

PROGRAMMA

INTERNATIONAL, Inc.
3400 Wilshire Boulevard
Los Angeles, CA 90010

(213) 384-0579

S P L / M C O M P I L E R
R E F E R E N C E M A N U A L
V E R 1 . 2

JUNE 1979

COPYRIGHT (c) 1979 BY THOMAS W. CROSLEY & PROGRAMMA INTL., INC.
ALL RIGHTS RESERVED. Reproduction in part or form of the contents of
this document or its accompanying cassette tape or disk, except for the
personal use of the original purchaser, is strictly forbidden without the
expressed written consent and permission of PROGRAMMA International, Inc.

A3 J14-002 10/10/79
JUNIOR DISSEMINATOR
S.L. 10/10/79

COPYRIGHT (c) 1979 BY THOMAS W. CROSLEY & PROGRAMMA INTL., INC.
JUNE 1979 EDITION

This edition (6800.002) is a major revision and obsoletes all previous editions and documents.

Technical changes are marked with a bar in the outer margin. Changes due to subsequent releases will be documented in the future publication bulletins or revisions.

Requests for copies of PROGRAMMA publications should be made to your PROGRAMMA representative or to the PROGRAMMA central office.

A reader's comment form is provided at the back of this publication. If the form has been removed, comments may be addressed to:

PROGRAMMA International, Inc.
Publications Department
P.O. Box 70279
Los Angeles, CA 90070

		PAGE 1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	PRIMITIVES.....	2
	Identifiers.....	2
III.	DATA REPRESENTATIONS.....	3
	Constants.....	3
	Variables.....	4
IV.	EXPRESSIONS AND ASSIGNMENT STATEMENTS.....	5
	Operator Precedence.....	6
	Assignment Statements.....	7
	Implicit Type Conversions.....	8
V.	DECLARATIONS.....	9
	Variable Declarations.....	9
	Constant Data Declarations.....	10
	Symbolic Constant Declarations.....	11
VI.	FLOW OF CONTROL & GROUPING.....	12
	IF Statement.....	12
	DO-FND Groups.....	13
	DO-WHILF Statement.....	13
VII.	PROCEDURES.....	15
	CALL Statement.....	15
	RETURN Statement.....	17
VIII.	MISCELLANFOUS FACILITIES.....	18
	Direct References to Memory.....	18
	Explicit Type Conversions.....	19
	GENFRATF Statement.....	19
IX.	PROGRAM ORGANIZATION AND SCOPE.....	21
	Block Structure and Scope.....	21
	Program Origins.....	22
X.	COMPILE AND CONFIGURATION OPTIONS.....	24
	System Considerations.....	24
	Compiler Disk.....	24
	Running the Compiler.....	24
	Include Files.....	26
	Printer Considerations.....	27
	Memory Usage.....	28
XI.	ERROR HANDLING.....	29

		PAGE 11 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

XII. APPENDICES

- A. SPL/M Compiler Interface Routines.....A.1
- B. SPL/M DOS Library Routines.....B.1
- C. "Size" Program (SPL/M Source).....C.1
- D. SPL/M Reserved Words.....D.1
- E. Grammar for SPL/M.....E.1

		PAGE 1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

I. INTRODUCTION

SPL/M (Small Programming Language for Microprocessors) is based on the language PL/M, initially developed by the Intel Corporation.

SPL/M is a block-structured language which features arbitrary length identifiers and structured programming constructs. It is suitable for systems programming on small computers, since the compiler requires only 20K of memory to run. Either two cassette decks or a disk are also required.

The language can be compiled in only one pass, which means that the source code has to be read only once.

Unlike most high-level language translators available for microprocessors, SPL/M is a true compiler: it generates absolute 6800 object code which requires no run-time interpreter. Due to extensive intra-statement optimization, the generated code is almost as efficient as the equivalent assembly language.

The compiler has a number of compile-time options, including a printout that contains the interlisted object code. Syntactical error messages use position indicators to indicate exactly where an error occurs.

This manual has been organized to be usable as both a tutorial and a reference guide. In addition to the many examples in the text, a complete SPL/M program is presented in Appendix C.

As an example of the type of application SPL/M is suited for, this entire manual was formatted using a text processing system written in 800 lines of SPL/M.

Some details of the compiler implementation are presented in the paper "SPL/M - A Cassette-Based Compiler", by Thomas W. Crosley, in the Conference Proceedings, Second West Coast Computer Faire, March, 1978.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

II. PRIMITIVES

An SPL/M program consists of primitives (reserved words, identifiers, and constants), along with special characters (operators).

One or more blanks (spaces) are required between any two primitives on the same line, to tell them apart. Blanks are allowed anywhere else, except in the middle of a primitive or a two character operator (such as $>=$). A carriage return is treated the same as a blank; therefore statements can spill over onto as many lines as necessary.

Comments may be embedded in an SPL/M program anywhere a blank is legal. Comments are delimited by a /* ... */ pair:

```
/* COMMENTS MAY GO OVER
MORE THAN ONE LINE */
```

Identifiers

An identifier is a programmer assigned name for a variable, procedure, or symbolic constant. Identifier names may be up to 31 characters long.

The first character must be alphabetic (A-Z), while the remaining characters may be either alphanumeric (A-Z, 0-9) or the separation character (\$). The latter is completely ignored by the compiler: an identifier with imbedded \$'s is equivalent to the same identifier with the \$'s omitted.

