand. The length attribute value is equal to the length explicitly specified or implicit in the first operand.

Bytes Skipped for Alignment: Unlike the DC instruction, bytes skipped for alignment are not set to zero. Also, nothing is assembled into the storage area reserved by a DS instruction. No assumption should be made as to the contents of the skipped bytes or the reserved area.

The size of a storage area that can be reserved by a DS instruction is limited only by the size of virtual storage or by the maximum value of the location counter, whichever is smaller.

How to Use the DS Instruction

Use the DS instruction to:

- Reserve storage
- Force alignment of the location counter so that the data that follows is on a particular storage boundary
- Name fields in a storage area.

To Reserve Storage: If you want to take advantage of automatic boundary alignment (if the ALIGN option is specified) and implicit length calculation, you should not supply a length modifier in your operand specifications. Instead, specify a type subfield that corresponds to the type of area you need for your instructions.

Using a length modifier can give you the advantage of explicitly specifying the length attribute value assigned to the label naming the area reserved. However, your areas are not aligned automatically according to their type. If you omit the nominal value in the operand, you should use a length modifier for the binary (B), character (C), graphic (G), hexadecimal (X), and decimal (P and Z) type areas; otherwise, their labels are given a length attribute value of 1 (2 for G and CU type).

When you need to reserve large areas, you can use a duplication factor. However, in this case, you can only refer to the first area by its label. You can also use the character (C) and hexadecimal (X) field types to specify large areas using the length modifier. Duplication has no effect on implicit length.

Although the nominal value is optional for a DS instruction, you can put it to good use by letting the assembler compute the length for areas of the B, C, G, X, and

decimal (P or Z) type areas. You achieve this by specifying the general format of the nominal value that is placed in the area at execution time.

If a nominal value and no length modifier are specified for a Unicode character string, the length of the storage reserved is derived by multiplying by two the number of characters specified in the nominal value (after pairing).

To Force Alignment: Use the DS instruction to align the instruction or data that follows, on a specific boundary. You can align the location counter to a doubleword, a fullword, or a halfword boundary by using the correct constant type (for example, D, F, or H) and a duplication factor of zero. No space is reserved for such an instruction, yet the data that follows is aligned on the correct boundary. For example, the following statements set the location counter to the next doubleword boundary and reserve storage space for a 128-byte field (whose first byte is on a doubleword boundary).

```

                DS          0D
AREA          DS          CL128

```

Alignment is forced whether or not the ALIGN assembler option is set.

To Name Fields within an Area: Using a duplication factor of zero in a DS instruction also provides a label for an area of storage without actually reserving the area. Use DS or DC instructions to reserve storage for, and assign labels to, fields within the area. These fields can then be addressed symbolically. (Another way of accomplishing this is described in “DSECT Instruction” on page 158.) The whole area is addressable by its label. In addition, the symbolic label has the length attribute value of the whole area. Within the area, each field is addressable by its label.

For example, assume that 80-character records are to be read into an area for processing and that each record has the following format:

Positions 5-10	Payroll Number
Positions 11-30	Employee Name
Positions 31-36	Date
Positions 47-54	Gross Wages
Positions 55-62	Withholding Tax

The following example shows how DS instructions might be used to assign a name to the record area, then define the fields of the area and allocate storage for them. The first statement names the whole area by defining the symbol RDAREA; this statement gives RDAREA a length attribute of 80 bytes, but does not reserve any storage. Similarly, the fifth statement names a 6-byte area by defining the symbol DATE; the three subsequent statements actually define the fields of DATE and allocate storage for them. The second, ninth, and last statements are used for spacing purposes and, therefore, are not named.

DSECT Instruction

RDAREA	DS	0CL80
	DS	CL4
PAYNO	DS	CL6
NAME	DS	CL20
DATE	DS	0CL6
DAY	DS	CL2
MONTH	DS	CL2
YEAR	DS	CL2
	DS	CL10
GROSS	DS	CL8
FEDTAX	DS	CL8
	DS	CL18

Additional examples of DS statements are shown below:

ONE	DS	CL80	One 80-byte field, length attribute of 80
TWO	DS	80C	80 1-byte fields, length attribute of 1
THREE	DS	6F	6 fullwords, length attribute of 4
FOUR	DS	D	1 doubleword, length attribute of 8
FIVE	DS	4H	4 halfwords, length attribute of 2
SIX	DS	GL80	One 80-byte field, length attribute of 80
SEVEN	DS	80G	80 2-byte fields, length attribute of 2

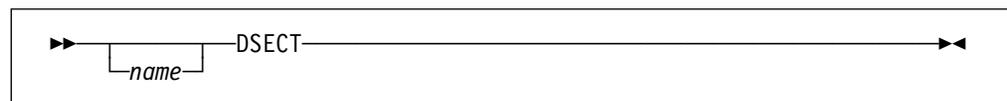
To define four 10-byte fields and one 100-byte field, the respective DS statements might be as follows:

FIELD	DS	4CL10
AREA	DS	CL100

Although FIELD might have been specified as one 40-byte field, the preceding definition has the advantage of providing FIELD with a length attribute of 10. This would be pertinent when using FIELD as an SS machine instruction operand.

DSECT Instruction

The DSECT instruction identifies the beginning or continuation of a dummy control section. One or more dummy sections can be defined in a source module.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

The DSECT instruction can be used anywhere in a source module after the ICTL instruction.

If *name* denotes an ordinary symbol, the ordinary symbol identifies the dummy section. If several DSECT instructions within a source module have the same

symbol in the name field, the first occurrence initiates the dummy section and the rest indicate the continuation of the dummy section. The ordinary symbol denoted by *name* represents the address of the first byte in the dummy section, and has a length attribute value of 1.

If *name* is not specified, or if *name* is a sequence symbol, the DSECT instruction initiates or indicates the continuation of the unnamed control section.

The location counter for a dummy section is always set to an initial value of 0. However, when an interrupted dummy control section is continued using the DSECT instruction, the location counter last specified in that control section is continued.

The source statements that follow a DSECT instruction belong to the dummy section identified by that DSECT instruction.

Notes:

1. The assembler language statements that appear in a dummy section are not assembled into object code.
2. When establishing the addressability of a dummy section, the symbol in the name field of the DSECT instruction, or any symbol defined in the dummy section can be specified in a USING instruction.
3. A symbol defined in a dummy section can be specified in an address constant only if the symbol is paired with another symbol from the same dummy section, and if the symbols have the opposite sign.

To effect references to the storage area defined by a dummy section, do the following:

- Provide either:
 - An ordinary or labeled USING statement that specifies both a general register that the assembler can use as a base register for the dummy section, and a value from the dummy section that the assembler may assume the register contains, or
 - A dependent or labeled dependent USING statement that specifies a supporting base address (for which there is a corresponding ordinary USING statement) that lets the assembler determine a base register and displacement for the dummy section, and a value from the dummy section that the assembler may assume is the same as the supporting base address
- Ensure that the base register is loaded with either:
 - The actual address of the storage area if an ordinary USING statement or a labeled USING statement was specified, or
 - The base address specified in the corresponding ordinary USING statement if a dependent or labeled dependent USING statement was specified.

The values assigned to symbols defined in a dummy section are relative to the initial statement of the section. Thus, all machine instructions that refer to names defined in the dummy section refer, at execution time, to storage locations relative to the address loaded into the register.

- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

duplication_factor

is the duplication factor subfield equivalent to the duplication factor subfield of the DS instruction.

type

is the type subfield equivalent to the type subfield of the DS instruction.

type_extension

is the type extension subfield equivalent to the type extension subfield of the DS instruction.

modifiers

is the modifiers subfield equivalent to the modifiers subfield of the DS instruction.

nominal_value

is the nominal-value subfield equivalent to the nominal-value subfield of the DS instruction.

The DXD instruction can be used anywhere in a source module, after the ICTL instruction.

In order to reference the storage defined by the external dummy section, the ordinary symbol denoted by *symbol* must appear in the operand of a Q-type constant. This symbol represents the address of the first byte of the external dummy section defined, and has a length attribute value of 1.

The subfields in the operand field (duplication factor, type, type extension, modifier, and nominal value) are specified in the same way as in a DS instruction. The assembler computes the amount of storage and the alignment required for an external dummy section from the area specified in the operand field. For more information about how to specify the subfields, see “DS Instruction” on page 155.

The linker uses the information provided by the assembler to compute the total length of storage required for all external dummy sections specified in a program.

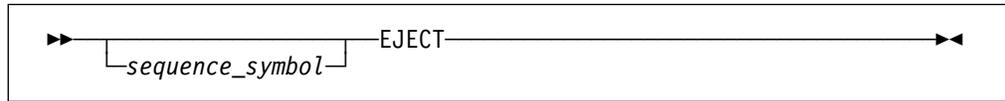
Notes:

1. The DSECT instruction also defines an external dummy section, but only if the symbol in the name field appears in a Q-type offset constant in the same source module. Otherwise, a DSECT instruction defines a dummy section.
2. If two or more external dummy sections for different source modules have the same name, the linker uses the most restrictive alignment, and the largest section to compute the total length.

EJECT Instruction

The EJECT instruction stops the printing of the assembler listing on the current page, and continues the printing on the next page.

END Instruction



sequence_symbol
is a sequence symbol.

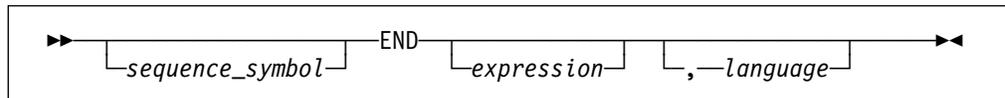
The EJECT instruction causes the next line of the assembler listing to be printed at the top of a new page. If the line before the EJECT statement appears at the bottom of a page, the EJECT statement has no effect.

An EJECT instruction immediately following another EJECT instruction is ignored. A TITLE instruction immediately following an EJECT instruction causes the title to change but no additional page eject is performed. (The TITLE instruction normally forces a page eject.)

The EJECT instruction statement itself is not printed in the listing.

END Instruction

Use the END instruction to end the assembly of a program. You can also supply an address in the operand field to which control can be transferred after the program is loaded. The END instruction must always be the last statement in the source program.



sequence_symbol
is a sequence symbol.

expression

specifies the point to which control can be transferred when loading of the object program completes. This point is usually the address of the first executable instruction in the program, as shown in the following sequence:

```
NAME      CSECT
AREA      DS          50F
BEGIN     BALR        2,0
          USING       *,2
          .
          .
          .
          END         BEGIN
```

If specified, *expression* may be generated by substitution into variable symbols. However, after substitution, that is, at assembly time:

- It must be a simply relocatable expression representing an address in the source module delimited by the END instruction, or
- If it contains an external symbol, the external symbol must be the only term in the expression, or the remaining terms in the expression must reduce to zero.

- It must not be a literal.

language

a marker for use by language translators that produce assembly code. The operand has three sub-operands. The values in this operand are copied into characters 53 to 71 of the END record in the object deck.

The syntax of this operand is

```
(char10,char4,char5)
```

where all three sub-operands, and the commas and parentheses are required.

char10 is a one to ten character code. It is intended to be a language translator identifier. char4 must be exactly four characters long. It is intended to be a version and release code. char5 must be exactly five characters long, and should be a date in the format "YYDDD." It is intended to be the compile date. For example:

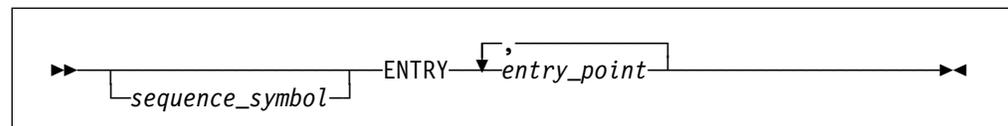
```
END ENRTPT,(MYCOMPILER,0101,00273)
```

Notes:

1. If the END instruction is omitted, one is generated by the assembler, and message ASMA140 END record missing is issued.
2. Refer to the note on page 312 about lookahead processing, and the effect it has on generated END statements.

ENTRY Instruction

The ENTRY instruction identifies symbols defined in one source module so that they can be referred to in another source module. These symbols are entry symbols.

*sequence_symbol*

is a sequence symbol.

entry_point

is a relocatable symbol that:

- Is a valid symbol
- Is defined in an executable control section
- Is not defined in a dummy control section, a common control section, or an external control section

Up to 65535 individual control sections, external symbols, and external dummy sections can be defined in a source module. However, the practical maximum number depends on the amount of table storage available during link-editing.

EQU Instruction

The assembler lists each entry symbol of a source module in an external symbol dictionary, along with entries for external symbols, common control sections, and external control sections.

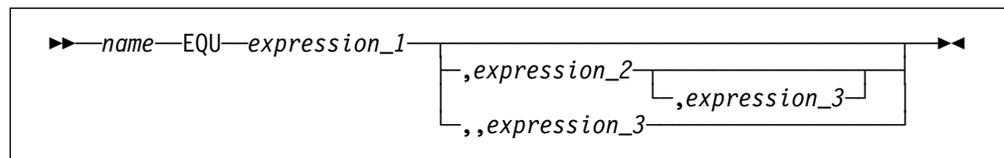
A symbol used as the name entry of a START or CSECT instruction is also automatically considered an entry symbol, and does not have to be identified by an ENTRY instruction.

The length attribute value of entry symbols is the same as the length attribute value of the symbol at its point of definition.

EQU Instruction

The EQU instruction assigns absolute or relocatable values to symbols. Use it to:

- Assign single absolute values to symbols.
- Assign the values of previously defined symbols or expressions to new symbols, thus letting you use different mnemonics for different purposes.
- Compute expressions whose values are unknown at coding time or difficult to calculate. The value of the expressions is then assigned to a symbol.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

expression_1

represents a value that the assembler assigns to the symbol in the name field. *Expression_1* may have any value allowed for an assembly expression: absolute (including negative), relocatable, or complexly relocatable. The assembler carries this value as a signed 4-byte (32-bit) number; all four bytes are printed in the program listings opposite the symbol.

Any symbols used in *expression_1* need not be previously defined. However, if any symbol is not previously defined, the value of *expression_1* is not assigned to the symbol in the name field until assembly time and therefore may not be used during conditional assembly.

If *expression_1* is a complexly relocatable expression, the whole expression, rather than its value, is assigned to the symbol. During the evaluation of any expression that includes a complexly relocatable symbol, that symbol is replaced by its own defining expression. Consider the following example, in which A1 and A2 are defined in one control section, and B1 and B2 in another:

```
X      EQU      A1+B1
Y      EQU      X-A2-B2
```

The first EQU statement assigns a complexly relocatable expression $(A1+B1)$ to X. During the evaluation of the expression in the second EQU statement, X is replaced by its defining relocatable expression $(A1+B1)$, and the assembler evaluates the resulting expression $(A1+B1-A2-B2)$ and assigns an absolute value to Y, because the relocatable terms in the expression are paired.

expression_2

represents a value that the assembler assigns as a *length attribute value* to the symbol in the name field. It is optional, but, if specified, must be an absolute value in the range 0 to 65,535. This value overrides the normal length attribute value implicitly assigned from *expression_1*.

All symbols appearing in *expression_2* must have been previously defined.

If *expression_2* is omitted, the assembler assigns a length attribute value to the symbol in the name field according to the length attribute value of the extreme left (or only) term of *expression_1*, as follows:

1. If the extreme left term of *expression_1* is a location counter reference (*), a self-defining term, or a symbol length attribute value reference, the length attribute is 1. This also applies if the extreme left term is a symbol that is equated to any of these values.
2. If the extreme left term of *expression_1* is a symbol that is used in the name field of a DC or DS instruction, the length attribute value is equal to the implicit or explicit length of the first (or only) constant specified in the DC or DS operand field.
3. If the extreme left term is a symbol that is used in the name field of a machine instruction, the length attribute value is equal to the length of the assembled instruction.
4. Symbols that name assembler instructions, except the DC, DS, CCW, CCW0, and CCW1 instructions, have a length attribute value of 1. Symbols that name a CCW, CCW0, or CCW1 instruction have a length attribute value of 8.
5. The length attribute value described in cases 2, 3, and 4 above is the assembly-time value of the attribute.

For more information about the length attribute value, see “Symbol Length Attribute Reference” on page 37.

expression_3

represents a value that the assembler assigns as a *type attribute value* to the symbol in the name field. It is optional, but, if specified, it must be an absolute value in the range 0 to 255. This value overrides the normal type attribute value implicitly assigned from *expression_1*.

All symbols appearing in *expression_3* must have been previously defined.

If *expression_3* is omitted, the assembler assigns a type attribute value of U to the symbol, which means the symbol in the name field has an undefined (or unknown or unassigned) type attribute. See the general discussion about data attributes on page 296, and “Type Attribute (T’)” on page 300.

The EQU instruction can be used anywhere in a source module after the ICTL instruction. Note, however, that the EQU instruction can initiate an unnamed control section (private code) if it is specified before the first control section (initiated by a START, CSECT, or RSECT instruction).

Using Conditional Assembly Values

The following rules describe when you can use the value, length attribute value, or type attribute value of an equated symbol in conditional assembly statements:

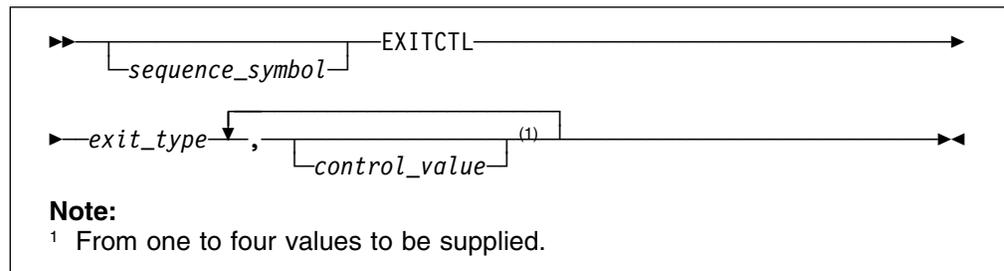
- If you want to use the value of the symbol in conditional assembly statements, then:
 - The EQU statement that defines the symbol must be processed by the assembler before the conditional assembly statement that refers to the symbol.
 - The symbol in the name field of the EQU statement must be an ordinary symbol.
 - *Expression_1* must be an absolute expression, and must contain only self-defining terms or previously defined symbols.
- If only *expression_1* is specified, the assembler assigns a value of 1 to the length attribute, and a value of U to the type attribute of the symbol during conditional assembly. You can use these values in conditional assembly statements, although references to the length attribute may be flagged.

If you specify *expression_2* or *expression_3* and you want to use the explicit attribute value during conditional assembly processing, then:

- The symbol in the name field must be an ordinary symbol.
- The expression must contain only self-defining terms.

EXITCTL Instruction

The EXITCTL instruction sets or modifies the contents of the four signed fullword exit-control parameters that the assembler maintains for each type of exit.



sequence_symbol
 is a sequence symbol.

exit_type
 identifies the type of exit to which this EXITCTL instruction applies. *Exit_type* must have one of the following values:

- SOURCE Sets the exit-control parameters for the user-supplied exit module specified in the INEXIT suboption of the EXIT assembler option.
- LIBRARY Sets the exit-control parameters for the user-supplied exit module specified in the LIBEXIT suboption of the EXIT assembler option.
- LISTING Sets the exit-control parameters for the user-supplied exit module specified in the PRTEXT suboption of the EXIT assembler option.

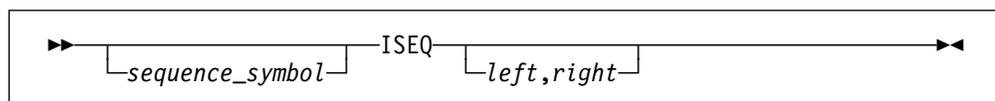
changing the begin column, you can even create a field before the begin column to contain identification or sequence numbers. For example, the following instruction designates the begin column as 9 and the end column as 80. Since the end column is specified as 80, no continuation records are recognized.

```
ICTL          9,80
```

COPY Instruction: The ICTL instruction does not affect the format of statements brought in by a COPY instruction or generated from a library macro definition. The assembler processes these statements according to the standard begin, end, and continue columns described in “Field Boundaries” on page 14.

ISEQ Instruction

The ISEQ instruction forces the assembler to check if the statements in a source module are in sequential order. In the ISEQ instruction, you specify the columns between which the assembler is to check for sequence numbers.



sequence_symbol
is a sequence symbol.

left
specifies the first column of the field to be sequence-checked. If specified, *left* must be a decimal self-defining term in the range 1 to 80, inclusive.

right
specifies the extreme right column of the field to be sequence checked. If specified, *right* must be a decimal self-defining term in the range 1 to 80, inclusive, and must be greater than or equal to *left*.

If *left* and *right* are omitted, sequence checking is ended. Sequence checking can be restarted with another ISEQ statement. An ISEQ statement that is used to end sequence checking is itself sequence-checked.

The assembler begins sequence checking with the first statement line following the ISEQ instruction. The assembler also checks continuation lines.

Sequence numbers on adjacent statements or lines are compared according to the 8-bit internal EBCDIC collating sequence. When the sequence number on one line is not greater than the sequence number on the preceding line, a sequence error is flagged, and a warning message is issued, but the assembly is not ended.

If the sequence field in the preceding line is blank, the assembler uses the last preceding line with a nonblank sequence field to make its comparison.

The assembler checks only those statements that are specified in the coding of a source module. This includes any COPY instruction statement or macro instruction. The assembler does not check:

- Statements inserted by a COPY instruction

LOCTR Instruction

- Statements generated from model statements inside macro definitions or from model statements in open code (statement generation is discussed in detail in Chapter 7, “How to Specify Macro Definitions” on page 217)
- Statements in library macro definitions

LOCTR Instruction

The LOCTR instruction specifies multiple location counters within a control section. The assembler assigns consecutive addresses to the segments of code using one location counter before it assigns addresses to segments of coding using the next location counter.



```
▶▶ name LOCTR ◀◀
```

name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

By using the LOCTR instruction, you can code your control section in a logical order. For example, you can code work areas and data constants within the section of code, using them without having to branch around them:

```
A      CSECT                               See note 1
      LR          12,15
      USING      A,12
      .
B      LOCTR                               See note 2
      .
C      LOCTR
      .
B      LOCTR                               See note 3
      .
A      LOCTR                               See note 4
      .
DUM    DSECT                               See note 1
C      LOCTR                               See note 5
      .
      END
```

Notes:

1. The first location counter of a control section is defined by the name of the START, CSECT, DSECT, or COM instruction defining the section.
2. The LOCTR instruction defines a location counter.
3. The LOCTR continues a previously defined location counter. A location counter remains in use until it is interrupted by a LOCTR, CSECT, DSECT, or COM instruction.
4. A LOCTR instruction with the same name as a control section continues the first location counter of that section.

5. A LOCTR instruction with the same name as a LOCTR instruction in a previous control section causes that control section to be continued using the location counter specified.

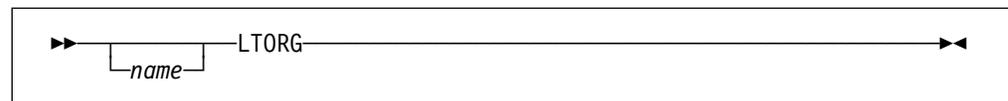
A control section cannot have the same name as a previous LOCTR instruction. A LOCTR instruction placed before the first control section definition initiates an unnamed control section before the LOCTR instruction is processed.

The length attribute of a LOCTR name is 1.

LOCTR instructions do not force alignment; code assembled under a location counter other than the first location counter of a control section is assembled starting at the next available byte after the previous segment.

LTORG Instruction

Use the LTOrg instruction so that the assembler can collect and assemble literals into a literal pool. A literal pool contains the literals you specify in a source module either after the preceding LTOrg instruction, or after the beginning of the source module.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

If *symbol* is an ordinary symbol or a variable symbol that has been assigned an ordinary symbol, the ordinary symbol is assigned the value of the address of the first byte of the literal pool. This symbol is aligned on a doubleword boundary and has a length attribute of 1. If bytes are skipped after the end of a literal pool to achieve alignment for the next instruction, constant, or area, the bytes are not filled with zeros.

The assembler ignores the borders between control sections when it collects literals into pools. Therefore, you must be careful to include the literal pools in the control sections to which they belong (for details, see “Addressing Considerations” on page 173).

The creation of a literal pool gives the following advantages:

- Automatic organization of the literal data into sections that are correctly aligned and arranged so that minimal space is wasted.
- Assembling of duplicate data into the same area.
- Because all literals are cross-referenced, you can find the literal constant in the pool into which it has been assembled.

Literal Pool

A literal pool is created under the following conditions:

- Immediately after a LTOrg instruction.
- If no LTOrg instruction is specified, and no LOCTRs are used in the first control section, a literal pool generated after the END statement is created at the end of the first control section, and appears in the listing after the END statement.
- If no LTOrg instruction is specified, and LOCTRs are used in the first control section, a literal pool generated after the END statement is created at the end of the most recent LOCTR segment of the first section, and appears in the listing after the END statement.
- To force the literal pool to the end of the control section when using LOCTRs, you must resume the last LOCTR of the CSECT before the LTOrg statement (or before the END statement if no LTOrg statement is specified).

Each literal pool has four segments into which the literals are stored (a) in the order that the literals are specified, and (b) according to their assembled lengths, which, for each literal, is the total explicit or implied length, as described below.

- The *first segment* contains all literal constants whose assembled lengths are a multiple of 8.
- The *second segment* contains those whose assembled lengths are a multiple of 4, but not of 8.
- The *third segment* contains those whose assembled lengths are even, but not a multiple of 4.
- The *fourth segment* contains all the remaining literal constants whose assembled lengths are odd.

Since each literal pool is aligned on a doubleword boundary, this guarantees that all literals in the first segment are doubleword aligned; in the second segment, fullword aligned; and, in the third, halfword aligned. No space is wasted except, possibly, at the origin of the pool, and in aligning to the start of the statement following the literal pool.

Literals from the following statements are in the pool, in the segments indicated by the parenthesized numbers:

FIRST	START	0	
	.		
	MVC	T0,=3F'9'	(2)
	AD	2,=D'7'	(1)
	IC	2,=XL1'8'	(4)
	MVC	MTH,=CL3'JAN'	(4)
	LM	4,5,=2F'1,2'	(1)
	AH	5,=H'33'	(3)
	L	2,=A(ADDR)	(2)
	MVC	FIVES,=XL8'05'	(1)

Addressing Considerations

If you specify literals in source modules with multiple control sections, you should:

- Write a LTORG instruction at the end of each control section, so that all the literals specified in the section are assembled into the one literal pool for that section. If a control section is divided and interspersed among other control sections, you should write a LTORG instruction at the end of each segment of the interspersed control section.
- When establishing the addressability of each control section, make sure (a) that all of the literal pool for that section is also addressable, by including it within a USING range, and (b) that the literal specifications are within the corresponding USING domain. The USING range and domain are described in “USING Instruction” on page 194.

All the literals specified after the last LTORG instruction, or, if no LTORG instruction is specified, all the literals in a source module are assembled into a literal pool at the end of the first control section. You must then make this literal pool addressable, along with the addresses in the first control section. This literal pool is printed in the program listing after the END instruction.

Duplicate Literals

If you specify duplicate literals within the part of the source module that is controlled by a LTORG instruction, only one literal constant is assembled into the pertinent literal pool. This also applies to literals assembled into the literal pool at the end of the first or only control section of a source module that contains no LTORG instructions.

Literals are duplicates only if their specifications are identical, not if the object code assembled happens to be identical.

When two literals specifying identical A-type, Y-type or S-type address constants contain a reference to the value of the location counter (*), both literals are assembled into the literal pool. This is because the value of the location counter may be different in the two literals. Even if the location counter value is the same for both, they are still both assembled into the literal pool.

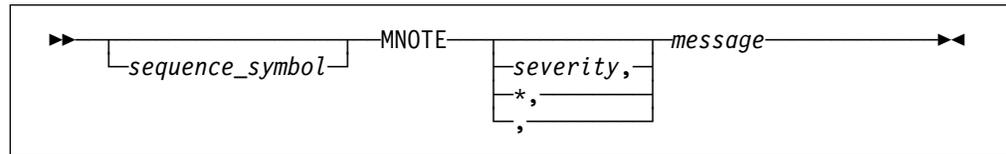
The following examples show how the assembler stores pairs of literals, if the placement of each pair is controlled by the same LTORG statement.

=X'F0'	Both are
=C'0'	stored
=XL3'0'	Both are
=HL3'0'	stored
=A(++4)	Both are
=A(++4)	stored
=X'FFFF'	Identical,
=X'FFFF'	only one copy is stored

MNOTE Instruction

The MNOTE instruction generates your own error messages or displays intermediate values of variable symbols computed during conditional assembly.

The MNOTE instruction can be used inside macro definitions or in open code, and its operation code can be created by substitution. The MNOTE instruction causes the generation of a message that is given a statement number in the printed listing.



sequence_symbol
is a sequence symbol.

severity
is a severity code. The *severity* operand may be a decimal self defining term or an arithmetic term allowed in the operand field of a SETA instruction. The term must have a value in the range 0 through 255. The severity code is used to determine the return code issued by the assembler when it returns control to the operating system. The severity may also change the value of the system variable symbols &SYSM_HSEV and &SYSM_SEV (see “&SYSM_HSEV System Variable Symbol” on page 253 and “&SYSM_SEV System Variable Symbol” on page 253).

message
is the message text. It may be any combination of characters enclosed in single quotation marks.

The rules that apply to this character string are as follows:

- Variable symbols are allowed. The single quotation marks that enclose the message can be generated from variable symbols.
- Two ampersands and two single quotation marks are needed to generate an ampersand or a single quotation mark, respectively. If variable symbols have ampersands or single quotation marks as values, the values must be coded as two ampersands or two single quotation marks.
- If the number of characters in the character string plus the rest of the MNOTE operand exceeds 1024 bytes the assembler issues diagnostic message
ASMA062E Illegal operand format
- Double-byte data is permissible in the operand field when the DBCS assembler option is specified. The double-byte data must be valid.
- The DBCS ampersand and apostrophe are not recognized as delimiters.
- A double-byte character that contains the value of an EBCDIC ampersand or apostrophe in either byte is not recognized as a delimiter when enclosed by SO and SI.

Remarks: Any remarks for the MNOTE instruction statement must be separated by one or more blanks from the single quotation mark that ends the message.

If *severity* is provided, or *severity* is omitted but the comma separating it from *message* is present, the message is treated as an error message; otherwise the message is treated as comments. The rules for specifying the contents of *severity* are:

- The severity code can be specified as any arithmetic expression allowed in the operand field of a SETA instruction. The expression must have a value in the range 0 through 255.

Example:

```
MNOTE 2, 'ERROR IN SYNTAX'
```

The generated result is:

```
2,ERROR IN SYNTAX
```

- If the severity code is omitted, but the comma separating it from the message is present, the assembler assigns a default value of 1 as the severity code.

Example:

```
MNOTE , 'ERROR, SEV 1'
```

The generated result is:

```
,ERROR, SEV 1
```

- An asterisk in the severity code subfield causes the message and the asterisk to be generated as a comment statement.

Example:

```
MNOTE *, 'NO ERROR'
```

The generated result is:

```
*,NO ERROR
```

- If the severity code subfield is omitted, including the comma separating it from the message, the assembler generates the message as a comment statement.

Example:

```
MNOTE 'NO ERROR'
```

The generated result is:

```
NO ERROR
```

Notes:

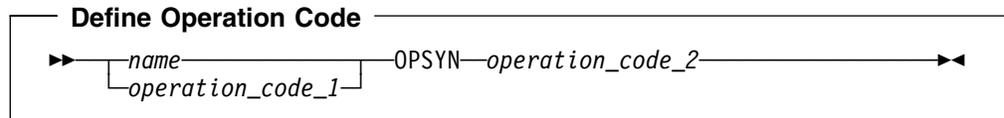
1. An MNOTE instruction causes a message to be printed, if the current PRINT option is ON, even if the PRINT NOGEN option is specified.
2. The statement number of the message generated from an MNOTE instruction with a severity code is listed among any other error messages for the current source module. However, the message is printed only if the severity code specified is greater than or equal to the severity code *nnn* specified in the FLAG(*nnn*) assembler option.
3. The statement number of the comments generated from an MNOTE instruction without a severity code is not listed among other error messages.

OPSYN Instruction

The OPSYN instruction defines or deletes symbolic operation codes.

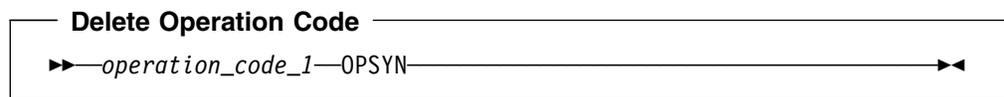
The OPSYN instruction has two formats. The first format defines a new operation code to represent an existing operation code, or to redefine an existing operation code for:

- Machine and extended mnemonic branch instructions
- Assembler instructions, including conditional assembly instructions
- Macro instructions



The second format deletes an existing operation code for:

- Machine and extended mnemonic branch instructions
- Assembler instructions, including conditional assembly instructions
- Macro instructions



name

is one of the following:

- An ordinary symbol that is not the same as an existing operation code
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol and is not the same as an existing operation code

operation_code_1

is one of the following:

- An operation code described in this chapter, or in Chapter 4, “Machine Instruction Statements” on page 68, or Chapter 9, “How to Write Conditional Assembly Instructions” on page 291
- The operation code defined by a previous OPSYN instruction

operation_code_2

is one of the following:

- An operation code described in this chapter, or in Chapter 4, “Machine Instruction Statements” on page 68, or Chapter 9, “How to Write Conditional Assembly Instructions” on page 291
- The operation code defined by a previous OPSYN instruction

In the first format, the OPSYN instruction assigns the properties of the operation code denoted by *operation_code_2* to the ordinary symbol denoted by *symbol* or the operation code denoted by *operation_code_1*.

In the second format, the OPSYN instruction causes the operation code specified in *operation_code_1* to lose its properties as an operation code.

The OPSYN instruction can be coded anywhere in the program to redefine an operation code.

The symbol in the name field can represent a valid operation code. It loses its current properties as if it had been defined in an OPSYN instruction with a blank operand field. In the following example, L and LR both possess the properties of the LR machine instruction operation code:

```
L      OPSYN      LR
```

When the same symbol appears in the name field of two OPSYN instructions, the latest definition takes precedence. In the example below, STORE now represents the STH machine operation:

```
STORE  OPSYN      ST
STORE  OPSYN      STH
```

Note: OPSYN is not processed during lookahead mode (see “Lookahead” on page 311). Therefore it cannot be used during lookahead to replace an opcode that must be processed during lookahead, such as COPY. For example, assuming AFTER is defined in COPYBOOK, the following code gives an ASMA042E error (Length attribute of symbol is unavailable):

```
      AIF (L'AFTER LT 2).BEYOND
OPCOPY OPSYN COPY      OPSYN not processed during look ahead
      OPCOPY COPYBOOK  OPCOPY fails
.BEYOND ANOP ,
```

Redefining Conditional Assembly Instructions

A redefinition of a conditional assembly instruction only comes into effect in macro definitions occurring after the OPSYN instruction. The original definition is always used when a macro instruction calls a macro that was defined and edited before the OPSYN instruction.

An OPSYN instruction that redefines the operation code of an assembler or machine instruction generated from a macro instruction is, however, effective immediately, even if the definition of the macro was made prior to the OPSYN instruction. Consider the following example:

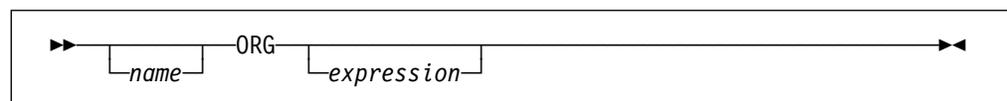
ORG Instruction

	MACRO		Macro header
	MAC	...	Macro prototype
	AIF	...	
	MVC	...	
	.		
	MEND		Macro trailer
	.		
AIF	OPSYN	AGO	Assign AGO properties to AIF
MVC	OPSYN	MVI	Assign MVI properties to MVC
	.		
	MAC	...	Macro call (AIF interpreted as AIF instruction; generated AIFs not printed)
+	MVC	...	Interpreted as MVI instruction
	.		
	.		Open code started at this point
	AIF	...	Interpreted as AGO instruction
	MVC	...	Interpreted as MVI instruction

In this example, AIF and MVC instructions are used in a macro definition. AIF is a conditional assembly instruction, and MVC is a machine instruction. OPSYN instructions are used to assign the properties of AGO to AIF and to assign the properties of MVI to MVC. In subsequent calls of the macro MAC, AIF is still defined, and used, as an AIF operation, but the generated MVC is treated as an MVI operation. In open code following the macro call, the operations of both instructions are derived from their new definitions assigned by the OPSYN instructions. If the macro is redefined (by another macro definition), the new definitions of AIF and MVC (that is, AGO and MVI) are used for further generations.

ORG Instruction

The ORG instruction alters the setting of the location counter and thus controls the structure of the current control section. This redefines portions of a control section.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

If *symbol* denotes an ordinary symbol, the ordinary symbol is defined with the value that the location counter had before the ORG statement is processed.

expression

is a relocatable expression, the value of which is used to set the location counter. If *expression* is omitted, the location counter is set to the next available location for the current control section.

In general, symbols used in *expression* need not have been previously defined. However, the relocatable component of *expression* (that is, the unpaired relocatable term) must have been previously defined in the same control section in which the ORG statement appears, or be equated to a previously defined value.

An ORG statement cannot be used to specify a location below the beginning of the control section in which it appears. For example, the following statement is not correct if it appears less than 500 bytes from the beginning of the current control section.

```
ORG          *-500
```

This is because the expression specified is negative, and sets the location counter to a value larger than the assembler can process. The location counter *wraps around* (the location counter is discussed in detail in “Location Counter Reference” on page 35).

An ORG statement cannot be used to change sections or LOCTR segments. For example:

```
AA          CSECT
X           DS          D
Y           DS          F
BB          CSECT
           ORG          Y
```

is invalid, because the section containing the ORG statement (BB) is not the same as the section in AA in which the ORG operand expression Y is defined.

With the ORG statement, you can give two instructions the same location counter values. In such a case, the second instruction does not always eliminate the effects of the first instruction. Consider the following example:

```
ADDR      DC          A(ADDR)
           ORG        *-4
B         DC          C'BETA'
```

In this example, the value of B ('BETA') is destroyed by the relocation of ADDR during linkage editing.

Using Figure 55 on page 180 as an example, to build a translate table (for example, to convert EBCDIC character code into some other internal code):

1. Define the table (see **1** in Figure 55) as being filled with zeros.
2. Use the ORG instruction to alter the location counter so that its counter value indicates a specific location (see **2** in Figure 55) within the table.
3. Redefine the data (see **3** in Figure 55) to be assembled into that location.
4. After repeating the first three steps (see **4** in Figure 55) until your translate table is complete, use an ORG instruction with a null operand field to alter the location counter. The counter value then indicates the next available location (see **5** in Figure 55) in the current control section (after the end of the translate table).

Both the assembled object code for the whole table filled with zeros, and the object code for the portions of the table you redefined, are printed in the program listings.

ORG Instruction

However, the data defined later is loaded over the previously defined zeros and becomes part of your object program, instead of the zeros.

That is, the ORG instruction can cause the location counter to be set to any part of a control section, even the middle of an instruction, into which you can assemble data. It can also cause the location counter to be set to the next available location so that your program can be assembled sequentially.

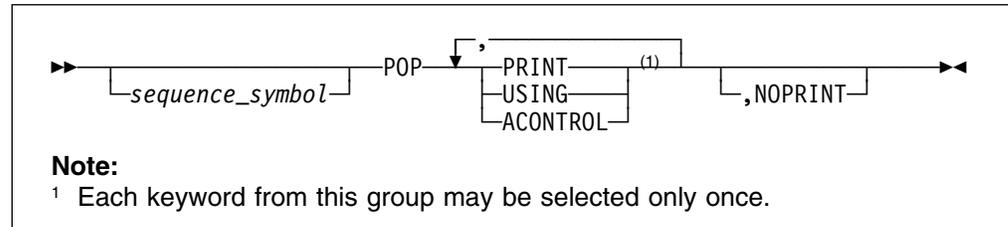
Source Module		Object Code
FIRST	START 0	
	.	
1	TABLE DC XL256'0'	TABLE (in Hex)
2	ORG TABLE+0	+0
	DC C'0'	F0
	DC C'1'	F1
	.	.
	ORG TABLE+13	+13
	DC C'D'	C4
	DC C'E'	C5
	.	.
4	ORG TABLE+C'D'	
	DC AL1(13)	+196
	DC AL1(14)	13
	.	14
	ORG TABLE+C'0'	+240
	DC AL1(0)	.
	DC AL1(1)	00
	.	01
	ORG	+255
5	GOON DS 0H	
	.	
TABLE+256	TR INPUT, TABLE	
	.	
INPUT	DS CL20	
	.	
	END	

Figure 55. Building a Translate Table

Restriction on ORG when the LOCTR Instruction is Used: If you specify multiple location counters with the LOCTR instruction, the ORG instruction can alter only the location counter in use when the instruction appears. Thus, you cannot control the structure of the whole control section using ORG, but only the part that is controlled by the current location counter.

POP Instruction

The POP instruction restores the PRINT, USING or ACONTROL status saved by the most recent PUSH instruction.



sequence_symbol
 is a sequence symbol.

PRINT

instructs the assembler to restore the PRINT status to the status saved by the most recent PUSH instruction.

USING

instructs the assembler to restore the USING status to the status saved by the most recent PUSH instruction.

ACONTROL

instructs the assembler to restore the ACONTROL status to the status saved by the most recent PUSH instruction.

NOPRINT

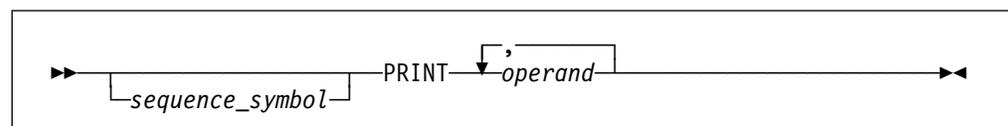
instructs the assembler to suppress the printing of the POP statement in which it is specified.

The POP instruction causes the status of the current PRINT, USING or ACONTROL instruction to be overridden by the PRINT, USING or ACONTROL status saved by the last PUSH instruction. For example:

	PRINT	GEN	Printed macro generated code
	DCMAC	X,27	Call macro to generate DC
+	DC	X'27'	... Generated statement
	PUSH	PRINT	Save PRINT status
	PRINT	NOGEN	Suppress macro generated code
	DCMAC	X,33	Call macro to generate DC
	POP	PRINT	Restore PRINT status
	DCMAC	X,42	Call macro to generate DC
+	DC	X'42'	... Generated statement

PRINT Instruction

The PRINT instruction controls the amount of detail printed in the listing of programs.



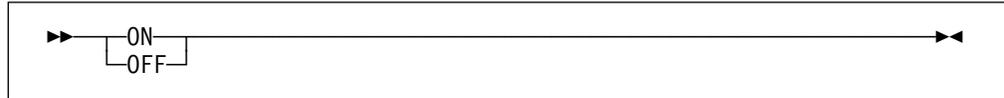
PRINT Instruction

sequence_symbol

is a sequence symbol.

operand

is an operand from one of the groups of operands described below. If a null operand is supplied, it is accepted by the assembler with no effect on the other operands specified. The operands are listed in hierarchic order. The effect, if any, of one operand on other operands is also described.



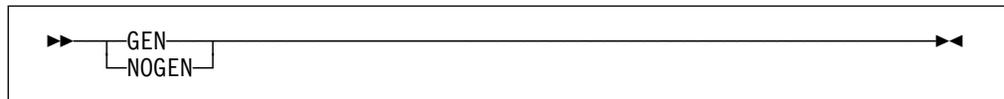
ON

instructs the assembler to print, or resume printing, the *source and object* section of the assembler listing. Initial value.

OFF

instructs the assembler to stop printing the *source and object* section of the assembler listing. A subsequent PRINT ON instruction resumes printing.

When this operand is specified the printing actions requested by the GEN, DATA, MCALL, and MSOURCE operands do not apply.



GEN

instructs the assembler to print all statements generated by the processing of a macro. This operand does not apply if PRINT OFF has been specified. Initial value.

NOGEN

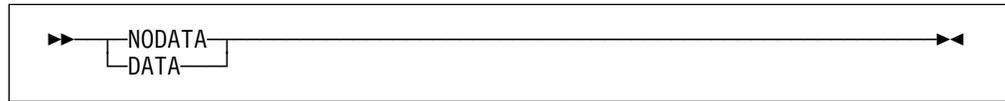
instructs the assembler not to print statements generated by the processing of a macro. This applies to all levels of macro nesting; no generated code is displayed while PRINT NOGEN is in effect. If this operand is specified, the DATA operand does not apply to constants that are generated during macro processing. Also, if this operand is specified, the MSOURCE operand does not apply. When the PRINT NOGEN instruction is in effect, the assembler prints one of the following on the same line as the macro call or model statement:

- The object code for the first instruction generated. The object code includes the data that is shown under the ADDR1 and ADDR2 columns of the assembler listing.
- The first 8 bytes of generated data from a DC instruction

When the assembler forces alignment of an instruction or data constant, it generates zeros in the object code and prints the generated object code in the listing. When you use the PRINT NOGEN instruction the generated zeros are not printed.

Note: If the next line to print after macro call or model statement is a diagnostic message, the object code or generated data is not shown in the assembler listing.

The MNOTE instruction always causes a message to be printed.

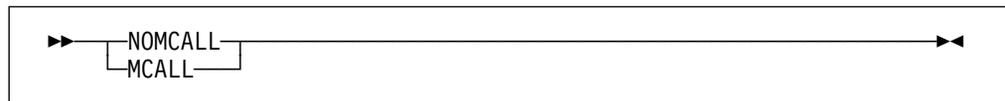


NODATA

instructs the assembler to print only the first 8 bytes of the object code of constants. This operand does not apply if PRINT OFF has been specified. If PRINT NOGEN has been specified, this operand does not apply to constants generated during macro processing. Initial value.

DATA

instructs the assembler to print the object code of all constants in full. This operand does not apply if PRINT OFF has been specified. If PRINT NOGEN has been specified, this operand does not apply to constants generated during macro processing.



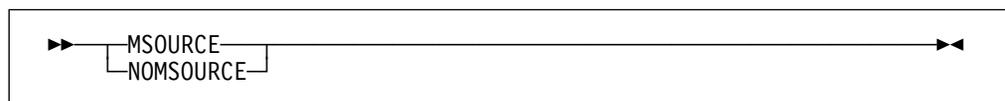
NOMCALL

instructs the assembler to suppress the printing of nested macro call instructions. Initial value.

MCALL

instructs the assembler to print nested macro call instructions, including the name of the macro definition to be processed and the operands and values passed to the macro definition. The assembler only prints the operands and comments up to the size of its internal processing buffer. If this size is exceeded the macro call instruction is truncated, and the characters . . . MORE are added to the end of the printed macro call. This does not affect the processing of the macro call.

This operand does not apply if either PRINT OFF or PRINT NOGEN has been specified.

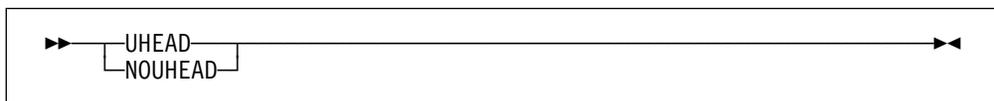


MSOURCE

instructs the assembler to print the source statements generated during macro processing, as well as the assembled addresses and generated object code of the statements. This operand does not apply if either PRINT OFF or PRINT NOGEN has been specified. Initial value.

NOMSOURCE

instructs the assembler to suppress the printing of source statements generated during macro processing, without suppressing the printing of the assembled addresses and generated object code of the statements. This operand does not apply if either PRINT OFF or PRINT NOGEN has been specified.

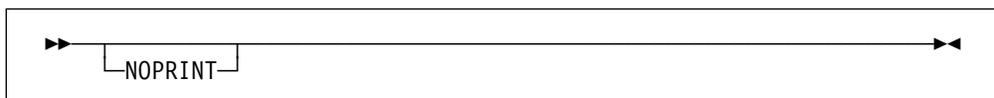


UHEAD

instructs the assembler to print a summary of active USINGs following the TITLE line on each page of the *source and object program* section of the assembler listing. This operand does not apply if PRINT OFF has been specified. initial value.

NOUHEAD

instructs the assembler not to print a summary of active USINGs.



NOPRINT

instructs the assembler to suppress the printing of the PRINT statement in which it is specified. The NOPRINT operand may only be specified in conjunction with one or more other operands.

The PRINT instruction can be specified any number of times in a source module, but only those operands actually specified in the instruction change the current print status.

PRINT options can be generated by macro processing during conditional assembly. However, at assembly time, all options are in force until the assembler encounters a new and opposite option in a PRINT instruction.

The PUSH and POP instructions, described in “PUSH Instruction” on page 186 and “POP Instruction” on page 181, also influence the PRINT options by saving and restoring the PRINT status.

You can override the effect of the operands of the PRINT instruction by using the PCONTROL assembler option. For more information about this option, see the *HLASM Programmer's Guide*.

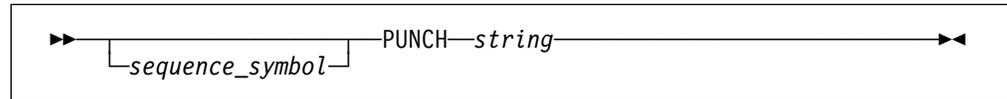
Unless the NOPRINT operand is specified, or the assembler listing is suppressed by the NOLIST assembler option, the PRINT instruction itself is printed.

Process Statement

The process statement is described under “*PROCESS Statement” on page 89.

PUNCH Instruction

The PUNCH instruction creates a record containing a source or other statement, or an object record.



sequence_symbol
is a sequence symbol.

string
is a character string of up to 80 characters, enclosed in single quotation marks. All 256 characters in the EBCDIC character set are allowed in the character string. Variable symbols are also allowed.

Double-byte data is permissible in the operand field when the DBCS assembler option is specified. However, the following rules apply to double-byte data:

- The DBCS ampersand and the single quotation mark are not recognized as delimiters.
- A double-byte character that contains the value of an EBCDIC ampersand or a single quotation mark in either byte is not recognized as a delimiter when enclosed by SO and SI.

The position of each character specified in the PUNCH statement corresponds to a column in the record to be punched. However, the following rules apply to ampersands and single quotation marks:

- A single ampersand initiates an attempt to identify a variable symbol and to substitute its current value.
- A pair of ampersands is punched as one ampersand.
- A pair of single quotation marks is punched as one single quotation mark.
- An unpaired single quotation mark followed by one or more blanks simply ends the string of characters punched. If a nonblank character follows an unpaired single quotation mark, an error message is issued and nothing is punched.

Only the characters punched, including blanks, count toward the maximum of 80 allowed.

The PUNCH instruction causes the data in its operand to be punched into a record. One PUNCH instruction produces one record, but as many PUNCH instructions as necessary can be used.

You can code PUNCH statements in:

- A source module to produce control statements for the linker. The linker uses these control statements to process the object module.
- Macro definitions to produce, for example, source statements in other computer languages or for other processing phases.

The assembler writes the record produced by a PUNCH statement when it writes the object deck. The ordering of this record in the object deck is determined by the order in which the PUNCH statement is processed by the assembler. The record appears after any object deck records produced by previous statements, and before any other object deck records produced by subsequent statements.

PUSH Instruction

The PUNCH instruction statement can appear anywhere in a source module. If a PUNCH instruction occurs before the first control section, the resultant record punched precedes all other records in the object deck.

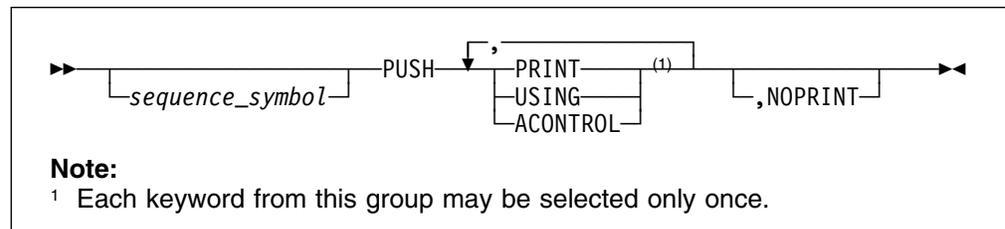
The record punched as a result of a PUNCH instruction is not a logical part of the object deck, even though it can be physically interspersed in the object deck.

Notes:

1. The identification and sequence number field generated as part of other object deck records is not generated for the record punched by the PUNCH instruction.
2. If the NODECK and NOOBJECT assembler options are specified, no records are punched for the PUNCH instruction.

PUSH Instruction

The PUSH instruction saves the current PRINT, USING or ACONTROL status in push-down storage on a last-in, first-out basis. You restore this PRINT, USING or ACONTROL status later, also on a last-in, first-out basis, by using a POP instruction.



sequence_symbol
is a sequence symbol.

PRINT

instructs the assembler to save the PRINT status in a push-down stack.

USING

instructs the assembler to save the USING status in a push-down stack.

ACONTROL

instructs the assembler to save the ACONTROL status in a push-down stack.

NOPRINT

instructs the assembler to suppress the printing of the PUSH statement in which it is specified.

The PUSH instruction only causes the status of the current PRINT, USING or ACONTROL instructions to be saved. The PUSH instruction does not:

- Change the status of the current PRINT or ACONTROL instructions
- Imply a DROP instruction, or change the status of the current USING instructions

REPRO Instruction

The REPRO instruction causes the data specified in the statement that follows to be punched into a record.



sequence_symbol
is a sequence symbol.

The REPRO instruction can appear anywhere in a source module. One REPRO instruction produces one punched record. The punched records are not part of the object deck, even though they can be physically interspersed in the object deck.

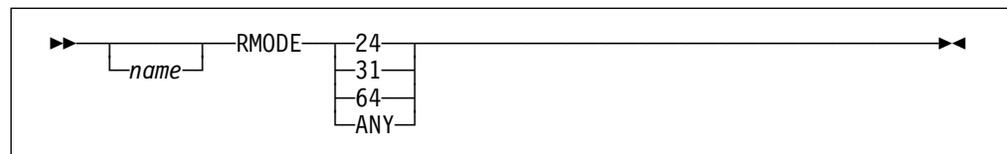
The statement to be reproduced can contain any of the 256 characters in the EBCDIC character set, including blanks, ampersands, and single quotation marks. Unlike the PUNCH instruction, the REPRO instruction does not allow values to be substituted into variable symbols before the record is punched.

Notes:

1. The identification and sequence numbers generated as part of other object deck records is not generated for records punched by the REPRO instruction.
2. If the NODECK and NOOBJECT assembler options are specified, no records are punched for the REPRO instruction, or for the object deck of the assembly.
3. Since the text of the line following a REPRO statement is not validated or changed in any way, it can contain double-byte data, but this data is not validated.

RMODE Instruction

The RMODE instruction specifies the residence mode to be associated with control sections in the object deck.



name

is the name field that associates the residence mode with a control section. If there is a symbol in the name field, it must also appear in the name field of a START, CSECT, RSECT, or COM instruction in this assembly. If the name field is blank, there must be an unnamed control section in this assembly. If the name field contains a sequence symbol (see “Symbols” on page 28 for details), it is treated as a blank name field.

- 24** specifies that a residence mode of 24 is to be associated with the control section; that is, the control section must be resident below 16 megabytes.

RMODE Instruction

31 specifies that a residence mode of either 24 or 31 is to be associated with the control section; that is, the control section can be resident above or below 16 megabytes.

64 Specifies that a residence mode of 64 is to be associated with the control section (see “64-bit Addressing Mode” on page 88).

ANY

is understood to mean RMODE 31.

Any field of this instruction may be generated by a macro, or by substitution in open code.

Notes:

1. RMODE can be specified anywhere in the assembly. It does not initiate an unnamed control section.
2. An assembly can have multiple RMODE instructions; however, two RMODE instructions cannot have the same name field.
3. The valid and invalid combinations of AMODE and RMODE are shown in the following table. Note that combinations involving AMODE 64 and RMODE 64 are subject to the support outlined in “64-bit Addressing Mode” on page 88.

Figure 56. AMODE/RMODE Combinations

	RMODE 24	RMODE 31	RMODE 64
AMODE 24	OK	invalid	invalid
AMODE 31	OK	OK	invalid
AMODE ANYIANY31	OK	OK	invalid
AMODE 64	OK	OK	OK

4. AMODE or RMODE cannot be specified for an unnamed *common* control section.

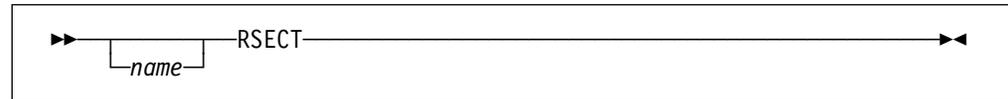
5. The defaults used when zero or one MODE is specified are shown in the following table. Note that combinations involving AMODE 64 and RMODE 64 are subject to the support outlined in “64-bit Addressing Mode” on page 88.

Figure 57. AMODE/RMODE Defaults

Specified	Default
Neither	AMODE 24,RMODE 24
AMODE 24	RMODE 24
AMODE 31	RMODE 24
AMODE ANYIANY31	RMODE 24
RMODE 24	AMODE 24
RMODE 31 (was ANY)	AMODE 31
AMODE 64	RMODE 31
RMODE 64	AMODE 64

RSECT Instruction

The RSECT instruction initiates a read-only executable control section or indicates the continuation of a read-only executable control section.



name

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

When an executable control section is initiated by the RSECT instruction, the assembler automatically checks the control section for possible coding violations of program reenterability, regardless of the setting of the RENT assembler option. As the assembler cannot check program logic, the checking is not exhaustive. Non-reentrant code is diagnosed by a warning message.

The RSECT instruction can be used anywhere in a source module after the ICTL instruction. If it is used to initiate the first executable control section, it must not be preceded by any instruction that affects the location counter and thereby cause the first control section to be initiated.

If *name* denotes an ordinary symbol, the ordinary symbol identifies the control section. If several RSECT instructions within a source module have the same symbol in the name field, the first occurrence initiates the control section and the rest indicate the continuation of the control section. The ordinary symbol denoted by *name* represents the address of the first byte in the control section, and has a length attribute value of 1.

If *name* is not specified, or if *name* is a sequence symbol, the RSECT instruction initiates or indicates the continuation of the unnamed control section.

See “CSECT Instruction” on page 108 for a discussion on the interaction between RSECT and the GOFF assembler option.

The beginning of a control section is aligned on a doubleword boundary. However, when an interrupted control section is continued using the RSECT instruction, the location counter last specified in that control section is continued.

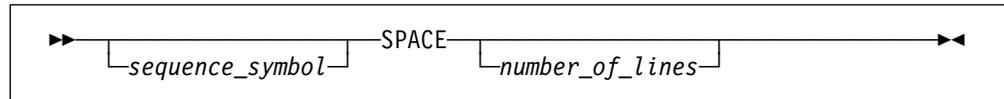
The source statements following a RSECT instruction that either initiate or indicate the continuation of a control section are assembled into the object code of the control section identified by that RSECT instruction.

Notes:

1. The assembler indicates that a control section is read-only by setting the read-only attribute in the object module.
2. The end of a control section or portion of a control section is marked by (a) any instruction that defines a new or continued control section, or (b) the END instruction.

SPACE Instruction

The SPACE instruction inserts one or more blank lines in the listing of a source module. This separates sections of code on the listing page.



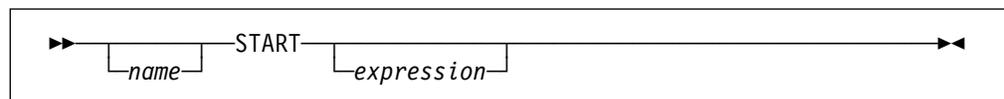
sequence_symbol
is a sequence symbol.

number_of_lines
is an absolute value that specifies the number of lines to be left blank. You may use any absolute expression to specify *number_of_lines*. If *number_of_lines* is omitted, one line is left blank. If *number_of_lines* has a value greater than the number of lines remaining on the listing page, the instruction has the same effect as an EJECT statement.

The SPACE statement itself is not printed in the listing unless a variable symbol is specified as a point of substitution in the statement, in which case the statement is printed before substitution occurs.

START Instruction

The START instruction can be used to initiate the first or only control section of a source module, and optionally to set an initial location counter value.



name
is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol
- A sequence symbol

expression
is an absolute expression, the value of which the assembler uses to set the location counter to an initial value for the source module.

Any symbols referenced in *expression* must have been previously defined.

The START instruction must be the first instruction of the first executable control section of a source module. It must not be preceded by any instruction that affects the location counter, and thereby causes the first control section to be initiated.

Use the START instruction to initiate the first or only control section of a source module, because it:

- Determines exactly where the first control section is to begin, thus avoiding the accidental initiation of the first control section by some other instruction.
- Gives a symbolic name to the first control section, which can then be distinguished from the other control sections listed in the external symbol dictionary.
- Specifies the initial setting of the location counter for the first or only control section.

If *name* denotes an ordinary symbol, the ordinary symbol identifies the first control section. It must be used in the name field of any CSECT instruction that indicates the continuation of the first control section. The ordinary symbol denoted by *name* represents the address of the first byte in the control section, and has a length attribute value of 1.

If *name* is not specified, or if *name* is a sequence symbol, the START instruction initiates an unnamed control section.

The assembler uses the value *expression* in the operand field, if specified, to set the location counter to an initial value for the source module. All control sections are aligned on a doubleword boundary. Therefore, if the value specified in *expression* is not divisible by 8, the assembler sets the initial value of the location counter to the next higher doubleword boundary. If *expression* is omitted, the assembler sets the initial value to 0.

The source statements that follow the START instruction are assembled into the first control section. If a CSECT instruction indicates the continuation of the first control section, the source statements that follow this CSECT instruction are also assembled into the first control section.

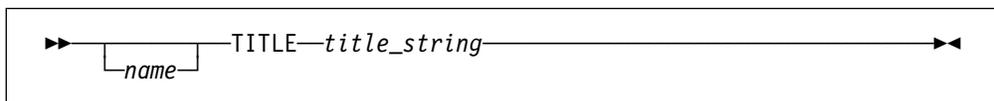
Any instruction that defines a new or continued control section marks the end of the preceding control section. The END instruction marks the end of the control section in effect.

TITLE Instruction

The TITLE instruction:

- Provides headings for each page of the *source and object* section of the assembler listing. If the first statement in your source program is an ICTL instruction or a *PROCESS statement then the title is not printed on the first page of the *Source and Object* section, because each of these instructions must precede all other instructions.
- Identifies the assembly output records of your object modules. You can specify up to 8 identification characters that the assembler includes as a *deck ID* in all object records, beginning at byte 73. If the deck ID is less than 8 characters, the assembler puts sequence numbers in the remaining bytes up to byte 80.

TITLE Instruction



name

You can specify *name* only once in the source module. It is one of the following:

- A string of printable characters
- A variable symbol that has been assigned a string of printable characters
- A combination of the above
- A sequence symbol

Except when the *name* is a sequence symbol, the assembler uses the first 8 characters you specify, and discards the remaining characters without warning.

title_string

is a string of 1 to 100 characters enclosed in single quotation marks

If two or more TITLE instructions are together, the title provided by the last instruction is printed as the heading.

Deck ID in Object Records

When you specify the *name*, and it is not a sequence symbol, it has a special significance. The assembler uses the *name* value to generate the *deck ID* in object records. The deck ID is placed in the object records starting at byte 73. It is not generated for records produced by the PUNCH and REPRO instructions. The *name* value does not need to be on the first TITLE instruction.

The *name* value is not defined as a symbol, so it can be used in the name entry of any other statement in the same source module, provided it is a valid ordinary symbol.

GOFF Assembler Option (MVS and CMS): When you specify the GOFF assembler option the deck ID is not generated.

Printing the Heading

The character string denoted by *title_string* is printed as a heading at the top of each page of the *source and object* section of the assembler listing. The heading is printed beginning on the page in the listing that follows the page on which the TITLE instruction is specified. A new heading is printed each time a new TITLE instruction occurs in the source module. If the TITLE instruction is the first instruction in the source module the heading is printed on the first page of the listing.

When a TITLE instruction immediately follows an EJECT instruction, the assembler changes the title but does not perform an additional page-eject.

Printing the TITLE Statement

The TITLE statement is printed in the listing when you specify a variable symbol in the *name*, or in the *title_string*, in which case the statement is printed before substitution occurs.

Sample Program Using the TITLE Instruction

The following example shows three TITLE instructions:

```
PGM1      TITLE 'The First Heading'
PGM1      CSECT
          USING PGM1,12          Assign the base register
          TITLE 'The Next Heading'
          LR 12,15              Load the base address
&VARSYM SETC 'Value from Variable Symbol'
          TITLE 'The &VARSYM'
          BR 14                  Return
          END
```

After the program is assembled, the characters PGM1 are placed in bytes 73 to 76 of all object records, and the heading appears at the top of each page in the listing as shown in Figure 58. The TITLE instruction at statement 7 is printed because it contains a variable symbol.

```
PGM1      The First Heading                                     Page 3
Active Usings: None
Loc Object Code Addr1 Addr2 Stmt Source Statement          HLASM R4.0 2000/09/25 17.48
000000          R:C 00000 00004 2 PGM1 CSECT              LRM00020
          R:C 00000          3          USING PGM1,12      Assign the base register
PGM1      The Next Heading                                     Page 4
Active Usings: PGM1(X'I000'),R12
Loc Object Code Addr1 Addr2 Stmt Source Statement          HLASM R4.0 2000/09/25 17.48
000000 18CF          5          LR 12,15                Load the base address
          6 &VARSYM SETC 'Value from Variable Symbol'
          7          TITLE 'The &VARSYM'
PGM1      The Value from Variable Symbol                       Page 5
Active Usings: PGM1(X'I000'),R12
Loc Object Code Addr1 Addr2 Stmt Source Statement          HLASM R4.0 2000/09/25 17.48
000002 07FE          8          BR 14                  Return
          9          END                                  LRM00090
```

Figure 58. Sample Program Using TITLE Instruction

Page Ejects

Each inline TITLE statement causes the listing to be advanced to a new page before the heading is printed unless it is preceded immediately by one of the following:

- A CEJECT instruction
- An EJECT instruction
- A SPACE instruction that positions the current print line at the start of a new page
- A TITLE instruction

If the TITLE statement appears in a macro or contains a variable symbol *and* PRINT NOGEN is specified, the listing is not advanced to a new page.

Valid Characters

Any printable character specified appears in the heading, including blanks. Double-byte data can be used when the DBCS assembler option is specified. The double-byte data must be valid. Variable symbols are allowed. However, the following rules apply to ampersands and single quotation marks:

- The DBCS ampersand and single quotation mark are not recognized as delimiters.
- A double-byte character that contains the value of an EBCDIC ampersand or single quotation mark in either byte is not recognized as a delimiter when enclosed by SO and SI.
- A single ampersand initiates an attempt to identify a variable symbol and to substitute its current value.
- A pair of ampersands is printed as one ampersand.
- A pair of single quotation marks is printed as one single quotation mark.
- An unpaired single quotation mark followed by one or more blanks simply ends the string of characters printed. If a nonblank character follows an unpaired single quotation mark, the assembler issues an error message and prints no heading.

Only the characters printed in the heading count toward the maximum of 100 characters allowed. If the count of characters to be printed exceeds 100, the heading that is printed is truncated and error diagnostic message

```
ASMA062E Illegal operand format  
is issued.
```

USING Instruction

The USING instruction specifies a base address and range and assigns one or more base registers. If you also load the base register with the base address, you have established addressability in a control section.

To use the USING instruction correctly, you should know:

- Which locations in a control section are made addressable by the USING instruction
- Where in a source module you can use implicit addresses in instruction operands to refer to these addressable locations

Base Address: The term *base address* is used throughout this manual to mean the location counter value within a control section from which the assembler can compute displacements to locations, or *addresses*, within the control section. Don't confuse this with the storage address of a control section when it is loaded into storage at execution time.

The USING instruction has three formats:

- The first format specifies a base address, an optional range, and one or more base registers. This format of the USING instruction is called an *ordinary USING instruction*, and is described under "Ordinary USING Instruction" on page 196.

- The second format specifies a base address, an optional range, one or more base registers, and a USING label which may be used as a symbol qualifier. This format of the USING instruction is called a *labeled USING instruction*, and is described under “Labeled USING Instruction” on page 199.
- The third format specifies a base address, an optional range, and a relocatable expression instead of one or more base registers. This format of a USING instruction is called a *dependent USING instruction*, and is described under “Dependent USING Instruction” on page 202. If a USING label is also specified, this format of the USING instruction is called a *labeled dependent USING instruction*.

Note: The assembler identifies and warns about statements where the implied alignment of an operand does not match the requirements of the instruction. However, if the base for a USING is not aligned on the required boundary, the assembler cannot diagnose a problem. For example:

```

DS1      DSECT
          DS    H
CHAR8    DS    CL8           Halfword alignment
DS2      DSECT
DOUBLEWD DS    CL8           Doubleword alignment
          CSECT
          ...
          USING DS1,R1       Ordinary USING
          USING DS2,CHAR8    Dependent USING
          CVD  R2,CHAR8      CHAR8 is not a double word
          CVD  R2,DOUBLEWD   but DOUBLEWD is implicitly aligned
    
```

The first CVD instruction is diagnosed as an alignment error. The second CVD instruction is not, even though the same storage location is implied by the code.

You must take care to ensure base addresses match the alignment requirements of storage mapped by a USING. For a description of the alignment requirements of instructions, see the relevant *Principles of Operation*.

How to Use the USING Instruction

Specify the USING instruction so that:

- All the required implicit addresses in each control section lie within a USING range.
- All the references for these addresses lie within the corresponding USING domain.

You could, therefore, place all ordinary USING instructions at the beginning of the control section and specify a base address in each USING instruction that lies at the beginning of each control section.

For Executable Control Sections: To establish the addressability of an executable control section defined by a START or CSECT instruction, specify a base address and assign a base register in the USING instruction. At execution time, the base register must be loaded with the correct base address.

If a control section is longer than 4096 bytes, you must assign more than one base register. This establishes the addressability of the entire control section with one USING instruction.

For Reference Control Sections: A dummy section is a reference control section defined by the DSECT instructions. To establish the addressability of a dummy section, specify the address of the first byte of the dummy section as the base address, so that all its addresses lie within the pertinent USING range. The address you load into the base register must be the address of the storage area being described by the dummy section.

The assembler assumes that you are referring to the symbolic addresses of the dummy section, and it computes displacements accordingly. However, at execution time, the assembled addresses refer to the location of real data in the storage area.

Base Registers for Absolute Addresses

Absolute addresses used in a source module must also be made addressable. Absolute addresses require a base register other than the base register assigned to relocatable addresses (as described above).

However, the assembler does not need a USING instruction to convert absolute implicit addresses in the range 0 through 4095 to their explicit form. The assembler uses register 0 as a base register. Displacements are computed from the base address 0, because the assembler assumes that a base or index of 0 implies that a zero quantity is to be used in forming the address, regardless of the contents of register 0. The USING domain for this automatic base register assignment is the entire source module.

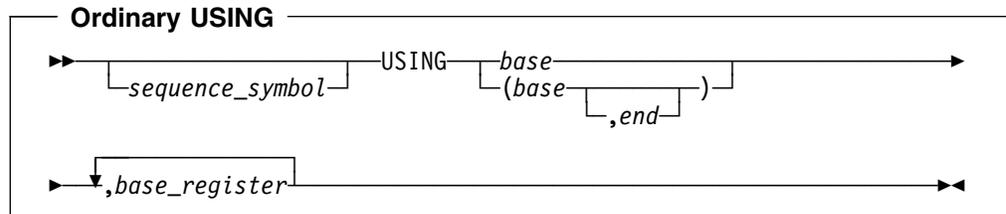
For absolute implicit addresses greater than 4095, a USING instruction must be specified according to the following:

- With a base address representing an absolute expression
- With a base register that has not been assigned by a USING instruction in which a relocatable base address is specified

This base register must be loaded with the base address specified.

Ordinary USING Instruction

The ordinary USING instruction format specifies a base address and one or more base registers.



sequence_symbol
is a sequence symbol.

base
specifies a base address, which can be a relocatable or an absolute expression. The value of the expression must lie between 0 and $2^{31}-1$.

end

specifies the end address, which can be a relocatable or an absolute expression. The value of the expression must lie between 0 and $2^{31}-1$. The end address may exceed the (base address + default range) without error. The *end* address must be greater than the *base* and must have the same relocatability attributes.

base_register

is an absolute expression whose value represents general registers 0 through 15.

The default range is 4096 per base register.

The assembler assumes that the base register denoted by the first *base_register* operand contains the base address *base* at execution time. If present, the subsequent *base_register* operands represent registers that the assembler assumes contain the address values *base*+4096, *base*+8192, and so forth.

For example:

```
USING      BASE,9,10,11
```

has the logical equivalent of:

```
USING      BASE,9
USING      BASE+4096,10
USING      BASE+8192,11
```

In another example, the following statement:

```
USING      *,12,13
```

tells the assembler to assume that the current value of the location counter is in general register 12 at execution time, and that the current value of the location counter, incremented by 4096, is in general register 13 at execution time.

Computing Displacement: If you change the value in a base register being used, and want the assembler to compute displacement from this value, you must tell the assembler the new value by means of another USING statement. In the following sequence, the assembler first assumes that the value of ALPHA is in register 9. The second statement then causes the assembler to assume that ALPHA+1000 is the value in register 9.

```
USING      ALPHA,9
.
.
USING      ALPHA+1000,9
```

Using General Register Zero: You can refer to the first 4096 bytes of storage using general register 0, subject to the following conditions:

- The value of operand *base* must be either absolute or relocatable zero or simply relocatable.
- Register 0 must be specified as the first *base_register* operand.

The assembler assumes that register 0 contains zero. Therefore, regardless of the value of operand *base*, it calculates displacements as if operand *base* were

absolute or relocatable zero. The assembler also assumes that subsequent registers specified in the same USING statement contain 4096, 8192, etc.

If register 0 is used as a base register, the referenced control section (or dummy section) is not relocatable, despite the fact that operand *base* may be relocatable. The control section can be made relocatable by:

- Replacing register 0 in the USING statement
- Loading the new register with a relocatable value
- Reassembling the program

Range of an Ordinary USING Instruction

The range of an ordinary USING instruction (called the ordinary USING range, or simply the USING range) is the 4096 bytes beginning at the base address specified in the USING instruction, or the range as specified by the range end, whichever is the lesser. Addresses that lie within the USING range can be converted from their implicit to their explicit form using the designated base registers; those outside the USING range cannot be converted.

The USING range does not depend upon the position of the USING instruction in the source module; rather, it depends upon the location of the base address specified in the USING instruction.

The USING range is the range of addresses in a control section that is associated with the base register specified in the USING instruction. If the USING instruction assigns more than one base register, the composite USING range is the sum of the USING ranges that would apply if the base registers were specified in separate USING instructions.

Two USING ranges coincide when the same base address is specified in two different USING instructions, even though the base registers used are different. When two USING ranges coincide, the assembler uses the higher-numbered register for assembling the addresses within the common USING range. In effect, the domain of the USING instruction that specifies the lower-numbered register is ended by the other USING instruction. If the domain of the USING instruction that specifies the higher-number register is subsequently terminated, the domain of the other USING instruction is resumed.

Two USING ranges overlap when the base address of one USING instruction lies within the range of another USING instruction. You can use the WARN suboption of the USING assembler option to find out if you have any overlapping USING ranges. When an overlap occurs the assembler issues a diagnostic message. However, the assembler does allow an overlap of one byte in USING ranges so that you don't receive a diagnostic message if you code the following statements:

```
@PSTART  CSECT
          LR      R12,R15
          LA      R11,4095(,R12)
          USING   @PSTART,R12
          USING   @PSTART+4095,R11
```

In the above example, the second USING instruction begins the base address of the second base register (R11) in the 4096th byte of the first base register (R12) USING range. If you don't want the USING ranges to overlap, you can code the following statements:

```
@PSTART CSECT
      LR      R12,R15
      LA      R11,4095(,R12)
      LA      R11,1(,R11)
      USING  @PSTART,R12
      USING  @PSTART+4096,R11
```

When two ranges overlap, the assembler computes displacements from the base address that gives the smallest displacement; it uses the corresponding base register when it assembles the addresses within the range overlap. This applies only to implicit addresses that appear after the second USING instruction.

Domain of an Ordinary USING Instruction

The domain of an ordinary USING instruction (called the *ordinary USING domain*, or simply the *USING domain*) begins where the USING instruction appears in a source module. It continues until the end of a source module, except when:

- A subsequent DROP instruction specifies the same base register or registers assigned by the preceding USING instruction.
- A subsequent USING instruction specifies the same register or registers assigned by the preceding USING instruction.

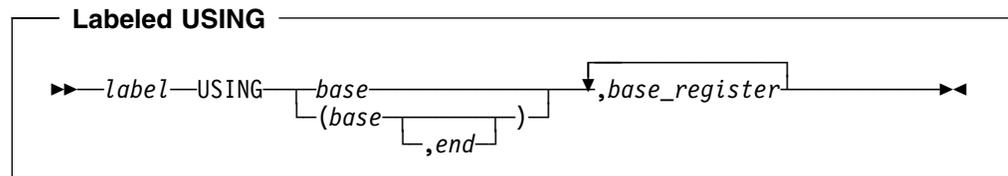
The assembler converts implicit address references into their explicit form when the following conditions are met:

- The address reference appears in the domain of a USING instruction.
- The addresses referred to lie within the range of the same USING instruction.

The assembler does not convert address references that are outside the USING domain. The USING domain depends on the position of the USING instruction in the source module after conditional assembly, if any, has been done.

Labeled USING Instruction

The labeled USING instruction specifies a base address, one or more base registers, and a USING label which can be used as a symbol qualifier.



label

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

base

specifies a base address, which can be a relocatable or an absolute expression. The value of the expression must lie between 0 and $2^{31}-1$.

USING Instruction

end

specifies the end address, which can be a relocatable or an absolute expression. The value of the expression must lie between 0 and $2^{31}-1$. The end address may exceed the (base address + default range) without error. The *end* address must be greater than the *base* and must have the same relocatability attributes.

base_register

is an absolute expression whose value represents general registers 0 through 15.

The default range is 4096 per base register.

The essential difference between a labeled USING instruction and an ordinary USING instruction is the label placed on the USING statement. You can use the label to direct the assembler to use only this USING by qualifying any relevant symbols with the label. Qualifying a symbol consists of preceding the symbol with the label on the USING followed by a period. This label cannot be used for any other purpose in the program, except possibly as a label on other USING instructions.

The following examples show how labeled USINGs are used:

```
PRIOR    USING  IHADCB,R10
NEXT     USING  IHADCB,R2
        MVC    PRIOR.DCBLRECL,NEXT.DCBLRECL
```

The same code without labeled USINGs could be written like this:

```
        USING  IHADCB,R10
        MVC    DCBLRECL,DCBLRECL-IHADCB(R2)
```

In the following example, a new element, NEW, is inserted into a doubly-linked list between two existing elements LEFT and RIGHT, where the links are stored as pointers LPTR and RPTR:

```
LEFT     USING  ELEMENT,R3
RIGHT    USING  ELEMENT,R6
NEW      USING  ELEMENT,R1
        .
        .
        MVC    NEW.RPTR,LEFT.RPTR    Move previous Right pointer
        MVC    NEW.LPTR,RIGHT.LPTR   Move previous Left pointer
        ST     R1,LEFT.RPTR          Chain new element from Left
        ST     R1,RIGHT.LPTR         Chain new element from Right
        .
        .
ELEMENT  DSECT
LPTR     DS     A                    Link to left element
RPTR     DS     A                    Link to right element
        .
        .
```

Range of a Labeled USING Instruction

The range of a labeled USING instruction (called the *labeled USING range*) is the 4096 bytes beginning at the base address specified in the labeled USING instruction, or the range as specified by the range end, whichever is the lesser. Addresses that lie within the labeled USING range can be converted from their implicit form (qualified symbols) to their explicit form; those outside the USING range cannot be converted.

Like the ordinary USING range, the labeled USING range is the range of addresses in a control section that is associated with the base register specified in the labeled USING instruction. If the labeled USING instruction assigns more than one base register, the composite labeled USING range is the product of the number of registers specified in the labeled USING instruction and 4096 bytes. The composite labeled USING range begins at the base address specified in the labeled USING instruction. Unlike the ordinary USING range, however, you cannot specify separate labeled USING instructions to establish the same labeled USING range.

You can specify the same base address in any number of labeled USING instructions. You can also specify the same base address in an ordinary USING and a labeled USING. However, unlike ordinary USING instructions that have the same base address, if you specify the same base address in an ordinary USING instruction and a labeled USING instruction, High Level Assembler does not treat the USING ranges as coinciding. When you specify an unqualified symbol in an assembler instruction, the base register specified in the ordinary USING is used by the assembler to resolve the address into base-displacement form. An example of coexistent ordinary USINGS and labeled USINGS is given below:

```

                USING  IHADCB,R10
SAMPLE USING  IHADCB,R2
                MVC   DCBLRECL,SAMPLE.DCBLRECL

```

In this MVC instruction, the (unqualified) first operand is resolved with the ordinary USING, and the (qualified) second operand is resolved with the labeled USING.

Domain of a Labeled USING Instruction

The domain of a labeled USING instruction (called the *labeled USING domain*) begins where the USING instruction appears in a source module. It continues to the end of the source module, except when:

- A subsequent DROP instruction specifies the label used in the preceding labeled USING instruction.
- A subsequent USING instruction specifies the same label used in the preceding labeled USING instruction. The second specification of the label causes the assembler to end the domain of the prior USING with the same label.

You can specify the same base register or registers in any number of labeled USING instructions. However, unlike ordinary USING instructions, as long as all the labeled USINGS have unique labels, the assembler considers the domains of all the labeled USINGS to be active and their labels eligible to be used as symbol qualifiers. With ordinary USINGS, when you specify the same base register in a subsequent USING instruction, the domain of the prior USING is ended.

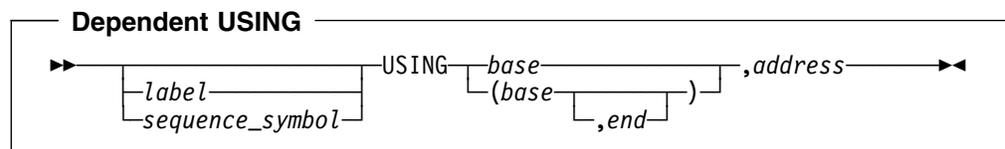
USING Instruction

The assembler converts implicit address references into their explicit form using the base register or registers specified in a labeled USING instruction when the following conditions are met:

- The address reference appears in the domain of the labeled USING instruction.
- The address reference takes the form of a qualified symbol and the qualifier is the label of the labeled USING instruction.
- The addresses lie within the range of the same labeled USING instruction.

Dependent USING Instruction

The dependent USING instruction format specifies a base address and a relocatable expression instead of one or more base registers. If a USING label is also specified, this format USING instruction is called a *labeled dependent USING* instruction.



label

is one of the following:

- An ordinary symbol
- A variable symbol that has been assigned a character string with a value that is valid for an ordinary symbol

sequence_symbol

is a sequence symbol.

base

specifies a base address, which must be a relocatable expression. The value of the expression must lie between 0 and $2^{31}-1$.

address

is a simply relocatable expression that represents an implicit address within the range of an active USING instruction.

end

specifies the end address, which can be a relocatable or an absolute expression. The value of the expression must lie between 0 and $2^{31}-1$. The end address may exceed the (base address + default range) without error. The *end* address must be greater than the *base* and must have the same relocatability attributes.

The implicit address denoted by *address* specifies the address where *base* is to be based, and is known as the *supporting base address*. As *address* is a relocatable expression, it distinguishes a dependent USING from an ordinary USING. The assembler converts the implicit address denoted by *address* into its explicit base-displacement form. It then assigns the base register from this explicit address as the base register for *base*. The assembler assumes that the base register contains the base address *base* minus the displacement determined in the explicit address. The assembler also assumes that *address* is appropriately aligned for the

code based on *base*. Warnings are not issued for potential alignment problems in the dependent USING *address*.

A dependent USING depends on the presence of one or more corresponding labeled or ordinary USINGs being in effect to resolve the symbolic expressions in the range of the dependent USING.

The following example shows the use of an unlabeled dependent USING:

```

EXAMPLE  CSECT
          USING  EXAMPLE,R10,R11                Ordinary USING
          .
          .
          USING  IHADCB,DCBUT2                 Unlabeled dependent USING
          LH     R0,DCBBLKSI                   Uses R10 or R11 for BASE
          .
          .
DCBUT2   DCB    DDNAME=SYSUT2,...
    
```

The following example shows the use of two labeled dependent USINGs:

```

EXAMPLE  CSECT
          USING  EXAMPLE,R10,R11                Ordinary USING
          .
          .
DCB1     USING  IHADCB,DCBUT1                 Labeled dependent USING
DCB2     USING  IHADCB,DCBUT2                 Labeled dependent USING
          MVC   DCB2.DCBBLKSI,DCB1.DCBBLKSI   Uses R10 or R11 for BASE
          .
          .
DCBUT1   DCB    DDNAME=SYSUT1,...
DCBUT2   DCB    DDNAME=SYSUT2,...
    
```

Range of a Dependent USING Instruction

The range of a dependent USING instruction (called the dependent USING range) is either the range as specified by the range end, or the range of the corresponding USING minus the offset of *address* within that range, whichever is the lesser. If the corresponding labeled or ordinary USING assigns more than one base register, the maximum dependent USING range is the composite USING range of the labeled or ordinary USING.

If the dependent USING instruction specifies a supporting base address that is within the range of more than one ordinary USING, the assembler determines which base register to use during base-displacement resolution as follows:

- The assembler computes displacements from the ordinary USING base address that gives the smallest displacement, and uses the corresponding base register.
- If more than one ordinary USING gives the smallest displacement, the assembler uses the higher-numbered register for assembling addresses within the coinciding USING ranges.

Domain of a Dependent USING Instruction

The domain of a dependent USING instruction (called the dependent USING domain) begins where the dependent USING appears in the source module and continues until the end of the source module, except when:

- You end the domain of the corresponding ordinary USING by specifying the base register or registers from the ordinary USING instruction in a subsequent DROP instruction.
- You end the domain of the corresponding ordinary USING by specifying the same base register or registers from the ordinary USING instruction in a subsequent ordinary USING instruction.
- You end the domain of a labeled dependent USING by specifying the label of the labeled dependent USING in the operand of a subsequent DROP instruction.
- You end the domain of a labeled dependent USING by specifying the label of the labeled dependent USING in the operand of a subsequent labeled USING instruction.

When a labeled dependent USING domain is dropped, none of any subordinate USING domains are dropped. In the following example the labeled dependent USING BLBL1 is not dropped, even though it appears to be dependent on the USING ALBL2 that is being dropped:

```

ALBL1    USING      DSECTA,14
         USING      DSECTA,14
         USING      DSECTB,ALBL1.A
         .
         .
ALBL2    USING      DSECTA,ALBL1.A
         .
BLBL1    USING      DSECTA,ALBL2.A
         .
         DROP      ALBL2
         .
DSECTA   DSECT
A        DS          A
DSECTB   DSECT
B        DS          A
    
```

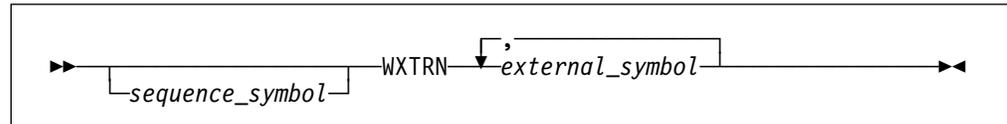
A dependent USING is *not* dependent on another dependent USING. It *is* dependent on the ordinary or labeled USING that is finally used to resolve the address. For example, the USING at BLBL1 is dependent on the ALBL1 USING.

WXTRN Instruction

The WXTRN statement identifies “weak external” symbols referred to in a source module but defined in another source module. The WXTRN instruction differs from the EXTRN instruction as follows:

- The EXTRN instruction causes the linker to automatically search libraries (if automatic library call is in effect) to find the module that contains the external symbols that you identify in its operand field. If the module is found, linkage addresses are resolved; the module is then linked to your module, which contains the EXTRN instruction.

- The WXTRN instruction suppresses automatic search of libraries. The linker only resolves the linkage addresses if the external symbols that you identify in the WXTRN operand field are defined:
 - In a module that is linked and loaded along with the object module assembled from your source module, or
 - In a module brought in from a library because of the presence of an EXTRN instruction in another module linked and loaded with yours.



sequence_symbol
is a sequence symbol.

external_symbol
is a relocatable symbol that is not:

- Used as the name entry of a source statement in the source module in which it is defined
- Paired in an expression

The external symbols identified by a WXTRN instruction have the same properties as the external symbols identified by the EXTRN instruction. However, the type code assigned to these external symbols differs.

V-Type Address Constant: If a symbol, specified in a V-type address constant, is also identified by a WXTRN instruction, it is assigned the same ESD type code as the symbol in the WXTRN instruction, and is treated by the linkage editor as a *weak external* symbol.

If an external symbol is identified by both an EXTRN and WXTRN instruction in the same source module, the first declaration takes precedence, and subsequent declarations are flagged with warning messages.

XATTR Instruction (MVS and CMS)

The XATTR instruction enables attributes to be assigned to an external symbol. This instruction is only valid when you specify the GOFF assembler option.



name
is a symbol which has been declared implicitly or explicitly as an external symbol. Further, if the PSECT attribute is specified, must be a RSECT, CSECT or START name or an ENTRY name (where the entry is in one of the preceding types of section)

XATTR Instruction

attribute

is one or more attributes from the group of attributes described below. The assembler sets the appropriate attribute flags in the GOFF External Symbol Directory record.

Notes:

1. If more than one value is specified for a given attribute, no diagnostic is issued and only the last value is used.
2. All attributes of an external symbol must be specified in a single XATTR statement (which may be continued).

ATTRIBUTES

▶▶ ATTRIBUTES (—*label*—) ▶▶

ATTRIBUTES(*label*), abbreviation ATTR(*label*)

is a symbol (internal or external) known in the declaring program. It names the location of the extended attribute information to be associated with *name*.

Instructs the assembler to place the ESDID and offset of the label in the GOFF External Symbol Dictionary record.

LINKAGE

▶▶ LINKAGE (—^{OS}XPLINK—) ▶▶

LINKAGE(OS), abbreviation LINK(OS)

Instructs the assembler not to set the “Linkage Type” attribute.

LINKAGE(XPLINK), abbreviation LINK(XPLINK)

Instructs the assembler to set the “Linkage Type” attribute to indicate the “Extra Performance Linkage” attribute.

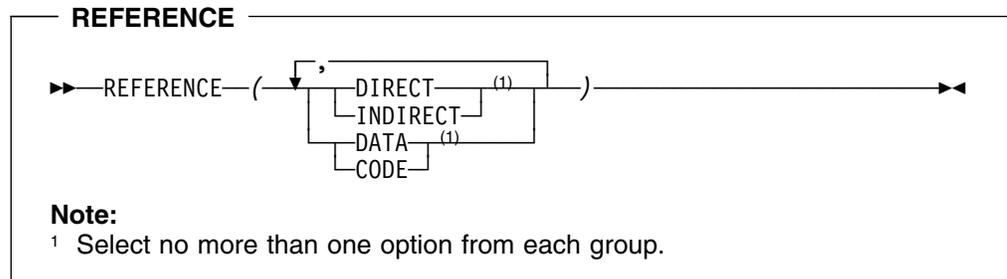
PSECT

▶▶ PSECT (—*name*—) ▶▶

PSECT (*name*)

Identifies the PSECT associated with *name* by its being an internal or external symbol belonging to an element in the class to which the PSECT belongs. It is one of:

- an ENTRY name, where the entry is in the same section (CSECT or RSECT) as *name*, but in a *different* class. For reentrant code, the PSECT is normally a non-shared class, so a separate CATTR statement is needed to declare that class and its attributes.
- an internal label within the PSECT.



REFERENCE(DIRECT), abbreviation REF(DIRECT)

Instructs the assembler to reset (clear) the “Indirect Reference” attribute.

REFERENCE(INDIRECT), abbreviation REF(INDIRECT)

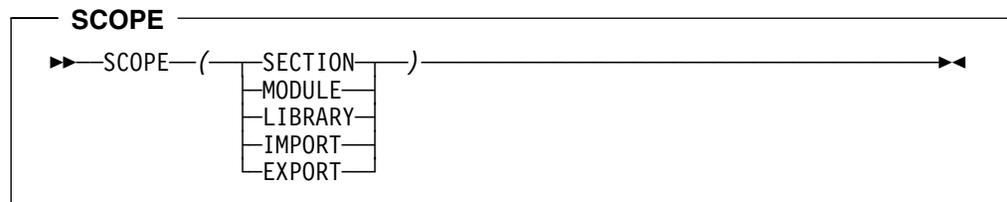
Instructs the assembler to assign the “Indirect Reference” attribute.

REFERENCE(CODE), abbreviation REF(CODE)

Instructs the assembler to set the Executable attribute.

REFERENCE(DATA), abbreviation REF(DATA)

Instructs the assembler to set the Not Executable attribute.



SCOPE(SECTION), abbreviation SCOPE(S)

Instructs the assembler to set the binding scope to “Section.”

SCOPE(MODULE), abbreviation SCOPE(M)

Instructs the assembler to set the binding scope to “Module.”

SCOPE(LIBRARY), abbreviation SCOPE(L)

Instructs the assembler to set the binding scope to “Library.”

SCOPE(IMPORT), abbreviation SCOPE(X)

Instructs the assembler to set the binding scope to “Export-Import.”

SCOPE(EXPORT), abbreviation SCOPE(X)

Instructs the assembler to set the binding scope to “Export-Import.”

XATTR Instruction

Part 3. Macro Language

Chapter 6. Introduction to Macro Language	212
Using Macros	212
Macro Definition	212
Model Statements	213
Processing Statements	214
Comment Statements	214
Macro Instruction	215
Source and Library Macro Definitions	215
Macro Library	216
System Macro Instructions	216
Conditional Assembly Language	216
Chapter 7. How to Specify Macro Definitions	217
Where to Define a Macro in a Source Module	217
Format of a Macro Definition	218
Macro Definition Header and Trailer	218
MACRO Statement	218
MEND Statement	219
Macro Instruction Prototype	219
Body of a Macro Definition	221
Model Statements	221
Variable Symbols as Points of Substitution	222
Listing of Generated Fields	222
Rules for Concatenation	223
Rules for Model Statement Fields	225
Symbolic Parameters	227
Positional Parameters	228
Keyword Parameters	229
Combining Positional and Keyword Parameters	229
Subscripted Symbolic Parameters	229
Processing Statements	229
Conditional Assembly Instructions	229
Inner Macro Instructions	230
AEJECT Instruction	230
AINsert Instruction	231
AREAD Instruction	231
ASPACE Instruction	233
COPY Instruction	234
MEXIT Instruction	234
Comment Statements	235
Ordinary Comment Statements	235
Internal Macro Comment Statements	235
System Variable Symbols	235
Scope and Variability of System Variable Symbols	236
&SYSADATA_DSN System Variable Symbol	237
&SYSADATA_MEMBER System Variable Symbol	238
&SYSADATA_VOLUME System Variable Symbol	238
&SYSASM System Variable Symbol	239
&SYSCLOCK System Variable Symbol	239
&SYSDATC System Variable Symbol	240

Part 3. Macro Language

&SYSDATE System Variable Symbol	240
&SYSECT System Variable Symbol	241
&SYSIN_DSN System Variable Symbol	243
&SYSIN_MEMBER System Variable Symbol	244
&SYSIN_VOLUME System Variable Symbol	245
&SYSJOB System Variable Symbol	245
&SYSLIB_DSN System Variable Symbol	246
&SYSLIB_MEMBER System Variable Symbol	246
&SYSLIB_VOLUME System Variable Symbol	247
&SYSLIN_DSN System Variable Symbol	247
&SYSLIN_MEMBER System Variable Symbol	249
&SYSLIN_VOLUME System Variable Symbol	249
&SYSLIST System Variable Symbol	250
&SYSLOC System Variable Symbol	252
&SYSMAC System Variable Symbol	253
&SYSM_HSEV System Variable Symbol	253
&SYSM_SEV System Variable Symbol	253
&SYSNDX System Variable Symbol	254
&SYSNEST System Variable Symbol	257
&SYSOPT_DBCS System Variable Symbol	258
&SYSOPT_OPTABLE System Variable Symbol	258
&SYSOPT_RENT System Variable Symbol	258
&SYSOPT_XOBJECT System Variable Symbol	259
&SYSPARM System Variable Symbol	259
&SYSPRINT_DSN System Variable Symbol	260
&SYSPRINT_MEMBER System Variable Symbol	261
&SYSPRINT_VOLUME System Variable Symbol	261
&SYSPUNCH_DSN System Variable Symbol	262
&SYSPUNCH_MEMBER System Variable Symbol	263
&SYSPUNCH_VOLUME System Variable Symbol	264
&SYSSEQF System Variable Symbol	264
&SYSSTEP System Variable Symbol	265
&SYSSTMT System Variable Symbol	265
&SYSSTYP System Variable Symbol	266
&SYSTEM_ID System Variable Symbol	266
&SYSTEM_DSN System Variable Symbol	267
&SYSTEM_MEMBER System Variable Symbol	268
&SYSTEM_VOLUME System Variable Symbol	268
&SYSTIME System Variable Symbol	269
&SYSVER System Variable Symbol	270
Chapter 8. How to Write Macro Instructions	271
Macro Instruction Format	271
Alternative Ways of Coding a Macro Instruction	272
Name Entry	273
Operation Entry	273
Operand Entry	274
Sublists in Operands	278
Values in Operands	281
Omitted Operands	281
Unquoted Operands	282
Special Characters	282
Nesting Macro Instruction Definitions	285
Inner and Outer Macro Instructions	286

Levels of Macro Call Nesting	286
General Rules and Restrictions	286
Passing Values through Nesting Levels	287
System Variable Symbols in Nested Macros	289
Chapter 9. How to Write Conditional Assembly Instructions	291
SET Symbols	292
Subscripted SET Symbols	292
Scope of SET Symbols	292
Scope of Symbolic Parameters	292
SET Symbol Specifications	293
Subscripted SET Symbols Specifications	295
Created SET Symbols	296
Data Attributes	296
Combining Attributes with Symbols	299
Type Attribute (T')	300
Length Attribute (L')	304
Scaling Attribute (S')	305
Integer Attribute (I')	306
Count Attribute (K')	306
Number Attribute (N')	307
Defined Attribute (D')	308
Operation Code Attribute (O')	308
Sequence Symbols	310
Lookahead	311
Open Code	313
Conditional Assembly Instructions	314
Declaring SET Symbols	314
GBLA, GBLB, and GBLC Instructions	315
LCLA, LCLB, and LCLC Instructions	316
Assigning Values to SET Symbols	318
SETA Instruction	318
SETB Instruction	328
SETC Instruction	333
Extended SET Statements	341
SETAF Instruction	342
SETCF Instruction	343
Substring Notation	344
Branching	346
AIF Instruction	346
AGO Instruction	349
ACTR Instruction	350
ANOP Instruction	351
Chapter 10. MHELP Instruction	353

Chapter 6. Introduction to Macro Language

This chapter introduces the basic macro concept: what you can use the macro facility for, how you can prepare your own macro definitions, and how you call these macro definitions for processing by the assembler.

Macro language is an extension of assembler language. It provides a convenient way to generate a sequence of assembler language statements many times in one or more programs. A macro definition is written only once; thereafter, a single statement, a macro instruction statement, is written each time you want to generate the sequence of statements. This simplifies the coding of programs, reduces the chance of programming errors, and ensures that standard sequences of statements are used to accomplish the functions you want.

In addition, conditional assembly lets you code statements that may or may not be assembled, depending upon conditions evaluated at assembly time. These conditions are usually tests of values which may be defined, set, changed, and tested during assembly. Conditional assembly statements can be used within macro definitions or in open code.

Using Macros

The main use of macros is to insert assembler language statements into a source program.

You call a named sequence of statements (the *macro definition*) by using a macro instruction, or *macro call*. The assembler replaces the macro call by the statements from the macro definition and inserts them into the source module at the point of call. The process of inserting the text of the macro definition is called *macro generation* or macro expansion. Macro generation occurs during conditional assembly.

The expanded stream of code then becomes the input for processing at assembly time; that is, the time at which the assembler translates the machine instructions into object code.

Macro Definition

A macro definition is a named sequence of statements you can call with a macro instruction. When it is called, the assembler processes and usually generates assembler language statements from the definition into the source module. The statements generated can be:

- Copied directly from the definition
- Modified by parameter values and other values in variable symbols before generation
- Manipulated by internal macro processing to change the sequence in which they are generated

You can define your own macro definitions in which any combination of these three processes can occur. Some macro definitions, like some of those used for system

generation, do not generate assembler language statements, but do only internal processing.

A macro definition provides the assembler with:

- The name of the macro
- The parameters used in the macro
- The sequence of statements the assembler generates when the macro instruction appears in the source program.

Every macro definition consists of a macro definition header statement (MACRO), a macro instruction prototype statement, one or more assembler language statements, and a macro definition trailer statement (MEND), as shown in Figure 59.

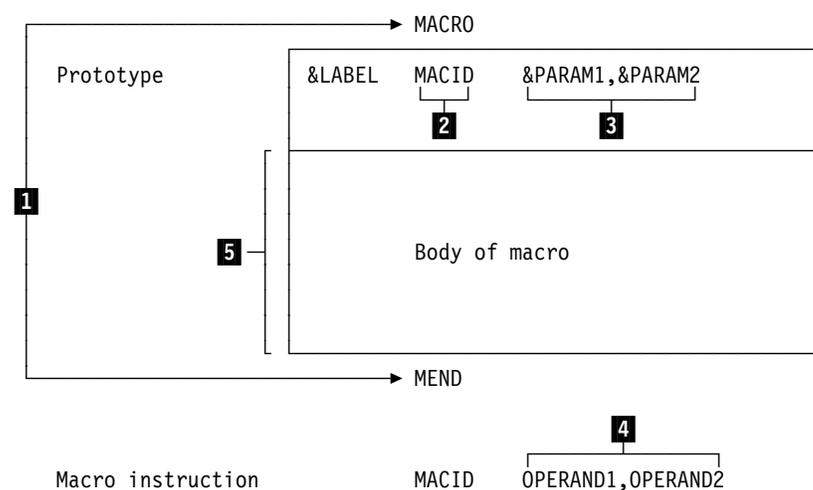


Figure 59. Parts of a Macro Definition

- The macro definition header and trailer statements (MACRO and MEND) indicate to the assembler the beginning and end of a macro definition (see **1** in Figure 59).
- The macro instruction prototype statement names the macro (see **2** in Figure 59), and declares its parameters (see **3** in Figure 59). In the operand field of the macro instruction, you can assign values (see **4** in Figure 59) to the parameters declared for the called macro definition.
- The body of a macro definition (see **5** in Figure 59) contains the statements that are generated when you call the macro. These statements are called *model statements*; they are usually interspersed with conditional assembly statements or other processing statements.

Model Statements

You can write machine instruction statements and assembler instruction statements as model statements. During macro generation, the assembler copies them exactly as they are written. You can also use variable symbols as points of substitution in a model statement. The assembler enters values in place of these points of substitution each time the macro is called.

Introduction to Macro Language

The three types of variable symbols in the assembler language are:

- Symbolic parameters, declared in the prototype statement
- System variable symbols
- SET symbols, which are part of the conditional assembly language

The assembler processes the generated statements, with or without value substitution, at assembly time.

Processing Statements

Processing statements are processed during conditional assembly, when macros are expanded, but they are not themselves generated for further processing at assembly time. The processing statements are:

- AEJECT instructions
- AREAD instructions
- ASPACE instructions
- Conditional assembly instructions
- Inner macro calls
- MEXIT instructions
- MNOTE instructions

The AEJECT and ASPACE instructions let you control the listing of your macro definition. Use the AEJECT instruction to stop printing the listing on the current page and continue printing on the next. Use the ASPACE instruction to insert blank lines in the listing. The AEJECT instruction is described on page 230. The ASPACE instruction is described on page 233.

The AREAD instruction assigns a character string value, of a statement that is placed immediately after a macro instruction, to a SETC symbol. The AREAD instruction is described on page 231.

Conditional assembly instructions, inner macro calls, and macro processing instructions are described in detail in the following chapters.

The MNOTE instruction generates an error message with an error condition code attached, or generates comments in which you can display the results of a conditional assembly computation. The MNOTE instruction is described on page 174.

The MEND statement delimits the contents of a macro definition, and also provides an exit from the definition. The MEND instruction is described on page 219.

The MEXIT instruction tells the assembler to stop processing a macro definition, and provides an exit from the macro definition at a point before the MEND statement. The MEXIT instruction is described on page 234.

Comment Statements

One type of comment statement describes conditional assembly operations and is not generated. The other type describes assembly-time operations and is, therefore, generated. For a description of the two types of comment statements, see “Comment Statements” on page 235.

Macro Instruction

A macro instruction is a source program statement that you code to tell the assembler to process a particular macro definition. The assembler generates a sequence of assembler language statements for each occurrence of the same macro instruction. The generated statements are then processed as any other assembler language statement.

The macro instruction provides the assembler with:

- The name of the macro definition to be processed.
- The information or values to be passed to the macro definition. The assembler uses the information either in processing the macro definition or for substituting values into a model statement in the definition.

The output from a macro definition, called by a macro instruction, can be:

- A sequence of statements generated from the model statements of the macro for further processing at assembly time.
- Values assigned to global SET symbols. These values can be used in other macro definitions and in open code.

You can call a macro definition by specifying a macro instruction anywhere in a source module. You can also call a macro definition from within another macro definition. This type of call is an inner macro call; it is said to be nested in the macro definition.

Source and Library Macro Definitions

You can include a macro definition in a source module. This type of definition is called a *source macro definition*, or, sometimes, an *in-line macro definition*.

You can also insert a macro definition into a system or user library by using the applicable utility program. This type of definition is called a *library macro definition*. The IBM-supplied macro definitions are examples of library macro definitions.

You can call a source macro definition only from the source module in which it is included. You can call a library macro definition from any source module if the library containing the macro definition is available to the assembler.

Syntax errors in processing statements are handled differently for source macro definitions and library macro definitions. In source macro definitions, error messages are listed following the statements in error. In library macros, however, error messages cannot be associated with the statement in error, because the statements in library macro definitions are not included in the assembly listing. Therefore, the error messages are listed directly following the first call of that macro.

Because of the difficulty of finding syntax errors in library macros, a macro definition should be run and “debugged” as a source macro before it is placed in a macro library. Alternatively, you can use the LIBMAC assembler option to have the assembler automatically include the source statements of the library macro in your source module. For more information about the LIBMAC option, see the *HLASM Programmer's Guide*.

Macro Library

The same macro definition may be made available to more than one source program by placing the macro definition in the macro library. The macro library is a collection of macro definitions that can be used by all the assembler language programs in an installation. When a macro definition has been placed in the macro library, it can be called by coding its corresponding macro instruction in a source program. Macro definitions must be in a macro library with a member name that is the same as the macro name. The procedure for placing macro definitions in the macro library is described in the applicable utilities manual.

The DOS/VSE assembler requires library macro definitions to be placed in the macro library in a special edited format. High Level Assembler does not require this. Library macro definitions must be placed in the macro library in source statement format. If you wish to use edited macros in VSE you can provide a LIBRARY exit to read the edited macros and convert them into source statement format. A library exit is supplied with VSE and is described in *VSE/ESA Guide to System Functions*.

System Macro Instructions

The macro instructions that correspond to macro definitions prepared by IBM are called *system macro instructions*. System macro instructions are described in the applicable operating system manuals that describe macro instructions for supervisor services and data management.

Conditional Assembly Language

The conditional assembly language is a programming language with most of the features that characterize a programming language. For example, it provides:

- Variables
- Data attributes
- Expression computation
- Assignment instructions
- Labels for branching
- Branching instructions
- Substring operators that select characters from a string

Use the conditional assembly language in a macro definition to receive input from a calling macro instruction. You can produce output from the conditional assembly language by using the MNOTE instruction.

Use the functions of the conditional assembly language to select statements for generation, to determine their order of generation, and to do computations that affect the content of the generated statements.

The conditional assembly language is described in Chapter 9, “How to Write Conditional Assembly Instructions” on page 291.

Chapter 7. How to Specify Macro Definitions

A *macro definition* is a set of statements that defines the name, the format, and the conditions for generating a sequence of assembler language statements. The macro definition can then be called by a macro instruction to process the statements. See page 215 for a description of the macro instruction. To define a macro you must:

- Give it a name
- Declare any parameters to be used
- Write the statements it contains
- Establish its boundaries with a macro definition header statement (MACRO) and a macro definition trailer statement (MEND)

Except for conditional assembly instructions, this chapter describes all the statements that can be used to specify macro definitions. Conditional assembly instructions are described in Chapter 9, “How to Write Conditional Assembly Instructions” on page 291.

Where to Define a Macro in a Source Module

Macro definitions can appear anywhere in a source module. They remain in effect for the rest of your source module, or until another macro definition defining a macro with the same operation code is encountered, or until an OPSYN statement deletes its definition. Thus, you can redefine a macro at any point in your program. The new definition is used for all subsequent calls to the macro in the program.

This type of macro definition is called a *source macro definition*, or, sometimes, an *in-line macro definition*. A macro definition can also reside in a system library; this type of macro is called a *library macro definition*. Either type can be called from the source module by the applicable macro instruction.

Macro definitions can also appear inside other macro definitions. There is no limit to the levels of macro definitions permitted.

The assembler does not process inner macro definitions until it finds the definition during the processing of a macro instruction calling the outer macro. The following example shows an inner macro definition:

Example:

	MACRO		Macro header for outer macro
	OUTER	&A,&C=	Macro prototype
	AIF	('&C' EQ '').A	
	MACRO		Macro header for inner macro
	INNER		Macro prototype
	.		
	.		
	MEND		Macro trailer for inner macro
.A	ANOP		
	.		
	MEND		Macro trailer for outer macro

MACRO and MEND Statements

The assembler does not process the macro definition for INNER until OUTER is called with a value for &C other than a null string.

Open Code: Open code is that part of a source module that lies outside of any source macro definition. At coding time, it is important to distinguish between source statements that lie in open code, and those that lie inside macro definitions.

Format of a Macro Definition

The general format of a macro definition is shown in Figure 60. The four parts are described in detail in the following sections.

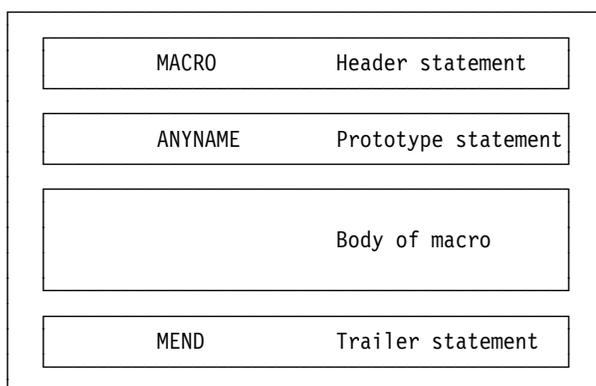


Figure 60. Format of a Macro Definition

Macro Definition Header and Trailer

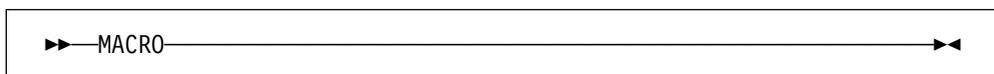
You must establish the boundaries of a macro definition by coding:

- A macro definition header statement as the first statement of the macro definition (a MACRO statement)
- A macro definition trailer statement as the last statement of the macro definition (a MEND statement)

The instructions used to define the boundaries of a macro instruction are described in the following sections.

MACRO Statement

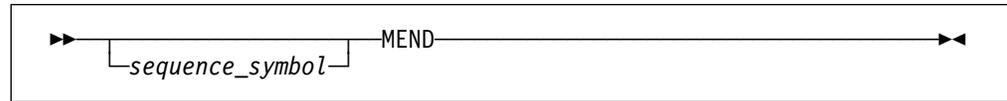
Use the MACRO statement to indicate the beginning of a macro definition. It must be the first non-comment statement in every macro definition. Library macro definitions may have ordinary or internal macro comments before the MACRO statement.



The MACRO statement must not have a name entry or an operand entry.

MEND Statement

Use the MEND statement to indicate the end of a macro definition. It also provides an exit when it is processed during macro expansion. It can appear only once within a macro definition and must be the last statement in every macro definition.



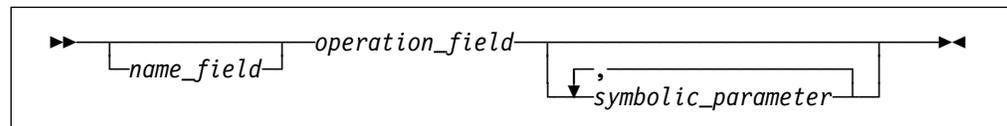
sequence_symbol
is a sequence symbol.

See “MEXIT Instruction” on page 234 for details on exiting from a macro before the MEND statement.

Macro Instruction Prototype

The macro instruction prototype statement (hereafter called the prototype statement) specifies the mnemonic operation code and the format of all macro instructions that you use to call the macro definition.

The prototype statement must be the second non-comment statement in every macro definition. Both ordinary comment statements and internal comment statements are allowed between the macro definition header and the macro prototype. Such comment statements are listed only with the macro definition.



name_field
is a variable symbol.

You can write a name field parameter, similar to the symbolic parameter, as the name entry of a macro prototype statement. You can then assign a value to this parameter from the name entry in the calling macro instruction.

If this parameter also appears in the body of a macro, it is given the value assigned to the parameter in the name field of the corresponding macro instruction.

operation_field
is an ordinary symbol.

The symbol in the operation field of the prototype statement establishes the name by which a macro definition must be called. This name becomes the operation code required in any macro instruction that calls the macro.

Any operation code can be specified in the prototype operation field. If the entry is the same as an assembler or a machine operation code, the new definition overrides the previous use of the symbol. The same is true if the specified operation code has been defined earlier in the program as a macro, or is the operation code of a library macro.

Prototype Statement

Macros that are defined inline may use any ordinary symbol, up to 63 characters in length, for the operation field. However, operating system rules may prevent some of these macros from being stored as member names.

The assembler requires that the library member name and macro name be the same; otherwise error diagnostic message ASMA126S Library macro name incorrect is issued.

symbolic_parameter

The symbolic parameters are used in the macro definition to represent the operands of the corresponding macro instruction. A description of symbolic parameters appears under “Symbolic Parameters” on page 227.

The operand field in a prototype statement lets you specify positional or keyword parameters. These parameters represent the values you can pass from the calling macro instruction to the statements within the body of a macro definition.

The operand field of the macro prototype statement must contain 0 to 32000 symbolic parameters separated by commas. They can be positional parameters or keyword parameters, or both.

If no parameters are specified in the operand field and if the absence of the operand entry is indicated by a comma preceded and followed by one or more blanks, remarks are allowed.

The following is an example of a prototype statement:

```
&NAME    MOVE                &TO,&FROM
```

Alternative Ways of Coding the Prototype Statement

The prototype statement can be specified in one of the following three ways:

- The normal way, with all the symbolic parameters preceding any remarks
- An alternative way, allowing remarks for each parameter
- A combination of the first two ways

The following examples show the normal statement format (&NAME1), the alternative statement format (&NAME2), and a combination of both statement formats (&NAME3):

Name	Opera- tion	Operand	Comment	Cont.
&NAME1	OP1	&OPERAND1,&OPERAND2,&OPERAND3	This is the normal statement format	X
&NAME2	OP2	&OPERAND1, &OPERAND2	This is the alternative statement format	X
&NAME3	OP3	&OPERAND1, &OPERAND2,&OPERAND3, &OPERAND4	This is a combination of both	X X

Notes:

1. Any number of continuation lines is allowed. However, each continuation line must be indicated by a nonblank character in the column after the end column on the preceding line.
2. For each continuation line, the operand field entries (symbolic parameters) must begin in the continue column; otherwise, the whole line and any lines that follow are considered to contain remarks.

No error diagnostic message is issued to indicate that operands are treated as remarks in this situation. However, the FLAG(CONT) assembler option can be specified so that the assembler issues warning messages if it suspects an error in a continuation line.

3. The standard value for the continue column is 16, and, for the column after the end column, is 72.
4. A comma is required after each parameter except the last. If you code excess commas between parameters, they are considered null positional parameters. No error diagnostic message is issued.
5. One or more blanks is required between the operand and the remarks.
6. If the DBCS assembler option is specified, the continuation features outlined in “Continuation of double-byte data” on page 16 apply to continuation in the macro language. Extended continuation may be useful if a macro keyword parameter contains double-byte data.

Body of a Macro Definition

The body of a macro definition contains the sequence of statements that constitutes the working part of a macro. You can specify:

- Model statements to be generated
- Processing statements that, for example, can alter the content and sequence of the statements generated or issue error messages
- Comment statements, some that are generated and others that are not
- Conditional assembly instructions to compute results to be displayed in the message created by the MNOTE instruction, without causing any assembler language statements to be generated

The statements in the body of a macro definition must appear between the macro prototype statement and the MEND statement of the definition. The body of a macro definition can be empty, that is, contain no statements.

Nesting Macros: You can include macro definitions in the body of a macro definition.