Examples of valid identifiers:

ACIANO	ACIA\$NO	(same variable)
BUFFER1		
A\$RATHER\$LONG\$PROCEDURE\$NAME		

Identifier names must not conflict with the reserved words of SPL/M, such as DECLARE, PROCEDURE, etc. A complete list of reserved words for both Versions 1 and 2 of SPL/M is provided in Appendix D.

All identifiers must be declared before they are referenced. Variables and symbolic constants are defined via the DECLARE statement (Section V); procedures are defined via the PROCEDURE statement (Section VII).

		PAGE 3 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

III. DATA REPRESENTATIONS

Constants

Constants can be either a number or a character string. As their name implies, their value remains constant during program execution.

A numeric constant, or number, is a string of digits representing an unsigned integer in the range 0-65535. A number is assumed to be decimal unless it is terminated by the letter H, indicating hexadecimal. The first character of a hexadecimal constant must always be numeric (a leading zero is always sufficient).

Examples of numeric constants:

0	32	65535
10	20H	OFFFH
OAH		

A character constant, or string, consists of one or more ASCII characters enclosed in apostrophes. A null string (i.e. '') is not permitted. Imbedded apostrophes are represented by two consecutive apostrophes (e.g. DON'T).

Constants of one or two characters are equivalent to the numeric constant representing the ASCII code for the character(s). In a two character constant, the left-most character is placed in the most significant byte.

Character constants of more than two characters may only appear in a DATA declaration (Section V).

Examples of character constants:

'A'	= 41H
'.'	= 20H
'12'	= 3132H
'..'	= 27H (one ')

"THIS IS A LONG STRING"

		PAGE 4 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

Variables

Variables are memory locations set aside by the programmer to hold data that changes during the execution of a program. Variables can be declared as either type BYTE (8 bit data) or type ADDRESS (16 bit data). BYTE variables should be used whenever possible to avoid the overhead associated with double precision arithmetic on the 6300.

Variables are defined using the DECLARE statement (Section V), e.g.

```
DECLARE CTR BYTE;
DECLARE BUF$PTR ADDRESS;
```

Vectors (one dimensional arrays) can also be declared, e.g.

```
DECLARE LIST (10) BYTE;
```

which sets aside 10 bytes of storage. A vector has n elements, referenced as

```
V(0), V(1), ..., V(n-1)
```

The value in parentheses is the subscript, which can be any SPL/M expression (Section IV). The subscript is added to the base address for BYTE vectors to generate the correct memory reference. For ADDRESS variables, twice the subscript is added to the base to generate the correct memory reference.

For example, if the BYTE vector LIST declared above was located at memory address 400, then LIST(4) would refer to memory address 404. However if LIST was an ADDRESS vector, then LIST(4) would refer to memory addresses 408 and 409.

Subscripted variables can be used anywhere a variable is allowed in SPL/M, except as the operand of the dot operator (Section IV).

The first element of a vector may also be referenced without the subscript; i.e. V and V(0) are the same.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

IV. EXPRESSIONS AND ASSIGNMENT STATEMENTS

An expression is simply a way of computing a value. Expressions are formed by combining operators (such as + or *) with either operands (variables or constants) or other expressions enclosed in parentheses.

An arithmetic expression consists of one or more operands which are combined using the following arithmetic operators:

+	addition
-	subtraction (unary minus also allowed)
*	unsigned multiplication
/	unsigned integer division
MOD	modulo (remainder from a division)
.	dot operator (see below)

Examples:

```

X
ALPHA - BETA
10 MOD 3      (result =1)
-1
X*(Y+Z)/2
.BUF1

```

The unary dot operator (.) generates a numeric constant equal to the memory address of a variable. The variable cannot have a subscript.

A relational expression consists of two arithmetic expressions combined with one of the following relational operators:

<	less than
<=	less than or equal to
=	equal to
<>	not equal to
>=	greater than or equal to
>	greater than

Comparisons are always performed assuming the operands are unsigned integers. If the specified relation holds, a value of OFFH (true) is returned; otherwise the result is 0 (false).

		PAGE 6 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

Examples:

```
A > 1
CNTR <= LIMIT+OVER
LOOP<>0
```

A logical expression consists of either arithmetic or relational expressions combined with one or more of the following logical operators:

OR	bitwise OR
XOR	bitwise exclusive OR
AND	bitwise AND
NOT	1's complement (unaryoperator)

Examples:

```
LADIES AND GENTLEMEN
NOT FLAGS           (same as FLAGS XOR -1)
X > 1 OR Y < 2
```

The following table summarizes the effect of each logical operator:

X	Y	X OR Y	X XOR Y	X AND Y	NOT X
-	-	—	—	—	—
0	0	0	0	0	1
0	1	1	1	0	1
1	0	1	1	0	0
1	1	1	0	1	0

Logical expressions are used in assignment statements to perform bit manipulation, and in IF and DO-WHILE statements (Section VI) to specify a series of conditional tests.

Operator Precedence

The order of evaluation of operators in an expression is primarily determined by operator precedence.

Operands are associated with the adjacent operator of highest precedence. Operands adjacent to two operators of equal precedence may be associated with either one. Operators with the highest precedence are evaluated first. Two operators of the same precedence may be evaluated in either order.