Model Statements

Model statements are statements from which assembler language statements are generated during conditional assembly. They let you determine the form of the statements to be generated. By specifying variable symbols as points of substitution in a model statement, you can vary the contents of the statements

Model Statements

generated from that model statement. You can also substitute values into model statements in open code.

A model statement consists of one or more fields, separated by one or more blanks, in columns 1 to 71. The fields are called the name, operation, operand, and remarks fields.

Each field or subfield can consist of:

- An ordinary character string composed of alphanumeric and special characters
- A variable symbol as a point of substitution
- Any combination of ordinary character strings and variable symbols to form a concatenated string

The statements generated from model statements during conditional assembly must be valid machine or assembler instructions, but must not be conditional assembly instructions. They must follow the coding rules described in “Rules for Model Statement Fields” on page 225 or they are flagged as errors at assembly time.

Examples:

LABEL	L	3,AREA
LABEL2	L	3,20(4,5)
&LABEL	L	3,&AREA
FIELD&A	L	3,AREA&C

Variable Symbols as Points of Substitution

Values can be substituted for variable symbols that appear in the name, operation, and operand fields of model statements; thus, variable symbols represent points of substitution. The three main types of variable symbol are:

- Symbolic parameters (positional or keyword)
- System variable symbols (see “System Variable Symbols” on page 235)
- SET symbols (global or local SETA, SETB, or SETC symbols)

Examples:

```
&PARAM(3)
&SYSLIST(1,3)
&SYSLIST(2)
&SETA(10)
&SETC(15)
```

Symbols That Can Be Subscripted: Symbolic parameters, SET symbols, and the system variable symbol, &SYSLIST, can all be subscripted. All remaining system variable symbols contain only one value.

Listing of Generated Fields

The different fields in a macro-generated statement or a statement generated in open code appear in the listing in the same column as they are coded in the model statement, with the following exceptions:

- If the substituted value in the name or operation field is too large for the space available, the next field is moved to the right with one blank separating the fields.

- If the substituted value in the operand field causes the remarks field to be displaced, the remarks field is written on the next line, starting in the column where it is coded in the model statement.
- If the substituted value in the operation field of a macro-generated statement contains leading blanks, the blanks are ignored.
- If the substituted value in the operation field of a model statement in open code contains leading blanks, the blanks are used to move the field to the right.
- If the substituted value in the operand field contains leading blanks, the blanks are used to move the field to the right.
- If the substituted value contains trailing blanks, the blanks are ignored.

Listing of Generated Fields Containing Double-Byte Data: If the DBCS assembler option is specified, then the following differences apply:

- Any continuation indicators present in the model statement are discarded.
- Double-byte data that must be split at a continuation point is always readable on a device capable of presenting DBCS characters—SI and SO are inserted at the break point, and the break-point always occurs between double-byte characters.
- The continuation indicator is extended to the left, if necessary, to fill space that cannot be filled with double-byte data because of alignment and delimiter considerations. The maximum number of columns is 3.
- If continuation is required and the character to the left of the continuation indicator is X, then + is used as the continuation indicator so as to clearly distinguish the position of the end column. This applies to any generated field, regardless of its contents, to prevent ambiguity.
- Redundant SI/SO pairs may be present in a field after substitution. If they occur at a continuation point, the assembler does not distinguish them from SI and SO inserted by the assembler to preserve readability. Refer to the object code to resolve this ambiguity.

Rules for Concatenation

If a symbolic parameter in a model statement is immediately preceded or followed by other characters or another symbolic parameter, the characters that correspond to the symbolic parameter are combined in the generated statement with the other characters, or with the characters that correspond to the other symbolic parameter. This process is called *concatenation*.

When variable symbols are concatenated to ordinary character strings, the following rules apply to the use of the concatenation character (a period). The concatenation character is mandatory when:

- 1** An alphanumeric character follows a variable symbol.
- 2** A left parenthesis that does not enclose a subscript follows a variable symbol.
- 3**—**4** A period (.) is to be generated. Two periods must be specified in the concatenated string following a variable symbol.

The concatenation character is not required when:

Model Statements

- 5** An ordinary character string precedes a variable symbol.
- 6** A special character, except a left parenthesis or a period, is to follow a variable symbol.
- 7** A variable symbol follows another variable symbol.
- 8** A variable symbol is used with a subscript. The concatenation character must not be used between a variable symbol and its subscript; otherwise, the characters are considered a concatenated string and not a subscripted variable symbol.

Figure 61, in which the numbers correspond to the numbers in the above list, gives the rules for concatenating variable symbols to ordinary character strings.

Figure 61. Rules for Concatenation

Concatenated String	Values to be Substituted		Generated Result
	Variable Symbol	Value	
&FIELD.A 1 &FIELD A	&FIELD &FIELD A	AREA SUM	AREA A SUM
&DISP.(&BASE) ¹ ↑ ↑ 2 6	&DISP &BASE	100 10	100(10)
DC D'&INT..&FRACT' ¹ ↑ 3	&INT &FRACT	99 88	DC D'99.88' ↑ 4
DC D'&INT&FRACT' ↑ 7			DC D'9988'
FIELD&A 5	&A	A	FIELD A
&A+&B*3-D ↑ ↑ 6	&A &B	A B	A+B*3-D
&SYM(&SUBSCR) ↑ 8	&SUBSCR &SYM(10)	10 ENTRY	ENTRY

Notes:

1. The concatenation character is not generated.

Concatenation of Fields Containing Double-Byte Data: If the DBCS assembler option is specified, then the following additional rules apply:

- Because ampersand is not recognized in double-byte data, variable symbols must not be present in double-byte data.
- The concatenation character is mandatory when double-byte data is to follow a variable symbol.
- The assembler checks for redundant SI and SO at concatenation points. If the byte to the left of the join is SI and the byte to the right of the join is SO, then the SI/SO pair is considered redundant and is removed.

The following example shows these rules:

```
&SYMBOL SETC          '<DcDd>'
DBCS      DC          C'<DaDb>&SYMBOL.<.&.S.Y.M.B.O.L>'
```

The SI/SO pairs between double-byte characters Db and Dc, and Dd and .&, are removed. The variable symbol &SYMBOL is recognized *between* the double-byte strings but not *in* the double-byte strings. The result after concatenation is:

```
DBCS      DC          C'<DaDbDcDd.&.S.Y.M.B.O.L>'
```

Rules for Model Statement Fields

The fields that can be specified in model statements are the same fields that can be specified in an ordinary assembler language statement. They are the name, operation, operand, and remarks fields. You can also specify a continuation-indicator field, an identification-sequence field, and, in source macro definitions, a field before the begin column if the correct ICTL instruction has been specified. Character strings in the last three fields (in the standard format only, columns 72 through 80) are generated exactly as they appear in the model statement, and no values are substituted for variable symbols.

Model statements must have an entry in the operation field, and, in most cases, an entry in the operand field in order to generate valid assembler language instructions.

Name Field

The entries allowed in the name field of a model statement, before generation, are:

- Blank
- An ordinary symbol
- A sequence symbol
- A variable symbol
- Any combination of variable symbols, or system variable symbols such as &SYSNDX, and other character strings concatenated together

The generated result must be a blank (if valid) or a character string that represents a valid assembler or machine instruction name field. Double-byte data is not valid in an assembler or machine instruction name field and must not be generated.

Variable symbols must not be used to generate comment statement indicators (* or .*).

Notes:

1. You can not reference an ordinary symbol defined in the name field of a model statement until the macro definition containing the model statement has been called, and the model statement has been generated.
2. Restrictions on the name entry of assembler language instructions are further specified where each individual assembler language instruction is described in this manual.

Operation Field

The entries allowed in the operation field of a model statement, before generation, are given in the following list:

- An ordinary symbol that represents the operation code for:
 - Any machine instruction
 - A macro instruction
 - MNOTE instruction
 - A variable symbol
 - A combination of variable strings concatenated together
 - All assembler instructions, except ICTL and conditional assembly instructions

The following rules apply to the operation field of a model statement:

- Operation code ICTL is not allowed inside a macro definition.
- The MACRO and MEND statements are not allowed in model statements; they are used only for delimiting macro definitions.
- If the REPRO operation code is specified in a model statement, no substitution is done for the variable symbols in the statement line following the REPRO statement.
- Variable symbols can be used alone or as part of a concatenated string to generate operation codes for:
 - Any machine instruction
 - Any assembler instruction, except COPY, ICTL, ISEQ, REPRO, and MEXIT

The generated operation code must not be an operation code for the following (or their OPSYN equivalents):

- A conditional assembly instruction
- The following assembler instructions: COPY, ICTL, ISEQ, MACRO, MEND, MEXIT, and REPRO
- Double-byte data is not valid in the operation field.

Operand Field

The entries allowed in the operand field of a model statement, before generation, are:

- Blank (if valid)
- An ordinary symbol
- A character string, combining alphanumeric and special characters (but not variable symbols)

- A variable symbol
- A combination of variable symbols and other character strings concatenated together
- If the DBCS assembler option is specified, character strings may contain double-byte data, provided the character strings are enclosed by apostrophes.

The allowable results of generation are a blank (if valid) and a character string that represents a valid assembler or machine instruction operand field.

Variable Symbols: Variable symbols must not be used in the operand field of a ICTL, or ISEQ instruction. A variable symbol must not be used in the operand field of a COPY instruction that is inside a macro definition.

Remarks Field

The remarks field of a model statement can contain any combination of characters. No substitution is done for variable symbols appearing in the remarks field. Only generated statements are printed in the listing.

Using Blanks: One or more blanks must be used in a model statement to separate the name, operation, operand, and remarks fields from each other. Blanks cannot be generated between fields in order to create a complete assembler language statement. The exception to this rule is that a combined operand-remarks field can be generated with one or more blanks to separate the two fields.

Symbolic Parameters

Symbolic parameters let you pass values into the body of a macro definition from the calling macro instruction. You declare these parameters in the macro prototype statement. They can serve as points of substitution in the body of the macro definition and are replaced by the values assigned to them by the calling macro instruction.

By using symbolic parameters with meaningful names, you can indicate the purpose for which the parameters (or substituted values) are used.

Symbolic parameters must be valid variable symbols. A symbolic parameter consists of an ampersand followed by an alphabetic character and from 0 to 61 alphanumeric characters.

The following are valid symbolic parameters:

```
&READER    &LOOP2
&A23456    &N
&X4F2      &$4
```

The following are not valid symbolic parameters:

```
CARDAREA   first character is not an ampersand
&256B      first character after ampersand is not a letter
&BCD%34    contains a special character other than initial ampersand
&IN AREA   contains a special character [blank] other than initial ampersand
```

Symbolic parameters have a local scope; that is, the name and value they are assigned only applies to the macro definition in which they have been declared.

Positional Parameters

The value of the parameter remains constant throughout the processing of the containing macro definition during each call of that definition.

Notes:

1. Symbolic parameters must not have multiple definitions or be identical to any other variable symbols within the given local scope. This applies to the system variable symbols described in “System Variable Symbols” on page 235, and to local and global SET symbols described in “SET Symbols” on page 292.
2. Symbolic parameters should not begin with &SYS because these characters are used for system variable symbols provided with High Level Assembler.

The two kinds of symbolic parameters are:

- Positional parameters
- Keyword parameters

Each positional or keyword parameter used in the body of a macro definition must be declared in the prototype statement.

The following is an example of a macro definition with symbolic parameters.

	MACRO		Header
&NAME	MOVE	&TO,&FROM	Prototype
&NAME	ST	2,SAVE	Model
	L	2,&FROM	Model
	ST	2,&TO	Model
	L	2,SAVE	Model
	MEND		Trailer

In the following macro instruction that calls the above macro, the characters HERE, FIELD A, and FIELD B of the MOVE macro instruction correspond to the symbolic parameters &NAME, &TO, and &FROM, respectively, of the MOVE prototype statement.

```
HERE    MOVE          FIELD A, FIELD B
```

If the preceding macro instruction were used in a source program, the following assembler language statements would be generated:

```
HERE    ST            2,SAVE
        L            2,FIELD B
        ST          2,FIELD A
        L            2,SAVE
```

Positional Parameters

You should use a positional parameter in a macro definition if you want to change the value of the parameter each time you call the macro definition. This is because it is easier to supply the value for a positional parameter than for a keyword parameter. You only have to write the value you want the parameter to have in the correct position in the operand of the calling macro instruction. However, if you need a large number of parameters, you should use keyword parameters. The keywords make it easier to keep track of the individual values you must specify at each call by reminding you which parameters are being given values.

See “Positional Operands” on page 274 for details of how to write macro definitions with positional parameters.

Keyword Parameters

You should use a keyword parameter in a macro definition for a value that changes infrequently, or if you have a large number of parameters. The keyword, repeated in the operand, reminds you which parameter is being given a value and for which purpose the parameter is being used. By specifying a standard default value to be assigned to the keyword parameter, you can omit the corresponding keyword operand in the calling macro instruction. You can specify the corresponding keyword operands in any order in the calling macro instruction.

See “Keyword Operands” on page 275 for details of how to write macro definitions with keyword parameters.

Combining Positional and Keyword Parameters

By using positional and keyword parameters in a prototype statement, you combine the benefits of both. You can use positional parameters in a macro definition for passing values that change frequently, and keyword parameters for passing values that do not change often.

Positional and keyword parameters can be mixed freely in the macro prototype statement.

See “Combining Positional and Keyword Operands” on page 277 for details of how to write macro definitions using combined positional and keyword parameters.

Subscripted Symbolic Parameters

Subscripted symbolic parameters must be coded in the format:

```
&PARAM(subscript)
```

where &PARAM is a variable symbol and *subscript* is an arithmetic expression. The subscript can be any arithmetic expression allowed in the operand field of a SETA instruction (arithmetic expressions are discussed in “SETA Instruction” on page 318). The arithmetic expression can contain subscripted variable symbols. Subscripts can be nested to any level provided that the total length of an individual operand does not exceed 255 characters.

The value of the subscript must be greater than or equal to one. The subscript indicates the position of the entry in the sublist that is specified as the value of the subscripted parameter (sublists as values in macro instruction operands are fully described in “Sublists in Operands” on page 278).

Processing Statements

Conditional Assembly Instructions

Conditional assembly instructions let you determine at conditional assembly time the content of the generated statements and the sequence in which they are generated. The instructions and their functions are listed below:

Conditional Assembly	Operation Done
GBLA, GBLB, GBLC LCLA, LCLB, LCLC	Declaration of variable symbols (global and local SET symbols) and setting of default initial values

Inner Macro Instructions • AEJECT Instruction

Conditional Assembly	Operation Done
SETA, SETB, SETC	Assignment of values to variable symbols (SET symbols)
SETAF, SETCF	External function assignment of values to variable symbols (SET symbols)
ACTR	Setting loop counter
AGO	Unconditional branch
AIF	Conditional branch (based on logical test)
ANOP	Pass control to next sequential instruction (no operation)

Conditional assembly instructions can be used both inside macro definitions and in open code. They are described in Chapter 9, “How to Write Conditional Assembly Instructions.”

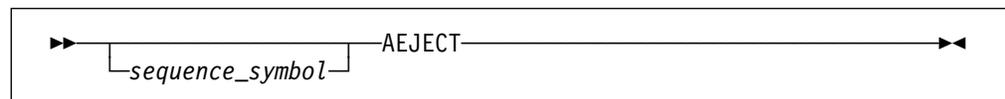
Inner Macro Instructions

Macro instructions can be nested inside macro definitions, allowing you to call other macros from within your own definition. The instructions and their functions are listed below:

Inner Macro Instruction	Operation Done
AEJECT	Skip to next page
AINsert	Insert statement into input stream
AREAD	Assign an arbitrary character string to a variable symbol (SETC symbol)
ASPACE	Insert one or more blank lines in listing
COPY	Copy the source statements from a source language library member.
MEXIT	Exit from the macro definition

AEJECT Instruction

Use the AEJECT instruction to stop the printing of the assembler listing of your macro definition on the current page, and continue the printing on the next page.



sequence_symbol
is a sequence symbol.

The AEJECT instruction causes the next line of the assembly listing of your macro definition to be printed at the top of a new page. If the line before the AEJECT statement appears at the bottom of a page, the AEJECT statement has no effect. An AEJECT instruction immediately following another AEJECT instruction causes a blank page in the listing of the macro definition.

Notes:

1. The AEJECT instruction can only be used inside a macro definition.
2. The AEJECT instruction itself is not printed in the listing.
3. The AEJECT instruction does not affect the listing of statements generated when the macro is called.

AINsert Instruction

The AINsert instruction, inside macro definitions, harnesses the power of macros to generate source statements, for instance, using variable substitution. Generated statements are queued in a special buffer and read after the macro generator finishes.

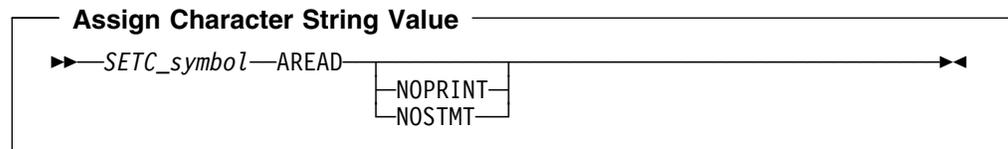
The specifications for the AINsert instruction, which can also be used in open code, are described in “AINsert Instruction” on page 94.

AREAD Instruction

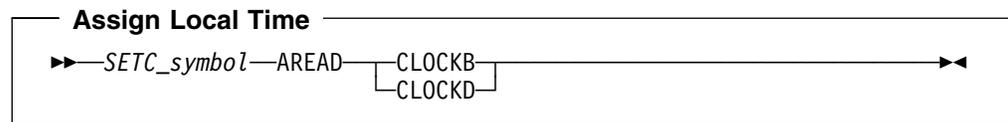
The AREAD instruction assigns an arbitrary character string value to a SETC symbol.

The AREAD instruction has two formats. The first format lets you assign to a SETC symbol the character string value of a statement that is placed immediately after a macro instruction.

The AREAD instruction can only be used inside macro definitions.



The second format of the AREAD instruction assigns to a SETC symbol a character string containing the local time.



SETC_symbol
is a SETC symbol. See “SETC Instruction” on page 333.

NOSTMT

specifies that the statement to be read by the AREAD instruction is printed in the assembly listing, but not given any statement number.

NOPRINT

specifies that the statement does not appear in the listing, and no statement number is assigned to it.

CLOCKB

assigns an 8-character string to *SETC_symbol* containing the local time in hundredths of a second since midnight.

CLOCKD

assigns an 8-character string to *SETC_symbol* containing the local time in the format *HHMMSSTH*, where *HH* is a value between 00 and 23, *MM* and *SS* each have a value between 00 and 59, and *TH* has a value between 00 and 99.

Assign Character String Value

The first format of AREAD functions in much the same way as symbolic parameters, but instead of providing your input to macro processing as part of the macro instruction, you add the values in the form of whole 80-character input records that follow immediately after the macro instruction. Any number of successive statements can be read into the macro for processing.

SETC_symbol may be subscripted. When the assembler encounters a Format-1 AREAD statement during the processing of a macro instruction, it reads the source statement following the macro instruction and assigns an 80-character string to the SETC symbol in the name field. In the case of nested macros, it reads the statement following the outermost macro instruction.

If no operand is specified, the statement to be read by AREAD is printed in the listing and assigned a statement number.

Repeated AREAD instruction statements read successive statements. In the following example, the input record starting with INRECORD1 is read by the first AREAD statement, and assigned to the SETC symbol &VAL. The input record starting with INRECORD2 is read by the second AREAD statement, and assigned to the SETC symbol &VAL1.

Example:

```
MACRO
MAC1
.
&VAL AREAD
.
&VAL1 AREAD
.
MEND
CSECT
.
MAC1
INRECORD1 THIS IS THE STATEMENT TO BE PROCESSED FIRST
INRECORD2 THIS IS THE NEXT STATEMENT
.
END
```

The records read by the AREAD instruction can be in code brought in with the COPY instruction, if the macro instruction appears in such code. If no more records exist in the code brought in by the COPY instruction, subsequent statements are read from the ordinary input stream.

Assign Local Time of Day

The second format of AREAD functions in much the same way as a SETC instruction, but instead of supplying the value you want assigned to the SETC symbol as a character string in the operand of the AREAD instruction, the value is provided by the operating system in the form of an 8-character string containing the local time. A Format-2 AREAD instruction does not cause the assembler to read the statement following the macro instruction.

Example:

```

        MACRO
        MAC2
        .
&VAL   AREAD CLOCKB
        DC   C'&VAL'
&VAL1  AREAD CLOCKD
        DC   C'&VAL1'
        .
        MEND
    
```

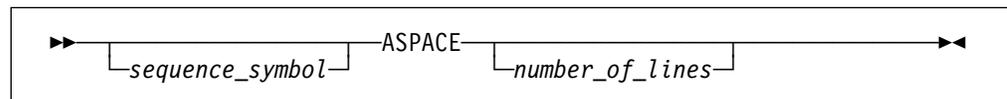
When the macro definition described above is called, the following statements are generated:

```

        MAC2
+       DC   C'03251400'
+       DC   C'09015400'
    
```

ASPACE Instruction

Use the ASPACE instruction to insert one or more blank lines in the listing of a macro definition in your source module. This separates sections of macro definition code on the listing page.



sequence_symbol
is a sequence symbol.

number_of_lines
is an absolute value that specifies the number of lines to be left blank. You may use any absolute expression to specify *number_of_lines*. If *number_of_lines* is omitted, one line is left blank. If *number_of_lines* has a value greater than the number of lines remaining on the listing page, the instruction has the same effect as an AEJECT statement.

Notes:

1. The ASPACE instruction can only be used inside a macro definition.
2. The ASPACE instruction itself is not printed in the listing.
3. The ASPACE instruction does not affect the listing of statements generated when the macro is called.

COPY Instruction

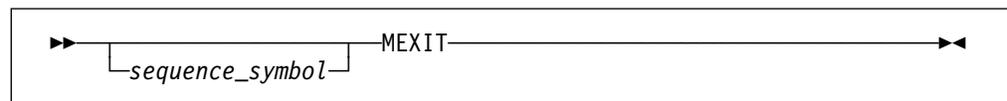
The COPY instruction, inside macro definitions, lets you copy into the macro definition any sequence of statements allowed in the body of a macro definition. These statements become part of the body of the macro before macro processing takes place. You can also use the COPY instruction to copy complete macro definitions into a source module.

The specifications for the COPY instruction, which can also be used in open code, are described in “COPY Instruction” on page 106.

MEXIT Instruction

The MEXIT instruction provides an exit for the assembler from any point in the body of a macro definition. The MEND instruction provides an exit only from the end of a macro definition (see “MEND Statement” on page 219 for details).

The MEXIT instruction statement can be used only inside macro definitions.



sequence_symbol
is a sequence symbol.

The MEXIT instruction causes the assembler to exit from a macro definition to the next sequential instruction after the macro instruction that calls the definition. (This also applies to nested macro instructions, which are described in “Nesting Macro Instruction Definitions” on page 285.)

For example, the following macro definition contains an MEXIT statement:

```
MACRO
EXITS
DC   C'A'
DC   C'B'
DC   C'C'
MEXIT
DC   C'D'
DC   C'E'
DC   C'F'
MEND
```

When the macro definition described above is called, the following statements are generated:

```
EXITS
+   DC   C'A'
+   DC   C'B'
+   DC   C'C'
```

Comment Statements

Two types of comment statements can be used within a macro definition:

- Ordinary comment statements
- Internal macro comment statements

Ordinary Comment Statements

Ordinary comment statements let you make descriptive remarks about the generated output from a macro definition. Ordinary comment statements can be used in macro definitions and in open code.

An ordinary comment statement consists of an asterisk in the begin column, followed by any character string. The comment statement is used by the assembler to generate an assembler language comment statement, just as other model statements are used by the assembler to generate assembler statements. No variable symbol substitution is done.

Internal Macro Comment Statements

You can also write internal macro comments in the body of a macro definition to describe the operations done during conditional assembly when the macro is processed.

An internal macro comment statement consists of a period in the begin column, followed by an asterisk, followed by any character string. No values are substituted for any variable symbols that are specified in internal macro comment statements.

Internal macro comment statements may appear anywhere in a macro definition.

Notes:

1. Internal macro comments are not generated.
2. The comment character string may contain double-byte data.
3. Internal macro comment statements can be used in open code, however, they are processed as *ordinary* comment statements.

System Variable Symbols

System variable symbols are a special class of variable symbols, starting with the characters &SYS. Their values are set by the assembler according to specific rules. You cannot declare them in local SET symbols or global SET symbols, nor use them as symbolic parameters in macro prototype statements. You can use these symbols as points of substitution in model statements and conditional assembly instructions.

All system variable symbols are subject to the same rules of concatenation and substitution as other variable symbols.

A description of each system variable symbols begins on page 237.

You should not prefix your SET symbols with the character sequence &SYS. The assembler uses this sequence as a prefix to all system variable symbol

System Variable Symbols

names, and using them for other SET symbol names might cause future conflicts.

Scope and Variability of System Variable Symbols

Global Scope: Some system variable symbols have values that are established at the beginning of an assembly and are available both in open code and from within macros. These symbols have global scope. Most system variable symbols with global scope have fixed values, although there are some whose value can change within a single macro expansion. The global system variables symbols with variable values are &SYSSTMT, &SYSM_HSEV, and &SYSM_SEV.

Local Scope: Some system variable symbols have values that are available only from within a macro expansion. These system variables have local scope. Since the value of system variable symbols with local scope is established at the beginning of a macro expansion and remains unchanged throughout the expansion, they are designated as having constant values, even though they might have different values in a later expansion of the same macro, or within inner macros.

Over half of the system variable symbols have local scope and therefore are not available in open code.

```
1      macro
2      getLocalSys
3 &n   seta n'&syslist          Save number of parameters
4 &i   seta 0                  Initalize loop counter
5 .loop anop
6 &i   seta &i+1              Increment loop counter
7 &lc  setc (lower '&syslist(&i)') Get next parm as lowercase
8 &lvar setc '&sysclock'      &Sysclock value when macro is called
9      aif ('&lc' eq 'sysclock').ainsert
10 &lvar setc '&sysloc'      Location counter when macro's called
11      aif ('&lc' eq 'sysloc').ainsert
12 &lvar setc '&sysin_dsn'    SYSIN at time the macro is called
13      aif ('&lc' eq 'sysin_dsn').ainsert
14      mnote 1,'&syslist(&i) is not a supported local system variable'
15      ago .chkloop
16 .ainsert ainsert '&&&syslist(&i) setc ''&lvar'' ',back
17 .chkloop aif (&i LT &n).loop   Loop if we have any parms left
18      mend                  else the macro's finished
000000      00000 0001A 19 R      CSECT
20      getLocalSys syslib_member,sysCLOCK,sysin_dsn,sysstyp
** ASMA254I *** MNOTE *** 21+      1,syslib_member is not a supported local system variable
22+      ainsert '&&&sysCLOCK setc ''2000-09-26 06:05:59.284223'' ',back
23+      ainsert '&&&sysin_dsn setc ''GETLOC2 ASSEMBLE A1'' ',back
** ASMA254I *** MNOTE *** 24+      1,sysstyp is not a supported local system variable
25>&sysCLOCK setc '2000-09-26 06:05:59.284223'
26>&sysin_dsn setc 'GETLOC2 ASSEMBLE A1'
000000 F1F9F9F860F0F860 27      DC C'&sysclock'
000000      +      DC C'2000-09-26 06:05:59.284223'
28      END R
```

Figure 62. Exposing the Value of a Local Scope Variable to Open Code

Uses, Values and Properties: System variable symbols have many uses, including:

- Helping to control conditional assemblies
- Capturing environmental data for inclusion in the generated object code
- Providing program debugging data

Refer to Appendix C, “Macro and Conditional Assembly Language Summary” on page 365 for a summary of the values and properties that can be assigned to system variable symbols.

&SYSADATA_DSN System Variable Symbol

Use &SYSADATA_DSN in a macro definition to obtain the name of the data set to which the assembler is writing the associated data.

The local system variable symbol &SYSADATA_DSN is assigned a read-only value each time a macro definition is called.

MVS When the assembler runs on the MVS/ESA operating systems, the value of the character string assigned to &SYSADATA_DSN is always the value stored in the JFCB for SYSADATA. If SYSADATA is allocated to DUMMY, or a NULLFILE, the value in &SYSADATA_DSN is NULLFILE.

For example, &SYSADATA_DSN might be assigned a value such as:

VCATR49.SYSADATA

MVS

CMS When the assembler runs on the CMS component of the VM/ESA operating systems, the value of the character string assigned to &SYSADATA_DSN is determined as follows:

Figure 63. Contents of &SYSADATA_DSN on CMS

SYSADATA Allocated To:	Contents of &SYSADATA_DSN:
CMS file	The 8-character filename, the 8-character filetype, and the 2-character filemode of the file, each separated by a blank
Dummy file (no physical I/O)	DUMMY
Labeled tape file	The data set name of the tape file
Unlabeled tape file	TAP n , where n is a value from 0 to 9, or A to F.

For example, &SYSADATA_DSN might be assigned a value such as:

SAMPLE SYSADATA A1

CMS

VSE The value of the character string assigned to &SYSADATA_DSN is the disk

For example, &SYSADATA_DSN might be assigned a value such as:

VCATR49.SYSADAT

VSE

Notes:

1. The value of the type attribute of &SYSADATA_DSN (T'&SYSADATA_DSN) is always U.
2. The value of the count attribute of &SYSADATA_DSN (K'&SYSADATA_DSN) is equal to the number of characters assigned as a value to &SYSADATA_DSN. In the CMS example above, the count attribute of &SYSADATA_DSN is 20.

&SYSADATA_MEMBER System Variable Symbol

VSE The value of &SYSADATA_MEMBER is always null. The value of the type attribute is O, and the value of the count attribute is 0. **VSE**

CMS, MVS You can use &SYSADATA_MEMBER in a macro definition to obtain the name of the data set member to which the assembler is writing the associated data.

The local system variable symbol &SYSADATA_MEMBER is assigned a read-only value each time a macro definition is called.

If the data set to which the assembler is writing the associated data is not an MVS partitioned data set, &SYSADATA_MEMBER is assigned a null character string.

CMS, MVS

Notes:

1. The value of the type attribute of &SYSADATA_MEMBER (T'&SYSADATA_MEMBER) is U, unless &SYSADATA_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
2. The value of the count attribute of &SYSADATA_MEMBER (K'&SYSADATA_MEMBER) is equal to the number of characters assigned as a value to &SYSADATA_MEMBER. If &SYSADATA_MEMBER is assigned a null character string, the value of the count attribute is 0.

&SYSADATA_VOLUME System Variable Symbol

Use &SYSADATA_VOLUME in a macro definition to obtain the volume identifier of the first volume containing the data set to which the assembler is writing the associated data.

The local system variable symbol &SYSADATA_VOLUME is assigned a read-only value each time a macro definition is called.

CMS If the assembler runs on the CMS component of the VM/ESA operating system, and the associated data is being written to a Shared File System CMS file, &SYSADATA_VOLUME is assigned the value ** SFS. **CMS**

If the volume on which the data set resides is not labeled, &SYSADATA_VOLUME is assigned a null character string.

Notes:

1. The value of the type attribute of &SYSADATA_VOLUME (T'&SYSADATA_VOLUME) is U, unless &SYSADATA_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
2. The value of the count attribute of &SYSADATA_VOLUME (K'&SYSADATA_VOLUME) is equal to the number of characters assigned as a value to &SYSADATA_VOLUME. If &SYSADATA_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.

&SYSASM System Variable Symbol

Use &SYSASM to obtain the name of the assembler being used to assemble your source module. &SYSASM has a global scope. For example, when IBM High Level Assembler for MVS & VM & VSE is used, &SYSASM has the value:

```
HIGH LEVEL ASSEMBLER
```

Notes:

1. The value of the type attribute of &SYSASM (T'&SYSASM) is always U.
2. The value of the count attribute (K'&SYSASM) is the number of characters assigned. In the above example, the count attribute of &SYSASM is 20.

&SYSCLOCK System Variable Symbol

Use &SYSCLOCK to obtain the TOD clock date and time at which the macro was generated.

The local system variable symbol &SYSCLOCK is assigned a read-only value each time a macro definition is called.

The value of &SYSCLOCK is a 26-character string in the format:

```
YYYY-MM-DD HH:MM:SS mmmmmm
```

where:

YYYY is a four-digit field that gives the year, including the century. It has a value between 0000 and 9999, inclusive.

MM is a two-digit field that gives the month of the year. It has a value between 01 and 12, inclusive.

DD is a two-digit field that gives the day of the month. It has a value between 01 and 31, inclusive.

HH is a two-digit field that gives the hour of the day. It has a value between 00 and 23, inclusive.

MM is a two-digit field that gives the minute of the hour. It has a value between 00 and 59, inclusive.

SS is a two-digit field that gives the second of the minute. It has a value between 00 and 59, inclusive.

mmmmmm is a six-digit field that gives the microseconds. It has a value between 000000 and 999999, inclusive.

&SYSDATC System Variable Symbol • &SYSDATE System Variable Symbol

Example:

2001-06-08 17:36:03 043284

Notes:

1. The value of the type attribute of &SYSCLOCK (T'&SYSCLOCK) is always U.
2. The value of the count attribute (K'&SYSCLOCK) is always 26.

&SYSDATC System Variable Symbol

Use &SYSDATC to obtain the date, including the century, on which your source module is assembled. &SYSDATC has a global scope.

The value of &SYSDATC is an 8-character string in the format:

YYYYMMDD

where:

YYYY is four-digit field that gives the year, including the century. It has a value between 0000 and 9999, inclusive.

MM is two-digit field that gives the month of the year. It has a value between 01 and 12, inclusive.

DD is two-digit field that gives the day of the month. It has a value between 01 and 31, inclusive.

Example:

20000328

Notes:

1. The date corresponds to the date printed in the page heading of listings and remains constant for each assembly.
2. The value of the type attribute of &SYSDATC (T'&SYSDATC) is always N.
3. The value of the count attribute (K'&SYSDATC) is always 8.

&SYSDATE System Variable Symbol

Use &SYSDATE to obtain the date, in standard format, on which your source module is assembled. &SYSDATE has a global scope.

The value of &SYSDATE is an 8-character string in the format:

MM/DD/YY

where:

MM is a two-digit field that gives the month of the year. It has a value between 01 and 12, inclusive.

DD is a two-digit field that gives the day of the month. It has a value between 01 and 31, inclusive. It is separated from *MM* by a slash.

YY is a two-digit field that gives the year of the century. It has a value between 00 and 99, inclusive. It is separated from *DD* by a slash.

Example:

09/25/00

Notes:

1. The date corresponds to the date printed in the page heading of listings and remains constant for each assembly.
2. The value of the type attribute of &SYSDATE (T'&SYSDATE) is always U.
3. The value of the count attribute (K'&SYSDATE) is always 8.

&SYSECT System Variable Symbol

Use &SYSECT in a macro definition to generate the name of the current control section. The current control section is the control section in which the macro instruction that calls the definition appears. You can't use &SYSECT in open code.

The local system variable symbol &SYSECT is assigned a read-only value each time a macro definition is called.

The value assigned is the symbol that represents the name of the current control section from which the macro definition is called. Note that it is the control section in effect when the macro is called. A control section that has been initiated or continued by substitution does not affect the value of &SYSECT for the expansion of the current macro. However, it does affect &SYSECT for a subsequent macro call. Nested macros cause the assembler to assign a value to &SYSECT that depends on the control section in force inside the outer macro when the inner macro is called.

Notes:

1. The control section whose name is assigned to &SYSECT can be defined by a program sectioning statement. This can be a START, CSECT, RSECT, DSECT, or COM statement.
2. The value of the type attribute of &SYSECT (T'&SYSECT) is always U.
3. The value of the count attribute (K'&SYSECT) is equal to the number of characters assigned as a value to &SYSECT.
4. Throughout the use of a macro definition, the value of &SYSECT is considered a constant, independent of any program sectioning statements or inner macro instructions in that definition.

The next example shows these rules:

&SYSECT System Variable Symbol

```

                MACRO
                INNER                &INCSECT
&INCSECT CSECT                        Statement 1
                DC                    A(&SYSECT)      Statement 2
                MEND

                MACRO
                OUTER1
CSOUT1 CSECT                            Statement 3
                DS                    100C
                INNER                INA            Statement 4
                INNER                INB            Statement 5
                DC                    A(&SYSECT)      Statement 6
                MEND

                MACRO
                OUTER2
                DC                    A(&SYSECT)      Statement 7
                MEND
-----
MAINPROG CSECT                            Statement 8
                DS                    200C
                OUTER1                Statement 9
                OUTER2                Statement 10
-----
MAINPROG CSECT
                DS                    200C
CSOUT1 CSECT
                DS                    100C
INA CSECT
                DC                    A(CSOUT1)
INB CSECT
                DC                    A(INA)
                DC                    A(MAINPROG)
                DC                    A(INB)

```

In this example:

- Statement 8 is the last program sectioning statement processed before statement 9 is processed. Therefore, &SYSECT is assigned the value MAINPROG for macro instruction OUTER1 in statement 9. MAINPROG is substituted for &SYSECT when it appears in statement 6.
- Statement 3 is the program sectioning statement processed before statement 4 is processed. Therefore, &SYSECT is assigned the value CSOUT1 for macro instruction INNER in statement 4. CSOUT1 is substituted for &SYSECT when it appears in statement 2.
- Statement 1 is used to generate a CSECT statement for statement 4. This is the last program sectioning statement that appears before statement 5. Therefore, &SYSECT is assigned the value INA for macro instruction INNER in statement 5. INA is substituted for &SYSECT when it appears in statement 2.
- Statement 1 is used to generate a CSECT statement for statement 5. This is the last program sectioning statement that appears before statement 10. Therefore, &SYSECT is assigned the value INB for macro instruction OUTER2 in statement 10. INB is substituted for &SYSECT when it appears in statement 7.

&SYSIN_DSN System Variable Symbol

Use &SYSIN_DSN in a macro definition to obtain the name of the data set from which the assembler is reading the source module.

The local system variable symbol &SYSIN_DSN is assigned a read-only value each time a macro definition is called.

MVS If concatenated data sets are used to provide the source module, &SYSIN_DSN has a value equal to the data set name of the data set that contains the open code source line of the macro call statement, irrespective of the nesting depth of the macro line containing the &SYSIN_DSN reference.

When the assembler runs on the MVS/ESA operating systems, the value of the character string assigned to &SYSIN_DSN is always the value stored in the JFCB for SYSIN. **MVS**

CMS When the assembler runs on the CMS component of the VM/ESA operating systems, the value of the character string assigned to &SYSIN_DSN is determined as follows:

Figure 64. Contents of &SYSIN_DSN on CMS

SYSIN Allocated To:	Contents of &SYSIN_DSN:
CMS file	The 8-character filename, the 8-character filetype, and the 2-character filemode of the file, each separated by a blank
Reader	READER
Terminal	TERMINAL
Labeled tape file	The data set name of the tape file
Unlabeled tape file	TAP n , where n is a value from 0 to 9, or A to F.

CMS

VSE When the assembler runs on the VSE operating system, the value of the character string assigned to &SYSIN_DSN is determined as follows:

Figure 65. Contents of &SYSIN_DSN on VSE

SYSIPT Assigned To:	Contents of &SYSIN_DSN:
Job stream (SYSIPT)	SYSIPT
Disk	The file-id
Labeled tape file	The file-id of the tape file
Unlabeled tape file	SYSIPT

VSE

Examples:

On MVS, &SYSIN_DSN might be assigned a value such as:

&SYSIN_MEMBER System Variable Symbol

VCATR49.ASSEMBLE.SOURCE

On CMS, &SYSIN_DSN might be assigned a value such as:

SAMPLE ASSEMBLE A1

Notes:

1. If the SOURCE user exit provides the data set information then the value in &SYSIN_DSN is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSIN_DSN (T'&SYSIN_DSN) is always U.
3. The value of the count attribute of &SYSIN_DSN (K'&SYSIN_DSN) is equal to the number of characters assigned as a value to &SYSIN_DSN. In the CMS example above, the count attribute of &SYSIN_DSN is 20.
4. Throughout the use of a macro definition, the value of &SYSIN_DSN is considered a constant.

&SYSIN_MEMBER System Variable Symbol

VSE The value of &SYSIN_MEMBER is always null.

The value of the type attribute is O, and the value of the count attribute is 0.

VSE

CMS, MVS You can use &SYSIN_MEMBER in a macro definition to obtain the name of the data set member from which the assembler is reading the source module. If concatenated data sets are used to provide the source module, &SYSIN_MEMBER has a value equal to the name of the data set member that contains the macro instruction that calls the definition.

The local system variable symbol &SYSIN_MEMBER is assigned a read-only value each time a macro definition is called.

If the data set from which the assembler is reading the source module is not an MVS partitioned data set or a CMS MACLIB, &SYSIN_MEMBER is assigned a null character string. **CMS, MVS**

Notes:

1. If the SOURCE user exit provides the data set information then the value in &SYSIN_MEMBER is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSIN_MEMBER (T'&SYSIN_MEMBER) is U, unless &SYSIN_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSIN_MEMBER (K'&SYSIN_MEMBER) is equal to the number of characters assigned as a value to &SYSIN_MEMBER. If &SYSIN_MEMBER is assigned a null character string, the value of the count attribute is 0.
4. Throughout the use of a macro definition, the value of &SYSIN_MEMBER is considered a constant.

&SYSIN_VOLUME System Variable Symbol

Use &SYSIN_VOLUME in a macro definition to obtain the volume identifier of the first volume containing the data set from which the assembler is reading the source module.

CMS, MVS ▶ If concatenated data sets are used to provide the source module, &SYSIN_VOLUME has a value equal to the volume identifier of the first volume containing the data set that contains the macro call instruction. ◀ **CMS, MVS**

The local system variable symbol &SYSIN_VOLUME is assigned a read-only value each time a macro definition is called.

If the assembler runs on the CMS component of the VM/ESA operating system, and the source module is being read from a Shared File System CMS file, &SYSIN_VOLUME is assigned the value ** SFS.

If the volume on which the input data set resides is not labeled, &SYSIN_VOLUME is assigned a null character string.

Notes:

1. If the SOURCE user exit provides the data set information then the value in &SYSIN_VOLUME is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSIN_VOLUME (T'&SYSIN_VOLUME) is U, unless &SYSIN_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSIN_VOLUME (K'&SYSIN_VOLUME) is equal to the number of characters assigned as a value to &SYSIN_VOLUME. If &SYSIN_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.
4. Throughout the use of a macro definition, the value of &SYSIN_VOLUME is considered a constant.

&SYSJOB System Variable Symbol

Use &SYSJOB to obtain the jobname of the assembly job used to assemble your source module. &SYSJOB has a global scope.

When the assembler runs on the CMS component of the VM/ESA operating systems, &SYSJOB is assigned a value of (NOJOB).

Notes:

1. The value of the type attribute of &SYSJOB (T'&SYSJOB) is always U.
2. The value of the count attribute (K'&SYSJOB) is the number of characters assigned.

&SYSLIB_DSN System Variable Symbol

Use &SYSLIB_DSN in a macro definition to obtain name of the data set from which the assembler read the macro definition statements. If the macro definition is a source macro definition, &SYSLIB_DSN is assigned the same value as &SYSIN_DSN.

The local system variable symbol &SYSLIB_DSN is assigned a read-only value each time a macro definition is called.

When the assembler runs on the MVS/ESA operating systems, the value of the character string assigned to &SYSLIB_DSN is always the value stored in the JFCB for SYSLIB.

When the assembler runs on the CMS component of the VM/ESA operating systems, and the macro definition is a library macro definition, &SYSLIB_DSN is assigned the file name, file type, and file mode of the data set.

VSE When the macro definition is a library macro definition, &SYSLIB_DSN is assigned the library name and sublibrary name of the VSE Librarian file. **VSE**

Examples

Under MVS, &SYSLIB_DSN might be assigned a value such as:

SYS1.MACLIB

Under CMS, &SYSLIB_DSN might be assigned a value such as:

DMSGPI MACLIB S2

Under VSE, &SYSLIB_DSN might be assigned a value such as:

IJSYSRS.SYSLIB

Notes:

1. If the LIBRARY user exit provides the data set information then the value in &SYSLIB_DSN is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSLIB_DSN (T'&SYSLIB_DSN) is always U.
3. The value of the count attribute of &SYSLIB_DSN (K'&SYSLIB_DSN) is equal to the number of characters assigned as a value to &SYSLIB_DSN.
4. Throughout the use of a macro definition, the value of &SYSLIB_DSN is considered a constant.

&SYSLIB_MEMBER System Variable Symbol

Use &SYSLIB_MEMBER in a macro definition to obtain the name of the data set member from which the assembler read the macro definition statements. If the macro definition is a source macro definition, &SYSLIB_MEMBER is assigned the same value as &SYSIN_MEMBER.

The local system variable symbol &SYSLIB_MEMBER is assigned a read-only value each time a macro definition is called.

Notes:

1. If the LIBRARY user exit provides the data set information then the value in &SYSLIB_MEMBER is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSLIB_MEMBER (T'&SYSLIB_MEMBER) is U, unless &SYSLIB_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSLIB_MEMBER (K'&SYSLIB_MEMBER) is equal to the number of characters assigned as a value to &SYSLIB_MEMBER. If &SYSLIB_MEMBER is assigned a null character string, the value of the count attribute is 0.
4. Throughout the use of a macro definition, the value of &SYSLIB_MEMBER is considered a constant.

&SYSLIB_VOLUME System Variable Symbol

Use &SYSLIB_VOLUME in a macro definition to obtain the volume identifier of the volume containing the data set from which the assembler read the macro definition statements. If the macro definition is a source macro definition, &SYSLIB_VOLUME is assigned the same value as &SYSIN_VOLUME.

The local system variable symbol &SYSLIB_VOLUME is assigned a read-only value each time a macro definition is called.

If the assembler runs on the CMS component of the VM/ESA operating system, and the source module is being read from a Shared File System CMS file, &SYSLIB_VOLUME is assigned the value ** SFS.

Notes:

1. If the LIBRARY user exit provides the data set information then the value in &SYSLIB_VOLUME is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSLIB_VOLUME (T'&SYSLIB_VOLUME) is U, unless &SYSLIB_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSLIB_VOLUME (K'&SYSLIB_VOLUME) is equal to the number of characters assigned as a value to &SYSLIB_VOLUME. If &SYSLIB_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.
4. Throughout the use of a macro definition, the value of &SYSLIB_VOLUME is considered a constant.

&SYSLIN_DSN System Variable Symbol

Use &SYSLIN_DSN in a macro definition to obtain the name of the data set to which the assembler is writing the object records when assembler option OBJECT, GOFF or XOBJECT is specified.

The local system variable symbol &SYSLIN_DSN is assigned a read-only value each time a macro definition is called.

&SYSLIN_DSN System Variable Symbol

MVS The value of the character string assigned to &SYSLIN_DSN is always the value stored in the JFCB for SYSLIN. If SYSLIN is allocated to DUMMY, or a NULLFILE, the value in &SYSLIN_DSN is NULLFILE. **MVS**

CMS The value of the character string assigned to &SYSLIN_DSN is determined as follows:

Figure 66. Contents of &SYSLIN_DSN on CMS

SYSLIN Allocated To:	Contents of &SYSLIN_DSN:
CMS file	The 8-character filename, the 8-character filetype, and the 2-character filemode of the file, each separated by a blank
Dummy file (no physical I/O)	DUMMY
Punch	PUNCH
Labeled tape file	The data set name of the tape file
Unlabeled tape file	TAP n , where n is a value from 0 to 9, or A to F.

CMS

VSE The value of the character string assigned to &SYSLIN_DSN is determined as follows:

Figure 67. Contents of &SYSLIN_DSN on VSE

SYSLNK Assigned To:	Contents of &SYSLIN_DSN:
Disk file	The file-id
Labeled tape file	The file-id of the tape file
Unlabeled tape file	SYSLNK

VSE

Examples:

On MVS, &SYSLIN_DSN might be assigned a value such as:

VCATR49.OBJ

On CMS, &SYSLIN_DSN might be assigned a value such as:

SAMPLE TEXT A1

Notes:

1. If the OBJECT user exit provides the data set information then the value in &SYSLIN_DSN is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSLIN_DSN (T'&SYSLIN_DSN) is always U.
3. The value of the count attribute of &SYSLIN_DSN (K'&SYSLIN_DSN) is equal to the number of characters assigned as a value to &SYSLIN_DSN.

&SYSLIN_MEMBER System Variable Symbol

VSE The value of &SYSLIN_MEMBER is always null.

The value of the type attribute is O, and the value of the count attribute is 0.

VSE

CMS, MVS You can use &SYSLIN_MEMBER in a macro definition to obtain the name of the data set member to which the assembler is writing the object module when the assembler option OBJECT, GOFF or XOBJECT is specified.

The local system variable symbol &SYSLIN_MEMBER is assigned a read-only value each time a macro definition is called.

If the library to which the assembler is writing the object records is not an MVS partitioned data set, &SYSLIN_MEMBER is assigned a null character string.

CMS, MVS

Notes:

1. If the OBJECT user exit provides the data set information then the value in &SYSLIN_MEMBER is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSLIN_MEMBER (T'&SYSLIN_MEMBER) is U, unless &SYSLIN_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSLIN_MEMBER (K'&SYSLIN_MEMBER) is equal to the number of characters assigned as a value to &SYSLIN_MEMBER. If &SYSLIN_MEMBER is assigned a null character string, the value of the count attribute is 0.

&SYSLIN_VOLUME System Variable Symbol

Use &SYSLIN_VOLUME in a macro definition to obtain the volume identifier of the object data set. The volume identifier is of the first volume containing the data set. &SYSLIN_VOLUME is only assigned a value when you specify the OBJECT, GOFF or XOBJECT assembler option.

The local system variable symbol &SYSLIN_VOLUME is assigned a read-only value each time a macro definition is called.

If the assembler runs on the CMS component of the VM/ESA operating system, and the assembler listing is being written to a Shared File System CMS file, &SYSLIN_VOLUME is assigned the value ** SFS.

If the volume on which the data set resides is not labeled, &SYSLIN_VOLUME is assigned a null character string.

&SYSLIST System Variable Symbol

Notes:

1. If the OBJECT user exit provides the data set information then the value in &SYSLIN_VOLUME is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSLIN_VOLUME (T'&SYSLIN_VOLUME) is U, unless &SYSLIN_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSLIN_VOLUME (K'&SYSLIN_VOLUME) is equal to the number of characters assigned as a value to &SYSLIN_VOLUME. If &SYSLIN_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.

&SYSLIST System Variable Symbol

Use &SYSLIST instead of a positional parameter inside a macro definition; for example, as a point of substitution. By varying the subscripts attached to &SYSLIST, you can refer to any sublist entry in a macro call, or any positional operands in a macro call. You can also refer to positional operands for which no corresponding positional parameter is specified in the macro prototype statement.

The local system variable symbol &SYSLIST is assigned a read-only value each time a macro definition is called.

&SYSLIST refers to the complete list of positional operands specified in a macro instruction. &SYSLIST does not refer to keyword operands. However, &SYSLIST cannot be specified as &SYSLIST alone. One of the two following forms must be used as a point of substitution:

1. &SYSLIST(n) can be used to refer to the n -th positional operand
2. If the n -th operand is a sublist, then &SYSLIST(n,m) can be used to refer to the m -th operand in the sublist.

The subscripts n and m can be any arithmetic expression allowed in the operand of a SETA instruction (See "SETA Instruction" on page 318). The subscript n must be greater than or equal to 0. The subscript m must be greater than or equal to 1.

When referring to multilevel (nested) sublists in operands of macro instructions, refer to elements of inner sublists by using the applicable number of subscripts for &SYSLIST.

The examples below show the values assigned to &SYSLIST according to the value of its subscripts n and m .

Macro instruction:

```
-----
NAME      MACALL      ONE,TWO,(3,(4,5,6),,8),,TEN
```

Point of Substitution in Macro Definition:	Value Substituted:	See note:
-----	-----	-----
&SYSLIST(2)	TWO	
&SYSLIST(3,1)	3	
&SYSLIST(3,2,2)	5	
&SYSLIST(4)	Null	1
&SYSLIST(9)	Null	1
&SYSLIST(3,3)	Null	2
&SYSLIST(3,5)	Null	2
&SYSLIST(2,1)	TWO	3
&SYSLIST(2,2)	Null	
&SYSLIST(0)	NAME	4
&SYSLIST(3)	(3,(4,5,6),,8)	

Notes:

1. If the position indicated by *n* refers to an omitted operand, or refers past the end of the list of positional operands specified, the null character string is substituted for &SYSLIST(*n*).
2. If the position (in a sublist) indicated by the second subscript, *m*, refers to an omitted entry, or refers past the end of the list of entries specified in the sublist referred to by the first subscript, *n*, the null character string is substituted for &SYSLIST(*n,m*).
3. If the *n*-th positional operand is not a sublist, &SYSLIST(*n,1*) refers to the operand. However, &SYSLIST(*n,m*), where *m* is greater than 1, causes the null character string to be substituted.
4. If the value of subscript *n* is 0, then &SYSLIST(*n*) is assigned the value specified in the name field of the macro instruction, except when it is a sequence symbol.

Attribute references can be made to the previously described forms of &SYSLIST. The attributes are the attributes inherent in the positional operands or sublist entries to which you refer. However, the number attribute of &SYSLIST (N' &SYSLIST) is different from the number attribute described in "Data Attributes" on page 296. One of two forms can be used for the number attribute:

- To indicate the number of positional operands specified in a call, use the form N' &SYSLIST.
- To indicate the number of sublist entries that have been specified in a positional operand, use the form N' &SYSLIST(*n*).

&SYSLOC System Variable Symbol

Notes:

1. N'&SYSLIST includes any positional operands that are omitted. Positional operands are omitted by coding a comma where an operand is expected.
2. N'&SYSLIST(*n*) includes those sublist entries specifically omitted by specifying the comma that would normally have followed the entry.
3. If the operand indicated by *n* is not a sublist, N'&SYSLIST(*n*) is 1. If it is omitted, N'&SYSLIST(*n*) is 0.

The COMPAT(SYSLIST) assembler option instructs the assembler to treat sublists in macro instruction operands as character strings, not sublists. See the *HLASM Programmer's Guide* for a description of the COMPAT(SYSLIST) assembler option.

Examples of sublists:

Macro Instruction	N'&SYSLIST
MACLST 1,2,3,4	4
MACLST A,B,,D,E	5
MACLST ,A,B,C,D	5
MACLST (A,B,C),(D,E,F)	2
MACLST	0
MACLST KEY1=A,KEY2=B	0
MACLST A,B,KEY1=C	2

	N'&SYSLIST(2)
MACSUB A,(1,2,3,4,5),B	5
MACSUB A,(1,,3,,5),B	5
MACSUB A,(,2,3,4,5),B	5
MACSUB A,B,C	1
MACSUB A,,C	0
MACSUB A,KEY=(A,B,C)	0
MACSUB	0

&SYSLOC System Variable Symbol

Use &SYSLOC in a macro definition to generate the name of the location counter in effect. If you have not coded a LOCTR instruction between the macro instruction and the preceding START, CSECT, RSECT, DSECT, or COM instruction, the value of &SYSLOC is the same as the value of &SYSECT.

The assembler assigns to the system variable symbol &SYSLOC a local read-only value each time a macro definition containing it is called. The value assigned is the symbol representing the name of the location counter in use at the point where the macro is called.

&SYSLOC can only be used in macro definitions.

Notes:

1. The value of the type attribute of &SYSLOC (T'&SYSLOC) is always U.
2. The value of the count attribute (K'&SYSLOC) is equal to the number of characters assigned as a value to &SYSLOC.
3. Throughout the use of a macro definition, the value of &SYSLOC is considered a constant.

&SYSMAC System Variable Symbol

By varying the subscripts attached to the &SYSMAC you can refer to the name of any of the macros called between opencode and the current nesting level, that is, &SYSMAC(&SYSNEST) returns 'OPEN CODE'. Valid subscripts are 0 to &SYSNEST. If &SYSMAC is used with a subscript greater than &SYSNEST, a null character string is returned.

&SYSMAC with no subscript is treated as &SYSMAC(0) and so provides the name of the macro being expanded. This is not considered to be an error and so no message is issued.

The local system variable symbol &SYSMAC is assigned a read-only value each time a macro definition is called.

Notes:

1. The value of the type attribute of &SYSMAC (T'&SYSMAC(n)) is U, unless &SYSMAC(n) is assigned a null character string, in which case the value of the type attribute is O.
2. The value of the count attribute (K'&SYSMAC(n)) is equal to the number of characters assigned as a value to &SYSMAC(n).

&SYSM_HSEV System Variable Symbol

Use &SYSM_HSEV to get the highest MNOTE severity so far for the assembly.

The global system variable symbol &SYSM_HSEV is assigned a read-only value. The assembler compares this value with the severity of MNOTE assembler instructions as they are encountered and, if lower, updates it with the higher value.

Notes:

1. The value of the type attribute of &SYSM_HSEV (T'&SYSM_HSEV) is always N.
2. The value of the count attribute (K'&SYSM_HSEV) is always 3.

In Figure 68 on page 254 the &SYSM_HSEV variable is updated immediately an MNOTE is issued with a higher severity.

&SYSM_SEV System Variable Symbol

Use &SYSM_SEV to get the highest MNOTE severity code for the macro most recently called directly from this level.

The global system variable symbol &SYSM_SEV is assigned a read-only value. The assembler assigns a value of zero when a macro is called and when a macro returns (MEND or MEXIT), the highest severity of all MNOTE assembler instructions executed in the called macro is used to update the variable.

&SYSNDX System Variable Symbol

Notes:

1. The value of the type attribute of &SYSM_SEV (T'&SYSM_SEV) is always N.
2. The value of the count attribute (K'&SYSM_SEV) is always 3.

In Figure 68 on page 254 the &SYSM_SEV variable has a value of 0 until INNER returns. The OUTER macro uses &SYSM_SEV to determine which statements to generate, and in this case issues an MNOTE to pass the severity back to the open code.

```

1      MACRO
2      OUTER &SEV
3      DC      A(&SYSM_HSEV,&SYSM_SEV) outer 1
4      MNOTE  &SEV,'OUTER - parm severity=&SEV'
5      DC      A(&SYSM_HSEV,&SYSM_SEV) outer 2
6      INNER
7      DC      A(&SYSM_HSEV,&SYSM_SEV) outer 3
8      AIF ('&SEV' GT '&SYSM_SEV').MN
9      MNOTE  &SYSM_SEV,'OUTER - returned severity=&SYSM_SEV'
10     .MN ANOP
11     DC      A(&SYSM_HSEV,&SYSM_SEV) outer 4
12     MEND
13     MACRO
14     INNER
15     DC      A(&SYSM_HSEV,&SYSM_SEV) inner 1
16     MNOTE  8,'INNER'
17     DC      A(&SYSM_HSEV,&SYSM_SEV) inner 2
18     MEND
000000      00000 00040 19 E_G CSECT
20 *,OPEN CODE      an mnote comment - sev=0
21     DC      A(&SYSM_HSEV,&SYSM_SEV) open_code
000000 00000000000000000000      + DC      A(000,000)          open_code
22     OUTER  4
000008 000000000000000000      23+  DC      A(000,000)          outer 1
** ASMA254I *** MNOTE ***      24+  4,OUTER - parm severity=4
000010 000000040000000000      25+  DC      A(004,000)          outer 2
000018 000000040000000000      26+  DC      A(004,000)          inner 1
** ASMA254I *** MNOTE ***      27+  8,INNER
000020 000000080000000000      28+  DC      A(008,000)          inner 2
000028 000000080000000000      29+  DC      A(008,008)          outer 3
** ASMA254I *** MNOTE ***      30+  008,OUTER - returned severity=008
000030 000000080000000000      31+  DC      A(008,008)          outer 4
32 *,OPEN CODE      an mnote comment - sev=0
000038 000000080000000000      33  DC      A(&SYSM_HSEV,&SYSM_SEV) open_code
+ DC      A(008,008)          open_code
34     END
```

Figure 68. Example of the behavior of the &SYSM_HSEV and &SYSM_SEV variables.