		PAGE 7 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

The following list summarizes the operator precedence for SPL/M:

highest:	() .
	unary -
	* / MOD
	+ -
	= < > <> <= >=
	NOT
	AND
lowest:	OR XOR

Since parentheses have the highest precedence, they can be used to override the implicit order of evaluation. The following fully parenthesized expression

IF (A=3) OR (B > (10*(I+1))) THEN

can also be written:

IF A=3 OR B>10*(I+1) THEN

The parentheses around the I+1, to force the addition to be done first, are the only ones required in this case.

Assignment Statements

Assignment statements perform the real work of a program. They are used to assign the result of an expression to a variable location. The format is:

variable = expression;

The value of the variable on the left-hand side of the equal sign is replaced by the value of the expression on the right-hand side.

Examples:

CTR = CTR + 1;
LIST(I) = 0;

		PAGE 8 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

Implicit Type Conversions

Mixed mode is a situation which arises when BYTE and ADDRESS variables or constant are combined in the same expression or assignment statement. To avoid generating unexpected results, SPL/M attempts to use double-precision arithmetic throughout mixed mode expressions.

As soon as an ADDRESS variable or constant is encountered (scanning from left to right), then the remainder of the statement or expression is evaluated in double-precision mode. For example, if X is an ADDRESS variable, then

X = -1;

will set X = OFFFFH since the unary subtraction will be carried out in double precision.

When operating in double-precision mode, the high-order eight bits of any BYTE variables or constants in an expression are assumed to be 0. In an assignment statement, if the variable on the left-hand side is type BYTE, whereas the expression on the right-hand side is type ADDRESS, then the high-order eight bits of the expression will be lost.

In a complex relational expression involving ADDRESS variables on one side and BYTE variables on the other, the ADDRESS variables should appear first to force the entire expression to be evaluated in double-precision.

Note: the rules used by SPL/M for evaluating mixed-mode expressions are not the same as PL/M.

Functions for performing explicit type conversions are also available in SPL/M; see Section VIII.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

V. DECLARATIONS

Variables, constant data arrays, and symbolic constants are defined using the DECLARE statement. (DCL is an allowed abbreviation for DECLARE). All programmer-defined identifiers must be declared before they are referenced in the program. Declarations are subject to "scope", which is explained under program organization (Section IX).

Variable Declarations

The general form of the declare statement is:

DECLARE identifier [(bounds)] type;

where "(bounds)" is optional and is used only for vector declarations (see below). The "type" may be either BYTE, denoting 8-bit data, or ADDRESS (abbreviated ADDR), denoting 16-bit data.

Examples:

```
DECLARE CTR BYTE;
DCL BUF$PTR ADDRESS;
```

Vectors (one-dimensional arrays) are defined by specifying the number of elements following the variable name; e.g.

```
DCL LIST (10) BYTE;
```

which sets aside 10 bytes of storage, and

```
DCL A$LIST (10) ADDR;
```

which allocates 20 bytes (two for each address element). Vectors are referenced using subscripts as explained in Section III.

The number of elements in a vector declaration may be zero, in which case no storage is reserved. The variable will refer to the same memory location as the next data declaration. For example,

```
DCL BIG$CTR (0) ADDR,
HIGH$CTR BYTE,
LOW$CTR BYTE;
```

		PAGE 10 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

HIGH\$CTR and LOW\$CTR overlay the high and low bytes of BIG\$CTR. This example also shows how several variables can be declared in the same statement. Each declaration is separated by a comma.

Sometimes it is desirable to declare a variable at a particular memory location. This is done by preceding the DECLARE statement with an origin, which will cause the next BYTE or ADDRESS variable to be allocated at the given address. Origins consist of a number followed by ':'. For example,

```
38H: DCL ACIA$NO ADDR, NO$PRNT BYTE;
      DCL BUF$BEG ADDR;
      DCL EUF$END ADDR;
```

will cause the following allocations to take place:

38H-39H	ACIANO
3AH	NOPRNT
3CH-3DH	BUFBFC
3FH-3FH	BUFEND

If a declaration is not preceded by an origin, variables are allocated storage immediately following the last declaration. Unless overridden by an explicit origin, the first variable declaration starts at 10H. Declare origins have no effect on DCL DATA and DCL LIT statements (discussed below); however an origin on either will affect the next variable allocation.

Constant Data Declarations

It is often necessary to define constant data, such as character strings or a table. This is done via a DECLARE DATA statement, which has the general form:

```
DECLARE identifier DATA (constant list) ;
```

where "constant list" is a list of numeric or character constants, separated by commas.

It is assumed that data declared in this way will not change during execution of the program. The data is located within the program object code.

		PAGE 11 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

The identifier defined in a DCL DATA statement is always of type byte, and is referenced using subscripts the same as any vector.

Examples:

```
DECLARE REVERSE$DIGITS DATA (9,8,7,6,5,4,3,2,1,0);
DCL MSG DATA ('A MESSAGE STRING',4);
```

Symbolic Constant Declaration

The DECLARE LITERALLY statement provides a compile-time symbolic constant substitution mechanism similar to the "equate" facility in assemblers. The general form is:

```
DECLARE identifier LITERALLY 'number';
```

LITERALLY may be abbreviated as LIT. Whenever the identifier is encountered in the program, it will be replaced by the number.