&SYSNDX System Variable Symbol

You can attach &SYSNDX to the end of a symbol inside a macro definition to generate a unique suffix for that symbol each time you call the definition. Although the same symbol is generated by two or more calls to the same definition, the suffix provided by &SYSNDX produces two or more unique symbols. Thus you avoid an error being flagged for multiply defined symbols.

The local system variable symbol &SYSNDX is assigned a read-only value each time a macro definition is called from a source module.

The value assigned to &SYSNDX is a number from 1 to 9999999. For the numbers 0001 through 9999, four digits are generated. For the numbers 10000 through 9999999, the value is generated with no zeros to the left. The value 0001 is assigned to the first macro called by a program, and is incremented by one for each subsequent macro call (including nested macro calls).

The maximum value for &SYSNDX can be controlled by the MHELP instruction described under “MHELP Control on &SYSNDX” on page 354.

Notes:

1. &SYSNDX does not generate a valid symbol, and it must:
 - Follow the symbol to which it is concatenated
 - Be concatenated to a symbol containing 59 characters or less
2. The value of the type attribute of &SYSNDX (T'&SYSNDX) is always N.
3. The value of the count attribute (K'&SYSNDX) is equal to the number of digits generated.

The example that follows, shows the use of &SYSNDX. It is assumed that the first macro instruction processed, OUTER1, is the 106th macro instruction processed by the assembler.

&SYSNDX System Variable Symbol

```

                MACRO
                INNER1
                GBLC                &NDXNUM
A&SYSNDX SR                2,5                Statement 1
                CR                2,5
                BE                B&NDXNUM                Statement 2
                B                A&SYSNDX                Statement 3
                MEND

                MACRO
                OUTER1
                GBLC                &NDXNUM
&NDXNUM SETC                '&SYSNDX'                Statement 4
&NAME SR                2,4
                AR                2,6
                INNER1                Statement 5
B&SYSNDX S                2,=F'1000'                Statement 6
                MEND
-----
ALPHA  OUTER1                Statement 7
BETA   OUTER1                Statement 8
-----
ALPHA  SR                2,4
                AR                2,6
A0107  SR                2,5
                CR                2,5
                BE                B0106
                B                A0107
B0106  S                2,=F'1000'
BETA   SR                2,4
                AR                2,6
A0109  SR                2,5
                CR                2,5
                BE                B0108
                B                A0109
B0108  S                2,=F'1000'

```

Statement 7 is the 106th macro instruction processed. Therefore, &SYSNDX is assigned the number 0106 for that macro instruction. The number 0106 is substituted for &SYSNDX when it is used in statements 4 and 6. Statement 4 is used to assign the character value 0106 to the SETC symbol &NDXNUM Statement 6 is used to create the unique name B0106.

Statement 5 is the 107th macro instruction processed. Therefore, &SYSNDX is assigned the number 0107 for that macro instruction. The number 0107 is substituted for &SYSNDX when it is used in statements 1 and 3. The number 0106 is substituted for the global SETC symbol &NDXNUM in statement 2.

Statement 8 is the 108th macro instruction processed. Therefore, each occurrence of &SYSNDX is replaced by the number 0108. For example, statement 6 is used to create the unique name B0108.

When statement 5 is used to process the 108th macro instruction, statement 5 becomes the 109th macro instruction processed. Therefore, each occurrence of &SYSNDX is replaced by the number 0109. For example, statement 1 is used to create the unique name A0109.

&SYSNEST System Variable Symbol

Use &SYSNEST to obtain the current macro instruction nesting level.

The local system variable symbol &SYSNEST is assigned a read-only value each time a macro definition is called from a source module.

The value assigned to &SYSNEST is a number from 1 to 99999999. No leading zeros are generated as part of the number. When a macro is called from open code, the value assigned to &SYSNEST is the number 1. Each time a macro definition is called by an inner macro instruction, the value assigned to &SYSNEST is incremented by 1. Each time an inner macro exits, the value is decremented by 1.

Notes:

1. The value of the type attribute of &SYSNEST (T'&SYSNEST) is always N.
2. The value of the count attribute (K'&SYSNEST) is equal to the number of digits assigned.

The following example shows the values assigned to &SYSNEST:

```

MACRO
OUTER
DC          A(&SYSNEST)          Statement 1
INNER1
INNER2
INNER2          Statement 3
MEND

MACRO
INNER1
DC          A(&SYSNEST)          Statement 4
INNER2
INNER2          Statement 5
MEND

MACRO
INNER2
DC          A(&SYSNEST)          Statement 6
MEND
-----
+ OUTER          Statement 7
+ DC          A(1)
+ DC          A(2)
+ DC          A(3)
+ DC          A(2)

```

Statement 7 is in open code. It calls the macro OUTER. &SYSNEST is assigned a value of 1 which is substituted in statement 1.

Statement 2, within the macro definition of OUTER, calls macro INNER1. The value assigned to &SYSNEST is incremented by 1. The value 2 is substituted for &SYSNEST in statement 4.

Statement 5, within the macro definition of INNER1, calls macro INNER2. The value assigned to &SYSNEST is incremented by 1. The value 3 is substituted for &SYSNEST in statement 6.

&SYSOPT_DBCS System Variable Symbol • &SYSOPT_RENT System Variable Symbol

When the macro INNER2 exits, the value assigned to &SYSNEST is decremented by 1. The value of &SYNEST is 2.

When the macro INNER1 exits, the value assigned to &SYSNEST is decremented by 1. The value of &SYSNEST is 1.

Statement 3, within the macro definition of OUTER, calls macro INNER2. The value assigned to &SYSNEST is incremented by 1. The value 2 is substituted for &SYSNEST in statement 6.

&SYSOPT_DBCS System Variable Symbol

You can use &SYSOPT_DBCS to determine if the DBCS assembler option was supplied for the assembly of your source module. &SYSOPT_DBCS is a Boolean system variable symbol, and has a global scope.

If the DBCS assembler option was specified, &SYSOPT_DBCS is assigned a value of 1. If the DBCS assembler option was not specified, &SYSOPT_DBCS is assigned a value of 0.

For more information about the DBCS assembler option, see the *HLASM Programmer's Guide*.

Notes:

1. The value of the type attribute of &SYSOPT_DBCS (T'&SYSOPT_DBCS) is always N.
2. The value of the count attribute (K'&SYSOPT_DBCS) is always 1.

&SYSOPT_OPTABLE System Variable Symbol

Use &SYSOPT_OPTABLE to determine the value that was specified for the OPTABLE assembler option. &SYSOPT_OPTABLE has a global scope.

The value that was specified for the OPTABLE assembler option indicates which operation code table the assembler has loaded, and is using.

For more information about the OPTABLE assembler option, see your *HLASM Programmer's Guide*.

Notes:

1. The value of the type attribute of &SYSOPT_OPTABLE (T'&SYSOPT_OPTABLE) is always U.
2. The value of the count attribute (K'&SYSOPT_OPTABLE) is the number of characters assigned.

&SYSOPT_RENT System Variable Symbol

Use &SYSOPT_RENT to determine if the RENT assembler option was specified for the assembly of your source module. The RENT option instructs the assembler to check for possible coding violations of program reenterability. &SYSOPT_RENT is a Boolean system variable symbol, and has a global scope.

&SYSOPT_XOBJECT System Variable Symbol • &SYSPARM System Variable Symbol

If the RENT assembler option was specified, &SYSOPT_RENT is assigned a value of 1. If the RENT assembler option was not specified, &SYSOPT_RENT is assigned a value of 0.

For more information about the RENT assembler option, see your *HLASM Programmer's Guide*.

Notes:

1. The value of the type attribute of &SYSOPT_RENT (T'&SYSOPT_RENT) is always N.
2. The value of the count attribute (K'&SYSOPT_RENT) is always 1.

&SYSOPT_XOBJECT System Variable Symbol

The &SYSOPT_XOBJECT system variable is set to 1 if GOFF or XOBJECT is specified, otherwise it is set to 0.

&SYSOPT_XOBJECT is a Boolean system variable symbol with global scope.

Notes:

1. The value of the type attribute of &SYSOPT_XOBJECT (T'&SYSOPT_XOBJECT) is always N.
2. The value of the count attribute (K'&SYSOPT_XOBJECT) is always 1.

&SYSPARM System Variable Symbol

The &SYSPARM system variable is assigned a read-only value from the assembler option SYSPARM. It is treated as a global SETC symbol in a source module except that its value cannot be changed. (Refer to chapter 3 of the *Programmer's Guide* for information on assembler options.)

Notes:

1. The largest value that &SYSPARM can hold is 255 characters. However, if the PARM field of the EXEC statement is used to specify its value, the PARM field restrictions reduce its maximum possible length.
2. No values are substituted for variable symbols in the specified value, however, on MVS and VSE, you must use double ampersands to represent a single ampersand.
3. On MVS and VSE, you must use two single quotation marks to represent a single quotation mark, because the entire EXEC PARM field is enclosed in single quotation marks.
4. If the SYSPARM assembler option is not specified, &SYSPARM is assigned the default value that was specified when the assembler was installed on your system.

If a default value for SYSPARM was not specified when the assembler was installed on your system, &SYSPARM is assigned a value of the null character string.

5. The value of the type attribute of &SYSPARM (T'&SYSPARM) is U, unless &SYSPARM is assigned a null value, in which case the value of the type attribute is O.

&SYSPRINT_DSN System Variable Symbol

6. The value of the count attribute (K'&SYSPARM) is the number of characters assigned as a value to &SYSPARM. If &SYSPARM is assigned a null character string, the value of the count attribute is 0.
7. If the SYSPARM option is passed to the assembler via the ASMAOPT file (CMS and MVS) or Librarian member (VSE) and the option contains imbedded spaces, it must be enclosed in quotes.

&SYSPRINT_DSN System Variable Symbol

Use &SYSPRINT_DSN in a macro definition to obtain the name of the data set to which the assembler writes the assembler listing.

The local system variable symbol &SYSPRINT_DSN is assigned a read-only value each time a macro definition is called.

When the assembler runs on the MVS/ESA operating systems, the value of the character string assigned to &SYSPRINT_DSN is always the value stored in the JFCB for SYSPRINT. If SYSPRINT is allocated to DUMMY, or a NULLFILE, the value in &SYSPRINT_DSN is NULLFILE.

When the assembler runs on the CMS component of the VM/ESA operating systems, the value of the character string assigned to &SYSPRINT_DSN is determined as follows:

Figure 69. Contents of &SYSPRINT_DSN on CMS

SYSPRINT Allocated To:	Contents of &SYSPRINT_DSN:
CMS file	The 8-character filename, the 8-character filetype, and the 2-character filemode of the file, each separated by a blank
Dummy file (no physical I/O)	DUMMY
Printer	PRINTER
Labeled tape file	The data set name of the tape file
Unlabeled tape file	TAP n , where n is a value from 0 to 9, or A to F.
Terminal	TERMINAL

When the assembler runs on VSE, the value of the character string assigned to &SYSPRINT_DSN is determined as follows:

Figure 70. Contents of &SYSPRINT_DSN on VSE

SYSLST Assigned To:	Contents of &SYSPRINT_DSN:
Disk file (not for dynamic partitions)	The file-id
Printer	SYSLST
Labeled tape file	The file-id of the tape file
Unlabeled tape file	SYSLST

Examples:

On MVS, &SYSPRINT_DSN might be assigned a value such as:

VCATR49.VCATR49A.JOB06734.D0000102.?

On CMS, &SYSPRINT_DSN might be assigned a value such as:

SAMPLE LISTING A1

Notes:

1. If the LISTING user exit provides the listing data set information then the value in &SYSPRINT_DSN is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSPRINT_DSN (T'&SYSPRINT_DSN) is always U.
3. The value of the count attribute of &SYSPRINT_DSN (K'&SYSPRINT_DSN) is equal to the number of characters assigned as a value to &SYSPRINT_DSN.

&SYSPRINT_MEMBER System Variable Symbol

VSE The value of &SYSPRINT_MEMBER is always null.

The value of the type attribute is O, and the value of the count attribute is 0.

VSE

CMS, MVS You can use &SYSPRINT_MEMBER in a macro definition to obtain the name of the data set member to which the assembler is writing the assembler listing.

The local system variable symbol &SYSPRINT_MEMBER is assigned a read-only value each time a macro definition is called.

If the data set to which the assembler is writing the assembler listing is not an MVS partitioned data set, &SYSPRINT_MEMBER is assigned a null character string.

CMS, MVS

Notes:

1. If the LISTING user exit provides the listing data set information then the value in &SYSPRINT_MEMBER is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSPRINT_MEMBER (T'&SYSPRINT_MEMBER) is U, unless &SYSPRINT_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSPRINT_MEMBER (K'&SYSPRINT_MEMBER) is equal to the number of characters assigned as a value to &SYSPRINT_MEMBER. If &SYSPRINT_MEMBER is assigned a null character string, the value of the count attribute is 0.

&SYSPRINT_VOLUME System Variable Symbol

Use &SYSPRINT_VOLUME in a macro definition to obtain the volume identifier of the first volume containing the data set to which the assembler writes the assembler listing.

The local system variable symbol &SYSPRINT_VOLUME is assigned a read-only value each time a macro definition is called.

&SYSPUNCH_DSN System Variable Symbol

If the assembler runs on the CMS component of the VM/ESA operating system, and the assembler listing writes to a Shared File System CMS file, &SYSPRINT_VOLUME is assigned the value ** SFS.

If the volume on which the data set resides is not labeled, &SYSPRINT_VOLUME is assigned a null character string.

Notes:

1. If the LISTING user exit provides the listing data set information then the value in &SYSPRINT_VOLUME is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSPRINT_VOLUME (T'&SYSPRINT_VOLUME) is U, unless &SYSPRINT_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSPRINT_VOLUME (K'&SYSPRINT_VOLUME) is equal to the number of characters assigned as a value to &SYSPRINT_VOLUME. If &SYSPRINT_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.

&SYSPUNCH_DSN System Variable Symbol

Use &SYSPUNCH_DSN in a macro definition to obtain the name of the data set to which the assembler is writing the object records when assembler option DECK is specified.

The local system variable symbol &SYSPUNCH_DSN is assigned a read-only value each time a macro definition is called.

When the assembler runs on the MVS/ESA operating systems, the value of the character string assigned to &SYSPUNCH_DSN is always the value stored in the JFCB for SYSPUNCH. If SYSPUNCH is allocated to DUMMY, or a NULLFILE, the value in &SYSPUNCH_DSN is NULLFILE.

When the assembler runs on the CMS component of the VM/ESA operating systems, the value of the character string assigned to &SYSPUNCH_DSN is determined as follows:

Figure 71. Contents of &SYSPUNCH_DSN on CMS

SYSPUNCH Allocated To:	Contents of &SYSPUNCH_DSN:
CMS file	The 8-character filename, the 8-character filetype, and the 2-character filemode of the file, each separated by a blank
Dummy file (no physical I/O)	DUMMY
Punch	PUNCH
Labeled tape file	The data set name of the tape file
Unlabeled tape file	TAP n , where n is a value from 0 to 9, or A to F.

&SYSPUNCH_MEMBER System Variable Symbol

On VSE, the value of the character string assigned to &SYSPUNCH_DSN is determined as follows:

Figure 72. Contents of &SYSPUNCH_DSN on VSE

SYSPCH Assigned To:	Contents of &SYSPUNCH_DSN:
Disk file	The file-id
Punch	SYSPCH
Labeled tape file	The file-id of the tape file
Unlabeled tape file	SYSPCH

Examples:

On MVS, &SYSPUNCH_DSN might be assigned a value such as:

VCATR49.VCATR49A.J0B06734.D0000103.?

On CMS, &SYSPUNCH_DSN might be assigned a value such as:

PUNCH

Notes:

1. If the PUNCH user exit provides the punch data set information then the value in &SYSPUNCH_DSN is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSPUNCH_DSN (T'&SYSPUNCH_DSN) is always U.
3. The value of the count attribute of &SYSPUNCH_DSN (K'&SYSPUNCH_DSN) is equal to the number of characters assigned as a value to &SYSPUNCH_DSN.

&SYSPUNCH_MEMBER System Variable Symbol

VSE The value of &SYSPUNCH_MEMBER is always null.

The value of the type attribute is O, and the value of the count attribute is 0.

VSE

CMS, MVS You can use &SYSPUNCH_MEMBER in a macro definition to obtain the name of the data set member to which the assembler is writing the object records when the assembler option DECK is specified.

The local system variable symbol &SYSPUNCH_MEMBER is assigned a read-only value each time a macro definition is called.

If the data set to which the assembler is writing the object records is not an MVS partitioned data set, &SYSPUNCH_MEMBER is assigned a null character string.

CMS, MVS

&SYSSEQF System Variable Symbol

Notes:

1. If the PUNCH user exit provides the punch data set information then the value in &SYSPUNCH_MEMBER is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSPUNCH_MEMBER (T'&SYSPUNCH_MEMBER) is U, unless &SYSPUNCH_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSPUNCH_MEMBER (K'&SYSPUNCH_MEMBER) is equal to the number of characters assigned as a value to &SYSPUNCH_MEMBER. If &SYSPUNCH_MEMBER is assigned a null character string, the value of the count attribute is 0.

&SYSPUNCH_VOLUME System Variable Symbol

Use &SYSPUNCH_VOLUME in a macro definition to obtain the volume identifier of the object data set. The volume identifier is of the first volume containing the data set. &SYSPUNCH_VOLUME is only assigned a value when you specify the DECK assembler option.

The local system variable symbol &SYSPUNCH_VOLUME is assigned a read-only value each time a macro definition is called.

If the assembler runs on the CMS component of the VM/ESA operating system, and the object records are being written to a Shared File System CMS file, &SYSPUNCH_VOLUME is assigned the value ** SFS.

If the volume on which the data set resides is not labeled, &SYSPUNCH_VOLUME is assigned a null character string.

Notes:

1. If the PUNCH user exit provides the punch data set information then the value in &SYSPUNCH_VOLUME is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSPUNCH_VOLUME (T'&SYSPUNCH_VOLUME) is U, unless &SYSPUNCH_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSPUNCH_VOLUME (K'&SYSPUNCH_VOLUME) is equal to the number of characters assigned as a value to &SYSPUNCH_VOLUME. If &SYSPUNCH_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.

&SYSSEQF System Variable Symbol

Use &SYSSEQF in a macro definition to obtain the value of the identification-sequence field of the macro instruction in open code that caused, directly or indirectly, the macro to be called.

The local system variable symbol &SYSSEQF is assigned a read-only value each time a macro definition is called from a source module.

The value assigned to &SYSSEQF is determined as follows:

&SYSSTEP System Variable Symbol • &SYSSTMT System Variable Symbol

1. If no ICTL instruction has been specified and sequence checking is not active, the contents of columns 73 to 80 inclusive of the source statement are assigned to &SYSSEQF.
2. If an ICTL instruction has been specified, but sequence checking is not active, the contents of the columns of the source statement to the right of the continuation-indicator column are assigned to &SYSSEQF. If the end column or the continuation-indicator column is 80, &SYSSEQF is assigned a null character string.
3. If an ISEQ instruction with operands has been specified to start sequence checking, the contents of columns specified in the ISEQ instruction operand are assigned to &SYSSEQF.
4. If an ISEQ instruction without an operand has been specified to end sequence checking, steps (1) and (2) are used to determine the value assigned to &SYSSEQF.

Notes:

1. The value of the type attribute of &SYSSEQF (T'&SYSSEQF) is U, unless &SYSSEQF is assigned a null character string, in which case the value of the type attribute is O.
2. The value of the count attribute of &SYSSEQF (K'&SYSSEQF) is equal to the number of characters assigned as a value to &SYSSEQF. If &SYSSEQF is assigned a null character string, the value of the count attribute is 0.
3. Throughout the use of a macro definition, the value of &SYSSEQF is considered a constant.

&SYSSTEP System Variable Symbol

Use &SYSSTEP to obtain the stepname of the job step used to assemble your source module. &SYSSTEP has a global scope.

On VSE the value of &SYSSTEP is always (NOSTEP).

On CMS, &SYSSTEP is assigned a value of (NOSTEP).

Notes:

1. The value of the type attribute of &SYSSTEP (T'&SYSSTEP) is always U.
2. The value of the count attribute (K'&SYSSTEP) is the number of characters assigned.

&SYSSTMT System Variable Symbol

Use &SYSSTMT to obtain the next statement number that is assigned to a statement by the assembler. &SYSSTMT has a global scope.

The value assigned to &SYSSTMT is an 8-character string, padded on the left with leading zeros. The following example shows the value assigned to &SYSSTMT. It assumes that the DC statement is in open code, and is the 23rd statement in the source module.

```
23          DC   C'&SYSSTMT'  
+          DC   C'00000024'
```

&SYSSTYP System Variable Symbol • &SYSTEM_ID System Variable Symbol

Notes:

1. The value of the type attribute of &SYSSTMT (T'&SYSSTMT) is always N.
2. The value of the count attribute of &SYSSTMT (K'&SYSSTMT) is always 8.

&SYSSTYP System Variable Symbol

Use &SYSSTYP in a macro definition to generate the type of the current control section. The current control section is the control section in which the macro instruction that calls the definition appears.

The local system variable symbol &SYSSTYP is assigned a read-only value each time a macro definition is called.

The value assigned is the symbol that represents the type of the current control section in effect when the macro is called. A control section that has been initiated or continued by substitution does not affect the value of &SYSSTYP for the expansion of the current macro. However, it does affect &SYSSTYP for a subsequent macro call. Nested macros cause the assembler to assign a value to &SYSSTYP that depends on the control section in force inside the calling macro when the inner macro is called.

The control section whose type is assigned to &SYSSTYP can be defined by a program sectioning statement. This can be a START, CSECT, RSECT, DSECT, or COM statement, or, for the first control section, any instruction described in “First Control Section” on page 52. Depending upon the instruction used to initiate the current control section, the value assigned to &SYSSTYP is either CSECT, RSECT, DSECT, or COM. If the current control section is an executable control section initiated by other than a CSECT or RSECT instruction, the value assigned to &SYSSTYP is CSECT.

If a control section has not been initiated, &SYSSTYP is assigned a null character string.

Notes:

1. The value of the type attribute of &SYSSTYP (T'&SYSSTYP) is U, unless &SYSSTYP is assigned a null character string, in which case the value of the type attribute is O.
2. The value of the count attribute of &SYSSTYP (K'&SYSSTYP) is equal to the number of characters assigned as a value to &SYSSTYP. If &SYSSTYP is assigned a null character string, the value of the count attribute is 0.
3. Throughout the use of a macro definition, the value of &SYSSTYP is considered a constant.

&SYSTEM_ID System Variable Symbol

Use &SYSTEM_ID to obtain the name and release of the operating system under which your source module is being assembled. &SYSTEM_ID has a global scope.

For example, on MVS, &SYSTEM_ID might contain one of the following:

```
MVS/ESA SP 4.3.0  
MVS/ESA SP 5.1.0  
... etc.
```

on CMS, &SYSTEM_ID might contain one of the following:

CMS 11
CMS 12
CMS 13
... etc.

on VSE, &SYSTEM_ID might contain one of the following:

VSE/AF 6.5.x
... etc.

Notes:

1. The value of the type attribute of &SYSTEM_ID (T'&SYSTEM_ID) is always U.
2. The value of the count attribute (K'&SYSTEM_ID) is the number of characters assigned.

&SYSTEMER_DSN System Variable Symbol

Use &SYSTEMER_DSN in a macro definition to obtain the name of the data set to which the assembler is writing the terminal records.

The local system variable symbol &SYSTEMER_DSN is assigned a read-only value each time a macro definition is called.

When the assembler runs on the MVS/ESA operating systems, the value of the character string assigned to &SYSTEMER_DSN is always the value stored in the JFCB for SYSTEMER. If SYSTEMER is allocated to DUMMY, or a NULLFILE, the value in &SYSTEMER_DSN is NULLFILE.

When the assembler runs on the CMS component of the VM/ESA operating systems, the value of the character string assigned to &SYSTEMER_DSN is determined as follows:

Figure 73. Contents of &SYSTEMER_DSN on CMS

SYSTEMER Allocated To:	Contents of &SYSTEMER_DSN:
CMS file	The 8-character filename, the 8-character filetype, and the 2-character filemode of the file, each separated by a blank
Dummy file (no physical I/O)	DUMMY
Printer	PRINTER
Labeled tape file	The data set name of the tape file
Unlabeled tape file	TAP n , where n is a value from 0 to 9, or A to F.
Terminal	TERMINAL

On VSE, the value of the character string assigned to &SYSTEMER_DSN is always SYSLOG.

Examples:

On MVS, &SYSTEMER_DSN might be assigned a value such as:

&SYSTEM_VOLUME System Variable Symbol

VCATR49.VCATR49A.JOB06734.D0000104.?

On CMS, &SYSTEM_DSN might be assigned a value such as:

TERMINAL

Notes:

1. If the TERM user exit provides the terminal data set information then the value in &SYSTEM_DSN is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSTEM_DSN (T'&SYSTEM_DSN) is always U.
3. The value of the count attribute of &SYSTEM_DSN (K'&SYSTEM_DSN) is equal to the number of characters assigned as a value to &SYSTEM_DSN.

&SYSTEM_MEMBER System Variable Symbol

VSE The value of &SYSTEM_MEMBER is always null.

The value of the type attribute is O, and the value of the count attribute is 0.

VSE

CMS, MVS You can use &SYSTEM_MEMBER in a macro definition to obtain the name of the data set member to which the assembler is writing the terminal records.

The local system variable symbol &SYSTEM_MEMBER is assigned a read-only value each time a macro definition is called.

If the data set to which the assembler is writing the terminal records is not an MVS partitioned data set, &SYSTEM_MEMBER is assigned a null character string.

CMS, MVS

Notes:

1. If the TERM user exit provides the terminal data set information then the value in &SYSTEM_MEMBER is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSTEM_MEMBER (T'&SYSTEM_MEMBER) is U, unless &SYSTEM_MEMBER is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSTEM_MEMBER (K'&SYSTEM_MEMBER) is equal to the number of characters assigned as a value to &SYSTEM_MEMBER. If &SYSTEM_MEMBER is assigned a null character string, the value of the count attribute is 0.

&SYSTEM_VOLUME System Variable Symbol

VSE The value of &SYSTEM_VOLUME is always null.

The value of the type attribute is U, and the value of the count attribute is 0.

VSE

CMS, MVS You can use &SYSTEM_VOLUME in a macro definition to obtain the volume identifier of the first volume containing the data set to which the assembler is writing the terminal records.

The local system variable symbol &SYSTEM_VOLUME is assigned a read-only value each time a macro definition is called.

If the assembler runs on the CMS component of the VM/ESA operating system, and the terminal records are being written to a Shared File System CMS file, &SYSTEM_VOLUME is assigned the value ** SFS.

If the volume on which the data set resides is not labeled, &SYSTEM_VOLUME is assigned a null character string. **CMS, MVS**

Notes:

1. If the TERM user exit provides the terminal data set information then the value in &SYSTEM_VOLUME is the value extracted from the Exit-Specific Information block described in the *HLASM Programmer's Guide*.
2. The value of the type attribute of &SYSTEM_VOLUME (T'&SYSTEM_VOLUME) is U, unless &SYSTEM_VOLUME is assigned a null character string, in which case the value of the type attribute is O.
3. The value of the count attribute of &SYSTEM_VOLUME (K'&SYSTEM_VOLUME) is equal to the number of characters assigned as a value to &SYSTEM_VOLUME. If &SYSTEM_VOLUME is assigned a null character string, the value of the count attribute is 0. The maximum length of this system variable symbol is 6.

&SYSTIME System Variable Symbol

Use &SYSTIME to obtain the time at which your source module is assembled. It is assigned a read-only value.

The value of &SYSTIME is a 5-character string in the format:

HH.MM

where:

HH is two-digit field that gives the hour of the day. It has a value between 00 and 23, inclusive.

MM is two-digit field that gives the minute of the hour. It has a value between 00 and 59, inclusive. It is separated from HH by a period.

Example:

09.45

Notes:

1. The time corresponds to the time printed in the page heading of listings and remains constant for each assembly.
2. The value of the type attribute of &SYSTIME (T'&SYSTIME) is always U.
3. The value of the count attribute (K'&SYSTIME) is always 5.

&SYSVER System Variable Symbol

&SYSVER System Variable Symbol

Use &SYSVER to obtain the version, release, and modification level of the assembler being used to assemble your source module. &SYSVER has a global scope. For example, when IBM High Level Assembler for MVS & VM & VSE Release 4 is used, &SYSVER has the value 1.4.0.

Notes:

1. The value of the type attribute of &SYSVER (T'&SYSVER) is always U.
2. The value of the count attribute (K'&SYSVER) is the number of characters assigned. In the above example, the count attribute of &SYSVER is 5.

Macro Instruction Format

sequence_symbol

is a sequence symbol. If a sequence symbol is coded in the name entry of a macro instruction, the value of the symbol is not passed to the called macro definition and therefore cannot be used as a value for substitution in the macro definition.

operation_code

is the symbolic operation code which identifies the macro definition that you want the assembler to process. For more information, see “Operation Entry” on page 273.

operand

The positional operands or keyword operands that you use to pass values into the called macro definition. For more information, see “Operand Entry” on page 274.

If no operands are specified in the operand field, and if the absence of the operand entry is indicated by a comma preceded and followed by one or more blanks, remarks are allowed.

The entries in the name, operation, and operand fields correspond to entries in the prototype statement of the called macro definition (see “Macro Instruction Prototype” on page 219).

Alternative Ways of Coding a Macro Instruction

A macro instruction can be specified in one of the three following ways:

- The normal way, with the operands preceding any remarks
- The alternative way, allowing remarks for each operand
- A combination of the first two ways

The following example show the normal statement format (*NAME1*), the alternative statement format (*NAME2*), and a combination of both statement formats (*NAME3*).

Name	Opera- tion	Operand	Comment	Cont.
NAME1	OP1	OPERAND1,OPERAND2,OPERAND3	This is the normal statement format	X
NAME2	OP2	OPERAND1, OPERAND2	This is the alternative statement format	X
NAME3	OP3	OPERAND1, OPERAND2,OPERAND3	This is a combination of both	X

Notes:

1. Any number of continuation lines are allowed. However, each continuation line must be indicated by a nonblank character in the column after the end column of the previous statement line (see “Continuation Lines” on page 15).
2. If the DBCS assembler option is specified, the continuation features outlined in “Continuation of double-byte data” on page 16 apply to continuation in the macro language. Extended continuation may be useful if a macro operand contains double-byte data.

3. Operands on continuation lines must begin in the continue column (column 16), or the assembler assumes that any lines that follow contain remarks.
If any entries are made in the columns before the continue column in continuation lines, the assembler issues an error message and the whole statement is not processed.
4. One or more blanks must separate the operand from the remarks.
5. A comma after an operand indicates more operands follow.
6. The last operand requires no comma following it, but using a comma does not cause an error.
7. You do not need to use the same format when you code a macro instruction as you use when you code the corresponding macro prototype statement.
8. Continued comments for a macro with an operand list that terminates in a null operand will be recognized provided each continued comment begins in the same or later column as the preceding line's comment.

Name Entry

Use the name entry of a macro instruction to:

- Pass a value into a macro definition through the name entry declared in the macro definition
- Provide a conditional assembly label (see “Sequence Symbols” on page 310) so that you can branch to the macro instruction during conditional assembly if you want the called macro definition expanded.

The name entry of a macro instruction can be:

- Blank
- An ordinary symbol, such as HERE
- A variable symbol, such as &A.
- Any combination of variable symbols and other character strings concatenated together, such as HERE.&A
- Any character string allowed in a macro instruction operand, such as 'Now is the hour' or STRING00, excluding sublist entries and attribute references (see “Values in Operands” on page 281)
- A sequence symbol, which is not passed to the macro definition, such as .SEQ

Operation Entry

The operation entry is the symbolic name of the operation code that identifies a macro definition to process.

The operation entry must be a valid symbol, and must be identical to the operation field in the prototype statement of the macro definition.

The assembler searches for source macro definitions before library macro definitions. If you have a source macro definition that has the same name as a library macro definition, the assembler only processes the source macro definition.

You can use a variable symbol as a macro instruction. For example if MAC1 has been defined as a macro, you can use the following statements to call it:

Macro Instruction Format

```
&CALL   SETC           'MAC1'  
        &CALL
```

You cannot use a variable symbol as a macro instruction that passes operands to the macro. The second statement in the following example generates an error:

```
&CALL   SETC           'MAC1 OPERAND1=VALUE '  
        &CALL
```

You must specify operand entries after the variable symbol, as shown in the following example:

```
&CALL   SETC           'MAC1 '  
        &CALL OPERAND1=VALUE
```

Operand Entry

Use the operand entry of a macro instruction to pass values into the called macro definition. These values can be passed through:

- The symbolic parameters you have specified in the macro prototype, or
- The system variable symbol `&SYSLIST` if it is specified in the body of the macro definition (see “`&SYSLIST` System Variable Symbol” on page 250).

The two types of operands allowed in a macro instruction are the positional and keyword operands. You can specify a sublist with multiple values in both types of operands. Special rules for the various values you can specify in operands are also given below.

Positional Operands

You can use a positional operand to pass a value into a macro definition through the corresponding positional parameter declared for the definition. You should declare a positional parameter in a macro definition when you want to change the value passed at every call to that macro definition.

You can also use a positional operand to pass a value to the system variable symbol `&SYSLIST`. If `&SYSLIST`, with the applicable subscripts, is specified in a macro definition, you do not need to declare positional parameters in the prototype statement of the macro definition. You can thus use `&SYSLIST` to refer to any positional operand. This allows you to vary the number of operands you specify each time you call the same macro definition.

The positional operands of a macro instruction must be specified in the same order as the positional parameters declared in the called macro definition.

Each positional operand constitutes a character string. This character string is the value passed through a positional parameter into a macro definition.

The general specifications for symbolic parameters also apply to positional operands. The specification for each positional operand in the prototype statement definition must be a valid variable symbol. Values are assigned (see **1** in Figure 74 on page 275) to the positional operands by the corresponding positional operands (see **2** in Figure 74) specified in the macro instruction that calls the macro definition.

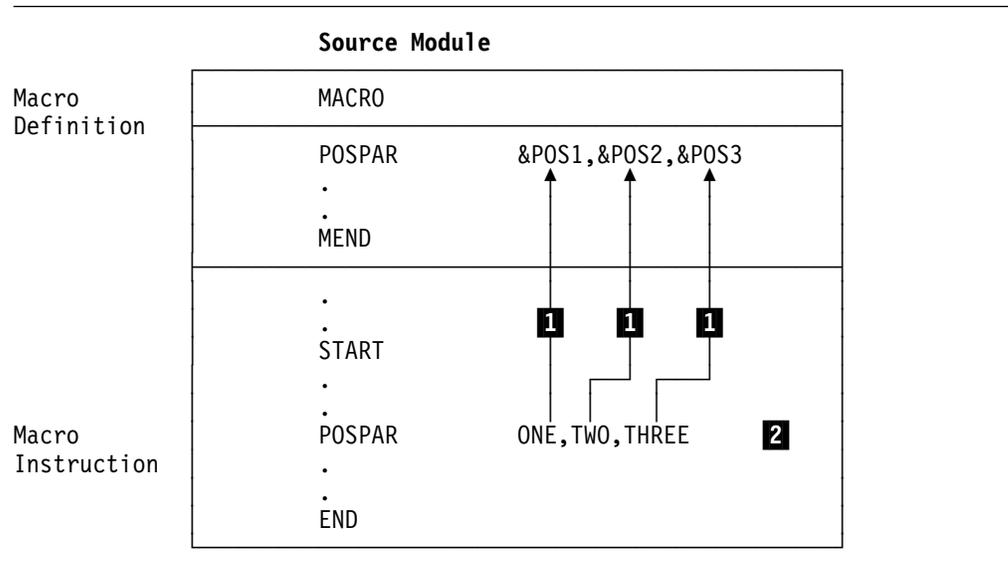


Figure 74. Positional Operands

Notes:

1. An omitted operand has a null character value.
2. Each positional operand can be up to 255 characters long.
3. If the DBCS assembler option is specified, the positional operand can be a quoted string containing double-byte data.

The following are examples of macro instructions with positional operands:

```

MACCALL      VALUE,9,8
MACCALL      &A,'QUOTED STRING'
MACCALL      EXPR+2,,SYMBOL
MACCALL      (A,B,C,D,E),(1,2,3,4)
MACCALL      &A,'<.S.T.R.I.N.G>'
    
```

The following list shows what happens when the number of positional operands in the macro instruction is equal to or differs from the number of positional parameters declared in the prototype statement of the called macro definition:

- Equal Valid, if operands are correctly specified.
- Greater than Meaningless, unless &SYSLIST is specified in definition to refer to excess operands.
- Less than Omitted operands give null character values to corresponding parameters (or &SYSLIST specification).

Keyword Operands

You can use a keyword operand to pass a value through a keyword parameter into a macro definition. The values you specify in keyword operands override the default values assigned to the keyword parameters. The default value should be a value you use frequently. Thus, you avoid having to write this value every time you code the calling macro instruction.

Macro Instruction Format

When you need to change the default value, you must use the corresponding keyword operand in the macro instruction. The keyword can indicate the purpose for which the passed value is used.

Any keyword operand specified in a macro instruction must correspond to a keyword parameter in the macro definition called. However, keyword operands do not have to be specified in any particular order.

The general specifications for symbolic parameters also apply to keyword operands. The actual operand keyword must be a valid variable symbol. A null character string can be specified as the standard value of a keyword operand, and is generated if the corresponding keyword operand is omitted.

A keyword operand must be coded in this format:

```
KEYWORD=VALUE
```

where:

KEYWORD has up to 62 characters without an ampersand.
VALUE can be up to 255 characters.

The corresponding keyword parameter in the called macro definition is specified as:

```
&KEYWORD=DEFAULT
```

If a keyword operand is specified, its value overrides the default value specified for the corresponding keyword parameter.

If the DBCS assembler option is specified, the keyword operand can be a quoted string containing double-byte data.

If the value of a keyword operand is a literal, two equal signs must be specified.

The following examples of macro instructions have keyword operands:

```
MACKEY      KEYWORD=(A,B,C,D,E)
MACKEY      KEY1=1,KEY2=2,KEY3=3
MACKEY      KEY3=2000,KEY1=0,KEYWORD=HALLO
MACKEY      KEYWORD='<.S.T.R.I.N.G>'
MACKEY      KEYWORD==C'STRING'
```

To summarize the relationship of keyword operands to keyword parameters:

- The keyword of the operand corresponds (see **1** in Figure 75 on page 277) to a keyword parameter. The value in the operand overrides the default value of the parameter.
- If the keyword operand is not specified (see **2** in Figure 75), the default value of the parameter is used.
- If the keyword of the operand does not correspond (see **3** in Figure 75) to any keyword parameter, the assembler issues an error message, but the macro is generated using the default values of the other parameters.
- The default value specified for a keyword parameter can be the null character string (see **4** in Figure 75). The null character string is a character string with a length of zero; it is not a blank, because a blank occupies one character position.

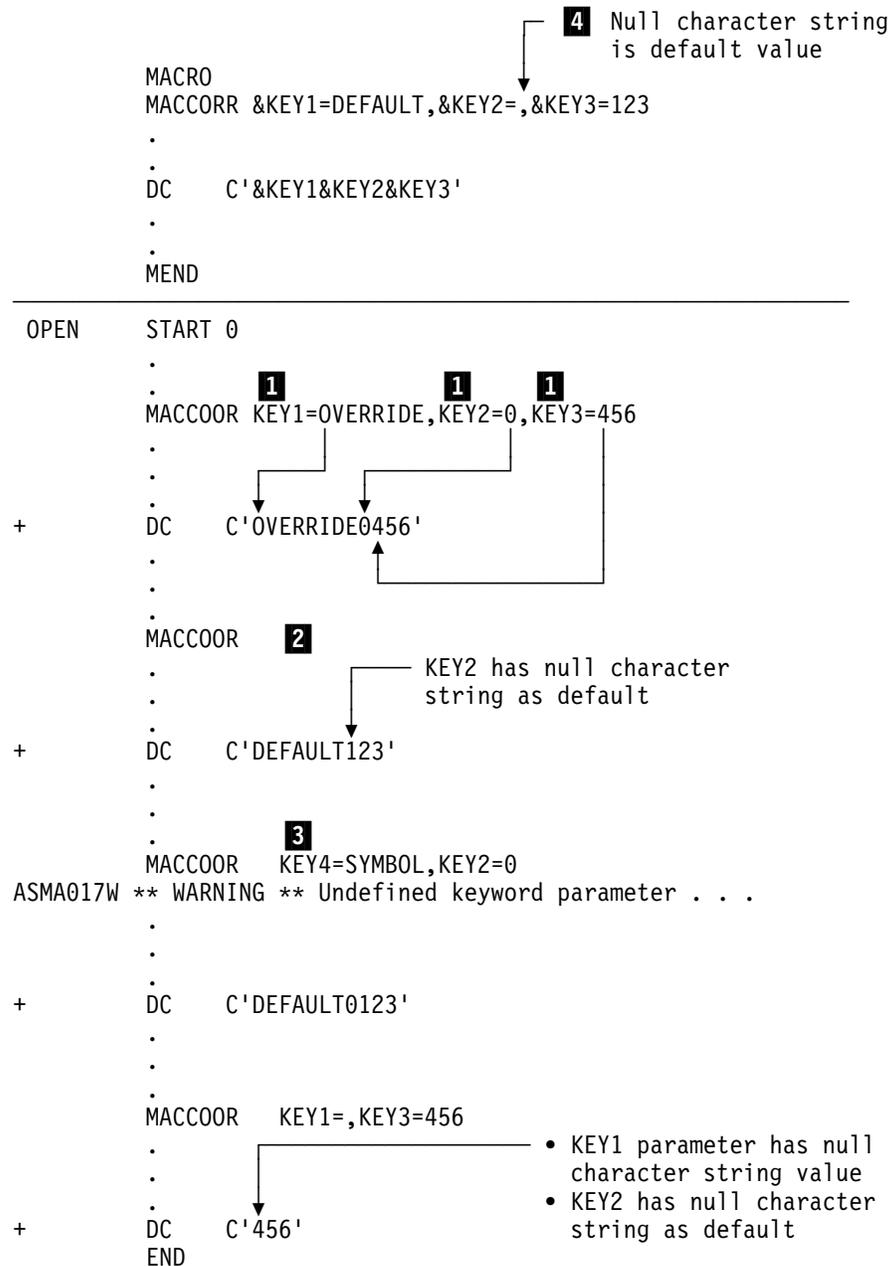


Figure 75. Relationship between Keyword Operands and Keyword Parameters and Their Assigned Values

Combining Positional and Keyword Operands

You can use positional and keyword operands in the same macro instruction. Use a positional operand for a value that you change often, and a keyword operand for a value that you change infrequently.

Positional and keyword parameters can be mixed freely in the macro prototype statement (see **1** in Figure 76). The same applies to the positional and keyword operands of the macro instruction (see **2** in Figure 76). Note, however, that the order in which the positional parameters appear (see **3** in Figure 76) determines

Sublists in Operands

the order in which the positional operands must appear. Interspersed keyword parameters and operands (see **4** in Figure 76) do not affect this order.

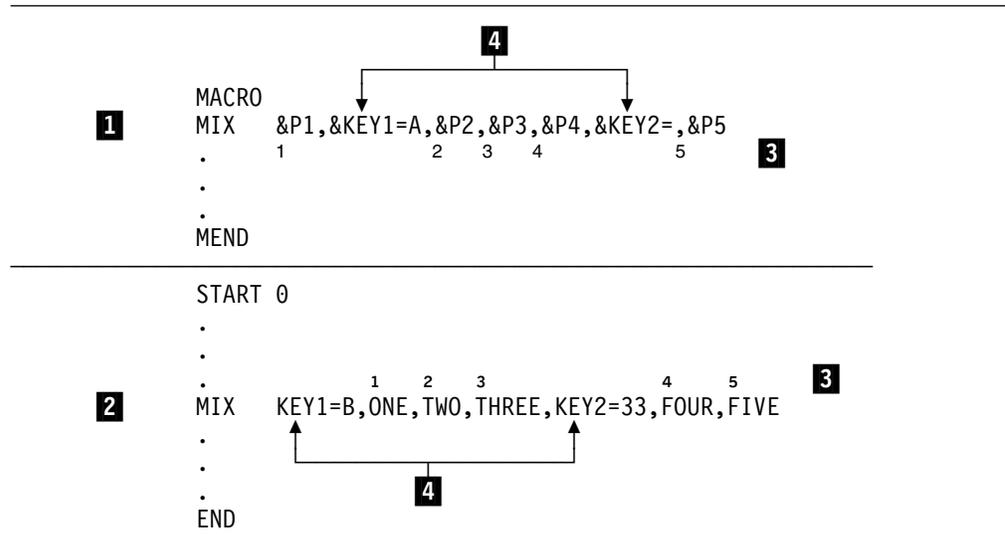


Figure 76. Combining Positional and Keyword Parameters

&SYSLIST(*n*): The system variable symbol **&SYSLIST(*n*)** refers only to the positional operands in a macro instruction.

Sublists in Operands

You can use a sublist in a positional or keyword operand to specify several values. A *sublist* is a character string that consists of one or more entries separated by commas and enclosed in parentheses.

If the COMPAT(SYSLIST) assembler option is not specified, a variable symbol that has been assigned a character string that consists of one or more entries separated by commas and enclosed in parentheses is also treated as a sublist. However, if the COMPAT(SYSLIST) assembler option is specified, a sublist assigned to a variable symbol is treated as a character string, not as a sublist.

A variable symbol is not treated as a sublist if the parentheses are not present. The following example shows two calls to macro MAC1. In the first call, the value of the operand in variable **&VAR1** is treated as a sublist. In the second call, the value of the operand is treated as a character string, not a sublist, because the variable **&VAR2** does not include parentheses.

```
&VAR1   SETC   '(1,2) '
        MAC1   KEY=&VAR1
&VAR2   SETC   '1,2'
        MAC1   KEY=(&VAR2)
```

To refer to an entry of a sublist code, use:

- The corresponding symbolic parameter with an applicable subscript, or
- The system variable symbol **&SYSLIST** with applicable subscripts, the first of which refers to the positional operand, and the second to the sublist entry in the operand. **&SYSLIST** can refer only to sublists in positional operands.

Figure 77 on page 279 shows that the value specified in a positional or keyword operand can be a sublist.

A symbolic parameter can refer to the whole sublist (see **1** in Figure 77), or to an individual entry of the sublist. To refer to an individual entry, the symbolic parameter (see **2** in Figure 77) must have a subscript whose value indicates the position (see **3** in Figure 77) of the entry in the sublist. The subscript must have a value greater than or equal to 1.

A sublist, including the enclosing parentheses, must not contain more than 255 characters. It consists of one or more entries separated by commas and enclosed in parentheses; for example, (A,B,C,D,E). () is a valid sublist with the null character string as the only entry.

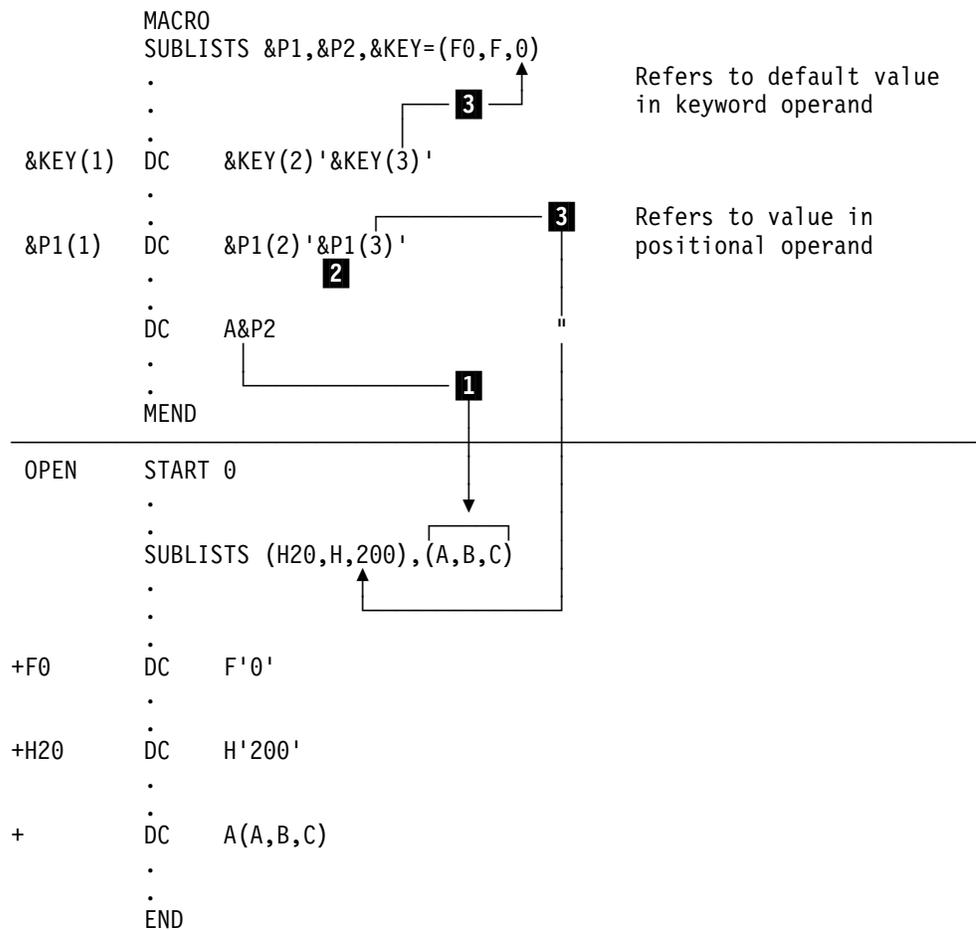


Figure 77. Sublists in Operands

Figure 78 shows the relationship between subscripted parameters and sublist entries if:

- A sublist entry is omitted (see **1** in Figure 78).
- The subscript refers past the end of the sublist (see **2** in Figure 78).
- The value of the operand is not a sublist (see **3** in Figure 78).
- The parameter is not subscripted (see **4** in Figure 78).

Sublists in Operands

&SYSLIST(*n,m*): The system variable symbol, &SYSLIST(*n,m*), can also refer to sublist entries, but only if the sublist is specified in a positional operand.

Figure 78. Relationship between Subscripted Parameters and Sublist Entries

Parameter	Sublist specified in corresponding operand or as default value of a keyword parameter	Value generated or used in computation
1 &PARM1(3)	(1,2,,4)	Null character string
2 &PARM1(5)	(1,2,3,4)	Null character string
3 &PARM1 &PARM1(1) &PARM1(2)	A A A	A A Null character string
4 &PARM1 &PARM1(1)	(A) ¹ (A) ¹	(A) A
2 &PARM1(2)	(A) ¹	Null character string
&PARM1 &PARM1(1) &PARM1(2)	() ¹ () ¹ () ¹	() Null character string Null character string
&PARM1(2)	(A, ,C,D) ²	Nothing ³
&PARM1(1)	() ²	Nothing ³
&PARM1 &PARM2(3) &SYSLIST(2,3)	A,(1,2,3,4) ⁴ A,(1,2,3,4) ⁴ A,(1,2,3,4) ⁴	A 3 3

Notes:

1. Considered a sublist.
2. The blank indicates the end of the operand field.
3. Produces error diagnostic message ASMA088E Unbalanced parentheses in macro call operand.
4. Positional operands.

Multilevel Sublists

You can specify multilevel sublists (sublists within sublists) in macro operands. The depth of this nesting is limited only by the constraint that the total operand length must not exceed 255 characters. Inner elements of the sublists are referenced using additional subscripts on symbolic parameters or on &SYSLIST.

N'&SYSLIST(*n*) gives the number of operands in the indicated *n*-th level sublist. The number attribute (N') and a parameter name with an *n*-element subscript array gives the number of operands in the indicated (*n*+1)-th level sublist. Figure 79 shows the value of selected elements if &P is the first positional parameter, and the value assigned to it in a macro instruction is (A,(B,(C)),D).

Figure 79. Multilevel Sublists

Selected Elements from &P	Selected Elements from &SYSLIST	Value of Selected Element
&P	&SYSLIST(1)	(A,(B,(C)),D)
&P(1)	&SYSLIST(1,1)	A
&P(2)	&SYSLIST(1,2)	(B,(C))
&P(2,1)	&SYSLIST(1,2,1)	B
&P(2,2)	&SYSLIST(1,2,2)	(C)
&P(2,2,1)	&SYSLIST(1,2,2,1)	C
&P(2,2,2)	&SYSLIST(1,2,2,2)	null
N'&P(2,2)	N'&SYSLIST(1,2,2)	1
N'&P(2)	N'&SYSLIST(1,2)	2
N'&P(3)	N'&SYSLIST(1,3)	1
N'&P	N'&SYSLIST(1)	3

Passing Sublists to Inner Macro Instructions

You can pass a suboperand of an outer macro instruction sublist as a sublist to an inner macro instruction. However, if you specify the COMPAT(SYSLIST) assembler option, a sublist assigned to a variable symbol is treated as a character string, not as a sublist.

Values in Operands

You can use a macro instruction operand to pass a value into the called macro definition. The two types of value you can pass are:

- Explicit values or the actual character strings you specify in the operand
- Implicit values, or the attributes inherent in the data represented by the explicit values

The explicit value specified in a macro instruction operand is a character string that can contain zero or more variable symbols.

The character string must not be greater than 255 characters after substitution of values for any variable symbols. This includes a character string that constitutes a sublist.

The character string values in the operands, including sublist entries, are assigned to the corresponding parameters declared in the prototype statement of the called macro definition. A sublist entry is assigned to the corresponding subscripted parameter.

Omitted Operands

When a keyword operand is omitted, the default value specified for the corresponding keyword parameter is the value assigned to the parameter. When a positional operand or sublist entry is omitted, the null character string is assigned to the parameter.

Values in Operands

Notes:

1. Blanks appearing between commas (without surrounding single quotation marks) do not signify an omitted positional operand or an omitted sublist entry; they indicate the end of the operand field.
2. Adjacent commas indicate omission of positional operands; no comma is needed to indicate omission of the last or only positional operand.

The following example shows a macro instruction preceded by its corresponding prototype statement. The macro instruction operands that correspond to the third and sixth operands of the prototype statement are omitted in this example.

```
EXAMPLE      &A,&B,&C,&D,&E,&F
EXAMPLE      17,*+4,,AREA,FIELD(6)
```

Unquoted Operands

The assembler normally retains the case of unquoted macro operands. However, to maintain uppercase alphabetic character set compatibility with earlier assemblers, High Level Assembler provides the COMPAT(MACROCASE) assembler option. When you specify this option, the assembler converts lowercase alphabetic characters (a through z) in unquoted macro instruction operands to uppercase alphabetic characters (A through Z).

Special Characters

Any of the 256 characters of the EBCDIC character set can appear in the value of a macro instruction operand (or sublist entry). However, the following characters require special consideration:

Ampersands

A single ampersand indicates the presence of a variable symbol. The assembler substitutes the value of the variable symbol into the character string specified in a macro instruction operand. The resultant string is then the value passed into the macro definition. If the variable symbol is undefined, an error message is issued.

Double ampersands must be specified if a single ampersand is to be passed to the macro definition.

Examples:

```
&VAR
&A+&B+3+&C*10
'&MESSAGE'
&&REGISTER
```

Single Quotation Marks

A single quotation mark is used:

- To indicate the beginning and end of a quoted string
- In a length, type, integer, or scaling attribute reference notation that is not within a quoted string

Examples:

```
'QUOTED STRING'
L'SYMBOL
T'SYMBOL
```

Shift-out (SO) and Shift-in (SI)

If the DBCS assembler option is specified, then SO (X'0E') and SI (X'0F') are recognized as shift codes within quoted strings. SO and SI delimit the start and end of double-byte data respectively. Double-byte data is only recognized within a quoted string.

Quoted Strings

A quoted string is any sequence of characters that begins and ends with a single quotation mark (compare with conditional assembly character expressions described in “Character (SETC) Expressions” on page 335).

Two single quotation marks must be specified inside each quoted string. This includes substituted single quotation marks.

Quoted strings can contain double-byte data, if the DBCS assembler option is specified. The double-byte data must be bracketed by the SO and SI delimiters. Only valid double-byte data is recognized between the SO and SI. The SI may be in any odd-numbered byte position after the SO. If the end of the operand is reached before SI is found, then error ASMA203E Unbalanced double-byte delimiters is issued.

Macro instruction operands can have values that include one or more quoted strings. Each quoted string can be separated from the following quoted string by one or more characters, and each must contain an even number of single quotation marks.

Examples:

```
''
'L' 'SYMBOL'
'QUOTE1'AND'QUOTE2'
```

Attribute Reference Notation

You can specify an attribute reference notation as a macro instruction operand value. The attribute reference notation must be preceded by a blank or any other special character except the ampersand and the single quotation mark. See “Data Attributes” on page 296 for details about data attributes, and the format of attribute references.

Examples:

```
MAC1          L'SYMBOL,10+L'AREA*L'FIELD
MAC1          I'PACKED-S'PACKED
```

Parentheses

In macro instruction operand values, there must be an equal number of left and right parentheses. They must be paired, that is, each left parenthesis needs a following right parenthesis at the same level of nesting. An unpaired (single) left or right parenthesis can appear only in a quoted string.

Examples:

```
(PAIRED-PARENTHESES)
()
(A(B)C)D(E)
(IN'('STRING)
```

Blanks

One or more blanks outside a quoted string indicates the end of the operands of a macro instruction. Thus blanks should only be used inside quoted strings.

Example:

```
'BLANKS ALLOWED'
```

Commas

A comma outside a quoted string indicates the end of an operand value or sublist entry. Commas that do not delimit values can appear inside quoted strings or paired parentheses that do not enclose sublists.