Examples:

```
DECLARE CASS1 LITERALLY 'OF050H';
DCL TRUE LIT 'OFFH', FALSE LIT '0';
:
:
:
```

```
IF DECK <> CASS1 THEN
  DEFAULT = FALSE;
```

		PAGE 12 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

VI. FLOW OF CONTROL & GROUPING

Various SPL/M statement types are used to alter the path of program execution. SPL/M does not have the GOTO statement available in BASIC and FORTRAN. However the structured programming constructs (IF-THEN-ELSE, DO-END, and DO-WHILE) can be used to express any program more clearly than if GOTO's were used.

IF Statement

The IF statement selects alternate execution paths, based on a conditional test. IF statements have two forms:

- a) IF expression THEN statement-1;
- b) IF expression
 THEN statement-1;
 ELSE statement-2;

Execution of an IF statement begins by evaluating the expression following the IF. If the right-most (least significant) bit of the result is a 1, then statement-1 is executed. If the bit is a 0, no action is taken for the first form (a), and statement-2 is executed for the second form (b).

Since the result of a relational expression is either OFFH (true) or 0 (false), the construction "IF relational-expr THEN" has the expected result.

In the second form of the IF statement above (b), statement-1 may not be an IF statement. This avoids any ambiguity in the following construction:

```
IF expression
    THEN IF expression
        THEN statement-1;
        ELSE statement-2;
```

The rule in this case is that the ELSE belongs to the second (innermost) IF statement. If needed, a DO-END group (defined below) can be used to associate the ELSE with the first IF statement:

		PAGE 13 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

```

IF expression
THEN DO;
    IF expression THEN statement-1;
END;
ELSE statement-2;

```

The ELSE now clearly belongs to the first IF. The following are examples of IF statements:

```

IF CFLAC THEN CTR = CTR+1;

IF A > 0 AND B > 0
THEN A=B;

IF X>0 THEN Y=1; ELSE Y=2;

```

DO-END Groups

The DO-END statement is used to group together a sequence of SPL/M statements, such that they are treated as a single executable statement in the flow of control. For example,

```

IF SWITCH
THEN DO;
    TEMP=A;
    A=B;
    B=TEMP;
END;

```

All three statements in the DO-END group will be executed if the variable SWITCH is true. Note that indentation is usually used with IF and DO statements to make the logic of the program stand out.

Simple DO-END groups are also used (less frequently) to create a block in which local variables are declared, as described in Section IX.

DO-WHILE Statement

The DO-WHILE statement causes a group of statements to be repeatedly executed as long as a condition is satisfied. The general form is:

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

```

DO WHILE expression;
    statement-1;
    .
    .
    .
    statement-n;
END;

```

The statements within the DO-WHILE are executed as long as the result of the expression has its right-most bit equal to 1. The expression is evaluated at the beginning of each execution cycle.

This version of SPL/M does not have the PL/M iterative-type DO (like the FOR statement in BASIC). However the more general DO-WHILE can be used in an identical manner:

```

I = 0;
DO WHILE I < 10;
    CHAR = I+'0';
    CALL PUTCHR; /* DISPLAY 0-9 */
    I = I+1;
END;

```

It is sometimes desirable to terminate the execution of a DO-WHILE abnormally (i.e. for some condition other than the expression following the DO). This is facilitated by the BREAK statement, which causes a transfer of control to the first statement following the END which terminates the innermost DO-WHILE.

Example:

```

I = 0; FOUND = 0;
DO WHILE NOT FOUND;
    IF LIST(I) = KEY           /* SEARCH LIST FOR KEY */
        THEN FOUND = 1;        /* EXIT NEXT CYCLE */
    ELSE DO;
        I = I+1;
        IF I >= 100 THEN BREAK; /* ABNORMAL EXIT */
    END;
END;

```

If the key is found in the list, the DO-WHILE will exit normally with FOUND=1 and I equal to the list index. Otherwise the BREAK will terminate abnormally with FOUND=0.

Note: the BREAK statement is an SPL/M extension and is not in PL/M.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

VII. PROCEDURES

Well designed programs make frequent use of subroutines, each of which is related to a particular function. In SPL/M, subroutines are called procedures, and are defined as follows:

```
label: PROCEDURE;
      statement-1;
      .
      .
      .
      statement-n;
END;
```

The "label" is the procedure name, which is required later when the procedure is called. PROCEDURE may be abbreviated PROC.

In this version of SPL/M, all procedures must be defined at the beginning of the program (see Section IX) and nesting of procedure definitions is not allowed.

Since a procedure is a block (also discussed in Section IX), all variables declared within it are "local" and cannot be referenced outside of the procedure. All storage declared in SPL/M is static. Automatic stacking of local variables is not done on entry to a procedure.

All values passed to and from procedures must be done via global variables since procedures cannot have parameters in this version of SPL/M.

CALL Statement

Procedures are invoked by the CALL statement:

```
CALL procedure-name;
```

where the procedure must have been previously defined as described above.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

Example:

```
DCL MAX$LINE LITERALLY '80';
DCL LINE (MAX$LINE) BYTE; /* GLOBAL */

.
.

CLEAR$LINE: PROCEDURE;
  DCL I BYTE; /* LOCAL */
  I=0;
  DO WHILE I < MAX$LINE;
    LINE(I) = ' ';
    I = I+1;
  END;
END;

CALL CLEAR$LINE;
```

It is also possible to call a procedure by its address. This makes it easier to link to assembly language subroutines in an operating system. For example,

```
CALL OFC37H; /* HOME CURSOR */
CALL OFC3DH; /* CLEAR SCREEN */
```

Note: the construction "CALL number" is an SPL/M extension and is not in PL/M.

The "declare literally" facility (Section V) can be used to define the address as a symbolic constant to keep the reference symbolic:

```
DCL HOME LIT 'OFC37H';
.
.
CALL HOME;
```

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

RETURN Statement

When a procedure is called, it starts execution at the beginning of the procedure and normally does not return until the END matching the PROCEDURE statement is reached. However it is possible to force an earlier return by using the RETURN statement, e.g.

```
IF ERROR THEN RETURN;
```

Whether a RETURN statement is used or not, a procedure returns to the statement following the original CALL.

		PAGE 18 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

VIII. MISCELLANEOUS FACILITIES

Direct References to Memory

It is sometimes desirable to refer to the memory address space of the 6800 directly. (In fact this is the only way I/O can be performed directly in SPL/M, since the language does not have explicit input/output statements. But I/O is usually done via calls on existing operating systems routines.)

When required, direct reference to memory can be done using the MEM and MEMA vectors, which are predeclared to start at address 0. MEM is type byte, while MEMA is type address. The normal doubling of subscripts is not done for MEMA; for example

MEMA(38H) = OF050H;

sets memory locations 38H and 39H to the hexadecimal value OF050H.

Note: MEM and MEMA are SPL/M extensions and are not in PL/M.

When used on the left-hand side of an assignment statement, MEM is like the POKE function in some BASIC's. On the right-hand side, MEM is like the PEEK function.

The subscript can be any arithmetic expression, but usually is just an address variable. In the following byte move subroutine, global variables BUF1 and BUF2 contain the start addresses of two buffers, and BSIZE is the number of bytes to move:

```
BYTE$MOVE: PROC;
  DO WHILE BSIZE <> 0;
    MEM(BUF2) = MEM(BUF1);
    BUF1 = BUF1+1; BUF2 = BUF2+1;
    BSIZE = BSIZE-1;
  END;
END;
```

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

Explicit Type Conversion

Section V discussed implicit (automatic) type conversions in mixed mode expressions. SPL/M also provides two explicit type conversions in the form of built-in functions, which take address expressions as arguments. The functions may appear anywhere an expression is legal.

`LOW(expr)` returns the least-significant byte of its argument.

`HIGH(expr)` returns the most-significant byte of its argument.

GENERATE Statement

It is occasionally necessary to link to operating system subroutines which pass values in registers. The GENERATE statement can be used to produce machine code "patches" to accomplish this. It generates code in-line wherever it appears in an SPL/M program. Because of the low-level nature of this statement, and the possibility of making errors, it should be used only where absolutely necessary.

The GENERATE statement has the form:

`GENERATE (constant list);`

where "constant list" is a list of numeric, character, or symbolic constants, including address (dot) references. GENERATE may be abbreviated GEN.

Note: the GENERATE statement is an SPL/M extension and is not in PL/M.

The following example stores the contents of the accumulator at location 42H after calling a subroutine to input a character:

```
CALL OFC4AH;
GEN(97H, 42H);
```

However using only hexadecimal constants makes the code nearly impossible to read. This can be improved by using DCL LIT's and declaring a variable at address 42H:

		PAGE 20 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

```

42H: DCL CHAR BYTE;
      DCL GET$CHAR LIT 'OFC4AH',
      STAA LIT '97H';
      :
      :
      :

CALL GET$CHAR;
GEN (STAA, .CHAR);

```

For additional examples, refer to the SPL/I library routines presented in Appendix B.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

IX. PROGRAM ORGANIZATION AND SCOPE

In general, an SPL/M program consists of a set of global declarations, followed by any procedure declarations, followed by the "main" portion of the program. The last line of the program must contain the characters EOF (end of file) which generates an RTS instruction to return to the caller of the main program.

DECLARE statements may appear anywhere in SPL/M, but their location may have different effects due to the "scoping" rules discussed below. In all cases, all names, whether they are variables, procedures, or symbolic constants, must be defined before they are referenced in the program.

Block Structure and Scope

The largest syntactic unit in an SPL/M program is the outermost program block, which consists of the global declarations, procedure definitions, and the "main" program.

Global declarations will be known, or available, to all procedures and the main program. Each procedure may also contain its own declarations, which are local; i.e. known only within that procedure.

Procedures and/or the main program may also have DO-END groups (Section VI) containing additional declarations, which are local to each group.

Example:

```

DCL A BYTE, B BYTE; /* GLOBAL*/ ] B ] A
    XYZ: PROC;
        DCL B ADDR, C ADDR; ] B,
        DO;                 ] A
            DCL A BYTE;      ] B, C
        END;                ] A
    END;                  ] B
    /* MAIN */           ] A
    DCL C BYTE;          ] B
    :                   ] A
    EOF                 ] C

```

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

The brackets indicate the "scope" of each variable.