Examples:

```
A,B,C,D  
(1,2)3'5,6'
```

Equal Signs

An equal sign can appear in the value of a macro instruction operand or sublist entry:

- As the first character
- Inside quoted strings
- Between paired parentheses
- In a keyword operand
- In a positional operand, provided the parameter does not resemble a keyword operand

The assembler issues a warning message for a positional operand containing an equal sign, if the operand resembles a keyword operand. Thus, if we assume that the following is the prototype of a macro definition:

```
MAC1          &F
```

the following macro instruction generates a warning message:

```
MAC1          K=L (K is a valid keyword)
```

while the following macro instruction does not:

```
MAC1          2+2=4 (2+2 is not a valid keyword)
```

Examples:

```
=H'201'  
A='B  
C(A=B)  
2X=B  
KEY=A=B
```

Periods

A period (.) can be used in the value of an operand or sublist entry. It is passed as a period. However, if it is used immediately after a variable symbol, it becomes a concatenation character. Two periods are required if one is to be passed as a character.

Examples:

3.4
 &A.1
 &A..1

Nesting Macro Instruction Definitions

A nested macro instruction definition is a macro instruction definition you can specify as a set of model statements in the body of an enclosing macro definition. This lets you create a macro definition by expanding the outer macro that contains the nested definition.

Note that all nested inner macro definitions are effectively “black boxes”: there is no visibility to the outermost macro definition of any variable symbol or sequence symbol within any of the nested macro definitions. This means that you cannot use an enclosing macro definition to tailor or parameterize the contents of a nested inner macro definition.

This lack of parameterization can be overcome in some cases by using the AINSERT statement. This lets you generate a macro definition from within another macro generation. In Figure 80 macro `ainsert_test_macro` generates the macro `mac1` using a combination of AINSERT and AREAD instructions. The `mac1` macro is then called with a list of seven parameters.

```

1      macro
2 &name  ainsert_test_macro
3      ainsert      '      Macro',back
4      ainsert      '      mac1',back
5      ainsert      'Blah blah blah',front
6 &aread  aread
7 &aread  setc      '&aread'(1,10)
8      ainsert      '&&n      seta n''&&syslist ',back
9      ainsert      '      dc a(&&n)',back
10     ainsert      '      dc c''&aread'' ',back
11     ainsert      '      mend',back
12     mend
13 *
14 testains csect 0
15 *
16     ainsert_test_macro
17+    ainsert      '      Macro',back
18+    ainsert      '      mac1',back
19+    ainsert      'Blah blah blah',front
20-Blah blah blah
21+    ainsert      '&&n      seta n''&&syslist ',back
22+    ainsert      '      dc a(&&n)',back
23+    ainsert      '      dc c''Blah blah '' ',back
24+    ainsert      '      mend',back
25>    Macro
26>    mac1
27>&n    seta n'&syslist
28>    dc a(&n)
29>    dc c'Blah blah '
30>    mend
31 *
32     mac1 a,b,c,d,e,f,g
33+    dc a(7)
34+    dc c'Blah blah '
35 *
36     end

```

Figure 80. Expanding Nested Macro Definitions

Inner and Outer Macro Instructions

Any macro instruction you write in the open code of a source module is an *outer macro instruction* or call. Any macro instruction that appears within a macro definition is an *inner macro instruction* or call.

Levels of Macro Call Nesting

The code generated by a macro definition called by an inner macro call is nested inside the code generated by the macro definition that contains the inner macro call. In the macro definition called by an inner macro call, you can include a macro call to another macro definition. Thus, you can nest macro calls at different levels.

The &SYSNEST system variable indicates how many levels you called. It has the value 1 in an outer macro, and is incremented by one at a macro call.

Recursion

You can also call a macro definition recursively; that is, you can write macro instructions inside macro definitions that are calls to the containing definition. This is how you define macros to process recursive functions.

General Rules and Restrictions

Macro instruction statements can be written inside macro definitions. Values are substituted in the same way as they are for the model statements of the containing macro definition. The assembler processes the called macro definition, passing to it the operand values (after substitution) from the inner macro instruction. In addition to the operand values described in “Values in Operands” on page 281, nested macro calls can specify values that include:

- Any of the symbolic parameters (see **1** in Figure 81) specified in the prototype statement of the containing macro definition
- Any SET symbols (see **2** in Figure 81) declared in the containing macro definition
- Any of the system variable symbols such as &SYSDATE, &SYSTIME, etc. (see **3** in Figure 81).

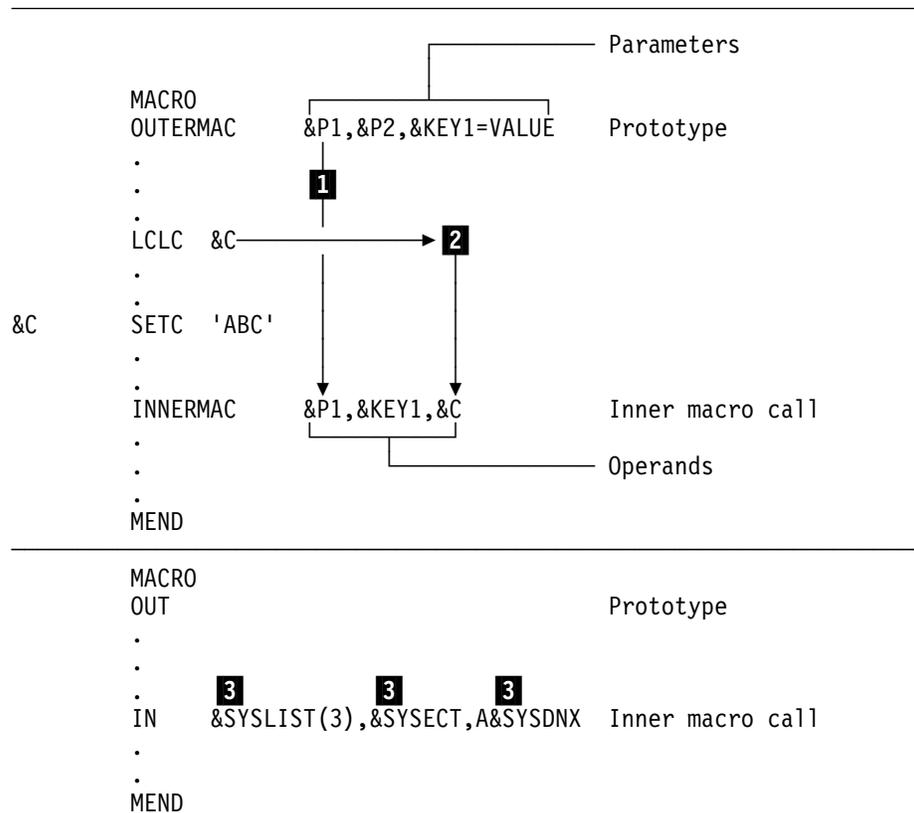


Figure 81. Values in Nested Macro Calls

The number of nesting levels permitted depends on the complexity and size of the macros at the different levels; that is, the number of operands specified, the number of local and global SET symbols declared, and the number of sequence symbols used.

When the assembler processes a macro exit instruction, either MEXIT or MEND, it selects the next statement to process depending on the level of nesting. If the macro exit instruction is from an inner macro, the assembler processes the next statement after the statement that called the inner macro. If the macro exit instruction is from an outer macro, the assembler processes the next statement in open code, after the statement that called the inner macro.

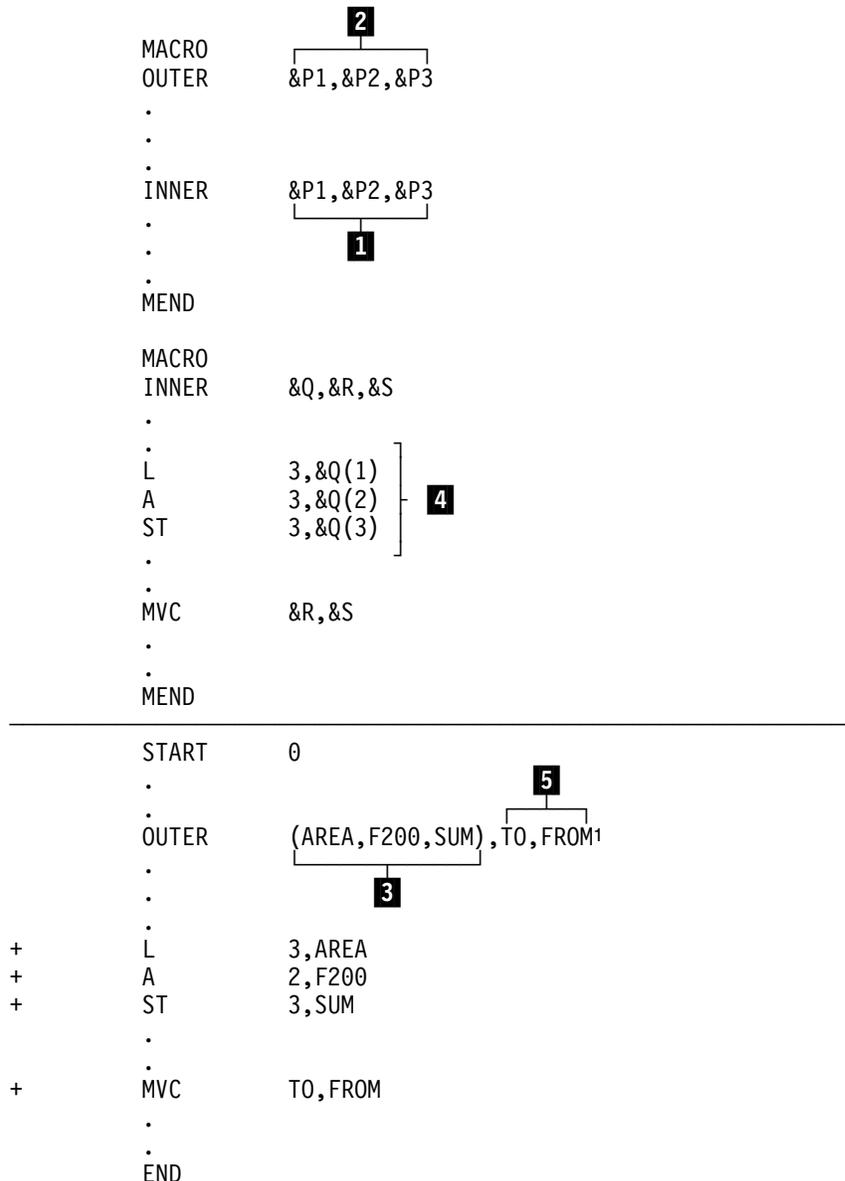
Passing Values through Nesting Levels

The value contained in an outer macro instruction operand can be passed through one or more levels of nesting (see Figure 82 on page 288). However, the value specified (see 1 in Figure 82) in the inner macro instruction operand must be identical to the corresponding symbolic parameter (see 2 in Figure 82) declared in the prototype of the containing macro definition.

Thus, a sublist can be passed (see 3 in Figure 82) and referred to (see 4 in Figure 82) as a sublist in the macro definition called by the inner macro call. Also, any symbol (see 5 in Figure 82) that is passed carries its attribute values through the nesting levels.

If inner macro calls at each level are specified with symbolic parameters as operand values, values can be passed from open code through several levels of macro nesting.

COMPAT(SYSLIST) Assembler Option: If the COMPAT(SYSLIST) assembler option is specified, and a symbolic parameter is only a part of the value specified in an inner macro instruction operand, only the character string value given to the parameter by an outer call is passed through the nesting level. Inner sublist entries are, therefore, not available for reference in the inner macro.



Notes:

1. The following inner macro call statement is generated, but not listed:

INNER (AREA, F200, SUM), TO, FROM

Figure 82. Passing Values Through Nesting Levels

System Variable Symbols in Nested Macros

The fixed global system variable symbols (see “System Variable Symbols” on page 235) are not affected by the nesting of macros. The variable global system variable symbols have values which may change during the expansion of a macro definition. The following system variable is specifically influenced by nested macros:

&SYSM_SEV

Provides the highest MNOTE severity code from the nested macro most recently called.

The local variable symbols are given read-only values each time a macro definition is called.

The following system variables can be affected by the position of a macro instruction in code and the operand value specified in the macro instruction:

&SYSCLOCK The assembler assigns &SYSCLOCK the constant string value representing the TOD clock value at the time at which a macro call is made. The time portion of this value goes down to the microsecond. For any inner macro call, the value assigned to &SYSCLOCK differs from that of its parent.

&SYSECT The assembler gives &SYSECT the character string value of the name of the control section in use at the point at which a macro call is made. For a macro definition called by an inner macro call, the assembler assigns to &SYSECT the name of the control section in effect in the macro definition that contains the inner macro call, at the time the inner macro is called.

If no control section is generated within a macro definition, the value assigned to &SYSECT does not change. It is the same for the next level of macro definition called by an inner macro instruction.

&SYSLIB_DSN, &SYSLIB_MEMBER, &SYSLIB_VOLUME

The assembler assigns the character string value of the syslib system variable symbols at the point at which a macro is called. For an inner macro call whose definition is from a library member, these values may differ, if this is the first time this macro is invoked.

&SYSLIST If &SYSLIST is specified in a macro definition called by an inner macro instruction, &SYSLIST refers to the positional operands of the inner macro instruction.

&SYSLOC The assembler gives &SYSLOC the character string value of the name of the location counter in use at the point at which a macro is called. For a macro definition called by an inner macro call, the assembler assigns to &SYSLOC the name of the location counter in effect in the macro definition that contains the inner macro call. If no LOCTR or control section is generated within a macro definition, the value assigned to &SYSLOC does not change. It is the same for the next level of macro definition called by an inner macro instruction.

&SYSNDX The assembler increments &SYSNDX by one each time it encounters a macro call. It retains the incremented value throughout the expansion of the macro definition called, that is, within the local scope of the nesting level.

- &SYSNEST** The assembler increments &SYSNEST by one each time it encounters a nested macro instruction. It retains the incremented value within the local scope of the macro definition called by the inner macro instruction. Subsequent nested macro instructions cause &SYSNEST to be incremented by 1. When the assembler exits from a nested macro it decreases the value in &SYSNEST by 1.
- &SYSSEQF** The assembler assigns &SYSSEQF the character string value of the identification-field of the outer-most macro instruction statement. The value of &SYSSEQF remains constant throughout the expansion of the called macro definition and all macro definitions called from within the outer macro.
- &SYSSTYP** The assembler gives &SYSSTYP the character string value of the type of the control section in use at the point at which a macro is called. For a macro definition called by an inner macro call, the assembler assigns to &SYSSTYP the type of the control section in effect in the macro definition that contains the inner macro call, at the time the inner macro is called.
- If no control section is generated within a macro definition, the value assigned to &SYSSTYP does not change. It is the same for the next level of macro definition called by an inner macro instruction.

Chapter 9. How to Write Conditional Assembly Instructions

This chapter describes the conditional assembly language. With the conditional assembly language, you can carry out general arithmetic and logical computations, and many of the other functions you can carry out with any other programming language. Also, by writing conditional assembly instructions in combination with other assembler language statements, you can:

- Select sequences of these source statements, called *model statements*, from which machine and assembler instructions are generated
- Vary the contents of these model statements during generation

The assembler processes the instructions and expressions of the conditional assembly language during conditional assembly processing. Then, at assembly time, it processes the generated instructions. Conditional assembly instructions, however, are not processed after conditional assembly processing is completed.

The conditional assembly language is more versatile when you use it to interact with symbolic parameters and the system variable symbols inside a macro definition. However, you can also use the conditional assembly language in open code; that is, code that is not within a macro definition.

Elements and Functions

The elements of the conditional assembly language are:

- SET symbols that represent data. See “SET Symbols” on page 292.
- Attributes that represent different characteristics of symbols. See “Data Attributes” on page 296.
- Sequence symbols that act as labels for branching to statements during conditional assembly processing. See “Sequence Symbols” on page 310.

The functions of the conditional assembly language are:

- Declaring SET symbols as variables for use locally and globally in macro definitions and open code. See “Declaring SET Symbols” on page 314.
- Assigning values to the declared SET symbols. See “Assigning Values to SET Symbols” on page 318.
- Selecting characters from strings for substitution in, and concatenation to, other strings; or for inspection in condition tests. See “Substring Notation” on page 344.
- Branching and exiting from conditional assembly loops. See “Branching” on page 346.

The conditional assembly language can also be used in open code with few restrictions. See “Open Code” on page 313.

The conditional assembly language provides instructions for evaluating conditional assembly expressions used as values for substitution, as subscripts for variable symbols, and as condition tests for branching. See “Conditional Assembly Instructions” on page 314 for details about the syntax and usage rules of each instruction.

SET Symbols

SET symbols are variable symbols that provide you with arithmetic, binary, or character data, and whose values you can vary during conditional assembly processing.

Use SET symbols as:

- Terms in conditional assembly expressions
- Counters, switches, and character strings
- Subscripts for variable symbols
- Values for substitution

Thus, SET symbols let you control your conditional assembly logic, and to generate many different statements from the same model statement.

Subscripted SET Symbols

You can use a SET symbol to represent a one-dimensional array of many values. You can then refer to any one of the values of this array by subscripting the SET symbol.

Scope of SET Symbols

The scope of a SET symbol is that part of a program for which the SET symbol has been declared. Local SET symbols need not be declared by explicit declarations. The assembler considers any undeclared variable symbol found in the name field of a SETx instruction as a local SET symbol.

If you declare a SET symbol to have a local scope, you can use it only in the statements that are part of either:

- The same macro definition, or
- Open code

If you declare a SET symbol to have a global scope, you can use it in the statements that are part of any one of:

- The same macro definition
- A different macro definition
- Open code

You must, however, declare the SET symbol as global for each part of the program (a macro definition or open code) in which you use it.

You can change the value assigned to a SET symbol without affecting the scope of this symbol.

Scope of Symbolic Parameters

A symbolic parameter has a local scope. You can use it only in the statements that are part of the macro definition for which the parameter is declared. You declare a symbolic parameter in the prototype statement of a macro definition.

The scope of system variable symbols is described in Figure 83 on page 293.

SET Symbol Specifications

SET symbols can be used in model statements, from which assembler language statements are generated, and in conditional assembly instructions. The three types of SET symbols are: SETA, SETB, and SETC. A SET symbol must be a valid variable symbol.

The rules for creating a SET symbol are:

- The first character must be an ampersand (&)
- The second character must be an alphabetic character
- The remaining characters must be 0 to 61 alphanumeric
- The first four characters should not be &SYS, which are used for system variable symbols

Examples:

```
&ARITHMETICVALUE439
&BOOLEAN
&C
&EASY-TO-READ
```

Local SET symbols need not be declared by explicit declarations. The assembler considers any undeclared variable symbol found in the name field of a SETx instruction as a local SET symbol. The instruction that declares a SET symbol determines its scope and type.

The features of SET symbols and other types of variable symbols are compared in Figure 83.

Figure 83 (Page 1 of 3). Features of SET Symbols and Other Types of Variable Symbols

Features	SETA, SETB, SETC symbols	Symbolic Parameters	System Variable Symbols
Can be used in: Open code	Yes	No	&SYSASM &SYSDATC &SYSDATE &SYSJOB &SYSM_HSEV &SYSM_SEV &SYSOPT_DBCS &SYSOPT_OPTABLE &SYSOPT_RENT &SYSOPT_XOBJECT &SYSPARM &SYSSTEP &SYSSTMT &SYSSTEM_ID &SYSTIME &SYSVER
Macro definitions	Yes	Yes	All

SET Symbols

Figure 83 (Page 2 of 3). Features of SET Symbols and Other Types of Variable Symbols

Features	SETA, SETB, SETC symbols	Symbolic Parameters	System Variable Symbols
Scope: Local	Yes	Yes	&SYSADATA_DSN &SYSADATA_MEMBER &SYSADATA_VOLUME &SYSCLOCK &SYSECT &SYSIN_DSN &SYSIN_MEMBER &SYSIN_VOLUME &SYSLIB_DSN &SYSLIB_MEMBER &SYSLIB_VOLUME &SYSLIN_DSN &SYSLIN_MEMBER &SYSLIN_VOLUME &SYSLIST &SYSLOC &SYSMAC &SYSNDX &SYSNEST &SYSPRINT_DSN &SYSPRINT_MEMBER &SYSPRINT_VOLUME &SYSPUNCH_DSN &SYSPUNCH_MEMBER &SYSPUNCH_VOLUME &SYSSEQF &SYSTEM_DSN &SYSTEM_MEMBER &SYSTEM_VOLUME
Global	Yes	No	&SYSASM &SYSDATC &SYSDATE &SYSJOB &SYSM_HSEV &SYSM_SEV &SYSOPT_DBCS &SYSOPT_OPTABLE &SYSOPT_RENT &SYSOPT_XOBJECT &SYSPARM &SYSSTEP &SYSSTMT &SYSTEM_ID &SYSTEMTIME &SYSVER

Figure 83 (Page 3 of 3). Features of SET Symbols and Other Types of Variable Symbols

Features	SETA, SETB, SETC symbols	Symbolic Parameters	System Variable Symbols
Values can be changed within scope of symbol	Yes ¹	No, read only value ²	No, read only value ²

Notes:

1. The value assigned to a SET symbol can be changed by using the SETA, SETAF, SETB, SETC, or SETCF instruction within the declared or implied scope of the SET symbol.
2. A symbolic parameter and the system variable symbols (except for &SYSSTMT, &SYSM_HSEV, and &SYSM_SEV) are assigned values that remain fixed throughout their scope. Wherever a SET symbol appears in a statement, the assembler replaces the symbol with the last value assigned to the symbol.

SET symbols can be used in the name, operation, and operand fields of macro instructions. The value thus passed through the name field symbolic parameter into a macro definition is considered as a character string and is generated as such. If the COMPAT(SYSLIST) assembler option is specified, the value passed through an operand field symbolic into a macro definition is also considered a character string and is generated as such. However, if the COMPAT(SYSLIST) assembler option is not specified, SET symbols can be used to pass sublists into a macro definition.

Subscripted SET Symbols Specifications

The format of a subscripted SET symbol is shown below.

►► *&symbol* (*subscript*) ◀◀

&symbol
is a variable symbol.

subscript
is an arithmetic expression with a value greater than or equal to 1.

Example:

```
&ARRAY(20)
```

The subscript can be any arithmetic expression allowed in the operand field of a SETA instruction (see “Arithmetic (SETA) Expressions” on page 319).

A subscripted SET symbol can be used anywhere an unsubscripted SET symbol is allowed. However, subscripted SET symbols must be declared as subscripted by a previous local or global declaration instruction.

The subscript refers to one of the many positions in an array of values identified by the SET symbol.

The dimension (the maximum value of the subscript) of a subscripted SET symbol is not determined by the explicit or implicit declaration of the symbol. The dimension specified can be exceeded in later SETx instructions.

The subscript can be a subscripted SET symbol.

Created SET Symbols

The assembler can create SET symbols during conditional assembly processing from other variable symbols and character strings. A SET symbol thus created has the form $\&(e)$, where e represents one or more of the following:

- Variable symbols, optionally subscripted
- Strings of alphanumeric characters
- Other created SET symbols

After substitution and concatenation, e must consist of a string of up to 62 alphanumeric characters, the first of which is alphabetic. The assembler considers the preceding ampersand and this string as the name of a SET variable.

You can use created SET symbols wherever ordinary SET symbols are permitted, including declarations. You can also nest them in other created SET symbols.

Consider the following example:

```
&ABC(1) SETC          'MKT','27','$5'
```

Let $\&(e)$ equal $\&(\&ABC(\&I)QUA\&I)$.

$\&I$	$\&ABC(\&I)$	Created SET Symbol	Comment
1	MKT	$\&MKTQUA1$	Valid
2	27	$\&27QUA2$	Invalid: character after '&' not alphabetic
3	\$5	$\&\$5QUA3$	Valid
4		$\&QUA4$	Valid

The created SET symbol can be thought of as a form of indirect addressing. With nested created SET symbols, you can get this kind of indirect addressing to any level.

In another sense, created SET symbols offer an associative storage facility. For example, a symbol table of numeric attributes can be referred to by an expression of the form $\&(\&SYM)(\&I)$ to yield the I th attribute of the symbol name in $\&SYM$.

Created SET symbols also enable you to get some of the effect of multiple-dimensioned arrays by creating a separate name for each element of the array. For example, a 3-dimensional array of the form $\&X(\&I,\&J,\&K)$ could be addressed as $\&(X\&I.\$&J.\$&K)$. Thus, $\&X(2,3,4)$ would be represented by $\&X2\$3\4 . The \$ separators guarantee that $\&X(2,33,55)$ and $\&X(23,35,5)$ are unique:

```
&X(2,33,55) becomes &X2\$33\$55  
&X(23,35,5) becomes &X23\$35\$5
```

Data Attributes

The data, such as instructions, constants, and areas, that you define in a source module, can be described by its:

- Type, which distinguishes one form of named object from another; for example, fixed-point constants from floating-point constants, or machine instructions from macro instructions

- Length, which gives the number of bytes occupied by the object code of the data
- Scaling, which shows the number of positions occupied by the fractional portion of fixed-point, floating-point, and decimal constants in their object code form
- Integer, which shows the number of positions occupied by the integer portion of fixed-point and decimal constants in their object code form
- Count, which gives the number of characters that would be required to represent the data, such as a macro instruction operand, as a character string
- Number, which gives the number of sublist entries in a macro instruction operand
- Defined, which determines whether a symbol has been defined prior to the point where the attribute reference is coded
- Operation Code, which shows if an operation code, such as a macro definition or machine instruction, is defined prior to the point where the attribute reference is coded

These characteristics are called the attributes of the symbols naming the data. The assembler assigns attribute values to the ordinary symbols and variable symbols that represent the data.

Specifying attributes in conditional assembly instructions allows you to control conditional assembly logic, which, in turn, can control the sequence and contents of the statements generated from model statements. The specific purpose for which you use an attribute depends on the kind of attribute being considered. The attributes and their main uses are shown below:

Figure 84 (Page 1 of 2). Data Attributes

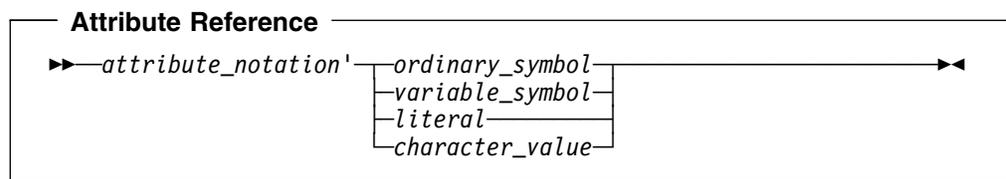
Attribute	Purpose	Main Uses
Type	Gives a letter that identifies type of data represented	<ul style="list-style-type: none"> • In tests to distinguish between different data types • For value substitution • In macros to discover missing operands
Length	Gives number of bytes that data occupies in storage	<ul style="list-style-type: none"> • For substitution into length fields • For computation of storage requirements
Scaling	Refers to the position of the decimal point in fixed-point, floating-point and decimal constants	<ul style="list-style-type: none"> • For testing and regulating the position of decimal points • For substitution into a scale modifier
Integer	Is a function of the length and scaling attributes of decimal, fixed-point, and floating-point constants	<ul style="list-style-type: none"> • To keep track of significant digits (integers)
Count	Gives the number of characters required to represent data	<ul style="list-style-type: none"> • For scanning and decomposing character strings • As indexes in substring notation
Number ¹	Gives the number of sublist entries in a macro instruction operand sublist	<ul style="list-style-type: none"> • For scanning sublists • As a counter to test for end of sublist

Figure 84 (Page 2 of 2). Data Attributes

Attribute	Purpose	Main Uses
Defined	Shows whether the symbol referenced has been defined prior to the attribute reference	<ul style="list-style-type: none"> To avoid assembling a statement again if the symbol referenced has been previously defined
Operation Code	Shows whether a given operation code has been defined prior to the attribute reference	<ul style="list-style-type: none"> To avoid assembling a macro, or instruction if it does not exist.

Notes:

- The number attribute of &SYSLIST(*n*) and &SYSLIST(*n,m*) is described in “&SYSLIST System Variable Symbol” on page 250.



attribute_notation'
is the attribute whose value you want, followed by a single quotation mark.

ordinary_symbol
is an ordinary symbol that represents the data that possesses the attribute. An ordinary symbol cannot be specified with the operation code attribute.

variable_symbol
is a variable symbol that represents the data that possesses the attribute.

literal
is a literal that represents the data that possesses the attribute. A literal cannot be specified with the operation code attribute or count attribute.

character_string
is a character string that represents the operation code in the operation code attribute.

Examples:

```
T'SYMBOL
L'&VAR
K'&PARAM
O'MVC
S'=P'975.32'
```

The assembler substitutes the value of the attribute for the attribute reference.

Reference to the count (K'), defined (D'), number (N'), and operation code (O') attributes can be used only in conditional assembly instructions or within macro definitions. The length (L'), type (T'), integer (I'), and scaling (S') attribute references can be in conditional assembly instructions, machine instructions, assembler instructions, and the operands of macro instructions.

Combining Attributes with Symbols

Figure 85 shows attributes (the column headers) and symbols (the row headers). The cell at the intersection of a column and row shows whether you can create a valid expression that includes the attribute of one symbol with another symbol. For example, the length (L') attribute is a number. Therefore you can't combine it with a SETC symbol (which is a character expression), but you can combine it with a SETA symbol (which is a numeric expression). The value in the cell shows whether you can combine the attribute with all of the particular type of symbol ("Yes"), some of the symbols ("SETC only"), or none of the particular symbols ("No").

Figure 85. Attributes and Related Symbols

Symbols Specified	Type T'	Length L'	Scaling S'	Integer I'	Count K'	Number N'	Defined D'	Operation Code O'
In open code:								
Ordinary symbols	Yes	Yes	Yes	Yes	No	No	Yes	No
SET symbols	SETB ² and SETC	SETA and SETB ³	SETB ² and SETC					
System variable symbols with global scope	Yes	No	No	No	Yes	Yes	No	No
Literals	Yes ¹	Yes	Yes	Yes	No	No	Yes	No
In macro definitions:								
Ordinary symbols	Yes	Yes	Yes	Yes	No	No	Yes	No
SET symbols	SETB ² and SETC	SETA and SETB ³	SETB ² and SETC					
Symbolic parameters	Yes							
System variable symbols:								
&SYSLIST	Yes	No						
All others	Yes	No	No	No	Yes	Yes	No	No
Literals	Yes ¹	Yes	Yes	Yes	No	No	Yes	No

Note:

1. The literal must also be defined.
2. Only in character relations.
3. Only in arithmetic relations.

The value of an attribute for an ordinary symbol specified in an attribute reference comes from the data represented by the symbol. The symbol must appear in the name field of an assembler or machine instruction, or in the operand field of an EXTRN or WXTRN instruction.

Notes:

1. You cannot refer to the names of instructions generated by conditional assembly substitution or macro generation until the instruction is generated.
2. If you use a symbol qualifier to qualify an ordinary symbol in an attribute reference, the qualifier is ignored.

The value of an attribute for a variable symbol specified in an attribute reference comes from the value substituted for the variable symbol as follows:

SET Symbols and System Variable Symbols: For SET symbols and all system variable symbols other than &SYSLIST, the attribute values come from the current data value of these symbols.

Symbolic Parameters and &SYSLIST: For symbolic parameters and the system variable symbol, &SYSLIST, the values of the count and number attributes come from the operands of macro instructions. The values of the type, length, scaling, and integer attributes, however, come from the values represented by the macro instruction operands, as follows:

1. If the operand is a sublist, the entire sublist and each entry of the sublist can possess attributes; all the individual entries and the whole sublist have the same attributes as those of the first suboperand in the sublist (except for the count attribute, which can be different, and the number attribute which is relevant only for the whole sublist).
2. If the first character or characters of the operand (or sublist entry) constitute an ordinary symbol, and this symbol is followed by either an arithmetic operator (+, -, *, or /), a left parenthesis, a comma, or a blank, then the value of the attributes for the operand are the same as for the ordinary symbol.
3. If the operand (or sublist entry) is a character string other than a sublist or the character string described in (b) above, the type attribute is undefined (U) and the length, scaling, and integer attributes are invalid.

Because the count (K'), number (N'), and defined (D') attribute references are allowed only in conditional assembly instructions, their values are available only during conditional assembly processing. They are not available at ordinary assembly time.

The system variable symbol &SYSLIST can be used in an attribute reference to refer to a macro instruction operand, and, in turn, to an ordinary symbol. Thus, any of the attribute values for macro instruction operands and ordinary symbols listed below can also be substituted for an attribute reference containing &SYSLIST.

Type Attribute (T')

The type attribute has a value of a single alphabetic character that shows the type of data represented by:

- An ordinary symbol
- A macro instruction operand
- A SET symbol
- A literal

The type attribute can change during an assembly. The lookahead search might assign one attribute, whereas the symbol table at the end of the assembly might display another.

The type attribute reference can be used in the operand field of the SETC instruction or as one of the values used for comparison in the operand field of a SETB or AIF instruction.

The type attribute can also be specified outside conditional assembly instructions. Then, the type attribute value is not available for conditional assembly processing, but is used as a value at assembly time.

The following letters are used for the type attribute of data represented by ordinary symbols and outer macro instruction operands that are symbols that name DC or DS statements.

|	A	A-, J-type address constant, implied length, aligned (also CXD instruction label)
	B	Binary constant
	C	Character constant
	D	Long floating-point constant, implicit length, aligned
	E	Short floating-point constant, implicit length, aligned
	F	Fullword fixed-point constant, implicit length, aligned
	G	Fixed-point constant, explicit length
	H	Halfword fixed-point constant, implicit length, aligned
	K	Floating-point constant, explicit length
	L	Extended floating-point constant, implicit length, aligned
	P	Packed decimal constant
	Q	Q-type address constant, implicit length, aligned
|	R	A-, S-, Q-, J-, R-, V-, or Y-type address constant, explicit length
	S	S-type address constant, implicit length, aligned
|	V	R-, V-type address constant, implicit length, aligned
	X	Hexadecimal constant
	Y	Y-type address constant, implicit length, aligned
	Z	Zoned decimal constant
	@	Graphic (G) constant

When a literal is specified as the name field on a macro call instruction, and if the literal has previously been used in a machine instruction, the type attribute of the literal is the same as for data represented by ordinary symbols or outer macro instructions operands.

The following letters are used for the type attribute of data represented by ordinary symbols (and outer macro instruction operands that are symbols) that name statements other than DC or DS statements, or that appear in the operand field of an EXTRN or WXTRN statement:

|	I	Machine instruction
	J	Control section name
	M	The name field on a macro instruction, when the name field is: <ul style="list-style-type: none"> • a valid symbol not previously defined • a valid literal not previously defined
	T	Identified as an external symbol by EXTRN instruction
	W	CCW, CCW0, or CCW1 instruction
	\$	Identified as an external symbol by WXTRN instruction

Data Attributes

The following letters are used for the type attribute of data represented by inner and outer macro instruction operands only.

- N** Self-defining term or the value of a SETA or SETB variable
- O** Omitted operand (has a value of a null character string)

The following letter is used for symbols or macro instruction operands that cannot be assigned any of the above letters:

- U** Undefined, unknown, or unassigned

The common use of the U type attribute is to describe a valid symbol that has not been assigned any of the type attribute values described above. If the assembler is not able to determine what the named symbol represents, it also assigns the U type attribute. Thus, the U type attribute can mean *undefined*, or *unknown*, or *unassigned* at the time of the reference. Consider the following macro definition:

Name	Operation	Operand
	macro	
	MAC1	&op1,&op2
&A	setc	T'&op1
&B	setc	T'&op2
	DC	C'&A' DC containing type attribute for op1
	DC	C'&B' DC containing type attribute for op2
	mend	

When the macro MAC1 is called in Figure 86, neither of the operands has previously been defined, however GOOD_SYMBOL is a valid symbol name, whereas ?BAD_SYMBOL? is a not valid symbol name. The type attribute for both operands is U, meaning GOOD_SYMBOL is undefined, and ?BAD_SYMBOL? is unknown.

```
000000          00000 00004    8 a  csect
000000 E4          9      mac1 GOOD_SYMBOL,?BAD_SYMBOL?
000001 E4         10+      DC C'U'          DC containing type attribute for op1
000002 E4         11+      DC C'U'          DC containing type attribute for op2
000003 E4         12 DC C'U'          DC containing type attribute for op1
000003 E4         13 DC C'U'          DC containing type attribute for op2
000003 E4         14      end
```

Figure 86. Undefined and Unknown Type Attributes

When the macro MAC1 is called in Figure 87, GOOD_SYMBOL is a valid symbol name, and has been defined in the DC instruction at statement 12. ?BAD_SYMBOL? is a not valid symbol name, and the assembler issues an error message at statement 13. The type attribute for GOOD_SYMBOL is C, meaning the symbol represents a character constant. The type attribute for ?BAD_SYMBOL? is U, meaning the type is unknown.

```
000000          00000 00006    8 a  csect
000000 C3          9      mac1 GOOD_SYMBOL,?BAD_SYMBOL?
000001 E4         10+      DC C'C'          DC containing type attribute for op1
000002 C3         11+      DC C'U'          DC containing type attribute for op2
000003 E4         12 DC C'C'          DC containing type attribute for op1
000004 A9         13 DC C'U'          DC containing type attribute for op2
000005 A9         14 GOOD_SYMBOL dc c11'z'
000005 A9         15 ?BAD_SYMBOL? dc c11'z'
** ASMA147E Symbol too long, or first character not a letter - ?BAD_SYMBOL?
000005 A9         16      end
```

Figure 87. Unknown Type Attribute for Invalid Symbol

The type attribute value U, meaning *undefined*, *unknown*, or *unassigned*, is assigned to the following:

- Ordinary symbols used as labels:
 - For the LTORG instruction
 - For the EQU instruction without a third operand
 - For DC and DS statements that contain variable symbols, for example, `U1 DC &X'1'`
 - That are defined more than once, even though only one label is generated due to conditional assembly statements
- SETC variable symbols that have a value other than a null character string or the name of an instruction that can be referred to be a type attribute reference
- System variable symbols except:
 - &SYSDATC, &SYSM_HSEV, &SYSM_SEV, &SYSNDX, &SYSNEST, &SYSOPT_DBCS, &SYSOPT_RENT, &SYSOPT_XOBJECT, and &SYSSTMT, which always have a type attribute value of N
 - Some other character type system variable symbols which may be assigned a value of a null string, when they have a type attribute value of O
- Macro instruction operands that specify a literal that is not a duplicate of a literal used in a machine instruction
- Inner macro instruction operands that are ordinary symbols

Notes:

1. Ordinary symbols used in the name field of an EQU instruction have the type attribute value U. However, the third operand of an EQU instruction can be used explicitly to assign a type attribute value to the symbol in the name field.
2. The type attribute of a sublist is set to the same value as the type attribute of the first element of the sublist.
3. High Level Assembler and earlier assemblers treat the type attribute differently:
 - Because High Level Assembler allows attribute references to statements generated through substitution, certain cases in which a type attribute of U (undefined, unknown, or unassigned) or M (macro name field) is given under the DOS/VSE Assembler, may give a valid type attribute under High Level Assembler. If the value of the SETC symbol is equal to the name of an instruction that can be referred to by the type attribute, High Level Assembler lets you use the type attribute with a SETC symbol.
 - Because High Level Assembler allows attribute references to literals, certain cases in which a type attribute of U (undefined, unknown, or unassigned) is given by Assembler F and Assembler H for a macro operand that specifies a literal, may give a valid type attribute under High Level Assembler. If the literal specified in the macro instruction operand is a duplicate of a literal specified in open code, or previously generated by conditional assembly processing or macro generation, High Level Assembler gives a type attribute that shows the type of data specified in the literal. The COMPAT(LITTYPE) option causes High Level Assembler to

behave like Assembler H, always giving a type attribute of U for the T' literal.

Length Attribute (L')

The length attribute has a numeric value equal to the number of bytes occupied by the data that is named by the symbol specified in the attribute reference.

If the length attribute value is desired for conditional assembly processing, the symbol specified in the attribute reference must ultimately represent the name entry of a statement in open code. In such a statement, the length modifier (for DC and DS instructions) or the length field (for a machine instruction), if specified, must be a self-defining term. The length modifier or length field must not be coded as a multiterm expression, because the assembler does not evaluate this expression until assembly time.

The assembler lets you use the length attribute with a SETC symbol, if the value of the SETC symbol is an ordinary symbol that can be referenced by the length attribute.

The length attribute can also be specified outside conditional assembly instructions. Then, the length attribute value is not available for conditional assembly processing, but is used as a value at assembly time.

Figure 88 is an example showing the evaluation of the length attribute for an assembler instruction in statement 1 and for a conditional assembly instruction in statement 8.

```

000000 E740          1 CSYM DC    CL(L'ZLOOKAHEAD)'X'  Length resolved later
                    2 &LEN SETA  L'CSYM
** ASMA042E Length attribute of symbol is unavailable; default=1
                    3      DC    C'&LEN '    REAL LENGTH NOT AVAILABLE
000002 F140          +      DC    C'1 '      REAL LENGTH NOT AVAILABLE
                    4 &TYP SETC  T'CSYM
                    5      DC    C'&TYP '   TYPE IS KNOWN
000004 C340          +      DC    C'C '     TYPE IS KNOWN
                    6 &DEF SETA  D'CSYM
                    7      DC    C'&DEF '   SYMBOL IS DEFINED
000006 F140          +      DC    C'1 '     SYMBOL IS DEFINED
                    8 &LEN SETA  L'zlookahead Length resolved immediately
                    9 CSYM2 DC    CL(&len)'X'
000008 E740          +CSYM2 DC    CL(2)'X'
                    10 &LEN SETA  L'CSYM2
                    11      DC    C'&LEN '   REAL LENGTH NOW AVAILABLE
00000A F240          +      DC    C'2 '     REAL LENGTH NOW AVAILABLE
00000C 0001          12 ZLOOKAHEAD DC    H'1'
                    13      END

```

Figure 88. Evaluation of Length Attribute References

In statement 2 the length of CSYM has not been established because the definition of CSYM in statement 1 is not complete. The reference to the length attribute results in a length of 1 and error message ASMA042E. However, statement 5 shows that the type attribute is assigned, and statement 7 shows that the defined attribute is assigned. In comparison, the length attribute for symbol CSYM2 is available immediately, as it was retrieved indirectly using the conditional assembly instruction in statement 8.

During conditional assembly, an ordinary symbol used in the name field of an EQU instruction has a length attribute value of 1. At assembly time, the symbol has the

same length attribute value as the first symbol of the expression in the first operand of the EQU instruction. However, the second operand of an EQU instruction can be used to assign a length attribute value to the symbol in the name field. This second operand can not be a forward reference to another EQU instruction.

Notes:

1. The length attribute reference, when used in conditional assembly processing, can be specified only in arithmetic expressions.
2. When used in conditional assembly processing, a length attribute reference to a symbol with the type attribute value of M, N, O, T, U, or \$ is flagged. The length attribute for the symbol has the default value of 1.

Scaling Attribute (S')

The scaling attribute can be used only when referring to fixed-point, floating-point, or decimal constants. The following table shows the numeric value assigned to the scaling attribute:

Constant Types Allowed	Type of DC Allowed	Value of Scaling Attribute Assigned
Fixed-Point	H and F	Equal to the value of the scale modifier (-187 through +346)
Floating Point	D, E, and L	Equal to the value of the scale modifier (0 through 14 — D, E) (0 through 28 — L)
Decimal	P and Z	Equal to the number of decimal digits specified to the right of the decimal point (0 through 31 — P) (0 through 16 — Z)

The scaling attribute can also be specified outside conditional assembly instructions. Then, the scaling attribute value is not available for conditional assembly processing, but is used as a value at assembly time.

Notes:

1. The scaling attribute reference can be used only in arithmetic expressions.
2. When no scaling attribute value can be determined, the reference is flagged and the scaling attribute is 1.
3. If the value of the SETC symbol is equal to the name of an instruction that can be referenced by the scaling attribute, the assembler lets you use the scaling attribute with a SETC symbol.
4. Binary floating-point constants return an attribute of 0.

Integer Attribute (I')

The integer attribute has a numeric value that depends on the length and scaling attribute values of the data being referred to by the attribute reference. The formulas relating the integer attribute to the length and scaling attributes are given in Figure 89.

The integer attribute can also be specified outside conditional assembly instructions. Then, the integer attribute value is not available for conditional assembly processing, but is used as a value at assembly time.

Figure 89. Relationship of Integer to Length and Scaling Attributes

Constant Type ¹	Formula Relating Integer to Length and Scaling Attributes ²	Examples	Values of the Integer Attribute
Fixed-point (H and F)	$I' = 8 * L' - S' - 1$	HALFCON DC HS6'-25.93' ONECON DC FS8'100.3E-2'	$I' = 8 * 2 - 6 - 1 = 9$ $I' = 8 * 4 - 8 - 1 = 23$
Floating-point (D, E, and L)	when $L' \leq 8$ $I' = 2 * (L' - 1) - S'$	SHORT DC ES2'46.415' LONG DC DS5'-3.729'	$I' = 2 * (4 - 1) - 2 = 4$ $I' = 2 * (8 - 1) - 5 = 9$
L-type only	when $L' > 8$ $I' = 2 * (L' - 1) - S' - 2$	EXTEND DC LS10'5.312'	$I' = 2 * (16 - 1) - 10 - 2 = 18$
Decimal ³ Packed (P)	$I' = 2 * L' - S' - 1$	PACK DC P'+3.513'	$I' = 2 * 3 - 3 - 1 = 2$
Zoned (Z)	$I' = L' - S'$	ZONE DC Z'3.513'	$I' = 4 - 3 = 1$

Notes:

1. If the value of a SETC symbol is equal to the name of an instruction that can be referenced by the integer attribute, you can use the integer attribute reference with the SETC symbol.
2. The integer attribute reference can only be used in arithmetic expressions in conditional assembly instructions, and in absolute and relocatable expressions in assembler and machine instructions.
3. The value of the integer attribute is equal to the number of digits to the left of the assumed decimal point after the constant is assembled.

Count Attribute (K')

The count attribute applies only to macro instruction operands, to SET symbols, and to the system variable symbols. It has a numeric value equal to the number of characters:

- That constitute the macro instruction operand, or

- That would be required to represent as a character string the current value of the SET symbol or the system variable symbol.

Notes:

1. The count attribute reference can be used only in arithmetic expressions.
2. The count attribute of an omitted macro instruction operand has a value of 0.
3. Doubled quotes (' ') count as one character. Doubled ampersands (&&) count as two characters. For more information about character pairs see “Evaluation of Character Expressions” on page 337.

Number Attribute (N')

The number attribute applies to the operands of macro instructions and subscripted SET symbols.

When applied to a macro operand, the number attribute is a numeric value equal to the number of sublist entries.

When applied to a subscripted SET symbol, the number attribute is equal to the highest element to which a value has been assigned in a SETx instruction. Consider the example in Figure 90.

		1	macro
		2	MAC1 &op1
		3	lcla &SETSUB(100)
		4	&SETSUB(5) seta 20,,70
		5	&B seta N'&SETSUB
		6	&C seta N'&op1
		7	DC C'Highest referenced element of SETSUB = &B'
		8	DC C'Number of sublist entries in OP1 = &C'
		9	mend
000000	00000 0004C	10	a csect
		11	MAC1 (1,(3),(4))
000000	C889878885A2A340	12+	DC C'Highest referenced element of SETSUB = 8'
000028	D5A4948285994096	13+	DC C'Number of sublist entries in OP1 = 3'
		14	end

Figure 90. Number Attribute Reference

N'&op1 is equal to 3 because there are three subscripts in the macro operand in statement 11: 1, (3), and (4).

N'&SETSUB is equal to 8 because &SETSUB(8), assigned the value 70 in statement 4, is the highest referenced element of the &SETSUB sublist entries.

Notes:

1. The number attribute reference can be used only in arithmetic expressions.
2. N'&SYSLIST refers to the number of positional operands in a macro instruction, and N'&SYSLIST(n) refers to the number of sublist entries in the n-th operand.
3. For all other system variable symbols, the number attribute value is always one. This is also true for &SYSMAC. The range of the subscript for &SYSMAC is zero to &SYSNEST inclusive.
4. N' is always zero for unsubscripted set symbols.

Defined Attribute (D')

The defined attribute shows whether or not the symbol or literal referenced has been defined prior to the attribute reference. A symbol is defined if it has been encountered in the operand field of an EXTRN or WXTRN statement, or in the name field of any other statement except a TITLE statement or a macro instruction. A literal is defined if it has been encountered in the operand field of a machine instruction. The value of the defined attribute is an arithmetic value that can be assigned to a SETA symbol, and is equal to 1 if the symbol has been defined, or 0 if the symbol has not been defined.

The defined attribute can reference:

- Ordinary symbols
- Macro instruction operands
- SET symbols
- Literals

The following is an example of how you can use the defined attribute:

Name	Operation	Operand
	AIF	(D'A) .AROUND
A	LA	1,4
.AROUND	ANOP	

In this example, assuming there has been no previous definition of the symbol A, the statement labeled A would be assembled, since the branch around it would not be taken. However, if by a branch the same statement were processed again, the statement at A would not be assembled:

Name	Operation	Operand
.UP	AIF	(D'A) .AROUND
A	LA	1,4
.AROUND	ANOP	
	.	
	.	
	AGO	.UP

You can save assembly time using the defined attribute which avoids lookahead mode (see “Lookahead” on page 311 for more information). You can use the defined attribute in your program to prevent the assembler from making this time-consuming forward scan. This attribute reference can be used in the operand field of a SETA instruction or as one of the values to be tested in the operand field of a SETB or AIF instruction.

Operation Code Attribute (O')

The operation code attribute shows whether a given operation code has been defined prior to the attribute reference. The operation code can be represented by a character string or by a variable symbol containing a character string. The variable must be set using a SETC assembler instruction prior to being referenced by the operation code (O') attribute.

The operation code attribute has a value of a single alphabetic character that shows the type of operation represented.

This attribute reference can be used in the operand field of the SETC instruction or as one of the values used for comparison in the operand field of a SETB or AIF instruction.

The following letters are used for the operation code attribute:

- A** Assembler operation code
- E** Extended mnemonic operation code
- M** Macro definition
- O** Machine operation code
- S** Macro definition found in library
- U** Undefined, unknown, unassigned, or deleted operation code

Notes:

1. The operation code (O') attribute can only be used on a conditional assembly statement.
2. The assembler does not enter lookahead mode to resolve the operation code type, therefore only operation codes defined at the time the attribute is referenced return an operation code type value other than U.
3. When the operation code is not an assembler instruction or a machine instruction, and the operation code is not a previously defined macro, then all libraries in the library dataset definition list are searched. This may have an adverse impact on the performance of the assembly, depending on the number of libraries assigned in the assembly job and the number of times the operation code attribute is used.

Examples:

Name	Operation	Operand
&A	SETC	0'MVC

&A contains the letter O, because MVC is a machine operation code:

Name	Operation	Operand
&A	SETC	'DROP'
&B	SETC	0'&A

&B contains the letter A, because DROP is an assembler operation code.

The following example checks to see if the macro MAC1 is defined. If not, the MAC1 macro instruction is bypassed. This prevents the assembly from failing when the macro is not available.

Name	Operation	Operand
&CHECKIT	SETC	0'MAC1
	AIF	('&CHECKIT' EQ 'U').NOMAC
	MAC1	
.NOMAC	ANOP	
	.	

Redefined Operation Codes: If an operation code is redefined using the OPSYN instruction then the value returned represents the new operation code. If the operation code is deleted using the OPSYN instruction then the value returned is U.

Sequence Symbols

You can use a sequence symbol in the name field of a statement to branch to that statement during conditional assembly processing, thus altering the sequence in which the assembler processes your conditional assembly and macro instructions. You can select the model statements from which the assembler generates assembler language statements for processing at assembly time.

A sequence symbol consists of a period (.) followed by an alphabetic character, followed by 0 to 61 alphanumeric characters.

Examples:

```
.BRANCHING_LABEL#1  
.A
```

Sequence symbols can be specified in the name field of assembler language statements and model statements; however, sequence symbols must not be used as name entries in the following assembler instructions:

ALIAS	ICTL	SETA
AREAD	LOCTR	SETB
DXD	MACRO	SETC
EQU	OPSYN	

Also, sequence symbols cannot be used as name entries in macro prototype instructions, or in any instruction that already contains an ordinary or a variable symbol in the name field.

Sequence symbols can be specified in the operand field of an AIF or AGO instruction to branch to a statement with the same sequence symbol as a label.

Scope: A sequence symbol has a local scope. Thus, if a sequence symbol is used in an AIF or an AGO instruction, the sequence symbol must be defined as a label in the same part of the program in which the AIF or AGO instruction appears; that is, in the same macro definition or in open code.

Symbolic Parameters: If a sequence symbol appears in the name field of a macro instruction, and the corresponding prototype statement contains a symbolic parameter in the name field, the sequence symbol does not replace the symbolic parameter wherever it is used in the macro definition. The value of the symbolic parameter is a null character string.

Example:

```

MACRO
&NAME MOVE      &TO,&FROM      Statement 1
&NAME ST        2,SAVEAREA    Statement 2
      L          2,&FROM
      ST        2,&TO
      L          2,SAVEAREA
MEND
-----
.SYM  MOVE      FIELDA,FIELDB  Statement 3
-----
+     ST        2,SAVEAREA    Statement 4
+     L          2,FIELDDB
+     ST        2,FIELDA
+     L          2,SAVEAREA

```

The symbolic parameter &NAME is used in the name field of the prototype statement (Statement 1) and the first model statement (Statement 2). In the macro instruction (Statement 3), a sequence symbol (.SYM) corresponds to the symbolic parameter &NAME. &NAME is not replaced by .SYM and, therefore, the generated statement (Statement 4) does not contain an entry in the name field.

Lookahead

Symbol attributes are established in either definition mode or lookahead mode.

Definition mode occurs whenever a previously undefined symbol is encountered in the name field of a statement, or in the operand field of an EXTRN or WXTRN statement during open code processing. Symbols within a macro definition are defined when the macro is expanded.

Lookahead mode is entered:

- When the assembler processes a conditional assembly instruction and encounters an attribute reference (other than D' and O') to an ordinary symbol that is not yet defined.
- When the assembler encounters a forward AGO or AIF branch in open code to a sequence symbol that is not yet defined.

Lookahead is a sequential, statement-by-statement, forward scan over the source text.

If the attribute reference is made in a macro, forward scan begins with the first source statement following the outermost macro instruction. During lookahead the assembler:

- Bypasses macro definition and generation
- Does not generate object text
- Does not perform open-code variable substitution
- Ignores AIF and AGO branch instructions
- Establishes interim data attributes for undefined symbols it encounters in operand fields of instructions. The data attributes are replaced when a symbol is subsequently encountered in definition mode.

Lookahead mode ends when the desired symbol or sequence symbol is found, or when the END statement or end of file is reached. All statements read by lookahead are saved on an internal file, and are fully processed when the lookahead scan ends.

If a COPY instruction is encountered during lookahead, it is fully processed at that time, the assembler copies the statements from the library, scans them, and saves them on the lookahead file. When lookahead mode has ended any COPY instructions saved to the lookahead file are ignored, as the statements from the copy member have already been read and saved to the lookahead file.

If a variable symbol is used for the member name of a COPY that is expanded during lookahead, the value of the variable symbol at the time the COPY is expanded is used.

For purposes of attribute definition, a symbol is considered partially defined if it depends in any way upon a symbol not yet defined. For example, if the symbol is defined by a forward EQU that is not yet resolved, that symbol is assigned a type attribute of U.

In this case, it is quite possible that, by the end of the assembly, the type attribute has changed to some other value.

Generating END statements: Because no variable symbol substitution is carried out during lookahead, you should consider the following effects of using macro, AINSERT or open code substitution to generate END statements that separate source modules assembled in one job step (BATCH assembler option). If a symbol is undefined within a module, lookahead might read statements past the point where the END statement is to be generated. Lookahead stops when:

1. It finds the symbol
2. It finds an END statement
3. It reaches the end of the source input data set

In the first two cases, the assembler begins the next module at the statement after lookahead stopped, which could be after the point where you wanted to generate the END statement.

Lookahead Restrictions

The assembler analyzes the statements it processes during lookahead, only to establish attributes of symbols in their name fields.

Variable symbols are not replaced. Modifier expressions are evaluated only if all symbols involved were defined prior to lookahead. Possible multiple or inconsistent definition of the same symbol is not diagnosed during lookahead because conditional assembly may eliminate one (or more) of the definitions.

Lookahead does not check undefined operation codes against library macro names. If the name field contains an ordinary symbol and the operation code cannot be matched with one in the current operation code table, then the ordinary symbol is assigned the type attribute of M. If the operation code contains special characters or is a variable symbol, a type attribute of U is assumed. This may be wrong if the undefined operation code is later defined by OPSYN. OPSYN statements are not processed; thus, labels are treated in accordance with the operation code definitions in effect at the time of entry to lookahead.

Sequence Symbols

The conditional assembly instructions `AGO` and `AIF` in open code control the sequence in which source statements are processed. Using these instructions it is possible to branch back to a sequence symbol label and re-use previously processed statements. Due to operating system restrictions, the primary input source can only be read sequentially, and cannot be re-read. Whenever a sequence symbol in the name field is encountered in open code, the assembler must assume that all subsequent statements may need to be processed more than once. The assembler uses the lookahead file to save the statement containing the sequence symbol label and all subsequent statements as they are read and processed. Any subsequent `AGO` or `AIF` to a previously encountered sequence symbol will be resolved to an offset into the lookahead file and input will continue from that point.

Open Code

Conditional assembly instructions in open code let you:

- Select, during conditional assembly, statements or groups of statements from the open code portion of a source module according to a predetermined set of conditions. The assembler further processes the selected statements at assembly time.
- Pass local variable information from open code through parameters into macro definitions.
- Control the computation in and generation of macro definitions using global `SET` symbols.
- Substitute values into the model statements in the open code of a source module and control the sequence of their generation.

All the conditional assembly elements and instructions can be specified in open code.

The specifications for the conditional assembly language described in this chapter also apply in open code. However, the following restrictions apply:

To Attributes In Open Code: For ordinary symbols, only references to the type, length, scaling, integer, defined, and operation code attributes are allowed.

References to the number attribute have no meaning in open code, because `&SYSLIST` is not allowed in open code, and symbolic parameters have no meaning in open code.

To Conditional Assembly Expressions: Figure 91 shows the restrictions for different expression types.

Figure 91 (Page 1 of 2). Restrictions on Coding Expressions

Expression	Must not contain
Arithmetic (SETA)	<ul style="list-style-type: none"> • <code>&SYSLIST</code> • Symbolic parameters • Any attribute references to symbolic parameters, or system variable symbols with local scope

Figure 91 (Page 2 of 2). Restrictions on Coding Expressions

Expression	Must not contain
Character (SETC)	<ul style="list-style-type: none"> • System variables with local scope • Attribute references to system variables with local scope • Symbolic parameters
Logical (SETB)	<ul style="list-style-type: none"> • Arithmetic expressions with the items listed above • Character expressions with the items listed above

Conditional Assembly Instructions

The remainder of this chapter describes, in detail, the syntax and rules for use of each conditional assembler instruction. The following table lists the conditional assembler instructions by type, and provides the page number where the instruction is described in detail.

Figure 92. Assembler Instructions

Type of Instruction	Instruction	Page No.
Establishing SET symbols	GBLA	315
	GBLB	315
	GBLC	315
	LCLA	316
	LCLB	316
	LCLC	316
	SETA	318
	SETB	328
	SETC	333
Branching	ACTR	350
	AGO	349
	AIF	346
	ANOP	351
External Function Calling	SETAF	342
	SETCF	343

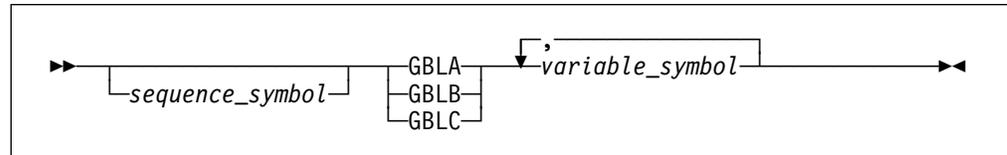
Declaring SET Symbols

You must declare a global SET symbol before you can use it. The assembler assigns an initial value to a global SET symbol at its point of declaration.

Local SET symbols need not be declared explicitly with LCLA, LCLB, or LCLC statements. The assembler considers any undeclared variable symbol found in the name field of a SETA, SETB, SETC, SETAF, or SETCF statement to be a local SET symbol. It is given the initial value specified in the operand field. If the symbol in the name field is subscripted, it is declared as a subscripted SET symbol.

GBLA, GBLB, and GBLC Instructions

Use the GBLA, GBLB, and GBLC instructions to declare the global SETA, SETB, and SETC symbols you need. The SETA, SETB, and SETC symbols are assigned the initial values of 0, 0, and null character string, respectively.



sequence_symbol
is a sequence symbol.

variable_symbol
is a variable symbol, with or without the leading ampersand (&).

These instructions can be used anywhere in the body of a macro definition or in the open code portion of a source module.

Any variable symbols declared in the operand field have a global scope. They can be used as SET symbols anywhere after the pertinent GBLA, GBLB, or GBLC instructions. However, they can be used only within those parts of a program in which they have been declared as global SET symbols; that is, in any macro definition and in open code.

The assembler assigns an initial value to the SET symbol only when it processes the first GBLA, GBLB, or GBLC instruction in which the symbol appears. Later GBLA, GBLB, or GBLC instructions do not reassign an initial value to the SET symbol.

Multiple GBLx statements can declare the same variable symbol if only one declaration for a given symbol is encountered during the expansion of a macro.

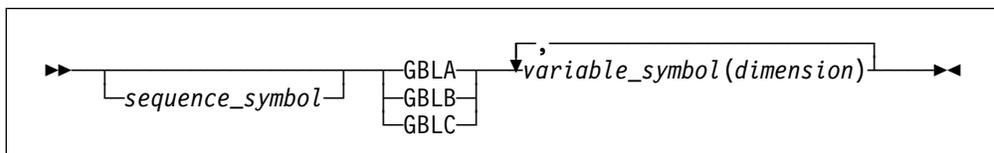
The following rules apply to the global SET variable symbol:

- Within a macro definition, it must not be the same as any symbolic parameter declared in the prototype statement.
- It must not be the same as any local variable symbol declared within the same local scope.
- The same variable symbol must not be declared or used as two different types of global SET symbol; for example, as a SETA or SETB symbol.
- A global SET symbol should not begin with &SYS because these characters are used for system variable symbols.

Subscripted Global SET Symbols

A global subscripted SET symbol is declared by the GBLA, GBLB, or GBLC instruction.

LCLA, LCLB, and LCLC Instructions



sequence_symbol
is a sequence symbol.

variable_symbol
is a variable symbol, with or without the leading ampersand (&).

dimension
is the dimension of the array. It must be an unsigned, decimal, self-defining term greater than zero.

Example:

```
GBLA          &GA(25), &GA1(15)
```

There is no limit on the maximum subscript allowed. Also, the limit specified in the global declaration (GBLx) can be exceeded. The dimension shows the number of SET variables associated with the subscripted SET symbol. The assembler assigns an initial value to every variable in the array thus declared.

Notes:

1. Global arrays are assigned initial values only by the first global declaration processed, in which a global subscripted SET symbol appears.
2. A subscripted global SET symbol can be used only if the declaration has a subscript, which represents a dimension; an unsubscripted global SET symbol can be used only if the declaration had no subscript.
3. Wherever a particular global SET symbol is declared with a dimension as a subscript, the dimension must be the same in each declaration.

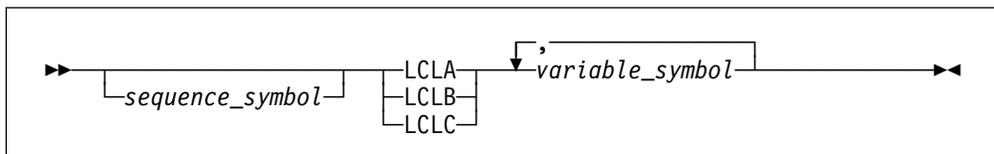
Alternative Format for GBLx Statements

The assembler permits the alternate statement format for GBLx instructions:

	Cont.	
GBLA	&GLOBAL-SYMBOL-FOR-DC-GEN,	X
	&LOOP-CONTRL-A,	X
	&VALUE-PASSED-TO-FIDO,	X
	&VALUE-RETURNED-FROM-FIDO	

LCLA, LCLB, and LCLC Instructions

Use the LCLA, LCLB, and LCLC instructions to declare the local SETA, SETB, and SETC symbols you need. The SETA, SETB, and SETC symbols are assigned the initial values of 0, 0, and null character string, respectively.



sequence_symbol
is a sequence symbol.

variable_symbol
is a variable symbol, with or without the leading ampersand (&).

These instructions can be used anywhere in the body of a macro definition or in the open code portion of a source module.

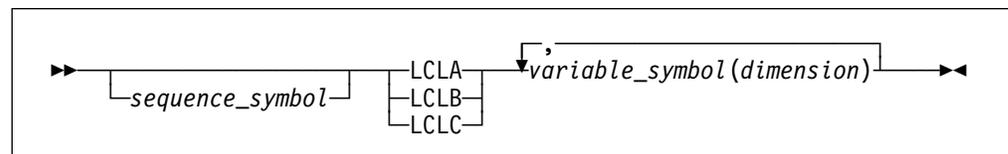
Any variable symbols declared in the operand field have a local scope. They can be used as SET symbols anywhere after the pertinent LCLA, LCLB, or LCLC instructions, but only within the declared local scope. Multiple LCLx statements can declare the same variable symbol if only one declaration for a given symbol is encountered during the expansion of a macro.

The following rules apply to a local SET variable symbol:

- Within a macro definition, it must not be the same as any symbolic parameter declared in the prototype statement.
- It must not be the same as any global variable symbol declared within the same local scope.
- The same variable symbol must not be declared or used as two different types of SET symbols; for example, as a SETA and a SETB symbol, within the same local scope.
- A local SET symbol should not begin with &SYS because these characters are used for system variable symbols.

Subscripted Local SET Symbols

A local subscripted SET symbol is declared by the LCLA, LCLB, or LCLC instruction.



sequence_symbol
is a sequence symbol.

variable_symbol
is a variable symbol, with or without the leading ampersand (&).

dimension
is the dimension of the array. It must be an unsigned, decimal, self-defining term greater than zero.

Example:

```
LCLB      &B(10)
```

There is no limit to SET symbol dimensioning. The limit specified in the explicit (LCLx) or implicit (SETx) declaration can also be exceeded by later SETx statements. The dimension shows the number of SET variables associated with

Assigning Values to SET Symbols • SETA Instruction

the subscripted SET symbol. The assembler assigns an initial value to every variable in the array thus declared.

Subscripted Local SET Symbol: A subscripted local SET symbol can be used only if the declaration has a subscript, which represents a dimension; an unsubscripted local SET symbol can be used only if the declaration had no subscript.

Alternative Format for LCLx Statements

The assembler permits an alternative statement format for LCLx instructions:

		Cont.
LCLA	&LOCAL_SYMBOL_FOR_DC_GEN,	X
	&COUNTER_FOR_INNER_LOOP,	X
	&COUNTER_FOR_OUTER_LOOP,	X
	&COUNTER_FOR_TRAILING_LOOP	

Assigning Values to SET Symbols

You can assign values to SET symbols by using the SETA, SETB, SETC, SETAF and SETCF instructions (SETx). You can also use these instructions to implicitly define local SET symbols. Local SET symbols need not be declared explicitly with LCLA, LCLB, or LCLC statements. The assembler considers any undeclared variable symbol found in the name field of a SETx statement to be a local SET symbol. It is given the initial value specified in the operand field of SETA, SETB and SETC instructions, and the value returned from the external function specified in the operand of SETAF and SETCF instructions. If the symbol in the name field is subscripted, it is declared as a subscripted SET symbol.

SETA Instruction

The SETA instruction assigns an arithmetic value to a SETA symbol. You can specify a single value or an arithmetic expression from which the assembler computes the value to assign.

You can change the values assigned to an arithmetic or SETA symbol. This lets you use SETA symbols as counters, indexes, or for other repeated computations that require varying values.

▶▶ *variable_symbol*—SETA—*expression* ◀◀

variable_symbol
is a variable symbol.

A global variable symbol in the name field must have been previously declared as a SETA symbol in a GBLA instruction. Local SETA symbols need not be declared in a LCLA instruction. The assembler considers any undeclared variable symbol found in the name field of a SETA instruction as a local SET symbol. The variable symbol is assigned a type attribute value of N.

expression

is an arithmetic expression evaluated as a signed 32-bit arithmetic value that is assigned to the SETA symbol in the name field. The minimum and maximum allowable values of the expression are -2^{31} and $+2^{31}-1$, respectively.

Subscripted SETA Symbols

The SETA symbol in the name field can be subscripted, but only if the same SETA symbol has been previously declared in a GBLA or LCLA instruction with an allowable dimension.

The assembler assigns the value of the expression in the operand field to the position in the declared array given by the value of the subscript. The subscript expression must not be 0 or have a negative value.

Arithmetic (SETA) Expressions

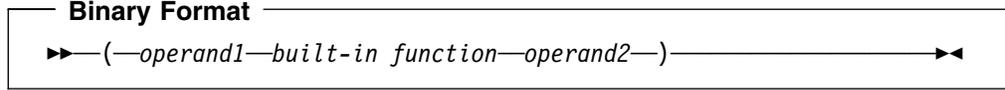
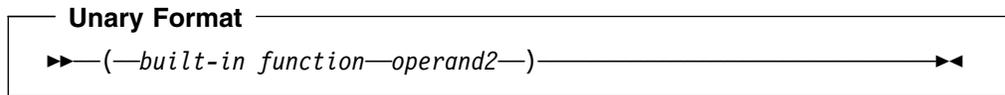
Figure 93 shows how arithmetic expressions can be used.

Figure 93. Use of Arithmetic Expressions

Used in	Used as	Example
SETA instruction	Operand	&A1 SETA &A1+2
AIF or SETB instruction	Term in arithmetic relation	AIF (&A*10 GT 30) .A
Subscripted SET symbols	Subscript	&ASYM(&A+10-&C)
Substring notation	Subscript	'STRING' (&A*2,&A-1)
Sublist notation	Subscript	Given sublist (A,B,C,D) if &A=1 then &PARAM(&A+1)=B
&SYSLIST	Subscript	&SYSLIST(&M+1,&N-2) &SYSLIST(N'&SYSLIST)
SETC instruction	Character string in operand	Given &C SETC '5-10*&A' 1 if &A=10 then &C=5-10*10 2 Given &D SETC '5-10*&A' 1 if &A=-10 then &D=5-10*10 3
Built in functions	Operand	&VAR SETA (NOT &OP1)

When an arithmetic expression is used in the operand field of a SETC instruction (see **1** in Figure 93), the assembler assigns the character value representing the arithmetic expression to the SETC symbol, after substituting values (see **2** in Figure 93) into any variable symbols. It does not evaluate the arithmetic expression. The mathematical sign (+ or -) is not included in the substituted value of a variable symbol (see **3** in Figure 93), and any insignificant leading zeros are removed.

Built-in Functions for Arithmetic Expressions: An arithmetic expression can consist of two expressions separated by a binary built-in function which returns an arithmetic value, or a single expression prefixed by a unary built-in function which returns an arithmetic value.



operand1

an expression of the type expected by the built-in function

operand2

an expression of the type expected by the built-in function

built-in function

is one of the following:

AND a bit position in the result is set to 1 if the corresponding bit positions in both operands contain 1, otherwise, the result bit is set to 0. After the following statements &VAR contains the arithmetic value +2.

Name	Operation	Operand
&OP1	SETA	10
&OP2	SETA	2
&VAR	SETA	(&OP1 AND &OP2)

FIND Finds the first match of any character from operand2 within operand1. The value returned by FIND indicates the position where the match occurs. FIND returns 0 if no match occurs or if either operand is a null string.

After the following statements &VAR contains the arithmetic value 3.

Name	Operation	Operand
&OP1	SETC	'abcdef'
&OP2	SETC	'cde'
&VAR	SETA	('&OP1' FIND '&OP2')

In the above example the character c in &OP2 is the first character found in &OP1. Consider the following example where the character c, in &OP1, has been replaced with the character g.

Name	Operation	Operand
&OP1	SETC	'abcdef'
&OP2	SETC	'gde'
&VAR	SETA	('&OP1' FIND '&OP2')

&VAR contains the arithmetic value 4. The character d in &OP2 is the first character found in &OP1.

In the following example, the ordering of the characters in the second operand is changed to egd.

Name	Operation	Operand
&OP1	SETC	'abcdef'
&OP2	SETC	'egd'
&VAR	SETA	('&OP1' FIND '&OP2')

&VAR still contains the arithmetic value 4. Because FIND is looking for a single character from the character string, the order of the characters in the second operand string is irrelevant.

INDEX Finds the first match of the operand2 character string within the operand1 character string. INDEX returns the position of the matched character string as an arithmetic value. INDEX returns 0 if no match occurs or if either operand is a null string. The returned offset must be assigned to a SETA variable. After the following statements &VAR contains the arithmetic value 3.

Name	Operation	Operand
&OP1	SETC	'abcdef'
&OP2	SETC	'cde'
&VAR	SETA	('&OP1' INDEX '&OP2')

Consider the following example where the character c, in &OP1, has been replaced with the character g.

Name	Operation	Operand
&OP1	SETC	'abcdef'
&OP2	SETC	'gde'
&VAR	SETA	('&OP1' INDEX '&OP2')

&VAR contains the arithmetic value 0, meaning that the value in &OP2 was not found in &OP1.

NOT the result of a NOT function is the ones complement of the value contained or evaluated in the operand. After the following statements &VAR contains the arithmetic value -11.

Name	Operation	Operand
&OP1	SETA	10
&VAR	SETA	(NOT &OP1)

OR a bit position in the result is set to 1 if the corresponding bit positions in one or both operands contains a 1, otherwise the result bit is set to 0. After the following statements &VAR contains the arithmetic value +10.

Name	Operation	Operand
&OP1	SETA	10
&OP2	SETA	2
&VAR	SETA	(&OP1 OR &OP2)

SLA the 31-bit numeric part of the signed first operand is shifted left the number of bits specified in the rightmost six bits of the second operand. The sign of the first operand remains unchanged. Zeros are used to fill the vacated bit positions on the right. After the following statements &VAR contains the arithmetic value +8.

Name	Operation	Operand
&OP1	SETA	2
&OP2	SETA	2
&VAR	SETA	(&OP1 SLA &OP2)

SLL the 32-bit first operand is shifted left the number of bits specified in the rightmost six bits of the second operand. Bits shifted out of bit position 0 are lost. Zeros are used to fill the vacated bit positions on the right. After the following statements &VAR contains the arithmetic value +40.

Name	Operation	Operand
&OP1	SETA	10
&OP2	SETA	2
&VAR	SETA	(&OP1 SLL &OP2)

SRA the 31-bit numeric part of the signed first operand is shifted right the number of bits specified in the rightmost six bits of the second operand. The sign of the first operand remains unchanged. Bits shifted out of bit position 31 are lost. Bits equal to the sign are used to fill the vacated bit positions on the left. After the following statements &VAR contains the arithmetic value +2.

Name	Operation	Operand
&OP1	SETA	10
&OP2	SETA	2
&VAR	SETA	(&OP1 SRA &OP2)

After the following statements &VAR contains the arithmetic value -1.

Name	Operation	Operand
&OP1	SETA	-344
&OP2	SETA	40
&VAR	SETA	(&OP1 SRA &OP2)

Compare this result with the result in the second example under SRL below.

SRL the 32-bit first operand is shifted right the number of bits specified in the rightmost six bits of the second operand. Bits shifted out of bit position 31 are lost. Zeros are used to fill the vacated bit positions on the left. After the following statements &VAR contains the arithmetic value +2.

Name	Operation	Operand
&OP1	SETA	10
&OP2	SETA	2
&VAR	SETA	(&OP1 SRL &OP2)

After the following statements &VAR contains the arithmetic value 0.

Name	Operation	Operand
&OP1	SETA	-344
&OP2	SETA	40
&VAR	SETA	(&OP1 SRL &OP2)

XOR a bit position in the result is set to 1 if the corresponding bit positions in the two operands are unlike, otherwise the result bit is set to 0. After the following statements &VAR contains the arithmetic value +8.

Name	Operation	Operand
&OP1	SETA	10
&OP2	SETA	2
&VAR	SETA	(&OP1 XOR &OP2)

Figure 94 defines an arithmetic expression.

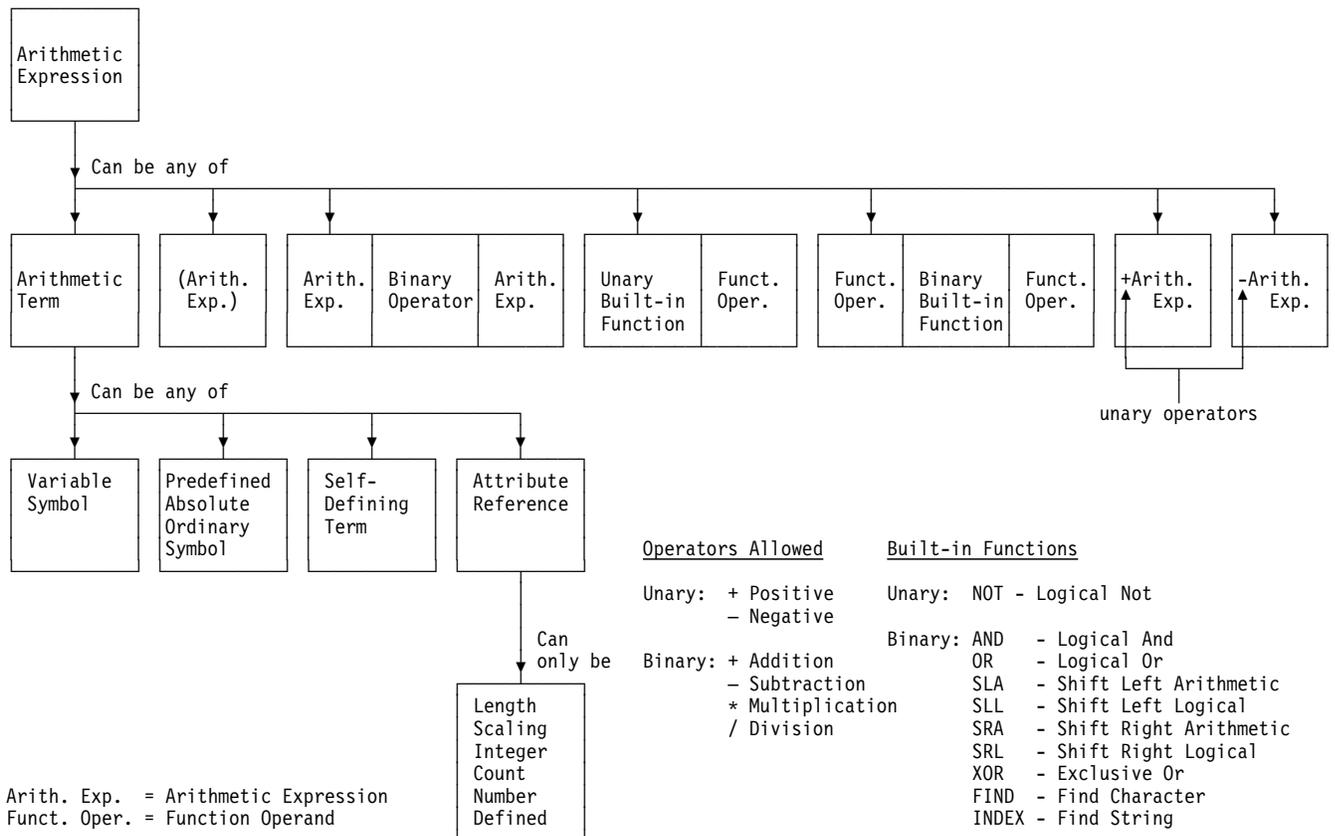


Figure 94. Defining Arithmetic (SETA) Expressions

Figure 95 shows the variable symbols that are allowed as terms in an arithmetic expression.

Figure 95 (Page 1 of 2). Variable Symbols Allowed as Terms in Arithmetic Expressions

Variable symbol	Restrictions	Example	Value
SETA	None	---	---
SETB	None	---	---
SETC	Value must evaluate to an unsigned binary, hexadecimal or decimal self-defining term in the range 0 to 2,147,483,647	&C	123
Symbolic parameters	Value must be a self-defining term	&PARAM &SUBLIST(3)	X'A1' C'Z'

Figure 95 (Page 2 of 2). Variable Symbols Allowed as Terms in Arithmetic Expressions

Variable symbol	Restrictions	Example	Value
&SYSLIST(<i>n</i>)	Corresponding operand or sublist entry must be a self-defining term	&SYSLIST(3)	24
&SYSLIST(<i>n,m</i>)		&SYSLIST(3,2)	B'101'
&SYSPARM	Value must evaluate to an unsigned decimal self-defining term in the range 0 to 2,147,483,647	&SYSPARM	2000
&SYSDATC &SYSM_HSEV &SYSM_SEV &SYSNDX &SYSNEST &SYSOPT_DBCS &SYSOPT_RENT &SYSOPT_XOBJECT &SYSSTMT	None	---	---

The following example shows a SETA statement with a valid self-defining term in its operand field:

```
&ASYM1 SETA C'D'          &ASYM1 has value 196 (C'D')
```

The second statement in the following example is valid because in the two positions in the SETA operand where a term is required (either side of the + sign), the assembler finds a valid self-defining term:

```
&CSYM2 SETC 'C'A''       &CSYM2 has value C'A'
&ASYM3 SETA &CSYM2+&CSYM2 &ASYM3 has value 386 (C'A' + C'A')
```

A SET statement is not rescanned by the assembler to see whether substitutions might affect the originally-determined syntax. The original syntax of the self-defining term must be correct. Therefore the assembler does not construct a self-defining term in a SETA statement. The third statement of the next example shows this:

```
&CSYM3 SETC '3'          &CSYM has value 3 (C'3')
&ASYM3 SETA &CSYM3       &ASYM has value 3
&ASYM4 SETA C'&ASYM3'    Invalid self-defining term
```

In this example C'&ASYM3' is not a valid term.

Rules for Coding Arithmetic Expressions: The following is a summary of coding rules for arithmetic expressions:

1. Both unary (operating on one value) and binary (operating on two values) operators are allowed in arithmetic expressions.
2. An arithmetic expression can have one or more unary operators preceding any term in the expression or at the beginning of the expression. The unary operators are + (positive) and - (negative).
3. The binary operators that can be used to combine the terms of an expression are + (addition), - (subtraction), * (multiplication), and / (division).
4. An arithmetic expression must not begin with a binary operator, and it must not contain two binary operators in succession.
5. An arithmetic expression must not contain two terms in succession.

6. An arithmetic expression must not contain a decimal point. For example, 123.456 is not a valid arithmetic term, but 123 is.
7. An arithmetic expression must not contain blanks between an operator and a term, nor between two successive operators.
8. Ordinary symbols specified in arithmetic expressions must be defined before the arithmetic expression is encountered, and must have an absolute value.
9. An arithmetic expression can contain up to 24 unary and binary operators, and is limited to 255 levels of parentheses. The parentheses required for sublist notation, substring notation, and subscript notation count toward this limit.

Evaluation of Arithmetic Expressions: The assembler evaluates arithmetic expressions during conditional assembly processing as follows:

1. It evaluates each arithmetic term.
2. It carries out arithmetic operations from left to right. However,
 - a. It carries out unary operations before binary operations, and
 - b. It carries out the binary operations of multiplication and division before the binary operations of addition and subtraction.
3. In division, it gives an integer result; any fractional portion is dropped. Division by zero gives a 0 result.
4. In parenthesized arithmetic expressions, the assembler evaluates the innermost expressions first, and then considers them as arithmetic terms in the next outer level of expressions. It continues this process until the outermost expression is evaluated.
5. The computed result, including intermediate values, must lie in the range -2^{31} through $+2^{31}-1$.

SETC Variables in Arithmetic Expressions: The assembler permits a SETC variable to be used as a term in an arithmetic expression if the character string value of the variable is a self-defining term. The value represented by the string is assigned to the arithmetic term. A null string is treated as zero.

Examples:

	LCLC	&C(5)
&C(1)	SETC	'B''101'''
&C(2)	SETC	'C''A'''
&C(3)	SETC	'23'
&A	SETA	&C(1)+&C(2)-&C(3)
&AA	SETA	&C(3)

In evaluating the arithmetic expression in the fifth statement, the first term, &C(1), is assigned the binary value 101 (decimal 5). To that is added the value represented by the EBCDIC character A (hexadecimal C1, which corresponds to decimal 193). Then the value represented by the third term &C(3) is subtracted, and the value of &A becomes $5+193-23=175$.

This feature lets you associate numeric values with EBCDIC or hexadecimal characters to be used in such applications as indexing, code conversion, translation, and sorting.

Assume that &X is a character string with the value ABC.

SETA Instruction

```
&I      SETC      'C'.'&X'(1,1).''''
&VAL    SETA      &TRANS(&I)
```

The first statement sets &I to C'A'. The second statement extracts the 193rd element of &TRANS (C'A' = X'C1' = 193).

The following code converts a hexadecimal value in &H into a decimal value in &VAL:

```
&X      SETC      'X'&H''
&VAL    SETA      &X
```

The following code converts the double-byte character Da into a decimal value in &VAL. &VAL can then be used to find an alternative code in a subscripted SETC variable:

```
&DA     SETC      'G'<Da>''
&VAL    SETA      &DA
```

DBCS Assembler Option: The G-type self-defining term is valid only if the DBCS assembler option is specified.

An arithmetic expression must not contain two terms in succession; however, any term may be preceded by any number of unary operators. +&A*-&B is a valid operand for a SETA instruction. The expression &FIELD+- is invalid because it has no final term.

Using SETA symbols

The arithmetic value assigned to a SETA symbol is substituted for the SETA symbol when it is used in an arithmetic expression. If the SETA symbol is not used in an arithmetic expression, the arithmetic value is converted to a character string containing its value as an unsigned integer, with leading zeros removed. If the value is 0, it is converted to a single 0.

Example:

```
MACRO
&NAME  MOVE      &TO,&FROM
        LCLA     &A,&B,&C,&D
&A     SETA      10          Statement 1
&B     SETA      12          Statement 2
&C     SETA      &A-&B       Statement 3
&D     SETA      &A+&C       Statement 4
&NAME  ST        2,SAVEAREA
        L        2,&FROM&C    Statement 5
        ST       2,&TO&D      Statement 6
        L        2,SAVEAREA
MEND

-----
HERE   MOVE      FIELDA,FLDDB
-----
+HERE ST        2,SAVEAREA
+  L        2,FLDDB2
+  ST       2,FLDDB8
+  L        2,SAVEAREA
```

Statements 1 and 2 assign the arithmetic values +10 and +12, respectively, to the SETA symbols &A and &B. Therefore, statement 3 assigns the SETA symbol &C

the arithmetic value -2 . When $\&C$ is used in statement 5, the arithmetic value -2 is converted to the unsigned integer 2. When $\&C$ is used in statement 4, however, the arithmetic value -2 is used. Therefore, $\&D$ is assigned the arithmetic value $+8$. When $\&D$ is used in statement 6, the arithmetic value $+8$ is converted to the unsigned integer 8.

The following example shows how the value assigned to a SETA symbol may be changed in a macro definition.

```

MACRO
&NAME MOVE      &TO,&FROM
      LCLA      &A
&A     SETA      5                Statement 1
&NAME ST        2,SAVEAREA
      L         2,&FROM&A        Statement 2
&A     SETA      8                Statement 3
      ST        2,&TO&A          Statement 4
      L         2,SAVEAREA
MEND
-----
HERE   MOVE      FIELDA,FIELDB
-----
+HERE ST        2,SAVEAREA
+  L         2,FIELDB5
+  ST        2,FIELD8
+  L         2,SAVEAREA

```

Statement 1 assigns the arithmetic value $+5$ to SETA symbol $\&A$. In statement 2, $\&A$ is converted to the unsigned integer 5. Statement 3 assigns the arithmetic value $+8$ to $\&A$. In statement 4, therefore, $\&A$ is converted to the unsigned integer 8, instead of 5.

A SETA symbol may be used with a symbolic parameter to refer to an operand in an operand sublist. If a SETA symbol is used for this purpose, it must have been assigned a positive value.

Any expression that may be used in the operand field of a SETA instruction may be used to refer to an operand in an operand sublist. Sublists are described in “Sublists in Operands” on page 278.

The following macro definition adds the last operand in an operand sublist to the first operand in an operand sublist and stores the result at the first operand. A sample macro instruction and generated statements follow the macro definition.

SETB Instruction

```
MACRO
ADDX      &NUMBER,&REG      Statement 1
LCLA     &LAST
&LAST    SETA      N'&NUMBER      Statement 2
L        &REG,&NUMBER(1)
A        &REG,&NUMBER(&LAST)      Statement 3
ST       &REG,&NUMBER(1)
MEND

-----
ADDX      (A,B,C,D,E),3      Statement 4
-----
+  L      3,A
+  A      3,E
+  ST     3,A
```

&NUMBER is the first symbolic parameter in the operand field of the prototype statement (statement 1). The corresponding characters (A,B,C,D,E) of the macro instruction (statement 4) are a sublist. Statement 2 assigns to &LAST the arithmetic value +5, which is equal to the number of operands in the sublist. Therefore, in statement 3, &NUMBER(&LAST) is replaced by the fifth operand of the sublist.

SETB Instruction

Use the SETB instruction to assign a bit value to a SETB symbol. You can assign the bit values, 0 or 1, to a SETB symbol directly and use it as a switch.

If you specify a logical (Boolean) expression in the operand field, the assembler evaluates this expression to determine whether it is true or false, and then assigns the value 1 or 0, respectively, to the SETB symbol. You can use this computed value in condition tests or for substitution.

▶▶ *variable_symbol* — SETB — *binary_value* —▶▶

variable_symbol
is a variable symbol.

A global variable symbol in the name field must have been previously declared as a SETB symbol in a GBLB instruction. Local SETB symbols need not be declared in a LCLB instruction. The assembler considers any undeclared variable symbol found in the name field of a SETB instruction as a local SET symbol. The variable symbol is assigned a type attribute value of N.

binary_value
is a binary bit value that may be specified as:

- A binary digit (0 or 1)
- A binary value enclosed in parentheses

An arithmetic value enclosed in parentheses is allowed. This value can be represented by:

- An unsigned, decimal, self-defining term
- A SETA symbol
- A previously defined ordinary symbol with an absolute value
- An attribute reference other than the type attribute reference.

If the value is 0, the assembler assigns a value of 0 to the symbol in the name field. If the value is not 0, the assembler assigns a value of 1.

- A logical expression enclosed in parentheses

A logical expression is evaluated to determine if it is true or false; the SETB symbol in the name field is then assigned the binary value 1 or 0, corresponding to true or false, respectively. The assembler assigns the explicitly specified binary value (0 or 1) or the computed logical value (0 or 1) to the SETB symbol in the name field.

Subscripted SETB Symbols

The SETB symbol in the name field can be subscripted, but only if the same SETB symbol has been previously declared in a GBLB or LCLB instruction with an allowable dimension.

The assembler assigns the binary value explicitly specified, or implicit in the logical expression present in the operand field, to the position in the declared array given by the value of the subscript. The subscript expression must not be 0 or have a negative value.

Logical (SETB) Expressions

You can use a logical expression to assign a binary value to a SETB symbol. You can also use a logical expression to represent the condition test in an AIF instruction. This use lets you code a logical expression whose value (0 or 1) varies according to the values substituted into the expression and thereby determine whether or not a branch is to be taken.

A logical expression can consist of a logical expression and a logical term separated by a logical operator. The logical operators are:

AND	the value is 1, if the logical expression and the logical term each contain or evaluate to 1, otherwise the value is 0.
AND NOT	the value in the logical term is inverted, and the expression is evaluated as though the AND operator was specified. For example, 1 AND NOT 0 is equivalent to 1 AND 1.
OR	the value is 1, if either the logical expression or the logical term contain or evaluate to 1. If they both contain or evaluate to 0 then the value is 0.
OR NOT	the value in the logical term is inverted, and the expression is evaluated as though the OR operator was specified. For example, 1 OR NOT 1 is equivalent to 1 OR 0.
XOR	the value is 1, if the logical expression and the logical term contain or evaluate to opposite bit values. If they both contain or evaluate to the same bit value, the result is 0.
XOR NOT	the value in the logical term is inverted, and the expression is evaluated as though the XOR operator was specified. For example, 1 XOR NOT 1 is equivalent to 1 XOR 0.

Figure 96 on page 331 defines a logical expression.

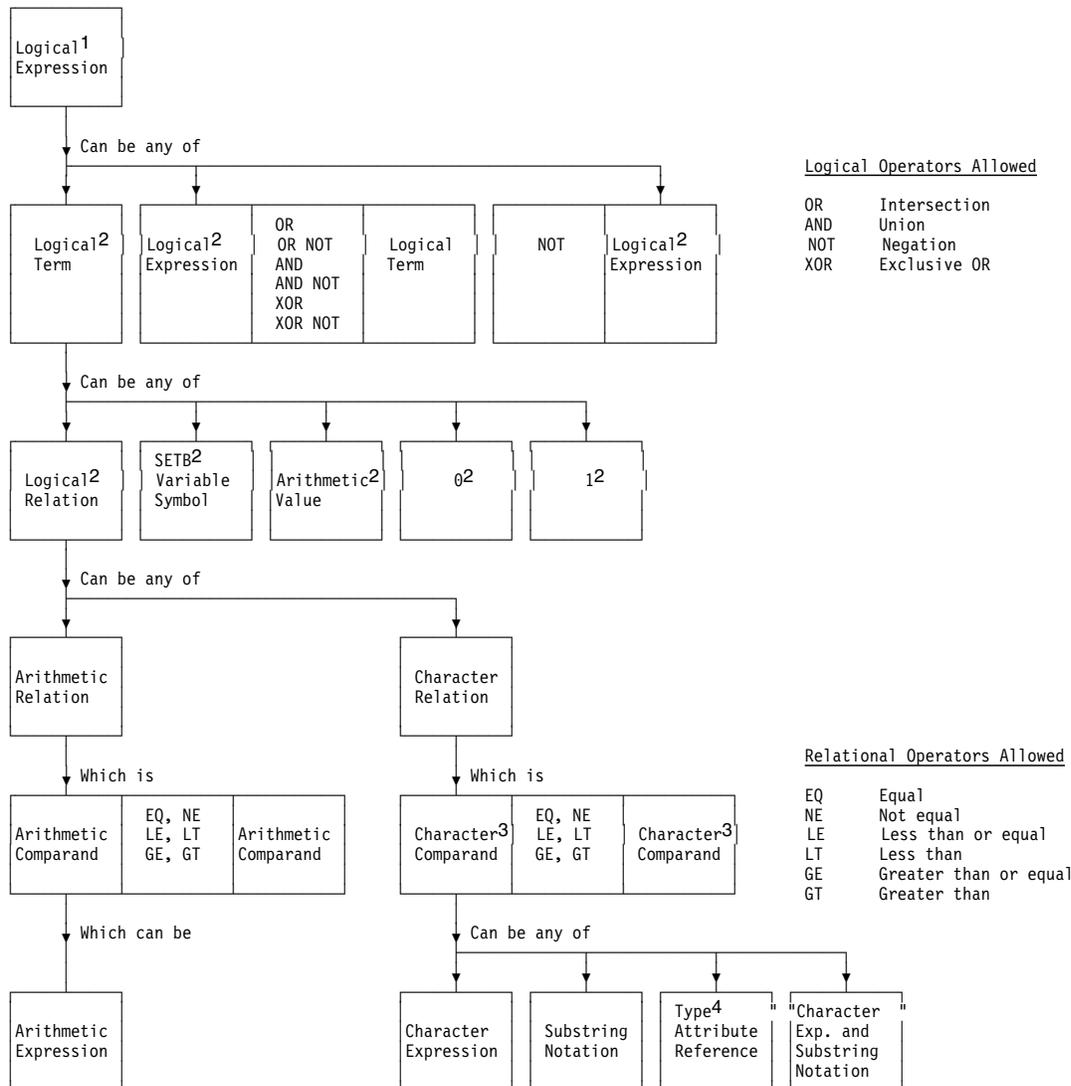
Relational Operators: Relational operators provide the means for comparing two items. A relational operator plus the items form a relation. Thus an arithmetic relation is two arithmetic expressions separated by a relational operator, and a character relation is two character strings (for example, a character expression and a type attribute reference) separated by a relational operator.

The relational operators are:

EQ equal
NE not equal
LE less than or equal
LT less than
GE greater than or equal
GT greater than

Rules for Coding Logical Expressions: The following is a summary of coding rules for logical expressions:

- A logical expression must not contain two logical terms in succession.
- A logical expression can begin with the logical unary operator NOT.
- A logical expression can contain two logical operators in succession; however, the only allowed combinations are OR NOT, XOR NOT and AND NOT. The two operators must be separated from each other by one or more blanks.
- Any logical term, relation, or inner logical expression can be optionally enclosed in parentheses.
- The relational and logical operators must be immediately preceded and followed by at least one blank or other special character.
- A logical expression can contain up to 18 logical operators. The relational and other operators used by the arithmetic and character expressions in relations do not count toward this total.
- Up to 255 levels of nested parentheses are allowed.
- Absolute ordinary symbols specified in logical expressions must be defined before the logical expression is encountered.
- The assembler determines the type of a logical relation by the first comparand. If the first comparand is a character expression that begins with a single quotation mark, then the logical relation is a character relation, otherwise the assembler treats it as an arithmetic relation.



Notes:

1. Outermost expression must be enclosed in parentheses in SETB and AIF instructions.
2. Optional parentheses around terms and expressions at this level.
3. Must be in the range 0 through 255 characters.
4. Must stand alone and not be enclosed in single quotation marks.

Figure 96. Defining Logical Expressions

Evaluation of Logical Expressions: The assembler evaluates logical expressions as follows:

1. It evaluates each logical term, which is given a binary value of 0 or 1.
2. If the logical term is an arithmetic or character relation, the assembler evaluates:
 - a. The arithmetic or character expressions specified as values for comparison in these relations
 - b. The arithmetic or character relation

SETB Instruction

- c. The logical term, which is the result of the relation. If the relation is true, the logical term it represents is given a value of 1; if the relation is false, the term is given a value of 0.

The two comparands in a character relation are compared, character by character, according to binary (EBCDIC) representation of the characters. If two comparands in a relation have character values of unequal length, the assembler always takes the shorter character value to be less.

3. The assembler carries out logical operations from left to right. However,
 - a. It carries out logical NOTs before logical ANDs, ORs and XORs
 - b. It carries out logical ANDs before logical ORs and XORs
 - c. It carries out logical ORs before logical XORs
4. In parenthesized logical expressions, the assembler evaluates the innermost expressions first, and then considers them as logical terms in the next outer level of expressions. It continues this process until it evaluates the outermost expression.

Using SETB Symbols: The logical value assigned to a SETB symbol is used for the SETB symbol appearing in the operand field of an AIF instruction or another SETB instruction.

If a SETB symbol is used in the operand field of a SETA instruction, or in arithmetic relations in the operand fields of AIF and SETB instructions, the binary values 1 (true) and 0 (false) are converted to the arithmetic values +1 and +0, respectively.

If a SETB symbol is used in the operand field of a SETC instruction, in character relations in the operand fields of AIF and SETB instructions, or in any other statement, the binary values 1 (true) and 0 (false), are converted to the character values '1' and '0', respectively.

The following example illustrates these rules. It assumes that L'&T0 EQ 4 is true, and S'&T0 EQ 0 is false.

```

MACRO
&NAME  MOVE      &T0,&FROM
        LCLA     &A1
        LCLB     &B1,&B2
        LCLC     &C1
&B1    SETB     (L'&T0 EQ 4)      Statement 1
&B2    SETB     (S'&T0 EQ 0)      Statement 2
&A1    SETA     &B1                Statement 3
&C1    SETC     '&B2'              Statement 4
        ST      2,SAVEAREA
        L      2,&FROM&A1
        ST      2,&T0&C1
        L      2,SAVEAREA
MEND

-----
HERE   MOVE      FIELDA,FIELDB
-----
+HERE ST      2,SAVEAREA
+     L      2,FIELDB1
+     ST      2,FIELDA0
+     L      2,SAVEAREA

```

Because the operand field of statement 1 is true, &B1 is assigned the binary value 1. Therefore, the arithmetic value +1 is substituted for &B1 in statement 3. Because the operand field of statement 2 is false, &B2 is assigned the binary value 0. Therefore, the character value 0 is substituted for &B2 in statement 4.

SETC Instruction

The SETC instruction assigns a character value to a SETC symbol. You can assign whole character strings, or concatenate several smaller strings together. The assembler assigns the composite string to your SETC symbol. You can also assign parts of a character string to a SETC symbol by using the substring notation; see “Substring Notation” on page 344.

You can change the character value assigned to a SETC symbol. This lets you use the same SETC symbol with different values for character comparisons in several places, or for substituting different values into the same model statement.

▶▶—*variable_symbol*—SETC—*character_value*————▶▶

variable symbol

is a variable symbol.

A global variable symbol in the name field must have been previously declared as a SETC symbol in a GBLC instruction. Local SETC symbols need not be declared in a LCLC instruction. The assembler considers any undeclared variable symbol found in the name field of a SETC instruction as a local SETC symbol. The variable symbol is assigned a type attribute value of U.

character_value

is a character value that may be specified by one of the following:

- An operation code attribute reference
- A type attribute reference
- A character expression
- A substring notation

The assembler assigns the character string value represented in the operand field to the SETC symbol in the name field. The string length must be in the range 0 (null character string) through 255 characters.

When a SETA or SETB symbol is specified in a character expression, the unsigned decimal value of the symbol (with leading zeros removed) is the character value given to the symbol.

A duplication factor can precede a character expression or substring notation. The duplication factor can be any arithmetic expression allowed in the operand of a SETA instruction. For example:

```
&C1      SETC          (3) 'ABC'
```

assigns the value 'ABCABCABC' to &C1.

Notes:

1. The assembler evaluates the represented character string (in particular, the substring) before applying the duplication factor. The resulting character string is then assigned to the SETC symbol in the name field. For example:

```
&C2      SETC          'ABC'.(3)'ABCDEF'(4,3)
```

assigns the value 'ABCDEFDEFDEF' to &C2.

2. If the character string contains double-byte data, then redundant SI/SO pairs are not removed on duplication. For example:

```
&C3      SETC          (3)'<.A.B>'
```

assigns the value '<.A.B><.A.B><.A.B>' to &C3.

3. To duplicate double-byte data, without including redundant SI/SO pairs, use the substring notation. For example:

```
&C4      SETC          (3)'<.A.B>(2,4)
```

assigns the value '.A.B.A.B.A.B' to &C4.

4. To duplicate the arithmetic value of a previously defined ordinary symbol with an absolute value, first assign the arithmetic value to a SETA symbol. For example:

```
A        EQU          123
&A1     SETA          A
&C5     SETC          (3)'&A1'
```

assigns the value '123123123' to &C5.

Subscripted SETC Symbols

The SETC symbol (see **1** in Figure 97) in the name field can be subscripted, but only if the same SETC symbol has been previously declared (see **2** in Figure 97) in a GBLC or an LCLC instruction with an allowable dimension.

The assembler assigns the character value represented in the operand field to the position in the declared array (see **3** in Figure 97) given by the value of the subscript. The subscript expression must not be 0 or have a negative value.

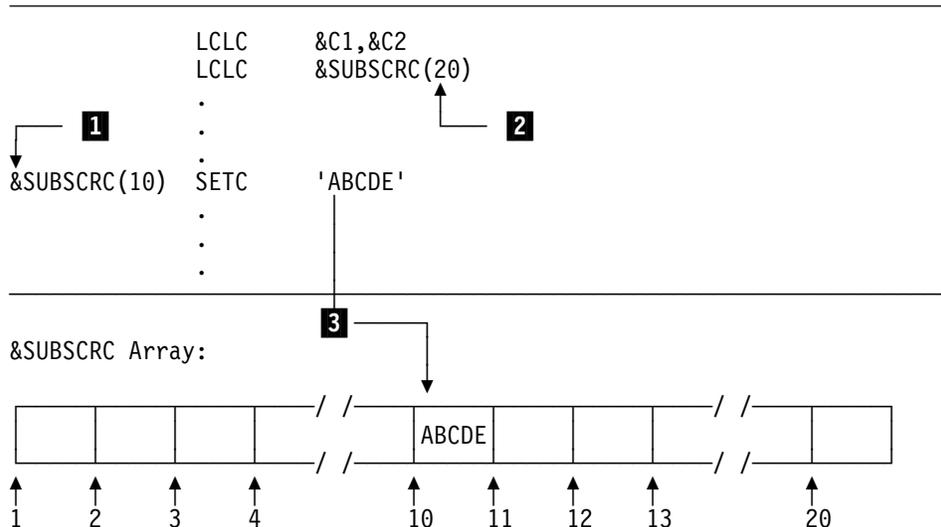


Figure 97. Subscripted SETC Symbols

Character (SETC) Expressions

The main purpose of a character expression is to assign a character value to a SETC symbol. You can then use the SETC symbol to substitute the character string into a model statement.

You can also use a character expression as a value for comparison in condition tests and logical expressions. Also, a character expression provides the string from which characters can be selected by the substring notation.

Substitution of one or more character values into a character expression lets you use the character expression wherever you need to vary values for substitution or to control loops.

Character (SETC) expressions can be used only in conditional assembly instructions. Figure 98 shows examples of using character expressions.

Figure 98. Use of Character Expressions

Used in	Used as	Example
SETC instruction	Operand	&C SETC 'STRING0'
AIF or SETB instruction	Character string in character relation	AIF ('&C' EQ 'STRING1').B
Substring notation	First part of notation	'SELECT'(2,5)='ELECT'
Built in functions	Operand	&VAR SETC (LOWER '&twenty.&six')

A character expression consists of any combination of characters enclosed in single quotation marks. Variable symbols are allowed. The assembler substitutes the representation of their values as character strings into the character expression before evaluating the expression. Up to 255 characters are allowed in a character expression.

An attribute reference must be the only term in a character expression.

Built-in Functions for Character Expressions: A character expression can consist of a single expression prefixed by a unary built-in function.

▶▶—*built-in function*—*operand*—◀◀

operand

is an arithmetic expression (for BYTE and SIGNED) or character expression (for DOUBLE, LOWER, and UPPER)

built-in function

is one of the following:

BYTE Converts a single byte arithmetic value to its equivalent EBCDIC character expression. After the following statements &VAR contains the character value '%'.
 Name Operation Operand

&percent	SETA	108
&VAR	SETC	(BYTE &percent)

This function might be used to introduce characters which are not on the keyboard.

DOUBLE Doubles any quotes and ampersands contained or evaluated in the character expression. After the following statements &VAR contains the character value '&&'TUV':

Name	Operation	Operand
&er	SETC	'&&'(1,1)
"e	SETC	''''
&OP2	SETC	'&er.S"e.TUV'
&VAR	SETC	(DOUBLE '&OP2')

LOWER Converts the characters contained or evaluated in the character expression in the operand to lowercase. After the following statements &VAR contains the character string 'twentysix'.

Name	Operation	Operand
&twenty	SETC	'Twenty'
&six	SETC	'SIX'
&VAR	SETC	(LOWER '&twenty.&six')

The characters A through Z are converted from uppercase to lowercase.

SIGNED Converts an arithmetic value to the character representation maintaining the signed value. After the following statements &VAR contains the character string '99 is greater than -99 but equals 99'.

&num	SETA	99
&plus	SETC	(SIGNED &num)
&num	SETA	-99
&minus	SETC	(SIGNED &num)
&VAR	SETC	'&plus is greater than &minus but equals &num'

UPPER Converts the characters contained or evaluated in the character expression in the operand to uppercase. After the following statements &VAR contains the character string 'FINE'.

Name	Operation	Operand
&weather	SETC	'Weather'
&fine	SETC	'Fine'
&VAR	SETC	(UPPER '&weather.&fine'(8,4))

The character expression includes the substring notation (8,4).

The characters a through z are converted from lowercase to uppercase.

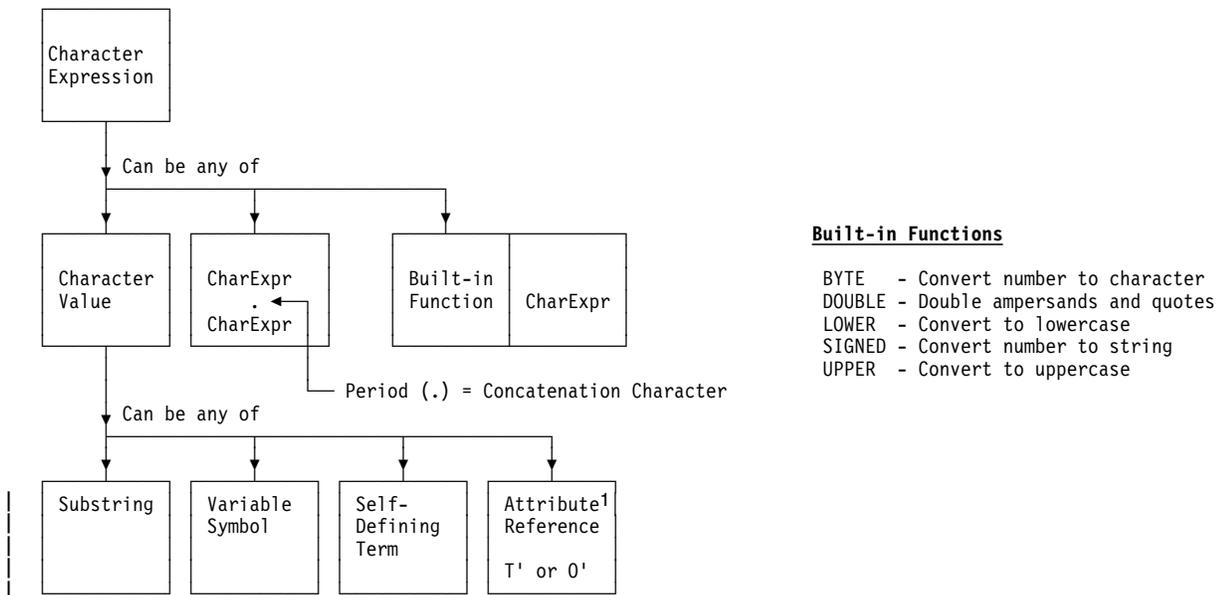


Figure 99. Defining Character (SETC) Expressions

Notes:

1. An attribute reference must be the only term in a character expression.

Evaluation of Character Expressions: The value of a character expression is the character string within the enclosing single quotation marks, after the assembler carries out any substitution for variable symbols.

Character strings, including variable symbols, can be concatenated to each other within a character expression. The resultant string is the value of the expression used in conditional assembly operations; for example, the value assigned to a SETC symbol.

Notes:

1. Use two single quotation marks to generate a single quotation mark as part of the value of a character expression.

The following statement assigns the character value L'SYMBOL to the SETC symbol &LENGTH.

```
&LENGTH SETC      'L'SYMBOL'
```

2. A double ampersand generates a double ampersand as part of the value of a character expression. To generate a single ampersand in a character expression, use the substring notation; for example:

```
&AMP SETC          '&&'(1,1)
```

The following statement assigns the character value HALF&& to the SETC symbol &AND.

```
&AND SETC          'HALF&&'
```

This is the only instance when the assembler does not pair ampersands to produce a single ampersand. However, if you substitute a SETC symbol with such a value into the nominal value in a DC instruction operand, or the operand

of an MNOTE instruction, when the assembler processes the DC or MNOTE instruction, it pairs the ampersands and produces a single ampersand.

3. To generate a period, two periods must be specified after a variable symbol, or the variable symbol must have a period as part of its value.

For example, if &ALPHA has been assigned the character value AB%4, the following statement can be used to assign the character value AB%4.RST to the variable symbol &GAMMA.

```
&GAMMA SETC          '&ALPHA..RST'
```

4. Double-byte data can appear in the character string if the assembler is invoked with the DBCS option. The double-byte data must be bracketed by the SO and SI delimiters, and the double-byte data must be valid.
5. The DBCS ampersand and apostrophe are not recognized as delimiters.
6. A double-byte character that contains the value of an EBCDIC ampersand or apostrophe in either byte is not recognized as a delimiter when enclosed by SO and SI.
7. Previous releases of HLASM permitted predefined absolute symbols in character expressions. Such usage is no longer supported.

Concatenation of Character String Values: Character expressions can be concatenated to each other or to substring notations in any order. The resulting value is a character string composed of the concatenated parts. This concatenated string can then be used in the operand field of a SETC instruction, or as a value for comparison in a logical expression.

You need the concatenation character (a period) to separate the single quotation mark that ends one character expression from the single quotation mark that begins the next.

For example, either of the following statements may be used to assign the character value ABCDEF to the SETC symbol &BETA.

```
&BETA SETC          'ABCDEF'
&BETA SETC          'ABC'. 'DEF'
```

Concatenation of strings containing double-byte data: If the assembler is invoked with the DBCS option, then the following additional considerations apply:

- When a variable symbol adjoins double-byte data, the SO delimiting the double-byte data is not a valid delimiter of the variable symbol. The variable symbol must be terminated by a period.
- The assembler checks for SI and SO at concatenation points. If the byte to the left of the join is SI and the byte to the right of the join is SO, then the SI/SO pair are considered redundant and are removed.
- To create redundant SI/SO pairs at concatenation points, use the substring notation and SETC expressions to create additional SI and SO characters. By controlling the order of concatenation, you can leave a redundant SI/SO pair at a concatenation point.

Examples:

```

&DBDA   SETC      '<Da>'
&SO     SETC      '&DBDA' (1,1)
&SI     SETC      '&DBDA' (4,1)
&DBCS1A SETC      '&DBDA.<Db>'
&DBCS1E SETC      '&DBDA<Db>'
&DBCS2  SETC      '&DBDA'.' '<Db>'
&DBCS2A SETC      '&DBDA'.' '<Db>'.' '&DBDA
&DBCS3  SETC      '&DBDA'.' '&SI'.' '&SO'.' '<Db>'
&DBCS3P SETC      '&DBDA'.' '&SI'
&DBCS3Q SETC      '&SO'.' '<Db>'
&DBCS3R SETC      '&DBCS3P'.' '&DBCS3Q'

```

These examples use the substring notation to create variables &SO and &SI, which have the values of SO and SI, respectively. The variable &DBCS1A is assigned the value <DaDb> with the SI/SO pair at the join removed. The assignment to variable &DBCS1E fails with error ASMA035E Invalid delimiter, because the symbol &DBDA is terminated by SO and not by a period. The variable &DBCS2 is assigned the value <DaDb>. The variable &DBCS2A is assigned the value <DaDbDa>. As with &DBCS1A, redundant SI/SO pairs are removed at the joins. The variable &DBCS3 is assigned the value <DaDb>. Although SI and SO have been added at the join, the concatenation operation removes two SI and two SO characters, since redundant SI/SO pairs are found at the second and third concatenations. However, by using intermediate variables &DBCS3P and &DBCS3Q to change the order of concatenation, the string <Da><Db> can be assigned to variable &DBCS3R.

Using SETC Symbols

The character value assigned to a SETC symbol is substituted for the SETC symbol when it is used in the name, operation, or operand field of a statement.

For example, consider the following macro definition, macro instruction, and generated statements:

```

MACRO
&NAME   MOVE      &TO,&FROM
        LCLC      &PREFIX
&PREFIX SETC      'FIELD'           Statement 1
&NAME   ST        2,SAVEAREA
        L         2,&PREFIX&FROM     Statement 2
        ST        2,&PREFIX&TO      Statement 3
        L         2,SAVEAREA
MEND
-----
HERE    MOVE      A,B
-----
+HERE  ST        2,SAVEAREA
+      L         2,FIELDB
+      ST        2,FIELDA
+      L         2,SAVEAREA

```

Statement 1 assigns the character value FIELD to the SETC symbol &PREFIX. In statements 2 and 3, &PREFIX is replaced by FIELD.

The following example shows how the value assigned to a SETC symbol may be changed in a macro definition.

SETC Instruction

```
MACRO
&NAME MOVE      &TO,&FROM
      LCLC      &PREFIX
&PREFIX SETC    'FIELD'          Statement 1
&NAME ST       2,SAVEAREA
      L        2,&PREFIX&FROM    Statement 2
&PREFIX SETC   'AREA'          Statement 3
      ST       2,&PREFIX&TO     Statement 4
      L        2,SAVEAREA
MEND
```

HERE MOVE A,B

```
+HERE ST      2,SAVEAREA
+  L          2,FIELD
+  ST         2,AREAA
+  L          2,SAVEAREA
```

Statement 1 assigns the character value FIELD to the SETC symbol &PREFIX. Therefore, &PREFIX is replaced by FIELD in statement 2. Statement 3 assigns the character value AREA to &PREFIX. Therefore, &PREFIX is replaced by AREA, instead of FIELD, in statement 4.

The following example uses the substring notation in the operand field of a SETC instruction.

```
MACRO
&NAME MOVE      &TO,&FROM
      LCLC      &PREFIX
&PREFIX SETC    '&TO'(1,5)      Statement 1
&NAME ST       2,SAVEAREA
      L        2,&PREFIX&FROM    Statement 2
      ST       2,&TO
      L        2,SAVEAREA
MEND
```

HERE MOVE FIELD,A,B

```
+HERE ST      2,SAVEAREA
+  L          2,FIELD
+  ST         2,FIELD
+  L          2,SAVEAREA
```

Statement 1 assigns the substring character value FIELD (the first five characters corresponding to symbolic parameter &TO to the SETC symbol &PREFIX. Therefore, FIELD replaces &PREFIX in statement 2.