Variables, once defined, can be redefined only within a nested block (procedure or DO-END group), which will result in additional static storage being allocated. The new definition is known only within the nested block(s); when the end of the nested block is reached the original definition is in effect again.

Variables, unless redefined, are known within the block in which they are declared and in all blocks nested within it.

Program Origins

Origins, which are simply a number followed by `:', have already been discussed in the context of declare statements (Section V).

A program origin is any origin not preceding a DECLARE statement. Program origins affect the generation of the next byte of object code, including DCL DATA constants (which are located within the program object module).

In this version of SPL/M, program origins are restricted to the following locations:

- 1) First statement of a program (defines starting address).
- 2) Beginning of each procedure definition (the origin must be placed just ahead of the procedure name).
- 3) First statement of "main" (allowed only if the program contains procedure definitions).

In all the cases above, origins are optional. In the absence of any origin the first byte object code will start at location 100H. If the main program or a procedure lacks an origin, the associated code will follow the code immediately preceding.

If provided, the initial (start) origin must be immediately followed by a "null statement" (e.g. OA100H::) to distinguish it from a declare origin.

When an origin is specified, the user is responsible for insuring that the resulting code does not overlap code that has already been generated.

		PAGE 23 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

The following example summarizes the SPL/M program organization. Everything in brackets [] is optional; and any addresses are for example only. Note that declares can go anywhere; however for clarity it is best to restrict them to the beginning of the program, the beginning of each procedure, and the beginning of "main".

```

[ 200H;; ]           /* OPT. START ADDRESS */
[[ 42H: ] DCL's]    /* GLOBAL DECLARES */
[[ 300H: ] XYZ: PROC;
  .
  .
  END;]             /* OPT. PROCEDURE
                      DEFINITIONS */
[ 400H: ]           /* OPT. ORIGIN FOR MAIN */
.
.
/* main */
.
.
EOF

```

A jump from the beginning of the program (e.g. 200H) to the beginning of the code for main (e.g. 400H) is automatically generated if there are procedure definitions and if there is either an explicit start address provided or there are any global DCL DATA's.

Refer also to Appendix C for an example of a complete SPL/M program that contains many of the elements described above.

		PAGE 24 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

X. COMPILE AND CONFIGURATION OPTIONS

(FLEX Version 1.2)

System Considerations

This version of the compiler is designed to run on a 6800-based system, such as the SWTPc, running under the FLEX Operating System. In particular, it assumes the existence of:

FLEX 1.0 or 2.0 (not minIFLEX)
 20K of user RAM starting at location 0000
 SWTBUG monitor ROM or equivalent

Compiler Disk

The disk supplied with the compiler contains the following files:

SPLM.CMD	- SPL/M compiler
FLX102.TXT	- Assembler source for compiler interfaces
SPLM.LIB	- SPL/M library (general DOS interfaces)
SPLMREAD.LIB	- SPL/M library (reading sequential files)
SPLMWRT.LIB	- SPL/M library (writing sequential files)
SIZE.TXT	- SPL/M source for sample program (SIZE)

The SIZE.TXT source file is intended to be used as a test of the compiler. It also brings in two of the library files using the #INCLUDE facility discussed below.

Running the Compiler

The compiler has several compile-time options which control the generation of listings and binary files.

The general syntax for the SPLM command is:

SPLM[,<source>[,<binary>][,+<option list>]]

The '<>' enclose a field defined below and are not actually typed. The '[]' surround optional fields.

All parameters are optional. If none are provided, then the compiler runs interactively with the source input coming directly from the keyboard. This is useful for experimenting, to see what kind of code the compiler generates for a particular input. In

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

this mode a full code listing is always output to the terminal. A binary object file is not produced.

The normal mode however is for a <source> file name to be specified to be compiled. In this case the compiler reads the named file from disk until an EOF statement is encountered in the source. The defaults for the <source> file specification are a .TXT extension and the working drive number.

If the optional <binary> file name is also specified, it is used as the name of the object file written to disk. If <binary> is not included in the command, the binary file will have the same 'name' as the source file, but with a .BIN extension.

The option list is prefixed with a plus sign ('+'), with each option represented by a single letter. The letters may be in any order. The following options are available:

- B (No binary). Do not create a binary file on disk, even if a <binary> file name is specified.
- Y (Yes, delete). Delete an old binary file of the same name as the one about to be produced. If this option is not specified, the compiler will prompt if the binary file already exists. Respond with 'Y' to delete it.
- E (Display errors only). The compiler normally produces a line-numbered source listing. If this option is selected only error lines (if any) will be displayed.
- C (Display code). Output a full listing, including both the source and the interlisted object code.
- G (Display globals symbols). Output a symbol table containing only globally-declared symbols (which includes all procedure entry points).
- A (Display all symbols). Output a symbol table with both global and local symbols. Each symbol table block will be displayed as the block is exited.

If a binary file is being produced, it will have a transfer address only if an initial origin (e.g. 0A100H::) is specified as described in Section IX.

If the code option (C) is selected, the object code for each statement is output as it is generated. Since this is a one-pass compiler, occasionally lines like:

		PAGE 26 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

155C: 7E 00 00

are output when the compiler knows that a forward jump is required (for example in an IF or DO-WHILE statement) but doesn't know the address yet. In such cases an additional entry is output further down in the listing, when the address is resolved. Parentheses are used to indicate that this entry is a "fixup" to a previous unresolved jump:

(155C: 7E 15 90)

A symbol table is output only if one of the options A or G is selected. The symbols are alphabetized on the first character only. Along with each symbol is listed the type (BYTE, ADDR, PROC, or LIT), and its value. Appendix C was printed with the G option.