Notes:

1. If the COMPAT(SYSLIST) assembler option is not specified, you can pass a sublist into a macro definition by assigning the sublist to a SETC symbol, and then specifying the SETC symbol as an operand in a macro instruction. However, if the COMPAT(SYSLIST) assembler option is specified, sublists assigned to SETC symbols are treated as a character string, not as a sublist.
2. Regardless of the setting of the COMPAT(SYSLIST) assembler option, you can not pass separate (as opposed to a sublist of) parameters into a macro

definition, by specifying a string of values separated by commas as the operand of a SETC instruction and then using the SETC symbol as an operand in the macro instruction. If you attempt to do this, the operand of the SETC instruction is passed to the macro instruction as one parameter, not as a list of parameters.

Concatenating Substring Notations and Character Expressions: Substring notations can be concatenated with character expressions in the operand field of a SETC instruction. If a substring notation follows a character expression, the two can be concatenated by placing a period between the terminating single quotation mark of the character expression and the opening single quotation mark of the substring notation.

For example, if &ALPHA has been assigned the character value AB%4, and &BETA has been assigned the character value ABCDEF, the following statement assigns &GAMMA the character value AB%4BCD:

```
&GAMMA SETC      '&ALPHA'. '&BETA' (2,3)
```

If a substring notation precedes a character expression or another substring notation, the two can be concatenated by writing the opening single quotation mark of the second item immediately after the closing parenthesis of the substring notation.

Optionally, you can place a period between the closing parenthesis of a substring notation and the opening single quotation mark of the next item in the operand field.

If &ALPHA has been assigned the character value AB%4, and &ABC has been assigned the character value 5RS, either of the following statements can be used to assign &WORD the character value AB%45RS.

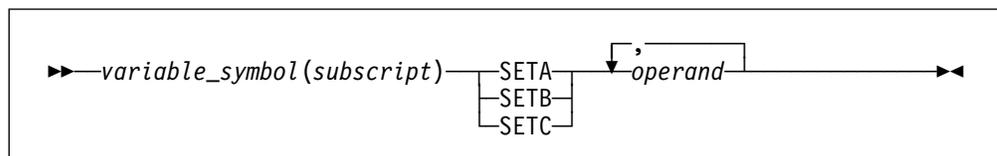
```
&WORD SETC      '&ALPHA' (1,4). '&ABC'  
&WORD SETC      '&ALPHA' (1,4)'&ABC' (1,3)
```

If a SETC symbol is used in the operand field of a SETA instruction, the character value assigned to the SETC symbol must be 1-to-10 decimal digits (not greater than 2147483647), or a valid self-defining term.

If a SETA symbol is used in the operand field of a SETC statement, the arithmetic value is converted to an unsigned integer with leading zeros removed. If the value is 0, it is converted to a single 0.

Extended SET Statements

As well as assigning single values to SET symbols, you can assign values to multiple elements in an array of a subscripted SET symbol with one single SETx instruction. Such an instruction is called an extended SET statement.



SETAF Instruction

variable_symbol(subscript)

is a variable symbol and a subscript that shows the position in the SET symbol array to which the first *operand* is to be assigned.

operand

is the arithmetic value, binary value, or character value to be assigned to the corresponding SET symbol array element.

The first *operand* is assigned to the SET symbol denoted by *variable_symbol(subscript)*. Successive *operands* are then assigned to successive positions in the SET symbol array. If an *operand* is omitted, the corresponding element of the array is unchanged. Consider the following example:

```
LCLA          &LIST(50)
&LIST(3) SETA      5,10,,20,25,30
```

The first instruction declares &LIST as a subscripted local SETA symbol. The second instruction assigns values to certain elements of the array &LIST. Thus, the instruction does the same as the following sequence:

```
&LIST(3) SETA      5
&LIST(4) SETA     10
&LIST(6) SETA     20
&LIST(7) SETA     25
&LIST(8) SETA     30
```

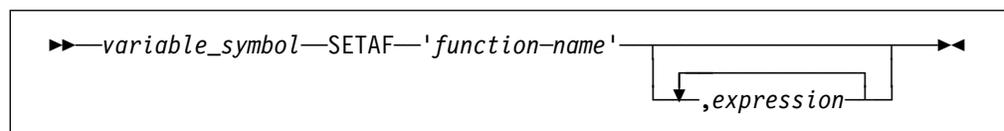
Alternative Statement Format: You can use the alternative statement format for extended SETx statements. The above coding could then be written as follows:

```
&LIST(3) SETA      5,          THIS IS      X
                   10,,        AN ARRAY     X
                   20,25,30    SPECIFICATION
```

SETAF Instruction

Use the SETAF instruction to call an external function to assign any number of arithmetic values to a SETA symbol. You can assign a large number of parameters—the exact number depending on factors such as the size of the program and of virtual storage—to pass to the external function routine.

The SETAF instruction can be used anywhere that a SETA instruction can be used.



variable symbol

is a variable symbol.

A global variable symbol in the name field must have been previously declared as a SETA symbol in a GBLA instruction. Local SETA symbols need not be declared in a LCLA instruction. The assembler considers any undeclared variable symbol found in the name field of a SETA instruction as a local SET symbol.

The variable symbol is assigned a type attribute value of N.

function_name

the name of an external function load module. The name must be specified as a character expression, and must evaluate to a valid module name no longer than 8 bytes.

Refer to Chapter 5, “Providing External Functions for Conditional Assembly” in the *HLASM Programmer's Guide* for information about external function load modules.

expression

is an arithmetic expression evaluated as a signed 32-bit arithmetic value. The minimum and maximum allowable values of the expression are -2^{31} and $+2^{31}-1$, respectively.

See “SETA Instruction” on page 318 for further information about setting SETA symbols, and ways to specify arithmetic expressions.

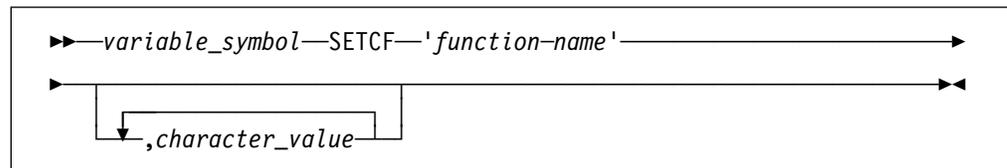
The function name must be enclosed in single quotes. For example:

```
&MAX_VAL SETAF 'MAX',7,4           Calls the external function X
                                   MAX, passing values 7 and X
                                   4 as operands.
```

SETCF Instruction

Use the SETCF instruction to call an external function to assign a character value to a SETC symbol. You can specify a large number of parameters—the exact number depending on factors such as the size of the program and of virtual storage—to pass to the external function routine.

The SETCF instruction can be used anywhere that a SETC instruction can be used.



variable symbol

is a variable symbol.

A global variable symbol in the name field must have been previously declared as a SETC symbol in a GBLC instruction. Local SETC symbols need not be declared in a LCLC instruction. The assembler considers any undeclared variable symbol found in the name field of a SETC instruction as a local SET symbol. The variable symbol is assigned a type attribute value of U.

The character value assigned to the variable symbol can have a string length in the range 0 (for a null character string) through 255.

function_name

the name of an external function load module. The name must be specified as a character expression, and must evaluate to a valid module name no longer than 8 bytes.

Substring Notation

Refer to Chapter 5, “Providing External Functions for Conditional Assembly” in the *HLASM Programmer's Guide* for information about external function load modules.

character_value

is a character value that may be specified by one of the following:

- A type attribute reference
- An operation code attribute reference
- A character expression
- A substring notation
- A concatenation of one or more of the above

The character value can have a string length in the range 0 (for a null character string) through 255.

When a SETA or SETB symbol is specified in a character expression, the unsigned decimal value of the symbol (with leading zeros removed) is the character value given to the symbol.

See “SETC Instruction” on page 333 for further information about setting SETC symbols, and ways to specify character expressions.

Substring Notation

The substring notation lets you refer to one or more characters within a character string. You can, therefore, either select characters from the string and use them for substitution or testing, or scan through a complete string, inspecting each character. By concatenating substrings with other substrings or character strings, you can rearrange and build your own strings.

The substring notation can be used only in conditional assembly instructions. Figure 100 shows how to use the substring notation.

Figure 100. Substring Notation in Conditional Assembly Instructions

Used in	Used as	Example	Value assigned to SETC Symbol
SETC instruction operand	Operand	&C1 SETC 'ABC'(1,3)	ABC
	Part of operand	&C2 SETC '&C1'(1,2)'.DEF'	ABDEF
AIF or SETB instruction operand (logical expression)	Character value in comparand of character relation	AIF ('&STRING'(1,4) EQ 'AREA').SEQ &B SETB ('&STRING'(1,4)'.9' EQ 'FULL9')	---

The substring notation must be specified as follows:

'CHARACTER STRING' (*e1*,*e2*)

where the CHARACTER STRING is a character expression from which the substring is to be extracted. The first subscript (*e1*) shows the first character that is to be extracted from the character string. The second subscript (*e2*) shows the number of characters to be extracted from the character string, starting with the character indicated by the first subscript. Thus, the second subscript specifies the length of the resulting substring.

The second subscript value of the substring notation can be specified as an (*). This shows that the length of the extracted string is equal to the length of the character expression, less the number of characters before the starting character.

The character string must be a valid character expression with a length, n , in the range 1 through 255 characters. The length of the resulting substring must be in the range 0 through 255.

The subscripts, $e1$ and $e2$, must be arithmetic expressions.

Evaluation of Substrings: The following examples show how the assembler processes substrings depending on the value of the elements n , $e1$, and $e2$.

- In the usual case, the assembler generates a correct substring of the specified length:

Notation	Value of Variable Symbol	Character Value of Substring
'ABCDE' (1,5)		ABCDE
'ABCDE' (2,3)		BCD
'ABCDE' (2,*)		BCDE
'ABCDE' (4,*)		DE
'&C' (3,3)	ABCDE	CDE
'&PARAM' (3,3)	((A+3)*10) A+3	

- When $e1$ has a value of 0 or a negative value, the assembler generates a null string and issues error message ASMA093E.

Notation	Value of Variable Symbol	Character Value of Substring
'ABCDE' (0,5)		null character string
'ABCDE' (0,*)		null character string

- When the value of $e1$ exceeds n , the assembler generates a null string and issues error message ASMA092E.

Notation	Value of Variable Symbol	Character Value of Substring
'ABCDE' (7,3)		null character string
'ABCDE' (6,*)		null character string

- When $e2$ has a value less than one, the assembler generates the null character string. If $e2$ is negative, the assembler also issues error message ASMA095W.

Notation	Value of Variable Symbol	Character Value of Substring
'ABCDE' (4,0)		null character string
'ABCDE' (3,-2)		null character string

- When $e2$ indexes past the end of the character expression (that is, $e1+e2$ is greater than $n+1$), the assembler issues warning message ASMA094I, and generates a substring that includes only the characters up to the end of the character expression specified. You can use the FLAG(NOSUBSTR) assembler option to suppress message ASMA094I.

logical_expression

is a logical expression (see “Logical (SETB) Expressions” on page 329) the assembler evaluates during conditional assembly time to determine if it is true or false. If the expression is true (logical value=1), the statement named by the sequence symbol in the operand field is the next statement processed by the assembler. If the expression is false (logical value=0), the next sequential statement is processed by the assembler.

In the following example, the assembler branches to the label `.OUT` if `&C = YES`:

```

                AIF          ('&C' EQ 'YES') .OUT
.ERROR        ANOP
                .
                .
                .
.OUT          ANOP

```

The sequence symbol in the operand field is a conditional assembly label that represents a statement number during conditional assembly processing. It is the number of the statement that is branched to if the logical expression preceding the sequence symbol is true.

The statement identified by the sequence symbol referred to in the AIF instruction can appear before or after the AIF instruction. However, the statement must appear within the local scope of the sequence symbol. Thus, the statement identified by the sequence symbol must appear:

- In open code, if the corresponding AIF instruction appears in open code
- In the same macro definition in which the corresponding AIF instruction appears.

You cannot branch from open code into a macro definition or between macro definitions, regardless of nested calls to other macro definitions.

The following macro definition generates the statements needed to move a fullword fixed-point number from one storage area to another. The statements are generated only if the type attribute of both storage areas is the letter F.

```

                MACRO
&N            MOVE          &T,&F
                AIF          (T'&T NE T'&F) .END   Statement 1
                AIF          (T'&T NE 'F') .END   Statement 2
&N            ST            2,SAVEAREA           Statement 3
                L            2,&F
                ST            2,&T
                L            2,SAVEAREA
.END          MEND                               Statement 4

```

The logical expression in the operand field of Statement 1 has the value true if the type attributes of the two macro instruction operands are not equal. If the type attributes are equal, the expression has the logical value false.

Therefore, if the type attributes are not equal, Statement 4 (the statement named by the sequence symbol `.END`) is the next statement processed by the assembler. If the type attributes are equal, Statement 2 (the next sequential statement) is processed.

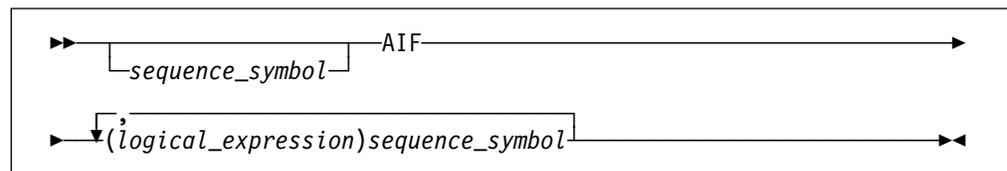
AIF Instruction

The logical expression in the operand field of Statement 2 has the value true if the type attribute of the first macro instruction operand is not the letter F. If the type attribute is the letter F, the expression has the logical value false.

Therefore, if the type attribute is not the letter F, Statement 4 (the statement named by the sequence symbol .END) is the next statement processed by the assembler. If the type attribute is the letter F, Statement 3 (the next sequential statement) is processed.

Extended AIF Instruction

The extended AIF instruction combines several successive AIF statements into one statement.



sequence_symbol
is a sequence symbol

logical_expression
is a logical expression the assembler evaluates during conditional assembly time to determine if it is true or false. If the expression is true (logical value=1), the statement named by the sequence symbol in the operand field is the next statement processed by the assembler. If the expression is false (logical value=0), the next logical expression is evaluated.

The extended AIF instruction is exactly equivalent to *n* successive AIF statements. The branch is taken to the first sequence symbol (scanning left to right) whose corresponding logical expression is true. If none of the logical expressions is true, no branch is taken.

Example:

AIF	('&L'(&C,1) EQ '\$').DOLR,	Cont.
	('&L'(&C,1) EQ '#').POUND,	X
	('&L'(&C,1) EQ '@').AT,	X
	('&L'(&C,1) EQ '=').EQUAL,	X
	('&L'(&C,1) EQ '(').LEFTPAR,	X
	('&L'(&C,1) EQ '+').PLUS,	X
	('&L'(&C,1) EQ '-').MINUS	

This statement looks for the occurrence of a \$, #, @, =, (, +, and -, in that order; and causes control to branch to .DOLR, .POUND, .AT, .EQUAL, .LEFTPAR, .PLUS, and .MINUS, respectively, if the string being examined contains any of these characters at the position designated by &C.

Alternative Format for AIF Statement

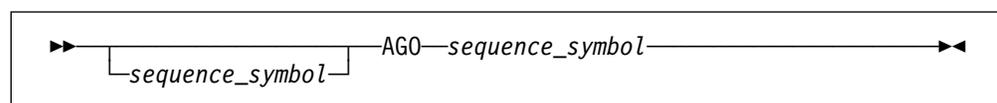
The alternative statement format is allowed for extended AIF instructions. This format is illustrated in the above example.

AIFB—Synonym of the AIF Instruction

For compatibility with some earlier assemblers, High Level Assembler supports the AIFB symbolic operation code as a synonym of the AIF instruction. However, you should not use the AIFB instruction in new applications as support for it might be removed in the future.

AGO Instruction

The AGO instruction branches unconditionally. You can thus alter the sequence in which your assembler language statements are processed. This provides you with final exits from conditional assembly loops.



sequence_symbol
is a sequence symbol.

The statement named by the sequence symbol in the operand field is the next statement processed by the assembler.

The statement identified by a sequence symbol referred to in the AGO instruction can appear before or after the AGO instruction. However, the statement must appear within the local scope of the sequence symbol. Thus, the statement identified by the sequence symbol must appear:

- In open code, if the corresponding AGO instruction appears in open code
- In the same macro definition in which the corresponding AGO instruction appears.

Example:

```

MACRO
&NAME MOVE      &T,&F
        AIF      (T'&T EQ 'F').FIRST   Statement 1
        AGO      .END                   Statement 2
.FIRST AIF      (T'&T NE T'&F).END     Statement 3
&NAME  ST       2,SAVEAREA
        L        2,&F
        ST       2,&T
        L        2,SAVEAREA
.END   MEND                                Statement 4

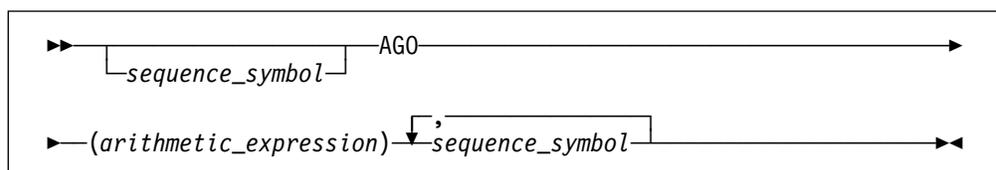
```

Statement 1 determines if the type attribute of the first macro instruction operand is the letter F. If the type attribute is the letter F, Statement 3 is the next statement processed by the assembler. If the type attribute is not the letter F, Statement 2 is the next statement processed by the assembler.

Statement 2 indicates to the assembler that the next statement to be processed is Statement 4 (the statement named by sequence symbol .END).

Computed AGO Instruction

The computed AGO instruction makes branches according to the value of an arithmetic expression specified in the operand.



sequence_symbol
is a sequence symbol.

arithmetic_expression
is an arithmetic expression the assembler evaluates to *k*, where *k* lies between 1 and *n* (the number of occurrences of *sequence_symbol* in the operand field) inclusive. The assembler branches to the *k*-th sequence symbol in the list. If *k* is outside that range, no branch is taken.

In the following example, control passes to the statement at .THIRD if &I= 3. Control passes through to the statement following the AGO if &I is less than 1 or greater than 4.

```

                AGO                (&I).FIRST,.SECOND,                Cont.
                                                .THIRD,.FOURTH                X
    
```

Alternative Format for AGO Statement

The alternative statement format is allowed for computed AGO instructions. The above example could be coded as follows:

```

                AGO                (&I).FIRST,                Cont.
                                                .SECOND,                X
                                                .THIRD,                X
                                                .FOURTH                X
    
```

AGOB—Synonym of the AGO Instruction

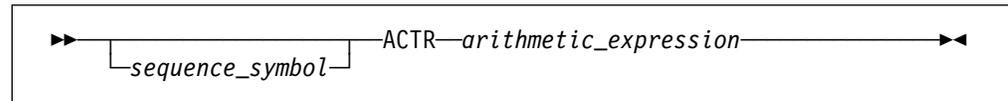
For compatibility with some earlier assemblers, High Level Assembler supports the AGOB symbolic operation code as a synonym of the AGO instruction. However, you should not use the AGOB instruction in new applications as support for it might be removed in the future.

ACTR Instruction

The ACTR instruction sets a conditional assembly loop counter either within a macro definition or in open code. The ACTR instruction can appear anywhere in open code or within a macro definition.

Each time the assembler processes an AIF or AGO branching instruction in a macro definition or in open code, the loop counter for that part of the program is decremented by one. When the number of conditional assembly branches reaches the value assigned to the loop counter by the ACTR instruction, the assembler exits from the macro definition or stops processing statements in open code.

By using the ACTR instruction, you avoid excessive looping during conditional assembly processing.



sequence_symbol
is a sequence symbol.

arithmetic_expression
is an arithmetic expression used to set or reset a conditional assembly loop counter.

A conditional assembly loop counter has a local scope; its value is decremented only by AGO and AIF instructions, and reassigned only by ACTR instructions that appear within the same scope. Thus, the nesting of macros has no effect on the setting of individual loop counters.

The assembler sets its own internal loop counter both for open code and for each macro definition, if neither contains an ACTR instruction. The assembler assigns a standard value of 4096 to each of these internal loop counters.

Loop Counter Operations

Within the local scope of a particular loop counter (including the internal counters run by the assembler), the following occurs:

1. Each time an AGO or AIF branch is executed, the assembler checks the loop counter for zero or a negative value.
2. If the count is not zero or negative, it is decremented by one.
3. If the count is zero, before decrementing, the assembler takes one of two actions:
 - a. If it is processing instructions in open code, the assembler processes the remainder of the instructions in the source module as comments. Errors discovered in these instructions during previous passes are flagged.
 - b. If it is processing instructions inside a macro definition, the assembler terminates the expansion of that macro definition and processes the next sequential instruction after the calling macro instruction. If the macro definition is called by an inner macro instruction, the assembler processes the next sequential instruction after this inner call; that is, it continues processing at the next outer level of nested macros.

The assembler halves the ACTR counter value when it encounters serious syntax errors in conditional assembly instructions.

ANOP Instruction

You can specify a sequence symbol in the name field of an ANOP instruction, and use the symbol as a label for branching purposes.

The ANOP instruction carries out no operation itself, but you can use it to allow conditional assembly to skip to an instruction that does not have a sequence symbol in its name field. For example, if you wanted to branch to a SETA, SETB,

ANOP Instruction

or SETC assignment instruction, which requires a variable symbol in the name field, you could insert a labeled ANOP instruction immediately before the assignment instruction. By branching to the ANOP instruction with an AIF or AGO instruction, you would, in effect, be branching to the assignment instruction.



sequence_symbol
is a sequence symbol.

No operation is carried out by an ANOP instruction. Instead, if a branch is taken to the ANOP instruction, the assembler processes the next sequential instruction.

Example:

```
MACRO
&NAME MOVE      &T,&F
      LCLC      &TYPE
      AIF      (T'&T EQ 'F').FTYPE      Statement 1
&TYPE SETC      'E'                      Statement 2
.FTYPE ANOP                      Statement 3
&NAME ST&TYPE   2,SAVEAREA              Statement 4
      L&TYPE    2,&F
      ST&TYPE   2,&T
      L&TYPE    2,SAVEAREA
MEND
```

Statement 1 determines if the type attribute of the first macro instruction operand is the letter F. If the type attribute is not the letter F, Statement 2 is the next statement processed by the assembler. If the type attribute is the letter F, Statement 4 should be processed next. However, because there is a variable symbol (&NAME) in the name field of Statement 4, the required sequence symbol (.FTYPE) cannot be placed in the name field. Therefore, an ANOP instruction (Statement 3) must be placed before Statement 4.

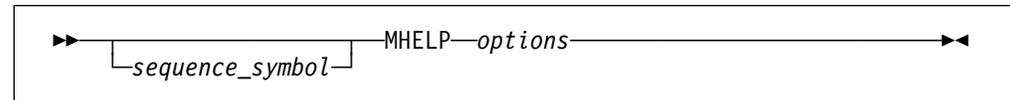
Then, if the type attribute of the first operand is the letter F, the next statement processed by the assembler is the statement named by sequence symbol .FTYPE. The value of &TYPE retains its initial null character value because the SETC instruction is not processed. Because .FTYPE names an ANOP instruction, the next statement processed by the assembler is Statement 4, the statement following the ANOP instruction.

Chapter 10. MHELP Instruction

The MHELP instruction controls a set of trace and dump facilities. MHELP statements can occur anywhere in open code or in macro definitions. MHELP options remain in effect until superseded by another MHELP statement.

MHELP Options

Options are selected by an absolute expression in the MHELP operand field.



sequence_symbol
is a sequence symbol.

options
is the sum of the binary or decimal options described below.

MHELP B' 1' or MHELP 1, Macro Call Trace: This option provides a one-line trace listing for each macro call, giving the name of the called macro, its nested depth, and its &SYSNDX value. The trace is provided only upon entry into the macro. No trace is provided if error conditions prevent entry into the macro.

MHELP B' 10' or MHELP 2, Macro Branch Trace: This option provides a one-line trace-listing for each AGO and AIF conditional assembly branch within a macro. It gives the model statement numbers of the “branched from” and the “branched to” statements, and the name of the macro in which the branch occurs. This trace option is suppressed for library macros.

MHELP B' 100' or MHELP 4, Macro AIF Dump: This option dumps undimensioned SET symbol values from the macro dictionary immediately before each AIF statement that is encountered.

MHELP B' 1000' or MHELP 8, Macro Exit Dump: This option dumps undimensioned SET symbols from the macro dictionary whenever an MEND or MEXIT statement is encountered.

MHELP B' 10000' or MHELP 16, Macro Entry Dump: This option dumps parameter values from the macro dictionary immediately after a macro call is processed.

MHELP B' 100000' or MHELP 32, Global Suppression: This option suppresses global SET symbols in two preceding options, MHELP 4 and MHELP 8.

MHELP B' 1000000' or MHELP 64, Macro Hex Dump: This option, when used with the Macro AIF dump, the Macro Exit dump, or the Macro Entry dump, dumps the parameter and SETC symbol values in EBCDIC and hexadecimal formats. Only positional and keyword parameters are dumped in hexadecimal; system parameters are dumped in EBCDIC. The full value of SETC variables or parameters is dumped in hexadecimal.

MHELP B' 1000000' or MHELP 128, MHELP Suppression: This option suppresses all currently active MHELP options.

MHELP Control on &SYSNDX: The maximum value of the &SYSNDX system variable can be controlled by the MHELP instruction. The limit is set by specifying a number in the operand of the MHELP instruction that is not one of the MHELP codes defined above, and is in the following number ranges:

- 256 to 65535
- Most numbers in the range 65792 to 9999999. Refer to MHELP Operand Mapping below for details.

When the &SYSNDX limit is reached, message ASMA013S ACTR counter exceeded is issued, and the assembler in effect ignores all further macro calls.

MHELP Operand Mapping

The MHELP operand field is actually mapped into a fullword. The predefined MHELP codes correspond to the fourth byte of this fullword, while the &SYSNDX limit is controlled by setting any bit in the third byte to 1. If all bits in the third byte are 0, then the &SYSNDX limit is not set.

The bit settings for bytes 3 and 4 are shown in Figure 102.

Figure 102. &SYSNDX Control Bits

Byte	Description
Byte 3 - &SYSNDX control	1... Bit 0 = 1. Value=32768. Limit &SYSNDX to 32768. .1.. Bit 1 = 1. Value=16384. Limit &SYSNDX to 16384. ..1. Bit 2 = 1. Value=8192. Limit &SYSNDX to 8192. ...1 Bit 3 = 1. Value=4096. Limit &SYSNDX to 4096. 1... Bit 4 = 1. Value=2048. Limit &SYSNDX to 2048. .... .1.. Bit 5 = 1. Value=1024. Limit &SYSNDX to 1024. .... ..1. Bit 6 = 1. Value=512. Limit &SYSNDX to 512. .... ...1 Bit 7 = 1. Value=256. Limit &SYSNDX to 256.
Byte 4	1... Bit 0 = 1. Value=128. MHELP Suppression. .1.. Bit 1 = 1. Value=64. Macro Hex Dump. ..1. Bit 2 = 1. Value=32. Global Suppression. ...1 Bit 3 = 1. Value=16. Macro Entry Dump. 1... Bit 4 = 1. Value=8. Macro Exit Dump. .... .1.. Bit 5 = 1. Value=4. Macro AIF Dump. .... ..1. Bit 6 = 1. Value=2. Macro Branch Trace. .... ...1 Bit 7 = 1. Value=1. Macro Call Trace.

Note: You can use any combination of bit settings in any byte of the MHELP fullword to set the limit, provided at least one bit in byte 3 is set. This explains why not all values between 65792 and 9999999 can be used to set the limit. For example, the number 131123 does not set the &SYSNDX limit because none of the bits in byte 3 are set to 1.

Examples:

```
MHELP 256      Limit &SYSNDX to 256
MHELP 1        Trace macro calls
MHELP 65536    No effect. No bits in bytes 3,4
MHELP 65792    Limit &SYSNDX to 65792
```

See Figure 103 on page 355 for more examples.

Combining Options

More than one MHELP option, including the limit for &SYSNDX, can be specified at the same time by combining the option codes in one MHELP operand. For example, call and branch traces can be invoked by:

```
MHELP B'11'  
MHELP 2+1  
MHELP 3
```

Substitution by variable symbols may also be used.

MHELP Instruction	MHELP Operand				MHELP Effect
	Decimal	Hexadecimal			
			&SYSNDX	MHELP	
MHELP 4869	4869	0000	13	05	Macro call trace and AIF dump; &SYSNDX limited to 4869
MHELP 65536	65536	0001	00	00	No effect
MHELP 16777232	16777232	0010	00	10	Macro entry dump
MHELP 28678	28678	0000	70	06	Macro branch trace and AIF dump; &SYSNDX limited to 28678
MHELP 256+1	257	0000	01	01	Macro call trace; &SYSNDX limited to 257
MHELP B'11'	3	0000	00	03	Macro call trace, and macro branch trace

Figure 103. MHELP Control on &SYSNDX

Part 4. Appendixes

Appendix A. Assembler Instructions	358
Appendix B. Summary of Constants	363
Appendix C. Macro and Conditional Assembly Language Summary	365
Appendix D. Standard Character Set Code Table	377

Appendix A. Assembler Instructions

Figure 104 summarizes the basic formats of assembler instructions, and Figure 105 on page 361 summarizes assembler statements.

Figure 104 (Page 1 of 5). Assembler Instructions

Operation Entry	Name Entry	Operand Entry
ACONTROL	A sequence symbol or blank	One or more operands, separated by commas
ACTR	A sequence symbol or blank	An arithmetic SETA expression
ADATA	A sequence symbol or blank	One-to-four decimal, self-defining terms, and one character string, separated by commas.
AEJECT ²	A sequence symbol or blank	Taken as a remark
AGO	A sequence symbol or blank	A sequence symbol
AIF	A sequence symbol or blank	A logical expression enclosed in parentheses, immediately followed by a sequence symbol
AINsert	A sequence symbol or blank	A character string, followed by FRONT or BACK
AMODE	Any symbol or blank	24, 31, 64, ANY or ANY31
ALIAS	A symbol	A character string or a hexadecimal string
ANOP	A sequence symbol or blank	Taken as a remark
AREAD ²	Any SETC symbol	NOPRINT, NOSTMT, CLOCKB, CLOCKD, or blank
ASPACE	A sequence symbol or blank	An absolute expression
CATTR (MVS and CMS)	A valid program object external class name	One or more attributes
CCW ⁴	Any symbol or blank	Four operands, separated by commas
CCW0 ⁴	Any symbol or blank	Four operands, separated by commas
CCW1 ⁴	Any symbol or blank	Four operands, separated by commas
CEJECT	A sequence symbol or blank	An absolute expression or blank
CNOP ⁴	Any symbol or blank	Two absolute expressions, separated by a comma
COM	Any symbol or blank	Taken as a remark
COPY	A sequence symbol or blank	An ordinary symbol, or, for open code statements, a variable symbol
CSECT	Any symbol or blank	Taken as a remark
CXD ⁴	Any symbol or blank	Taken as a remark
DC ⁴	Any symbol or blank	One or more operands, separated by commas
DROP	A sequence symbol or blank	One or more absolute expressions and symbols, separated by commas, or blank

Figure 104 (Page 2 of 5). Assembler Instructions

Operation Entry	Name Entry	Operand Entry
DS ⁴	Any symbol or blank	One or more operands, separated by commas
DSECT	A symbol or blank	Taken as a remark
DXD ⁴	A symbol	One or more operands, separated by commas
EJECT	A sequence symbol or blank	Taken as a remark
END	A sequence symbol or blank	A relocatable expression or blank
ENTRY	A sequence symbol or blank	One or more relocatable symbols, separated by commas
EQU	A variable symbol or an ordinary symbol	One to three operands, separated by commas
EXITCTL	A sequence symbol or blank	A character-string operand followed by one to four decimal self-defining terms, separated by commas
EXTRN	A sequence symbol or blank	One or more relocatable symbols, separated by commas
GBLA	A sequence symbol or blank	One or more variable symbols that are to be used as SET symbols, separated by commas ¹
GBLB	A sequence symbol or blank	One or more variable symbols that are to be used as SET symbols, separated by commas ¹
GBLC	A sequence symbol or blank	One or more variable symbols that are to be used as SET symbols, separated by commas ¹
ICTL	Blank	One to three decimal self-defining terms, separated by commas
ISEQ	A sequence symbol or blank	Two decimal self-defining terms, separated by a comma, or blank
LCLA	A sequence symbol or blank	One or more variable symbols that are to be used as SET symbols, separated by commas ¹
LCLB	A sequence symbol or blank	One or more variable symbols that are to be used as SET symbols, separated by commas ¹
LCLC	A sequence symbol or blank	One or more variable symbols separated by commas ¹
LOCTR	A variable or ordinary symbol	Blank
LTORG	Any symbol or blank	Taken as a remark
MACRO ²	Blank	Taken as a remark
MEND ²	A sequence symbol or blank	Taken as a remark
MEXIT ²	A sequence symbol or blank	Taken as a remark
MHELP	A sequence symbol or blank	Absolute expression, binary or decimal options

Figure 104 (Page 3 of 5). Assembler Instructions

Operation Entry	Name Entry	Operand Entry
MNOTE	A sequence symbol or blank	A severity code, followed by a comma, followed by a 1-to-256-character string enclosed in single quotation marks. Double-byte characters are permitted if the DBCS assembler option is specified.
OPSYN	An ordinary symbol	An machine instruction mnemonic or an operation code defined by a previous macro definition or OPSYN instruction
	An operation code mnemonic	Blank
ORG	A sequence symbol or blank	A relocatable expression or blank
POP	A sequence symbol or blank	One or more operands, separated by commas
PRINT	A sequence symbol or blank	One or more operands, separated by commas
PUNCH	A sequence symbol or blank	A 1-to-80-character string enclosed in single quotation marks. Double-byte characters are permitted if the DBCS assembler option is specified.
PUSH	A sequence symbol or blank	One or more operands, separated by commas
REPRO	A sequence symbol or blank	Taken as a remark
RMODE	Any symbol or blank	24, 31, 64 or ANY
RSECT	Any symbol or blank	Taken as a remark
SETA	A SETA symbol	An arithmetic expression
SETAF	A SETA symbol	An external function module, and the arithmetic expressions it requires, separated by commas
SETB	A SETB symbol	A 0 or a 1, or a logical expression enclosed in parentheses
SETC	A SETC symbol	A type attribute, a character expression, a substring notation, or a concatenation of character expressions and substring notations. Double-byte characters are permitted if the DBCS assembler option is specified.
SETCF	A SETC symbol	An external function module, and the character expressions it requires, separated by commas
SPACE	A sequence symbol or blank	An absolute expression
START	Any symbol or blank	An absolute expression or blank
TITLE ³	A 1-to-8-character string, a variable symbol, a combination of character string or variable symbol, a sequence symbol, or blank	A 1-to-100-character string enclosed in single quotation marks. Double-byte characters are permitted if the DBCS assembler option is specified.

Figure 104 (Page 4 of 5). Assembler Instructions

Operation Entry	Name Entry	Operand Entry
USING	A symbol or blank	Either a single absolute or relocatable expression or a pair of absolute or relocatable expressions enclosed in parentheses and followed by 1 to 16 absolute expressions, separated by commas, or followed by a relocatable expression
WXTRN	A sequence symbol or blank	One or more relocatable symbols, separated by commas
XATTR (MVS and CMS)	An external symbol	One or more operands, separated by commas

Notes:

1. SET symbols may be defined as subscripted SET symbols.
2. May only be used as part of a macro definition.
3. See "TITLE Instruction" on page 191 for a description of the name entry.
4. These instructions start a private section.

Figure 105 (Page 1 of 2). Assembler Statements

Instruction Entry	Name Entry	Operand Entry
Model Statements ^{1 and 2}	An ordinary symbol, variable symbol, sequence symbol, or a combination of variable symbols and other characters that is equivalent to a symbol, or blank	Any combination of characters (including variable symbols)
Prototype Statement ³	A symbolic parameter or blank	Zero or more operands that are symbolic parameters (separated by commas), and zero or more operands (separated by commas) of the form: symbolic parameter, equal sign, optional standard value
Macro Instruction Statement ³	An ordinary symbol, a variable symbol, or a combination of variable symbols and other characters that is equivalent to a symbol, any character string, a sequence symbol ⁴ or blank	Zero or more positional operands (separated by commas), and zero or more keyword operands (separated by commas) of the form keyword, equal sign, value ⁵

Figure 105 (Page 2 of 2). Assembler Statements

Instruction Entry	Name Entry	Operand Entry
Assembler Language Statement ¹²	An ordinary symbol, a variable symbol, a sequence symbol, or a combination of variable symbols and other characters that is equivalent to a symbol, or blank	Any combination of characters (including variable symbols)

Notes:

1. Variable symbols may be used to generate assembler language mnemonic operation codes (listed in Chapter 5, “Assembler Instruction Statements” on page 87), except COPY, ICTL, ISEQ, and REPRO. Variable symbols may not be used in the name and operand entries of COPY, ICTL, and ISEQ instructions, except for the COPY instruction in open code, where a variable symbol is allowed for the operand entry.
2. No substitution is done for variables in the line following a REPRO statement.
3. May only be used as part of a macro definition.
4. When the name field of a macro instruction contains a sequence symbol, the sequence symbol is not passed as a name field parameter. It only has meaning as a possible branch target for conditional assembly.
5. Variable symbols appearing in a macro instruction are replaced by their values before the macro instruction is processed.

Appendix B. Summary of Constants

Figure 106 and Figure 107 on page 364 summarize the types of assembler constants.

Figure 106. Summary of Constants (Part 1 of 2)

Constant	Type	Implicit Length (Bytes)	Alignment	Length Modifier Range	Specified By
Address	A	4	Fullword	.1 to 4 ¹	Any expression
Doubleword Address	AD	8	Doubleword	2 to 8	Any expression
Binary	B	As needed	Byte	.1 to 256	Binary digits
Character	C	As needed	Byte	.1 to 256 ²	Characters
Unicode Character	CU	As needed	Byte	1 to 256 ³	Characters
Floating Point Hex	D	8	Doubleword	.1 to 8	Decimal digits
Floating Point Hex	DH	8	Doubleword	.12 to 8	Decimal digits
Floating Point Binary	DB	8	Doubleword	.12 to 8	Decimal digit
Floating Point Hex	E	4	Fullword	.1 to 8	Decimal digits
Floating Point Hex	EH	4	Fullword	.12 to 8	Decimal digits
Floating Point Binary	EB	4	Fullword	.9 to 8	Decimal digits
Fixed Point	F	4	Fullword	.1 to 8	Decimal digits
Doubleword Fixed Point	FD	8	Doubleword	.1 to 8	Decimal digits
Graphic (DBCS)	G	As needed	Byte	2 to 256 ³	DBCS characters
Fixed Point	H	2	Halfword	.1 to 8	Decimal digits
Length	J	4	Fullword	1 to 4	Class name or external DSECT name ⁴
Floating Point Hex	L	16	Doubleword	.1 to 16	Decimal digits
Floating Point Hex	LH	16	Doubleword	.12 to 16	Decimal digit
Floating Point Binary	LB	16	Doubleword	.16 to 16	Decimal digit
Decimal	P	As needed	Byte	.1 to 16	Decimal digits
Offset	Q	4	Fullword	1 to 4	Symbol naming a DXD or DSECT
Address	R ⁴	4	Fullword	3, 4	Symbol
Address	S	2	Halfword	2 only	One absolute or relocatable expression, or two absolute expressions: exp(exp)
Address	V	4	Fullword	3, 4	Relocatable symbol
Hexadecimal	X	As needed	Byte	.1 to 256 ²	Hex digits
Address	Y	2	Halfword	.1 to 2 ¹	Any expression
Decimal	Z	As needed	Byte	.1 to 16	Decimal digits

Notes:

1. Bit length specification permitted with absolute expressions only; relocatable A-type constants, 2, 3, or 4 bytes only; relocatable Y-type constants, 2 bytes only.
2. In a DS assembler instruction, C-and-X type constants can have length specification to 65535.
3. The length modifier must be a multiple of 2, and may be up to 65534 in a DS assembler instruction.
4. GOFF only.

Summary of Constants

Figure 107. Summary of Constants (Part 2 of 2)

Constant	Type	No. of Constants per Operand	Range for Exponents	Range for Scale	Truncation or Padding Side
Address	A	Multiple			Left
Binary	B	Multiple			Left
Character	C	One			Right
Unicode Character	CU	One			Right
Floating Point Hex	D	Multiple	-85 to +75	0 to 14	Right ¹
Floating Point Hex	DH	Multiple	-2^{31} to $2^{31}-1$	0 to 14	Right ¹
Floating Point Binary	DB	Multiple	-2^{31} to $2^{31}-1$	N/A	Right ¹
Floating Point Hex	E	Multiple	-85 to +75	0 to 14	Right ¹
Floating Point Hex	EH	Multiple	-2^{31} to $2^{31}-1$	0 to 14	Right ¹
Floating Point Binary	EB	Multiple	-2^{31} to $2^{31}-1$	N/A	Right ¹
Fixed Point	F	Multiple	-85 to +75	-187 to +346	Left ¹
Graphic (DBCS)	G	One			Right
Fixed Point	H	Multiple	-85 to +75	-187 to +346	Left ¹
Length	J	Multiple			Left ¹
Floating Point Hex	L	Multiple	-85 to +75	0 to 28	Right ¹
Floating Point Hex	LH	Multiple	-2^{31} to $2^{31}-1$	0 to 28	Right ¹
Floating Point Binary	LB	Multiple	-2^{31} to $2^{31}-1$	N/A	Right ¹
Floating Point	L	Multiple	-85 to +75	0 to 28	Right ¹
Decimal	P	Multiple			Left
Offset	Q	Multiple			Left
Address	R	Multiple			Left
Address	S	Multiple			
Address	V	Multiple			Left
Hexadecimal	X	Multiple			Left
Address	Y	Multiple			Left
Decimal	Z	Multiple			Left

Notes:

1. Errors are flagged if significant bits are truncated or if the value specified cannot be contained in the implicit length of the constant.

Appendix C. Macro and Conditional Assembly Language Summary

This appendix summarizes the macro and conditional assembly language described in Part 3 of this publication. Figure 108 indicates which macro and conditional assembly language elements may be used in the name and operand entries of each statement. Figure 110 on page 369 summarizes the expressions that may be used in macro instruction statements. Figure 111 on page 370 summarizes the attributes that may be used in each expression. Figure 112 on page 371 summarizes the variable symbols that may be used in each expression. Figure 113 on page 372 summarizes the system variable symbols that may be used in each expression.

Macro and Conditional Assembly Language Summary

Figure 108 (Page 1 of 2). Macro Language Elements (Part 1)

Statement	Symbolic Parameter	Variable Symbols												Sequence Symbol			
		Global SET Symbols ²				Local SET Symbols ²											
		SETA	SETB	SETC		SETA	SETB	SETC		SETA	SETB	SETC					
MACRO																	
Prototype Statement	Name Operand																
GBLA	Operand ¹¹	Operand	Operand ¹¹	Operand ¹¹	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand ¹¹	Name	
GBLB	Operand ¹¹	Operand ¹¹	Operand	Operand ¹¹	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand^{11}	Operand ¹¹	Name	
GBLC	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Name	
LCLA	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Name	
LCLB	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Name	
LCLC	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Operand ¹¹	Name	
Model Statement	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name Operation Operand	Name	
SETA	Name ¹² Operand ³	Name Operand	Name ¹² Operand ⁴	Name ¹² Operand ¹⁰	Name ¹² Operand ¹⁰	Name											
SETAF	Name ¹² Operand ^{3,13}	Name Operand ¹³	Name ¹² Operand ^{4,13}	Name ^{10,12} Operand ¹³	Name ¹² Operand ^{4,13}	Name ^{10,12} Operand ¹³	Name ¹² Operand ^{4,13}	Name ^{10,12} Operand ¹³	Name ¹² Operand ^{4,13}	Name ^{10,12} Operand ¹³	Name ¹² Operand ^{4,13}	Name ^{10,12} Operand ¹³	Name ¹² Operand ^{4,13}	Name ^{10,12} Operand ¹³	Name ^{10,12} Operand ¹³	Name	
SETB	Name ¹² Operand ⁷	Name ¹² Operand ⁷	Name Operand	Name ¹² Operand ⁷	Name Operand	Name ¹² Operand ⁷	Name Operand	Name ¹² Operand ⁷	Name Operand	Name ¹² Operand ⁷	Name Operand	Name ¹² Operand ⁷	Name Operand	Name ¹² Operand ⁷	Name ¹² Operand ⁷	Name	
SETC	Name ¹² Operand	Name ¹² Operand ⁸	Name ¹² Operand ⁹	Name Operand	Name ¹² Operand ⁹	Name Operand	Name ¹² Operand ⁹	Name Operand	Name ¹² Operand ⁸	Name ¹² Operand ⁹	Name Operand	Name ¹² Operand ⁹	Name Operand	Name ¹² Operand ⁹	Name Operand	Operand	
SETCF	Name ¹² Operand ¹³	Name ¹² Operand ^{8,13}	Name ¹² Operand ^{9,13}	Name Operand ¹³	Name ¹² Operand ^{8,13}	Name Operand ¹³	Name ¹² Operand ^{9,13}	Name Operand ¹³	Name ¹² Operand ^{8,13}	Name ¹² Operand ^{9,13}	Name Operand ¹³	Name ¹² Operand ^{8,13}	Name ¹² Operand ^{9,13}	Name Operand ¹³	Name Operand ¹³	Name	
ACTR	Operand ³	Operand	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Operand	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Name	
AJECT																Name	
AGO																Name	
AIF	Operand ⁷	Operand ⁷	Operand	Operand ⁷	Operand	Operand ⁷	Operand	Operand ⁷	Operand ⁷	Operand	Operand ⁷	Operand	Operand ⁷	Operand	Operand ⁷	Name Operand	
ANOP																Name	
AREAD	Name ¹²	Name ¹²	Name^{12}	Name	Name^{12}	Name	Name^{12}	Name	Name ¹²	Name	Name	Name ¹²	Name	Name	Name	Name	
ASPACE	Operand ³	Operand	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Operand	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Operand ⁴	Operand ³	Name	
MEXIT																Name	
MNOTE	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Operand	Name	
MEND																Name	
Outer Macro		Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name Operand	Name

Figure 108 (Page 2 of 2). Macro Language Elements (Part 1)

Statement	Variable Symbols								Sequence Symbol Name
	Symbolic Parameter		Global SET Symbols ²		Local SET Symbols ²				
	Name Operand	SETA Name Operand	SETB Name Operand	SETC Name Operand	SETA Name Operand	SETB Name Operand	SETC Name Operand		
Inner Macro									

Notes:

1. Variable symbols in macro instructions are replaced by their values before processing.
2. Depending upon their values, system variable symbols with global scope can be used in the same way as global SET symbols, and system variable symbols with local scope can be used in the same way as local SET symbols.
3. Only if value is self-defining term.
4. Converted to arithmetic +0 or +1.
5. Only in character relations.
6. Only in arithmetic relations.
7. Only in arithmetic or character relations.
8. Converted to an unsigned number.
9. Converted to character 0 or 1.
10. Only if one to ten decimal digits, not greater than 2147483647.
11. Only in created SET symbols if value of parenthesized expression is an alphabetic character followed by 1 to 61 alphanumeric characters.
12. Only in created SET symbols (as described above) and in subscripts (see SETA statement).
13. The first operand of a SETAF or SETCF instruction must be a character (SETC) expression containing or evaluating to an eight byte module name.

Figure 109. Macro Language Elements (Part 2)

Statement	Attributes									
	Type	Length	Scaling	Integer	Count	Number	Defined	Operation Code		
MACRO										
Prototype Statement										
GBLA										
GBLB										
GBLC										
LCLA										
LCLB										
LCLC										
Model Statement										
SETA	Operand		Operand	Operand	Operand	Operand	Operand			
SETAF	Operand ¹³		Operand ¹³	Operand ¹³	Operand ¹³	Operand ¹³	Operand			
SETB	Operand ⁵	Operand ⁶	Operand ⁶	Operand ⁶	Operand ⁶	Operand ⁶	Operand ⁶	Operand ⁵		
SETC	Operand							Operand		
SETCF	Operand ¹³									
ACTR	Operand		Operand	Operand	Operand	Operand				
AEJECT										
AGO										
AIF	Operand ⁵	Operand ⁶	Operand ⁶	Operand ⁶	Operand ⁶	Operand ⁶	Operand	Operand		
ANOP										
AREAD										
ASPACE	Operand		Operand	Operand	Operand	Operand				
MEXIT										
MNOTE										
MEND										
Outer Macro										

Notes:

1. Variable symbols in macro instructions are replaced by their values before processing.
2. Depending upon their values, system variable symbols with global scope can be used in the same way as global SET symbols, and system variable symbols with local scope can be used in the same way as local SET symbols.
3. Only if value is self-defining term.
4. Converted to arithmetic +0 or +1.
5. Only in character relations.
6. Only in arithmetic relations.
7. Only in arithmetic or character relations.
8. Converted to an unsigned number.
9. Converted to character 0 or 1.
10. Only if one to ten decimal digits, not greater than 2147483647.
11. Only in created SET symbols if value of parenthesized expression is an alphabetic character followed by 1 to 61 alphanumeric characters.
12. Only in created SET symbols (as described above) and in subscripts (see SETA statement).
13. The first operand of a SETAF or SETCF instruction must be a character (SETC) expression containing or evaluating to an eight byte module name.

Macro and Conditional Assembly Language Summary

Figure 110 (Page 1 of 2). Conditional Assembly Expressions

Expression	Arithmetic Expressions	Character Expressions	Logical Expressions
Can contain	Self-defining terms Absolute, predefined ordinary symbols Length, scaling, integer, count, and number attributes SETA and SETB symbols SETC symbols whose values are a self-defining term Symbolic parameters if the corresponding operand is a decimal self-defining term Built-in Functions &SYSDATC &SYSLIST(<i>n</i>) if the corresponding operand is a decimal self-defining term &SYSLIST (<i>n,m</i>) if the corresponding operand is a decimal self-defining term &SYSOPT_DBCS, &SYSOPT_RENT, and &SYSOPT_XOBJECT &SYSM_HSEV and &SYSM_SEV &SYSPARM if its value is a decimal self-defining term &SYSNDX, &SYSNEST, and &SYSSTMT	Any combination of characters (including double-byte characters, if the DBCS assembler option is specified) enclosed in single quotation marks Any absolute, predefined ordinary symbols not enclosed in single quotation marks Any variable symbol enclosed in single quotation marks A concatenation of variable symbols and other characters enclosed in single quotation marks Built-in Functions A type attribute reference	A 0 or a 1 Absolute, predefined ordinary symbols used in arithmetic relations or character relations SETB symbols Arithmetic relations Character relations Arithmetic value
Operations	+, - (unary and binary), *, and /; Parentheses permitted	Concatenation, with a period (.), or by juxtaposition	AND, OR, NOT, XOR Parentheses permitted
Range of values	-2 ³¹ to +2 ³¹ -1	0 through 255 characters	0 (false) or 1 (true)
Built-in Functions	AND, FIND, INDEX, NOT, OR, SLA, SLL, SRA, SRL, XOR	BYTE, DOUBLE, LOWER, SIGNED, UPPER	See Operations above

Macro and Conditional Assembly Language Summary

Figure 110 (Page 2 of 2). Conditional Assembly Expressions

Expression	Arithmetic Expressions	Character Expressions	Logical Expressions
Used in	SETA operands	SETC operands	SETB operands
	Arithmetic relations	Character relations	AIF operands
	Created SET symbols	Created SET symbols	Created SET symbols
	Subscripted SET symbols		
	&SYSLIST subscript(s)		
	Substring notation		
	Sublist notation		

Figure 111 (Page 1 of 2). Attributes

Attribute	Notation	Can be used with:	Can be used only if Type Attribute is:	Can be used in:
Type	T'	Ordinary symbols defined in open code; symbolic parameters inside macro definitions; &SYSLIST(<i>n</i>), &SYSLIST(<i>n,m</i>) inside macro definitions; SET symbols; all system variable symbols	Any value	SETC operand fields Character relations
Length	L'	Ordinary symbols defined in open code; symbolic parameters inside macro definitions; &SYSLIST(<i>n</i>), and &SYSLIST(<i>n,m</i>) inside macro definitions	Any letter except M, N, O, T, U	Arithmetic expressions
Scaling	S'	Ordinary symbols defined in open code; symbolic parameters inside macro definitions; &SYSLIST(<i>n</i>), and &SYSLIST(<i>n,m</i>) inside macro definitions	H,F,G,D,E,L,K,P, and Z	Arithmetic expressions
Integer	I'	Ordinary symbols defined in open code; symbolic parameters inside macro definitions; &SYSLIST(<i>n</i>), and &SYSLIST(<i>n,m</i>) inside macro definitions	H,F,G,D,E,L,K,P, and Z	Arithmetic expressions

Figure 111 (Page 2 of 2). Attributes

Attribute	Notation	Can be used with:	Can be used only if Type Attribute is:	Can be used in:
Count	K'	Symbolic parameters inside macro definitions; &SYSLIST(<i>n</i>), and &SYSLIST(<i>n,m</i>) inside macro definitions; SET symbols; all system variable symbols	Any letter	Arithmetic expressions
Number	N'	Symbolic parameters, &SYSLIST and &SYSLIST(<i>n</i>) inside macro definitions	Any letter	Arithmetic expressions
Defined	D'	Ordinary symbols defined in open code; symbolic parameters inside macro definitions; &SYSLIST and &SYSLIST(<i>n</i>) inside macro definitions	Any letter except M, N, O, T, U	Arithmetic expressions
Operation Code	O'	A character string, or variable symbol containing a character string.	Any letter except N, O and (only sometimes) U	SETC operand fields Character relations

Refer to Chapter 9, “How to Write Conditional Assembly Instructions” on page 291 for usage restrictions of the attributes in Figure 111.

Figure 112 (Page 1 of 2). Variable Symbols

Variable Symbol	Declared by:	Initialized or set to:	Value changed by:	May be used in:
Symbolic ¹ parameter	Prototype statement	Corresponding macro instruction operand	Constant throughout definition	Arithmetic expressions if operand is self-defining term Character expressions
SETA	LCLA or GBLA instruction	0	SETA instruction	Arithmetic expressions Character expressions Logical expressions
SETB	LCLB or GBLB instruction	0	SETB instruction	Arithmetic expressions Character expressions Logical expressions

Macro and Conditional Assembly Language Summary

Figure 112 (Page 2 of 2). Variable Symbols

Variable Symbol	Declared by:	Initialized or set to:	Value changed by:	May be used in:
SETC	LCLC or GBLC instruction	String of length 0 (null)	SETC instruction	Arithmetic expressions if value is self-defining term Character expressions Logical expressions if value is self-defining term

Notes:

1. Can be used only in macro definitions.

Figure 113 (Page 1 of 5). System Variable Symbols

System Variable Symbol	Availability ²	Type ³	Type Attr. ⁴	Scope	Initialized or set to	Value changed by	May be used in
&SYSADATA_DSN ¹	HLA2	C	U	L	Current associated data file	Constant throughout assembly	Character expressions
&SYSADATA_MEMBER ¹	HLA2	C	U,O	L	Current associated data file member name	Constant throughout assembly	Character expressions
&SYSADATA_VOLUME ¹	HLA2	C	U,O	L	Current associated data file volume identifier	Constant throughout assembly	Character expressions
&SYSASM	HLA1	C	U	G	Assembler name	Constant throughout assembly	Character expression
&SYSCLOCK	HLA3	C	U	L	Current date and time	Constant throughout macro expansion	Character expressions
&SYSDATC	HLA1	C,A	N	G	Assembly date (with century)	Constant throughout assembly	Arithmetic expressions Character expressions
&SYSDATE	AsmH	C	U	G	Assembly date	Constant throughout assembly	Character expressions
&SYSECT ¹	All	C	U	L	Name of control section in effect where macro instruction appears	Constant throughout definition; set by START, CSECT, RSECT, DSECT, or COM	Character expressions
&SYSIN_DSN ¹	HLA1	C	U	L	Current primary input data set name	Constant throughout definition	Character expressions
&SYSIN_MEMBER ¹	HLA1	C	U,O	L	Current primary input member name	Constant throughout definition	Character expressions

Macro and Conditional Assembly Language Summary

Figure 113 (Page 2 of 5). System Variable Symbols

System Variable Symbol	Availability ²	Type ³	Type Attr. ⁴	Scope	Initialized or set to	Value changed by	May be used in
&SYSIN_VOLUME¹	HLA1	C	U,O	L	Current primary input volume identifier	Constant throughout definition	Character expressions
&SYSJOB	HLA1	C	U	G	Source module assembly jobname	Constant throughout assembly	Character expressions
&SYSLIB_DSN¹	HLA1	C	U	L	Current macro library filename	Constant throughout definition	Character expressions
&SYSLIB_MEMBER¹	HLA1	C	U,O	L	Current macro library member name	Constant throughout definition	Character expressions
&SYSLIB_VOLUME¹	HLA1	C	U,O	L	Current macro library volume identifier	Constant throughout definition	Character expressions
&SYSLIN_DSN¹	HLA2	C	U	L	Current object data set name	Constant throughout assembly	Character expressions
&SYSLIN_MEMBER¹	HLA2	C	U,O	L	Current object data set member name	Constant throughout assembly	Character expressions
&SYSLIN_VOLUME¹	HLA2	C	U,O	L	Current object data set volume identifier	Constant throughout assembly	Character expressions
&SYSLIST¹	All	C	any	L	Not applicable	Not applicable	N' &SYSLIST in arithmetic expressions
&SYSLIST(<i>n</i>)¹ &SYSLIST(<i>n,m</i>)¹	All	C	any	L	Corresponding macro instruction operand	Constant throughout definition	Arithmetic expressions if operand is self-defining term Character expressions
&SYSLOC¹	AsmH	C	U	L	Location counter in effect where macro instruction appears	Constant throughout definition; set by START, CSECT, RSECT, DSECT, COM, and LOCTR	Character expressions
&SYSMAC₁	HLA3	C	U,O	L	Macro name	Constant throughout definition	Arithmetic expressions
&SYSMAC(<i>n</i>)₁	HLA3	C	U,O	L	Ancestor macro name	Constant throughout definition	Arithmetic expressions
&SYSM_HSEV	HLA3	A	N	G	0	Mnote	Arithmetic expressions

Macro and Conditional Assembly Language Summary

Figure 113 (Page 3 of 5). System Variable Symbols

System Variable Symbol	Availability ²	Type ³	Type Attr. ⁴	Scope	Initialized or set to	Value changed by	May be used in
&SYSM_SEV	HLA3	A	N	G	0	At nesting and unnesting of macros, from MNOTE	Arithmetic expressions
&SYSNDX¹	All	C	N	L	Macro instruction index	Constant throughout definition; unique for each macro instruction	Arithmetic expressions Character expressions
&SYSNEST¹	HLA1	A	N	L	Macro instruction nesting level	Constant throughout definition; unique for each macro nesting level	Arithmetic expressions Character expressions
&SYSOPT_DBCS	HLA1	B	N	G	DBCS assembler option indicator	Constant throughout assembly	Arithmetic expressions Character expressions Logical expressions
&SYSOPT_OPTABLE	HLA3	C	U	G	OPTABLE assembler option value	Constant throughout assembly	Character expressions
&SYSOPT_RENT	HLA1	B	N	G	RENT assembler option indicator	Constant throughout assembly	Arithmetic expressions Character expressions Logical expressions
&SYSOPT_XOBJECT	HLA3	B	N	G	XOBJECT assembler option indicator	Constant throughout assembly	Arithmetic expressions Character expressions Logical expressions
&SYSPARM	All	C	U,O	G	User defined or null	Constant throughout assembly	Arithmetic expressions if value is self-defining term Character expressions
&SYSPRINT_DSN¹	HLA2	C	U	L	Current assembler listing data set name	Constant throughout assembly	Character expressions
&SYSPRINT_MEMBER¹	HLA2	C	U,O	L	Current assembler listing data set member name	Constant throughout assembly	Character expressions
&SYSPRINT_VOLUME¹	HLA2	C	U,O	L	Current assembler listing data set volume identifier	Constant throughout assembly	Character expressions

Macro and Conditional Assembly Language Summary

Figure 113 (Page 4 of 5). System Variable Symbols

System Variable Symbol	Availability ²	Type ³	Type Attr. ⁴	Scope	Initialized or set to	Value changed by	May be used in
&SYSPUNCH_DSN¹	HLA2	C	U	L	Current object data set name	Constant throughout assembly	Character expressions
&SYSPUNCH_MEMBER¹	HLA2	C	U,O	L	Current object data set member name	Constant throughout assembly	Character expressions
&SYSPUNCH_VOLUME¹	HLA2	C	U,O	L	Current object data set volume identifier	Constant throughout assembly	Character expressions
&SYSSEQF¹	HLA1	C	U,O	L	Outer-most macro instruction identification-sequence field	Constant throughout definition	Character expressions
&SYSSTEP	HLA1	C	U	G	Source module assembly job name	Constant throughout assembly	Character expressions
&SYSSTMT	HLA1	C,A	N	G	Next statement number	Assembler increments each time a statement is processed	Arithmetic expressions Character expressions
&SYSSTYP¹	HLA1	C	U,O	L	Type of control section in effect where macro instruction appears	Constant throughout definition; set by START, CSECT, RSECT, DSECT, or COM	Character expressions
&SYSTEM_ID	HLA1	C	U	G	Assembly operating system environment identifier	Constant throughout assembly	Character expressions
&SYSTEM_DSN¹	HLA2	C	U	L	Current terminal data set name	Constant throughout assembly	Character expressions
&SYSTEM_MEMBER¹	HLA2	C	U,O	L	Current terminal data set member name	Constant throughout assembly	Character expressions
&SYSTEM_VOLUME¹	HLA2	C	U,O	L	Current terminal data set volume identifier	Constant throughout assembly	Character expressions
&SYSTIME	AsmH	C	U	G	Source module assembly time	Constant throughout assembly	Character expressions

Macro and Conditional Assembly Language Summary

Figure 113 (Page 5 of 5). System Variable Symbols

System Variable Symbol	Availability ²	Type ³	Type Attr. ⁴	Scope	Initialized or set to	Value changed by	May be used in
&SYSVER	HLA1	C	U	G	Assembler release level	Constant throughout assembly	Character expressions

Notes:

1. Macro only

Can be used only in macro definitions.

2. Availability:

All All assemblers, including the DOS/VSE Assembler
 AsmH Assembler H Version 2 and High Level Assembler
 HLA1 High Level Assembler Release 1
 HLA2 High Level Assembler Release 2
 HLA3 High Level Assembler Release 3
 HLA4 High Level Assembler Release 4

3. Type:

A Arithmetic
 B Boolean
 C Character

4. Type Attr:

N Numeric (self-defining term)
 O Omitted
 U Undefined, unknown, deleted or unassigned

5. Scope:

L Local - only in macro
 G Global - in entire program

Appendix D. Standard Character Set Code Table

Figure 114. Standard Character Set Code Table - From Code Page 00037

Hex.	Dec.	EBCDIC	Binary	Hex.	Dec.	EBCDIC	Binary
00	0		0000 0000	20	32		0010 0000
01	1		0000 0001	21	33		0010 0001
02	2		0000 0010	22	34		0010 0010
03	3		0000 0011	23	35		0010 0011
04	4		0000 0100	24	36		0010 0100
05	5		0000 0101	25	37		0010 0101
06	6		0000 0110	26	38		0010 0110
07	7		0000 0111	27	39		0010 0111
08	8		0000 1000	28	40		0010 1000
09	9		0000 1001	29	41		0010 1001
0A	10		0000 1010	2A	42		0010 1010
0B	11		0000 1011	2B	43		0010 1011
0C	12		0000 1100	2C	44		0010 1100
0D	13		0000 1101	2D	45		0010 1101
0E	14		0000 1110	2E	46		0010 1110
0F	15		0000 1111	2F	47		0010 1111
10	16		0001 0000	30	48		0011 0000
11	17		0001 0001	31	49		0011 0001
12	18		0001 0010	32	50		0011 0010
13	19		0001 0011	33	51		0011 0011
14	20		0001 0100	34	52		0011 0100
15	21		0001 0101	35	53		0011 0101
16	22		0001 0110	36	54		0011 0110
17	23		0001 0111	37	55		0011 0111
18	24		0001 1000	38	56		0011 1000
19	25		0001 1001	39	57		0011 1001
1A	26		0001 1010	3A	58		0011 1010
1B	27		0001 1011	3B	59		0011 1011
1C	28		0001 1100	3C	60		0011 1100
1D	29		0001 1101	3D	61		0011 1101
1E	30		0001 1110	3E	62		0011 1110
1F	31		0001 1111	3F	63		0011 1111

Standard Character Set Code Table

Hex.	Dec.	EBCDIC	Binary	Hex.	Dec.	EBCDIC	Binary
40	64	SPACE	0100 0000	60	96	-	0110 0000
41	65		0100 0001	61	97	/	0110 0001
42	66		0100 0010	62	98		0110 0010
43	67		0100 0011	63	99		0110 0011
44	68		0100 0100	64	100		0110 0100
45	69		0100 0101	65	101		0110 0101
46	70		0100 0110	66	102		0110 0110
47	71		0100 0111	67	103		0110 0111
48	72		0100 1000	68	104		0110 1000
49	73		0100 1001	69	105		0110 1001
4A	74		0100 1010	6A	106		0110 1010
4B	75	.	0100 1011	6B	107	,	0110 1011
4C	76		0100 1100	6C	108		0110 1100
4D	77	(	0100 1101	6D	109	_	0110 1101
4E	78	+	0100 1110	6E	110		0110 1110
4F	79		0100 1111	6F	111		0110 1111
50	80	&	0101 0000	70	112		0111 0000
51	81		0101 0001	71	113		0111 0001
52	82		0101 0010	72	114		0111 0010
53	83		0101 0011	73	115		0111 0011
54	84		0101 0100	74	116		0111 0100
55	85		0101 0101	75	117		0111 0101
56	86		0101 0110	76	118		0111 0110
57	87		0101 0111	77	119		0111 0111
58	88		0101 1000	78	120		0111 1000
59	89		0101 1001	79	121		0111 1001
5A	90		0101 1010	7A	122		0111 1010
5B	91	\$	0101 1011	7B	123	#	0111 1011
5C	92	*	0101 1100	7C	124	@	0111 1100
5D	93	)	0101 1101	7D	125	'	0111 1101
5E	94		0101 1110	7E	126	=	0111 1110
5F	95		0101 1111	7F	127		0111 1111

Standard Character Set Code Table

Hex.	Dec.	EBCDIC	Binary	Hex.	Dec.	EBCDIC	Binary
80	128		1000 0000	A0	160		1010 0000
81	129	a	1000 0001	A1	161		1010 0001
82	130	b	1000 0010	A2	162	s	1010 0010
83	131	c	1000 0011	A3	163	t	1010 0011
84	132	d	1000 0100	A4	164	u	1010 0100
85	133	e	1000 0101	A5	165	v	1010 0101
86	134	f	1000 0110	A6	166	w	1010 0110
87	135	g	1000 0111	A7	167	x	1010 0111
88	136	h	1000 1000	A8	168	y	1010 1000
89	137	i	1000 1001	A9	169	z	1010 1001
8A	138		1000 1010	AA	170		1010 1010
8B	139		1000 1011	AB	171		1010 1011
8C	140		1000 1100	AC	172		1010 1100
8D	141		1000 1101	AD	173		1010 1101
8E	142		1000 1110	AE	174		1010 1110
8F	143		1000 1111	AF	175		1010 1111
90	144		1001 0000	B0	176		1011 0000
91	145	j	1001 0001	B1	177		1011 0001
92	146	k	1001 0010	B2	178		1011 0010
93	147	l	1001 0011	B3	179		1011 0011
94	148	m	1001 0100	B4	180		1011 0100
95	149	n	1001 0101	B5	181		1011 0101
96	150	o	1001 0110	B6	182		1011 0110
97	151	p	1001 0111	B7	183		1011 0111
98	152	q	1001 1000	B8	184		1011 1000
99	153	r	1001 1001	B9	185		1011 1001
9A	154		1001 1010	BA	186		1011 1010
9B	155		1001 1011	BB	187		1011 1011
9C	156		1001 1100	BC	188		1011 1100
9D	157		1001 1101	BD	189		1011 1101
9E	158		1001 1110	BE	190		1011 1110
9F	159		1001 1111	BF	191		1011 1111

Standard Character Set Code Table

Hex.	Dec.	EBCDIC	Binary	Hex.	Dec.	EBCDIC	Binary
C0	192		1100 0000	E0	224		1110 0000
C1	193	A	1100 0001	E1	225		1110 0001
C2	194	B	1100 0010	E2	226	S	1110 0010
C3	195	C	1100 0011	E3	227	T	1110 0011
C4	196	D	1100 0100	E4	228	U	1110 0100
C5	197	E	1100 0101	E5	229	V	1110 0101
C6	198	F	1100 0110	E6	230	W	1110 0110
C7	199	G	1100 0111	E7	231	X	1110 0111
C8	200	H	1100 1000	E8	232	Y	1110 1000
C9	201	I	1100 1001	E9	233	Z	1110 1001
CA	202		1100 1010	EA	234		1110 1010
CB	203		1100 1011	EB	235		1110 1011
CC	204		1100 1100	EC	236		1110 1100
CD	205		1100 1101	ED	237		1110 1101
CE	206		1100 1110	EE	238		1110 1110
CF	207		1100 1111	EF	239		1110 1111
D0	208		1101 0000	F0	240	0	1111 0000
D1	209	J	1101 0001	F1	241	1	1111 0001
D2	210	K	1101 0010	F2	242	2	1111 0010
D3	211	L	1101 0011	F3	243	3	1111 0011
D4	212	M	1101 0100	F4	244	4	1111 0100
D5	213	N	1101 0101	F5	245	5	1111 0101
D6	214	O	1101 0110	F6	246	6	1111 0110
D7	215	P	1101 0111	F7	247	7	1111 0111
D8	216	Q	1101 1000	F8	248	8	1111 1000
D9	217	R	1101 1001	F9	249	9	1111 1001
DA	218		1101 1010	FA	250		1111 1010
DB	219		1101 1011	FB	251		1111 1011
DC	220		1101 1100	FC	252		1111 1100
DD	221		1101 1101	FD	253		1111 1101
DE	222		1101 1110	FE	254		1111 1110
DF	223		1101 1111	FF	255		1111 1111

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing
IBM Corporation
North Castle Drive
Armonk, NY 10504-1785
U.S.A.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact:

IBM Corporation
Mail Station P300
522 South Road
Poughkeepsie New York 12601-5400
U.S.A.

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The licensed program described in this document and all licensed material available for it are provided by IBM

under terms of the IBM Customer Agreement, IBM International Program License Agreement or any equivalent agreement between us.

For license inquiries regarding double-byte (DBCS) information, contact the IBM Intellectual Property Department in your country or send inquiries, in writing, to:

IBM World Trade Asia Corporation
Licensing
2-31 Roppongi 3-chome, Minato-ku
Tokyo 106, Japan

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.

If you are viewing this information softcopy, the photographs and color illustrations may not appear.

Trademarks

The following are trademarks of International Business Machines Corporation in the United States, or other countries, or both:

CT	OS/390
DFSMS/MVS	SP
Enterprise Systems Architecture/390	ESA/390
ESA/390	VM/ESA
IBM	VSE/ESA
MVS/ESA	

Other company, product, and service names may be trademarks or service marks of others.

Bibliography

High Level Assembler Publications

HLASM General Information, GC26-4943

HLASM Installation and Customization Guide, SC26-3494

HLASM Language Reference, SC26-4940

HLASM Licensed Program Specifications, GC26-4944

HLASM Programmer's Guide, SC26-4941

Toolkit Feature Publications

HLASM Toolkit Feature User's Guide, GC26-8710

HLASM Toolkit Feature Debug Reference Summary, GC26-8712

HLASM Toolkit Feature Interactive Debug Facility User's Guide, GC26-8709

HLASM Toolkit Feature Installation Guide, GC26-8711

Related Publications (Architecture)

Enterprise Systems Architecture/390 Principles of Operation, SA22-7201

Vector Operations, SA22-7207

System/370 Enterprise Systems Architecture Principles of Operation, SA22-7200

System/370 Principles of Operation, GA22-7000

System/370 Extended Architecture Principles of Operation, SA22-7085

Related Publications for MVS

OS/390 MVS:

OS/390 MVS JCL Reference, GC28-1757

OS/390 MVS JCL User's Guide, GC28-1758

OS/390 MVS Programming: Assembler Services Guide, GC28-1757

OS/390 MVS Programming: Assembler Services Reference, GC28-1910

OS/390 MVS Programming: Authorized Assembler Services Guide, GC28-1763

OS/390 MVS Programming: Authorized Assembler Services Reference ALE-DYN, GC28-1764

OS/390 MVS Programming: Authorized Assembler Services Reference ENF-IXG, GC28-1765

OS/390 MVS Programming: Authorized Assembler Services Reference LLA-SDU, GC28-1766

OS/390 MVS Programming: Authorized Assembler Services Reference SET-WTO, GC28-1767

OS/390 MVS System Codes, GC28-1780

OS/390 MVS System Commands, GC28-1781

OS/390 MVS System Messages, Vol 1 (ABA-ASA), GC28-1784

OS/390 MVS System Messages, Vol 2 (ASB-ERB), GC28-1785

OS/390 MVS System Messages, Vol 3 (EWX-IEB), GC28-1786

OS/390 MVS System Messages, Vol 4 (IEC-IFD), GC28-1787

OS/390 MVS System Messages, Vol 5 (IGD-IZP), GC28-1788

MVS/ESA Version 5:

MVS/ESA JCL Reference, GC28-1479

MVS/ESA JCL User's Guide, GC28-1473

MVS/ESA Programming: Assembler Services Guide, GC28-1466

MVS/ESA Programming: Assembler Services Guide, GC28-1474

MVS/ESA Programming: Authorized Assembler Services Guide, GC28-1467

MVS/ESA Programming: Authorized Assembler Services Reference Volumes 1 - 4, GC28-1475, GC28-1476, GC28-1477, GC28-1478

MVS/ESA System Codes, GC28-1486

MVS/ESA System Commands, GC28-1442

MVS/ESA System Messages Volumes 1 - 5, GC28-1480, GC28-1481, GC28-1482, GC28-1483, GC28-1484

MVS/ESA OpenEdition®:

MVS/ESA OpenEdition MVS User's Guide, SC23-3013

OS/390 OpenEdition:

OS/390 UNIX System Services User's Guide, SC28-1891

MVS/DFP™:

Bibliography

MVS/DFP Version 3.3: Utilities, SC26-4559

MVS/DFP Version 3.3: Linkage Editor and Loader, SC26-4564

DFSMS/MVS®:

OS/390 DFSMS Program Management, SC27-0806

TSO/E (MVS):

TSO/E Command Reference, SC28-1881

TSO/E (OS/390):

OS/390 TSO/E Command Reference, SC28-1969

MVS SMP/E:

SMP/E Messages and Codes, SC28-1108

SMP/E Reference, SC28-1107

SMP/E Reference Summary, SX22-0006

SMP/E User's Guide, SC28-1302

OS/390 SMP/E:

OS/390 SMP/E Messages and Codes, SC28-1738

OS/390 SMP/E Reference, SC28-1806

OS/390 SMP/E User's Guide, SC28-1740

Related Publications for VM

VM/ESA CMS Application Development Guide, SC24-5761

VM/ESA CMS Application Development Guide for Assembler, SC24-5763

VM/ESA CMS Application Development Reference, SC24-5762

VM/ESA CMS Application Development Reference for Assembler, SC24-5764

VM/ESA CMS User's Guide, SC24-5775

VM/ESA XEDIT Command and Macro Reference, SC24-5780

VM/ESA XEDIT User's Guide, SC24-5779

VM/ESA CP Command and Utility Reference, SC24-5750

VM/ESA Planning and Administration, SC24-5773

VMSES/E Introduction and Reference, SC24-5837

VM/ESA Service Guide, SC24-5838

VM/ESA CMS Command Reference, SC24-5776

VM/ESA CMS File Pool Planning, Administration, and Operation, SC24-5751

VM/ESA System Messages and Codes Reference, SC24-5841

Related Publications for VSE

VSE/ESA Administration, SC33-6505

VSE/ESA Guide to System Functions, SC33-6511

VSE/ESA Installation, SC33-6504

VSE/ESA Planning, SC33-6503

VSE/ESA System Control Statements, SC33-6513

General Publications

BRIEF OS/390 Software Management Cookbook, SG24-4775

Index

Special Characters

*PROCESS statements'.PROCESS statements
 *PROCESS statement 89
 initiating the first control section 52
 &SYSADATA_DSN system variable symbol 237
 &SYSADATA_MEMBER system variable symbol 238
 &SYSADATA_VOLUME system variable symbol 238
 &SYSASM system variable symbol 239
 &SYSCLOCK system variable symbol 239
 &SYSDATC system variable symbol 240
 &SYSDATE system variable symbol 240
 &SYSECT system variable symbol 241
 &SYSIN_DSN system variable symbol 243
 &SYSIN_MEMBER system variable symbol 244
 &SYSIN_VOLUME system variable symbol 245
 &SYSJOB system variable symbol 245
 &SYSLIB_DSN system variable symbol 246
 &SYSLIB_MEMBER system variable symbol 246
 &SYSLIB_VOLUME system variable symbol 247
 &SYSLIN_DSN system variable symbol 247
 &SYSLIN_MEMBER system variable symbol 249
 &SYSLIN_VOLUME system variable symbol 249
 &SYSLIST system variable symbol 250
 &SYSLOC system variable symbol 252
 &SYSM_HSEV system variable symbol 253
 &SYSM_SEV system variable symbol 253
 &SYSMAC system variable symbol 253
 &SYSNDX system variable symbol
 controlling its value using MHELP 354
 definition 254
 &SYSNEST system variable symbol 257
 &SYSOPT_DBCS system variable symbol 258
 &SYSOPT_OPTABLE system variable symbol 258
 &SYSOPT_RENT system variable symbol 258
 &SYSOPT_XOBJECT system variable symbol 259
 &SYSPARM system variable symbol 259
 &SYSPRINT_DSN system variable symbol 260
 &SYSPRINT_MEMBER system variable symbol 261
 &SYSPRINT_VOLUME system variable symbol 261
 &SYSPUNCH_DSN system variable symbol 262
 &SYSPUNCH_MEMBER system variable symbol 263
 &SYSPUNCH_VOLUME system variable symbol 264
 &SYSSEQF system variable symbol 264
 &SYSSTEP system variable symbol 265
 &SYSSTMT system variable symbol 265
 &SYSSTYP system variable symbol 266
 &SYSTEM_ID system variable symbol 266
 &SYSTEM_DSN system variable symbol 267
 &SYSTEM_MEMBER system variable symbol 268
 &SYSTEM_VOLUME system variable symbol 268

&SYSTIME system variable symbol 269
 &SYSVER system variable symbol 270

Numerics

64-bit addressing mode 88

A

A-type address constant 135
 absolute addresses, base registers for 196
 absolute expression 44
 absolute terms 27
 ACONTROL instruction 90
 ACTR instruction 350
 ADATA assembler option 94
 ADATA instruction 93
 address constants
 A-type 135
 complex relocatable 135
 R-type 140
 S-type 137
 V-type 139
 Y-type 135
 addressability
 by means of the DROP instruction 152
 by means of the USING instruction 194
 dependent 49
 establishing 47
 qualified 48
 relative 49
 using base register instructions 48
 addresses, relocatable or absolute 76
 addressing mode
 64-bit 88
 addressing mode (AMODE) 59
 AEJECT instruction 230
 AFPR assembler option 75, 90
 AGO instruction
 alternative statement format 350
 general statement format 349
 AGOB, synonym of AGO instruction 350
 AIF instruction 346
 alternative statement format 349
 AIFB, synonym of AIF instruction 349
 AINSERT instruction 94, 231
 ALIAS instruction 95
 ALIGN assembler option 113, 157
 alphabetic character
 defined 29
 alternative statement format
 AGO instruction 350

Index

- alternative statement format (*continued*)
 - AIF instruction 349
 - continuation lines 16
- AMODE
 - indicators in ESD 59
 - instruction to specify addressing mode 96
- AMODE instruction 96
- AND (SETA built-in function) 320
- AND (SETB logical operator) 329
- AND NOT (SETB logical operator) 329
- ANOP instruction 351
- AREAD instruction 231
- arithmetic (SETA) expressions
 - built-in functions 319
 - evaluation of 325
 - rules for coding 324
 - SETC variables in 325
 - using 318
- arithmetic external function calls 342
- arithmetic relations in logical expressions 331
- ASCII translation table 14
- ASPACE instruction 233
- assembler instruction statements
 - base register instructions 48
 - data definition instructions 110
 - exit-control parameters 166
 - listing control instructions 191
 - operation code definition instruction 176
 - program control instructions 168
 - program sectioning and linking instructions 49
 - symbol definition instruction 164
- assembler language
 - assembler instruction statements 4
 - coding aids summary 9
 - coding conventions of 14
 - coding form for 14
 - compatibility of 4
 - conditional assembly instructions 291
 - introduction to 3
 - machine instruction statements 4, 68
 - macro instruction statements 4
 - statements, summary of 361
 - structure of 21
 - summary of instructions 358
- assembler option
 - GOFF 108
- assembler options
 - ADATA 94
 - AFPR 75
 - ALIGN 113, 157
 - BATCH 312
 - CODEPAGE 127
 - COMPAT 12, 252, 278, 281, 282, 288, 295, 340
 - controlling output using 6
 - DBCS 12, 15, 32, 34, 35, 127, 128, 185, 194, 258, 272, 275, 276, 283, 326, 360, 369
- assembler options (*continued*)
 - DCBS 174, 221, 223, 225, 227, 360
 - DECK 167, 262, 264
 - EXIT 166, 167
 - FLAG 16, 175, 221, 345
 - FOLD 14
 - GOFF 36, 57, 59, 94, 97, 98, 110, 151, 192, 247, 249
 - LIBMAC 215
 - NOAFPR 74, 75
 - NOALIGN 113
 - NODECK 186, 187
 - NOGOFF 36, 57, 59
 - NOLIST 184
 - NOOBJECT 186, 187
 - NOXOBJECT 59
 - OBJECT 247, 249
 - OPTABLE 258
 - PROFILE 53
 - RA2 137
 - RENT 189, 258
 - specifying with PROCESS statements 89
 - SYSPARM 259
 - USING 198
 - XOBJECT 59, 94, 96, 98, 247, 249
- assembler program
 - basic functions 5
 - processing sequence 7
 - relationship to operating system 7, 8
- associated data file
 - ADATA instruction 93
 - contents 6
 - writing to 93
- association of code and data areas 62
- attribute of relocatable term 44
- attributes 44
 - count (K') 306
 - data 296
 - defined (D') 308
 - definition mode 311
 - in combination with symbols 299
 - integer (I') 306
 - length (L') 304
 - lookahead 311
 - number (N') 307
 - of paired relocatable term 44
 - operation code (O') 308
 - scaling (S') 305
 - summary of 365, 371
 - type (T') 300
 - XATTR attribute 206

B

B-type constant 124

- base register instructions
 - DROP instruction 152
 - POP instruction 181
 - PUSH instruction 186
 - USING instruction 194
 - XATTR instruction 205
 - base registers for absolute addresses 196
 - BATCH assembler option 312
 - binary constant 124
 - binary self-defining term 34
 - bit-length modifier 120
 - blank lines
 - ASPACE instruction 233
 - in macros 18
 - in open code 18
 - books, High Level Assembler xii
 - branching 346
 - branching with extended mnemonic codes 70
 - built-in functions
 - AND 320
 - arithmetic (SETA) expressions 319
 - BYTE 335
 - character (SETC) expressions 335
 - DOUBLE 336
 - FIND 320
 - INDEX 321
 - LOWER 336
 - NOT 321
 - OR 321
 - SIGNED 336
 - SLA 321
 - SLL 322
 - SRA 322
 - SRL 322
 - UPPER 336
 - XOR 322
 - BYTE (SETC built-in function) 335
- C**
- C-type constant 125
 - CATTR instruction 98
 - CCW instruction 100
 - CCW0 instruction 100
 - CCW1 instruction 101
 - CD-ROM publications xiii
 - CEJECT instruction 103
 - character (SETC) expressions
 - built-in functions 335
 - using 333
 - character constant 125
 - Unicode 127
 - character external function calls 343
 - character relations in logical expressions 331, 332
 - comparing comparands of unequal length 332
 - character self-defining term 34
 - character set
 - code table, standard 377
 - double-byte 12
 - standard 11
 - translation table 14
 - character string values, concatenation of 338
 - characters, special 282
 - CNOP instruction 103
 - code areas
 - associated with data areas 62
 - code table, standard character set 377
 - CODEPAGE assembler option 127
 - coding aids summary 9
 - coding conventions, assembler language
 - comment statement 18
 - continuation line errors 16
 - continuation lines 15
 - field boundaries
 - standard coding format 14
 - statement coding rules 19
 - coding made easier 9
 - COM instruction 55, 105
 - combining keyword and positional parameters 229, 277
 - comment statements
 - format 18
 - function of 214
 - internal macro 235
 - ordinary 235
 - comparisons in logical expressions 331
 - COMPAT assembler option 90, 288
 - MACROCASE suboption 12, 282
 - SYSLIST suboption 252, 278, 281, 288, 295, 340
 - compatibility, language 4
 - complex relocatable
 - EQU instruction 164
 - expressions 45
 - computed AGO instruction 350
 - concatenation of character string values 338
 - concatenation of characters in model statements 223
 - conditional assembly instructions
 - ACTR instruction 350
 - AGO instruction 349
 - AIF instruction 346
 - ANOP instruction 351
 - computed AGO instruction 350
 - extended AIF instruction 348
 - function of 229
 - GBLA instruction 315
 - GBLB instruction 315
 - GBLC instruction 315
 - how to write 291
 - LCLA instruction 316
 - LCLB instruction 316
 - LCLC instruction 316

Index

- conditional assembly instructions (*continued*)
 - list of 314
 - MHELP instruction 353
 - OPSYN assembler instruction, effect of 177
 - redefining 177
 - SETA instruction 318
 - SETAF instruction 342
 - SETB instruction 328
 - SETC instruction 333
 - SETCF instruction 343
 - substring notations in 344
 - conditional assembly language
 - summary 216
 - summary of expressions 369
 - constants
 - address 135
 - alignment of 113
 - binary 124
 - character 125
 - comparison with literals and self-defining terms 39
 - decimal 133
 - duplication factor 116
 - fixed-point 130
 - floating-point 141
 - general information 113
 - graphic 128
 - hexadecimal 129
 - length attribute value of symbols naming 113
 - modifiers of 119
 - nominal values of 123
 - padding of values 114
 - subfield 1 116
 - subfield 2 117
 - subfield 3 118
 - subfield 4 119
 - subfield 5 123
 - summary of 363
 - symbolic addresses of 113
 - truncation of values 114
 - types extension 118
 - types of 110, 117
 - continuation line errors 221
 - continuation lines
 - description 15
 - errors in 16
 - continuation lines, unlimited number of 16
 - continuation-indicator field 14
 - control instructions 69
 - control sections
 - concept of 51
 - defining blank common 55
 - executable 51
 - first 52
 - identifying a 108, 189
 - reference 54
 - segments 58
 - control sections (*continued*)
 - unnamed 53
 - controlling the assembly 6
 - converting SETA symbol to SETC symbol 341
 - COPY instruction 106, 234
 - count attribute (K') 306
 - created SET symbols 296
 - CSECT instruction 108
 - Customization book xii
 - CXD instruction 109
- ## D
- D' defined attribute 308
 - D-type floating-point constant 141
 - data areas
 - associated with code areas 62
 - data attributes 296
 - data definition instructions
 - CCW instruction 100
 - CCW0 instruction 100
 - CCW1 instruction 101
 - DC instruction 110
 - DS instruction 155
 - data, immediate, in machine instructions 79
 - DBCS
 - See* double-byte data
 - DBCS assembler option 12, 15, 32, 34, 35, 127, 128, 185, 194, 258, 272, 275, 276, 283, 326, 360, 369
 - &SYSOPT_DBCS system variable symbol 258
 - determining if supplied 258
 - DC instruction 110
 - DCBS assembler option 174, 221, 223, 225, 227, 360
 - decimal constant
 - P-type 133
 - packed 133
 - Z-type 133
 - zoned 133
 - decimal instructions 69
 - decimal self-defining term 33
 - DECK assembler option 167, 262, 264
 - &SYSPUNCH_DSN system variable symbol 262
 - &SYSPUNCH_VOLUME system variable symbol 264
 - defined attribute (D') 308
 - definition mode 311
 - dependent addressing 49
 - dependent USING
 - domain 204
 - instruction syntax 202
 - range 203
 - DH-type floating-point constant 141
 - documentation
 - High Level Assembler 383
 - related publications 384

- documentation, High Level Assembler xii
 - DOUBLE (SETC built-in function) 336
 - double-byte character set (DBCS)
 - See double-byte data
 - double-byte data
 - code conversion in the macro language 326
 - concatenation in SETC expressions 338
 - concatenation of fields 225
 - continuation of 15, 16
 - definition of 12
 - duplication of 333
 - graphic constants 110, 128
 - graphic self-defining term 35
 - in C-type constants 127
 - in character self-defining terms 34
 - in comments 18
 - in keyword operands 276
 - in macro comments 235
 - in macro operands 227
 - in MNOTE operands 174
 - in positional operands 275
 - in PUNCH operands 185
 - in quoted strings 283
 - in remarks 21
 - in REPRO operands 187
 - in TITLE operands 194
 - listing of macro-generated fields 223
 - notation xv
 - shift-in (SI), DBCS character delimiter 12
 - shift-out (SO), DBCS character delimiter 12
 - DROP instruction 152
 - DS instruction 155
 - DSECT instruction 54, 158
 - dummy section
 - external 55
 - identifying 54, 158
 - See also external dummy sections
 - duplication factor in constants 116
 - DXD instruction 160
- E**
- E-Decks, reading in VSE 4
 - E-type floating-point constant 141
 - edited macros 216
 - edited macros in VSE 4
 - EH-type floating-point constant 141
 - EJECT instruction 161
 - elements and functions
 - data attributes 296
 - sequence symbols 310
 - SET symbols 292
 - END instruction 162, 312
 - ENTRY instruction 163
 - entry point symbol
 - referencing using the ENTRY instruction 163
 - entry point symbol (*continued*)
 - transfer control to, using END instruction 162
 - EQU instruction 164
 - assigning the length 304
 - ESD entries 58
 - exclusive OR (XOR)
 - SETA built-in function 322
 - SETB logical operator 329
 - EXCP access method 101
 - EXIT assembler option
 - ADEXIT suboption 167
 - INEXIT suboption 166
 - LIBEXIT suboption 166
 - OBJECT 167
 - OBJEXIT suboption 167
 - PRTEXIT suboption 166
 - TRMEXIT suboption 167
 - XOBJECT 167
 - exit-control parameters 166
 - EXITCTL instruction 166
 - exiting macros 219
 - exits
 - See user I/O exits
 - explicit addresses 47
 - explicit length attribute 113
 - exponent modifier
 - floating-point constants 141
 - specify 122
 - expressions
 - absolute 44
 - arithmetic 318
 - character 333
 - complex relocatable 45
 - conditional assembly, summary of 369
 - discussion of 42
 - EQU instruction 164
 - evaluation of 44, 331
 - evaluation of character 337
 - logical 328
 - paired relocatable terms 44
 - relocatable 45
 - rules for coding 42, 330
 - extended AGO instruction 350
 - extended AIF instruction 348
 - extended branch mnemonics 70
 - extended continuation-indicator
 - double-byte data continuation 16
 - listing of macro-generated fields 223
 - extended mnemonic codes, branching with 70
 - extended SET statement 341
 - external dummy sections
 - CXD instruction to define an 109
 - discussion of 55
 - DXD instruction to define an 160
 - external function calls
 - arithmetic 342

Index

external function calls (*continued*)
 character 343
 SETAF instruction 342
 SETCF instruction 343
external symbol dictionary entries 58
external symbols
 ALIAS command 95
 providing alternate names 95
EXTRN instruction 167

F

F-type fixed-point constant 130
field boundaries 14
FIND (built-in function) 320
first control section 52
fixed-point constant 130
FLAG assembler option 90, 175, 221
 CONT suboption 16, 221
 NOSUBSTR suboption 345
floating-point constants 141
floating-point instructions 69
FOLD assembler option 14
 field boundaries
 continuation-indicator field 14
 identification-sequence field 14
 statement field 14
format notation, description xiii—xv
format-0 channel command word 100
format-1 channel command word 101
FORTRAN communication 55
function calls
 See external function calls

G

G-type constant 128
GBLA instruction 315
GBLB instruction 315
GBLC instruction 315
General Information book xii
general instructions 68
generated fields, listing of 222
generating END statements 312
global scope system variable symbols 236
GOFF assembler option 36, 59, 94, 108, 110, 151, 192, 247, 249
 CATTR instruction 98
 entry point 97
 maximum value of control section 57
graphic constant 128
graphic self-defining term 35

H

H-type fixed-point constant 130
hardcopy publications xii
header, macro definition 218
hexadecimal constant 129
hexadecimal self-defining term 33
High Level Assembler
 publications xii

I

I' integer attribute 306
ICTL instruction 168
identification-sequence field 14
immediate data in machine instructions 79
implicit addresses 47
implicit length attribute 113
INDEX (built-in function) 321
inner and outer macro instructions 285
inner macro instructions 230
inner macro instructions, passing sublists to 281
input format control statement
 See ICTL instruction
input/output operations 70
installation and customization
 book information xii
instruction statement format 19
instructions
 assembler
 ACONTROL 90
 ADATA 93
 ALIAS 95
 AMODE 96
 CATTR 98
 CCW 100
 CCW0 100
 CCW1 101
 CEJECT 103
 CNOP 103
 COM 105
 COPY 106
 CSECT 108
 CXD 109
 DC 110
 DROP 152
 DS 155
 DSECT 158
 DXD 160
 EJECT 161
 END 162
 ENTRY 163
 EQU 164
 EXTRN 167
 ICTL 168
 ISEQ 169
 LOCTR 170

instructions (*continued*)assembler (*continued*)

LTORG 171
 OPSYN 176
 ORG 178
 POP 181
 PRINT 181
 PUNCH 184
 PUSH 186
 REPRO 187
 RMODE 187
 RSECT 189
 SPACE 190
 START 190
 TITLE 191
 USING 194
 WXTRN 204
 XATTR 205

conditional assembly

ACTR 350
 AGO 349
 AIF 346
 ANOP 351
 GBLA 315
 GBLB 315
 GBLC 315
 LCLA 316
 LCLB 316
 LCLC 316
 SETA 318
 SETAF 342
 SETB 328
 SETC 333
 SETCF 343

macro

AEJECT 230
 AINSERT 94, 231
 ASPACE 233
 COPY 234
 MEXIT 234
 MNOTE 174

integer attribute (I') 306

internal macro comment statement format 18

internal macro comment statements 235

ISEQ instruction 169

J

J-type length constant 151

K

K' count attribute 306

keyword parameters 229, 275

L

L' length attribute 304

L-type floating-point constant 141

labeled USING 199

domain 201

range 201

labels, on USING instructions 199

Language Reference xii

LCLA instruction 316

LCLB instruction 316

LCLC instruction 316

length attribute

(L') 304

assigned by modifier in DC instruction 119

bit-length modifier 120

DC instruction

address constant 135

binary constant 124

character constant 126

decimal constant 133

fixed-point constant 131

floating-point constant 143

graphic constant 128

hexadecimal constant 129

duplication factor 117

EQU instruction 304

explicit length 113

exponent modifier 123

implicit length 113

value assigned to symbols naming constants 113

length attribute reference 37

length counter, for control sections 57

length fields in machine instructions 79

length modifier

constant 119

exponent modifier 119

length modifier 119

scale modifier 119

syntax 119

length of control section 57

LH-type floating-point constant 141

LIBMAC assembler option 90, 215

library macro definitions 215

license inquiry 381

Licensed Program Specifications xiii

LINKAGE

XATTR attribute 206

linkages

by means of the ENTRY instruction 163

by means of the EXTRN instruction 167

by means of the WXTRN instruction 204

symbolic 60

linking 49

listing control instructions

AEJECT instruction 230

Index

listing control instructions (*continued*)

- AINsert instruction 94, 231
- ASPACE instruction 233
- CEJECT instruction 103
- EJECT instruction 161
- PRINT instruction 181
- SPACE instruction 190
- TITLE instruction 191

listing of generated fields 222

literal pool 42, 172

literals

- differences between constants, self-defining terms, and 39

- duplicate 173

- explanation of 39

- general rules for usage 40

- type attribute 303

local scope system variable symbols 236

location counter reference

- effect of duplication factor in constants 117

- effect of duplication factor in literals 117

- overview 35

location counter setting 56

LOCTR instruction 170

logical (SETB) expressions 328

logical AND 329

logical operators 329

logical OR 329

logical XOR 322

lookahead mode 311

LOWER (SETC built-in function) 336

LTOrg instruction 171

M

machine instruction formats

- RI format 80

- RR format 81

- RS format 81

- RSI format 82

- RX format 83

- SI format 84

- SS format 85

machine instruction statements

- addresses 76

- control 69

- decimal 69

- floating-point 69

- formats 72

- general 68

- immediate data 79

- input/output 70

- length field in 79

- operand entries 74

- registers, use of 74

- symbolic operations codes in 73

machine instructions, publications 383

macro comment statement format 18

macro definition header (MACRO) 218

macro definition trailer (MEND) 218

macro definitions

- body of a 221

- combining positional and keyword parameters 229

- comment statements 235

- COPY instruction 234

- description 212

- format of 218

- header 213, 218

- how to specify 217

- inner macro instructions 230

- internal macro comment statements 235

- keyword parameters 229

- MEXIT instruction 234

- MNOTE instruction 174

- model statements 213

- nesting in 285

- parts of a macro definition 213

- positional parameters 228

- prototype 213

- subscripted symbolic parameters 229

- symbolic parameters 227

- trailer 213, 218

- where to define in a source module 217

- where to define in open code 217

macro instruction

- description 215

- M type attribute 301

- name field type attribute 301

macro instructionants

- alternative ways of coding 272

- description of 271

- format of 271

- general rules and restrictions 286

- inner and outer 285

- multilevel sublists 280

- name entry 273

- operand entry 274

- operation entry 273

- passing sublists to inner 281

- passing values through nesting levels 287

- prototype 218

- sublists in operands 278

- summary of 361

- values in operands 281

macro language

- comment statements 214

- conditional assembly language 216

- defining 212

- library macro definition 215

- macro instruction 215

- model statements 213

- processing statements 214

- macro language (*continued*)
 - source macro definition 215
 - summary of 365
 - using 212
 - macro library 216
 - MACRO statement (header) 218
 - macros
 - continuation line errors 221
 - edited macros 216
 - exiting 219
 - format of a macro definition 218
 - how to specify 217
 - library macro definition 215
 - macro definition 212
 - macro definition header (MACRO) 213, 218
 - macro definition trailer (MEND) 213, 218
 - macro instruction 215
 - macro library 216
 - macro prototype statement 213
 - MACRO statement (header) 218
 - MEND statement (trailer) 219
 - MEXIT instruction 234
 - MNOTE instruction 174
 - model statements 213
 - prototype
 - (see also prototype, macro instruction)
 - source macro definition 215
 - using macros 212
 - manuals
 - High Level Assembler 383
 - related publications 384
 - manuals, High Level Assembler xii
 - MEXIT instruction 234
 - MHELP instruction 353
 - mnemonic codes
 - extended, branching with 70
 - machine instruction 73
 - MNOTE instruction 174
 - model statements
 - explanation of 221
 - function of 213
 - rules for concatenation of characters in 223
 - rules for specifying fields in 225
 - summary of 361
 - variable symbols as points of substitution in 221
 - modifiers of constants
 - exponent 122
 - length 120
 - scale 121
 - multilevel sublists 280
- N**
- N' number attribute 307
 - name entry coding 19
 - nested macros, system variable symbols in 289
 - nesting
 - levels of 285
 - recursion 285
 - nesting levels, passing values through 287
 - nesting macro instructions 285
 - NOAFPR assembler option 74, 75
 - NOALIGN assembler option 113
 - NODECK assembler option 186, 187
 - NOGOFF assembler option 36, 57, 59
 - NOLIST assembler option 184
 - nominal values of constants (literal)
 - address 135
 - binary 124
 - character 125
 - decimal 133
 - fixed-point 130
 - floating-point 141
 - graphic 128
 - hexadecimal 129
 - NOOBJECT assembler option 186, 187
 - NOPRINT operand
 - POP instruction 181
 - PRINT instruction 184
 - PUSH instruction 186
 - NOT (SETA built-in function) 321
 - notation, description xiii—xv
 - NOXOBJECT assembler option 59
 - number attribute (N') 307
- O**
- O' operation code attribute 308
 - OBJECT assembler option 167, 247, 249
 - object external class name
 - establishing 98
 - omitted operands 281, 282
 - online publications xiii
 - open code 217, 218, 313
 - operand entries
 - combining positional and keyword 277
 - in machine instructions 74
 - keyword 275
 - multilevel sublists in 280
 - omitted 281, 282
 - positional 274
 - special characters in 282
 - statement coding rules 20
 - sublists in 278
 - operands
 - compatibility with earlier assemblers 282
 - omitted 281, 282
 - sublists in 278
 - unquoted operands 282
 - values in 281

Index

operating system, relationship to assembler
 program 7, 8
operation code attribute (O') 308
operation codes, symbolic 73
operation entry coding 19
OPSYN instruction 176
OPTABLE assembler option 258
 &SYSOPT_OPTABLE system variable symbol 258
 determining value 258
OR (SETA built-in function) 321
OR (SETB logical operator) 329
OR NOT (SETB logical operator) 329
ordinary comment statements 235
ordinary symbols 29
ORG instruction 178
organization of this manual xi
OVERRIDE 89
 process, override 89
 restricted options 89

P

P-type decimal constant 133
packed decimal constant 133
paired relocatable terms 44
parameters
 combining positional and keyword 229
 keyword 229
 positional 228
 subscripted symbolic 229
 symbolic 227
parentheses, terms in 27
pool, literal
 See literal pool
POP instruction 181
positional parameters 228, 274
predefined absolute symbols
 illegal use 330
 in logical expressions 330
previously defined symbols 32
PRINT instruction 181
private code 52, 53, 165
private control section 52, 53
process statements
 See *PROCESS statement
processing statements
 conditional assembly instructions 229
 COPY instruction 234
 function of 214
 inner macro instructions 230
 MEXIT instruction 234
 MNOTE instruction 174
PROFILE assembler option 53
program control instructions
 CNOP instruction 103
 COPY instruction 106

program control instructions (*continued*)
 END instruction 162
 ICTL instruction 168
 ISEQ instruction 169
 LTOrg instruction 171
 ORG instruction 178
 POP instruction 181
 PUNCH instruction 184
 PUSH instruction 186
 REPRO instruction 187
program sectioning 49
 See also sectioning, program
program sectioning and linking instructions
 AMODE instruction 96
 CATTR instruction 98
 COM instruction 55, 105
 CSECT instruction 108
 CXD instruction 109
 DSECT instruction
 DXD instruction 160
 ENTRY instruction 163
 EXTRN instruction 167
 LOCTR instruction 170
 RMODE instruction 187
 RSECT instruction 189
 WXTRN instruction 204
Programmer's Guide xiii
Prototype Control Section
 See PSECT
prototype, macro instruction
 alternative ways of coding 220
 format of 219
 function of 218
 name field 219
 operand field 220
 operation field 219
 summary of 361
PSECT
 address 116, 140
 discussed 62
 XATTR attribute 206
publications
 general 384
 High Level Assembler xii, 383
 HLASM Toolkit 383
 machine instructions 383
 MVS 383
 online (CD-ROM) xiii
PUNCH instruction 184
PUSH instruction 186

Q

Q-type offset constant 150
qualified addressing 48

qualified symbols 199

R

R-type address constant 62, 116, 140
 RA2 assembler option 90, 137
 railroad track format, how to read xiii—xv
 reading edited macros in VSE 4
 redefining conditional assembly instructions 177
 REFERENCE
 XATTR attribute 207
 registers, use of, by machine instructions 74
 relative addressing 49
 relocatability attribute 44
 relocatable expression
 complex 45
 definition 45
 EQU instruction 164
 relocatable terms 27
 See also self-defining terms
 remarks entries 20
 RENT assembler option 189, 258
 &SYSOPT_RENT system variable symbol 258
 determining if supplied 258
 REPRO instruction 187
 residence mode (RMODE) 59
 RI format 80
 RMODE
 indicators in ESD 59
 instruction to specify residence mode 187
 RMODE instruction 187
 RR format 81
 RS format 81
 RSECT instruction 189
 RSI format 82
 rules for model statement fields 225
 RX format 83

S

S' scaling attribute 305
 S-type address constant 137
 scale modifier 119, 121
 scaling attribute (S') 305
 SCOPE
 XATTR attribute 207
 scope of SET symbols 292
 sectioning, program
 addressing mode of a control section 96
 control sections 51
 CSECT instruction 108
 defining 160
 ESD entries 58
 external symbols 167
 first control section 52
 identifying a blank common control section 55

sectioning, program (*continued*)
 identifying a dummy section 54
 length counter, for control sections 57
 location counter setting 56
 maximum length of control section 57
 multiple location counters in a control section 170
 read-only control section 189
 residence mode of a control section 187
 source module 50
 total length of external dummy sections 109
 unnamed control section 53
 weak external symbols 204
 segments of control sections 58
 self-defining terms
 binary 34
 character 34
 comparison with literals and constants 39
 decimal 33
 graphic 35
 hexadecimal 33
 overview 32
 using 33
 sequence symbols 30, 310
 SET symbols
 assigning values to 318
 created 296
 declaring 314
 define global 315
 define local 316
 description of 292
 extended 341
 external function calls 342, 343
 scope of 292
 SETA (set arithmetic) 318
 SETB (set binary) 328
 SETC (set character) 333
 specifications 293
 specifications for subscripted 295
 subscripted 292
 SETA
 arithmetic expression 318
 built-in functions 319
 instruction format 318
 symbol in operand field of SETC
 in arithmetic expressions 319
 leading zeros 341
 sign of substituted value 341
 symbols, subscripted 318
 symbols, using 326
 SETA instruction 318
 SETAF instruction 342
 SETB
 AND 329
 AND NOT 329
 built-in functions 320
 character relations in logical expressions 331, 332

Index

- SETB (*continued*)
 - exclusive OR 329
 - instruction format 328
 - logical AND 329
 - logical expression 328
 - logical operators 329
 - logical OR 329
 - OR 329
 - OR NOT 329
 - symbols, subscripted 328
 - symbols, using 332
 - XOR 329
 - XOR NOT 329
- SETB instruction 328
- SETC
 - built-in functions 335
 - character expression 333
 - character expressions 335
 - instruction format 333
 - SETA symbol in operand field 341
 - substring notation 333
 - symbols, subscripted 333
- SETC instruction 333
- SETCF instruction 343
- shift codes (double-byte character set) 12
- shift left arithmetic (SETA built-in function) 321
- shift left logical (SETA built-in function) 322
- shift right arithmetic (SETA built-in function) 322
- shift right logical (SETA built-in function) 322
- shift-in (SI), DBCS character delimiter 12
- shift-out (SO), DBCS character delimiter 12
- SI (shift-in) character
 - continuation of double-byte data 16
 - continuation-indicator field 15
 - double-byte character set 12
- SI format 84
- SIGNED (SETC built-in function) 336
- SLA (SETA built-in function) 321
- SLL (SETA built-in function) 322
- SO (shift-out) character
 - continuation of double-byte data 16
 - continuation-indicator field 15
 - double-byte character set 12
- softcopy publications xiii
- source macro definitions 215
- SPACE instruction 190
- special characters 282
- SRA (SETA built-in function) 322
- SRL (SETA built-in function) 322
- SS format 85
- stacked items xiv
- START instruction 190
 - beginning a source module 50
 - control section 51
 - syntax 190
- statement coding rules 19
- statement field 14
- structure 21
 - assembler language 21
- subfield 1 of constant 116
- subfield 2 of constant 117
- subfield 3 of constant 118
- subfield 4 of constant 119
- subfield 5 of constant 123
- sublists
 - compatibility with Assembler H 252
 - effect of COMPAT(SYSLIST) assembler option 278, 281
 - in operands 278
 - multilevel 280
 - passing, to inner macro instructions 281
- subscripted SET symbols 292, 295
- subscripted symbolic parameters 229
- substring notation
 - arithmetic expressions 319
 - assigning SETC symbols 333, 344
 - concatenating double-byte data 338
 - concatenation 341
 - definition 344
 - duplicating double-byte data 334
 - duplication factor 333
 - evaluation of 345
 - level of parentheses 325
 - using count (K') attribute 297
- symbol definition (EQU) instruction 164
- symbol length attribute reference 37
- symbol qualifiers 199
- symbol table 29
- symbolic linkages 60
- symbolic operation codes 73
 - defining 176
 - deleting 176
- symbolic parameters 227
- symbols
 - attributes in combination with 299
 - defining 30
 - explanation of 28
 - extended SET 341
 - labeled USING 199
 - length attribute reference 37
 - ordinary 29
 - previously defined 32
 - qualifiers 199
 - restrictions on 31
 - sequence 30, 310
 - system variable 235
 - USING instruction labels 199
 - variable 29
 - variable, as points of substitution in model statements 221

syntax notation, description xiii—xv
 SYSPARM assembler option 259
 &SYSPARM system variable symbol 259
 system macro instructions 215
 system variable symbols
 &SYSADATA_DSN 237
 &SYSADATA_MEMBER 238
 &SYSADATA_VOLUME 238
 &SYSASM 239
 &SYSCLOCK 239
 &SYSDATC 240
 &SYSDATE 240
 &SYSECT 241
 &SYSIN_DSN 243
 &SYSIN_MEMBER 244
 &SYSIN_VOLUME 245
 &SYSJOB 245
 &SYSLIB_DSN 246
 &SYSLIB_MEMBER 246
 &SYSLIB_VOLUME 247
 &SYSLIN_DSN 247
 &SYSLIN_MEMBER 249
 &SYSLIN_VOLUME 249
 &SYSLIST 250
 &SYSLOC 252
 &SYSM_HSEV 174, 253
 &SYSM_SEV 174, 253
 &SYSMAC 253
 &SYSNDX 254
 &SYSNEST 257
 &SYSOPT_DBCS 258
 &SYSOPT_OPTABLE 258
 &SYSOPT_RENT 258
 &SYSOPT_XOBJECT 259
 &SYSPARM 259
 &SYSPRINT_DSN 260
 &SYSPRINT_MEMBER 261
 &SYSPRINT_VOLUME 261
 &SYSPUNCH_DSN 262
 &SYSPUNCH_MEMBER 263
 &SYSPUNCH_VOLUME 264
 &SYSSEQF 264
 &SYSSTEP 265
 &SYSSTMT 265
 &SYSSTYP 266
 &SYSTEM_ID 266
 &SYSTEM_DSN 267
 &SYSTEM_MEMBER 268
 &SYSTEM_VOLUME 268
 &SYSTIME 269
 &SYSVER 270
 discussion of 235
 in nested macros 289
 summary of 372
 variability 236

T

T' type attribute 300
 terms 27
 terms in parentheses 27
 TITLE instruction 191
 Toolkit Customization book xiii
 Toolkit installation and customization
 book information xiii
 trailer, macro definition 218
 translation table 14
 type attribute
 (T') 300
 literals 302, 303
 name field of macro instruction 301
 undefined type attribute 302
 unknown type attribute 302
 type extension of constants 118
 types of constants 117

U

undefined type attribute 302
 Unicode
 character constant 127
 Unicode character constant 125
 Unicode data assembler option 127
 unknown type attribute 302
 unnamed control section 53
 unquoted operands 282
 unsigned integer conversion 341
 UPPER (SETC built-in function) 336
 user I/O exits 166
 user records
 ADATA instruction 93
 USING assembler option
 WARN suboption 198
 USING instruction 194
 base registers for absolute addresses 196
 discussion of 194
 domain of a 199
 range of a 198
 using 195
 for executable control sections 195
 for reference control sections 195

V

V-type address constant 62, 139
 values in operands 281
 variable symbols 29
 See also symbols
 &SYSADATA_DSN 237
 &SYSADATA_MEMBER 238
 &SYSADATA_VOLUME 238
 &SYSASM 239
 &SYSCLOCK 239

Index

variable symbols (*continued*)

&SYSDATC 240
&SYSDATE 240
&SYSECT 241
&SYSIN_DSN 243
&SYSIN_MEMBER 244
&SYSIN_VOLUME 245
&SYSJOB 245
&SYSLIB_DSN 246
&SYSLIB_MEMBER 246
&SYSLIB_VOLUME 247
&SYSLIN_DSN 247
&SYSLIN_MEMBER 249
&SYSLIN_VOLUME 249
&SYSLIST 250
&SYSLOC 252
&SYSM_HSEV 253
&SYSM_SEV 253
&SYSMAC 253
&SYSNDX 254
&SYSNEST 257
&SYSOPT_DBCS 258
&SYSOPT_OPTABLE 258
&SYSOPT_RENT 258
&SYSOPT_XOBJECT 259
&SYSPARM 259
&SYSPRINT_DSN 260
&SYSPRINT_MEMBER 261
&SYSPRINT_VOLUME 261
&SYSPUNCH_DSN 262
&SYSPUNCH_MEMBER 263
&SYSPUNCH_VOLUME 264
&SYSSEQF 264
&SYSSTEP 265
&SYSSTMT 265
&SYSSTYP 266
&SYSTEM_ID 266
&SYSTEM_DSN 267
&SYSTEM_MEMBER 268
&SYSTEM_VOLUME 268
&SYSTEMTIME 269
&SYSVER 270
summary of 371

variable symbols as points of substitution 221

XATTR attribute (*continued*)

REFERENCE 207
SCOPE 207

XATTR instruction 205

XOBJECT assembler option 59, 94, 167, 247, 249

alias string 96

CATTR instruction 98

XOR (SETA built-in function) 322

XOR (SETB logical operator) 329

XOR NOT (SETB logical operator) 329

Y

Y-type address constant 135

Z

Z-type decimal constant 133

zoned decimal constant

See Z-type decimal constant

W

WXTRN instruction 204

X

X-type constant 129

XATTR attribute

ATTRIBUTES 206

LINKAGE 206

PSECT 206

We'd Like to Hear from You

High Level Assembler for MVS® & VM & VSE
Language Reference
Release 4
Publication No. SC26-4940-03

Please use one of the following ways to send us your comments about this book:

- Mail—Use the Readers' Comments form on the next page. If you are sending the form from a country other than the United States, give it to your local IBM branch office or IBM representative for mailing.
- Fax—Use the Readers' Comments form on the next page and fax it to this U.S. number: 800-426-7773.
- Electronic mail—Use one of the following network IDs:
 - IBMLink: HLASMPUB at STLVM27
 - Internet: COMMENTS@VNET.IBM.COM

Be sure to include the following with your comments:

- Title and publication number of this book
- Your name, address, and telephone number if you would like a reply

Your comments should pertain only to the information in this book and the way the information is presented. To request additional publications, or to comment on other IBM information or the function of IBM products, please give your comments to your IBM representative or to your IBM authorized remarketer.

IBM may use or distribute your comments without obligation.

Readers' Comments

**High Level Assembler for MVS® & VM & VSE
Language Reference
Release 4**

Publication No. SC26-4940-03

How satisfied are you with the information in this book?

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Technically accurate	<input type="checkbox"/>				
Complete	<input type="checkbox"/>				
Easy to find	<input type="checkbox"/>				
Easy to understand	<input type="checkbox"/>				
Well organized	<input type="checkbox"/>				
Applicable to your tasks	<input type="checkbox"/>				
Grammatically correct and consistent	<input type="checkbox"/>				
Graphically well designed	<input type="checkbox"/>				
Overall satisfaction	<input type="checkbox"/>				

Please tell us how we can improve this book:

May we contact you to discuss your comments? Yes No

Name

Address

Company or Organization

Phone No.



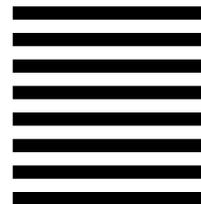
Fold and Tape

Please do not staple

Fold and Tape



NO POSTAGE
NECESSARY
IF MAILED IN THE
UNITED STATES



BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 40 ARMONK, NEW YORK

POSTAGE WILL BE PAID BY ADDRESSEE

Department J58
International Business Machines Corporation
PO BOX 49023
SAN JOSE CA 95161-9945



Fold and Tape

Please do not staple

Fold and Tape



Program Number: 5696-234



Printed in the United States of America
on recycled paper containing 10%
recovered post-consumer fiber.

High Level Assembler Publications

SC26-4941 *HLASM Programmer's Guide.*
GC26-4943 *HLASM General Information.*
GC26-4944 *HLASM Licensed Program Specifications.*
SC26-4940 *HLASM Language Reference.*
SC26-3494 *HLASM Installation and Customization Guide.*

High Level Assembler Toolkit Feature Publications

GC26-8709 *HLASM Toolkit Feature Interactive Debug Facility User's Guide.*
GC26-8710 *HLASM Toolkit Feature User's Guide.*
GC26-8711 *HLASM Toolkit Feature Installation Guide.*
GC26-8712 *HLASM Toolkit Feature Debug Reference Summary.*

SC26-4940-03





HLASM

Language Reference