When the compiler has finished executing, it will display the number of errors, followed by the highest memory address used by the symbol table. If the compiler returns to the monitor without displaying these last two items, a fatal error has occurred (see Section XI).

Examples:

- | | |
|-------------------------|---|
| SPLM | - Interactive input from keyboard |
| SPLM,SIZE | - Source = SIZE.TXT, binary = SIZE.BIN |
| SPLM,SIZE,+CY | - Source = SIZE.TXT, binary = SIZE.BIN,
display globals, delete old binary |
| SPLM,SIZE,O.SIZE.CMD,+E | - Source = SIZE.TXT, binary = O.SIZE.CMD,
display errors only |

Include Files

The compiler has a built-in include processor, which allows source library files to be brought in during a compile. The syntax is:

#INCLUDE <source>

where the <source> file name defaults to a .TXT extension and the working drive. The #INCLUDE must start in column 1. The include statement is replaced by the file it includes. When the end of the include file is reached, the compiler switches back to the original file. Included files should not be terminated by an EOF statement, and must not themselves contain #INCLUDE statements (i.e., includes can not be nested).

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

The source from an included file is normally output to the listing in place of the #INCLUDE statement. However this can be inhibited by the #NOLIST statement:

#NOLIST

source text

#LIST

None of the source text between the #NOLIST and the #LIST will be listed, except for any lines in error. Both statements must start in column 1, and neither are output to the listing.

The library files listed in Appendix B are intended to be included at the beginning of an SPL/M program, as needed. All the files have a #NOLIST statement at the beginning, and a #LIST statement at the end, so they won't be listed during every compile.

Printer Considerations

To have the listing output to a printer, precede the SPL/M command with a P (see the P command in the FLEX User's Manual). For example,

P,SPLM,SIZE

would cause the line-numbered source listing for SIZE.TXT (along with any error messages) to be output to the printer.

Each page of the listing starts with a form-feed (OCH) character, which is followed by the top margin, title and finally the source/object listing. The title includes the source file name (without extension), date, and page number and is followed by two blank lines. This title is generated in FLX102.TXT and thus can be changed by the user if desired.

The byte at location 3A2H specifies the top margin, i.e. the number of blank lines from the top of the page to the title. This number can be 0, which will cause the title to be printed on the top line.

The byte at location 3A1H specifies the number of lines to be printed on each page before the formfeed is issued. This count includes the top margin (see above), plus three for the title.

		PAGE 28 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

To accomodate narrow-width printers, if the byte at location 039DH = 1 the title and source/object listing is limited to 40 columns (assuming the input source is kept less than 32 characters wide).

Note: printer spooling should not be peformed during a compile, since the compiler reroutes SWI's back to the ROM monitor to handle fatal errors (see Section XI). The SWI vector is restored when the compiler returns to the DOS.

Memory Usage

The main part of the compiler uses RAM from 0380H to 3FFFH. The symbol table starts at location 4000H and can go up to 47FFH. The highest address actually used by the symbol table is displayed at the end of each compile.

The interface routines which link the compiler with the DOS are assembled to reside at 4800H-4FFFH, but they can be easily moved by changing one ORG statement in FLX102.TXT if more room is needed for the symbol table.

The compiler also uses low memory up to location 0EFFH. The top of the stack is set to 1FFH on entry but is restored on exit.

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

XI. ERROR HANDLING
(SSB/FLEX Version 1.2)

When an error is detected, the source line is printed followed by a line containing one or more single-character flags indicating the error(s). The error codes are:

- D - Duplicate declaration of the same identifier
- O - Origin error (see Section IX for rules)
- P - Procedure definition error (Section VII)
- S - Syntax error; statement has an illegal construction
- U - Undefined identifier

The flags are positioned under the primitive or operator where the error was discovered. For example, in the printout below,

```
0210 TBL(I) = CTR1 ++ CTR2;
**** U S U
```

TBL and CTR2 are undefined, and there is a syntax error because of the second '+'. When a syntax error is discovered, the remainder of the statement is ignored (up to the next ';'), except that undefined identifiers will continue to be flagged. Also, when undefined identifiers are encountered code is still generated (assuming an address of 0) to allow patching.

The above errors are the only ones which should occur for most users. They are all non-fatal; that is the compile is allowed to proceed.

In addition there are a number of fatal errors which result in the compiler aborting. They are implemented via software interrupts, and result in the ROM monitor (e.g. SWTEBUG) being entered.

If the compiler quits and a register dump is displayed, then a fatal error has occurred. The next to the last field of the dump gives the address of the software interrupt, which should be listed on the next page:

		PAGE 30 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

OE73 - expression too complex (operator stack overflow)
 OE7F - expression too complex (operand stack overflow)
 OE89 - expression too complex (expr type stack overflow)
 15AB - program too complex (symbol table nesting >64)
 1B94 - input line too long (>80 characters)
 26A9 - program too complex (fixup jump for IF or DO-WHILE is longer than 512 bytes)
 2712 - bad source format (input doesn't end with ODH)
 29EF - program too complex (IF chain nest >60)
 29FA - identifier too long (>31 characters)
 2F83 - out of symbol table memory (as defined by location 0386H)

If any of the above errors occur, return to the DOS via the warm start address, correct the problem and recompile.

If a fatal error occurs that is not listed above, an internal "impossible" compiler error has occurred. Please send the error code plus a listing of the program causing the error to Programma Consultants, using the attached SER (Suspected Error Report) form.

		PAGE A.1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

APPENDIX A

SPL/M Compiler Interface Routines

```
*****
* SPL/M COMPILER - INTERFACE ROUTINES
* (C) COPYRIGHT 1979 BY THOMAS W. CROSLEY
* FLEX 1.0/2.0 COMPILER VERSION 1.2
* THIS CODE CONTAINS THE DOS-SPECIFIC ROUTINES
* NECESSARY TO INTERFACE THE SPL/M COMPILER
* WITH A PARTICULAR OPERATING SYSTEM.
*****
```

```
*
* EQUATES FOR FLEX DOS
*
```

0000	XFC	FQU	0	FUNCTION CODE
0001	XES	FQU	1	ERROR STATUS
0003	XUN	FQU	3	UNIT NUMBER
0004	XFN	FQU	4	FILE NAME
000C	XEX	FQU	12	EXTENSION
003B	XSC	FQU	59	SPACE COMP FLAG
0002	QSO4W	FQU	2	OPEN FOR WRITE
0001	QSO4R	FQU	1	OPEN FOR READ
0004	QSCL	FQU	4	CLOSE
000C	QDEL	FQU	12	DELETE
0003	FFE	FQU	3	FILE EXISTS
0002	FFOF	FQU	8	END OF FILE
0001	TXTFEXT	FQU	1	TEXT EXTENSION
0000	BINFEXT	FQU	0	BINARY EXTENSION
0016	TRNREC	FQU	\$16	TRANSFR RECORD
0002	BINREC	FQU	2	BINARY RECORD
0003	FNLEN	FQU	8	FILE NAME LEN
B406	FMS	FQU	\$B406	
B403	FMSCLS	FQU	\$B403	
AD2D	GTFIL	FQU	\$AD2D	
AD3F	RPTFRR	FQU	\$AD3F	
AD03	WARM	EQU	\$AD03	
A080	IB	FQU	\$A080	INPUT LINE BUFFER
AC14	LINPTR	EQU	\$AC14	IB POINTER
AD1B	INBUFF	FQU	\$AD1F	
AC13	CURCHR	FQU	\$AC18	
AD15	GFTCHR	EQU	\$AD15	
AD18	PUTCHR	EQU	\$AD18	
AD12	OUTCH2	EQU	\$AD12	
AD27	NXTCH	EQU	\$AD27	
AD33	SETFEXT	EQU	\$AD33	
AD2A	RSTRI0	FQU	\$AD2A	
AD24	PCRLF	FQU	\$AD24	
AD39	OUTDEC	FQU	\$AD39	
ACOF	MONTH	EQU	\$ACOF	
ACOF	DAY	EQU	\$ACOF	
AC10	YEAR	EQU	\$AC10	

```

*
* EQUATES FOR SWTBUG
SFE1    EQU    $E124      NON-VECTORED SWI
SWIJMP   EQU    $AO12

*
* EQUATES TO INTERFACE WITH REST OF COMPILER
INPOPT   EQU    $570      INPUT OPTION
PRTOPT   EQU    $571      PRINT OPTION
OUTOPT   EQU    $572      COFE GENERATION OPTION
SYMOPT   EQU    $573      SYMBOL TABLE OPTION
3D80     SBFFND  EQU    $3D80     END OF SOURCE EUF
00C0     INTORG  EQU    $CO       INITIAL ORIGIN FLAG
003C     BUFAADR EQU    $3C       CURRENT BUF PTR
003E     BUFEND   FQU    $3E       END OF BUFFER PTR
*
000D     CR      EQU    $D
0020     SPACE   EQU    $20

*
* VECTOR TABLE FOR COMPILER:
*
0380     ORG    $380
* COLD START ENTRY POINT
0380 7E 2C 78  JMP    $2C78
*
* GETPARMS - JUMP TO USER SUB TO PARSE COMMAND LINE
0383 7F 48 00  JMP    GPARMS
*
* HIGH MEMORY - HIGHEST MEM LOC USED BY SYMBOL TABLE
0386 47 FF  FDB    GPARMS-1
*
* LOADX - ADDRESS OF USER SUB TO TRANSFER BA TO X
0388 00 00  FDB    0          IF 0, COMPILER WILL GENERATE
*
* PCRLF - JUMP TO USER ROUTINE TO OUTPUT CRLF
038A 7F AD 24  JMP    PCRLF
*
* PUTCHR - JUMP TO USER OUTPUT ROUTINE
038D 7F AD 18  JMP    PUTCHR
*
* CASS/DISK READ - JUMP TO USER ROUTINE TO READ SOURCE
0390 7F 49 7D  JMP    DREAD
*
* CASS/DISK WRITE - JUMP TO USER ROUTINE TO WRITE OBJECT
0393 7E 4A 65  JMP    DWRITE
*
* MULT - ADDRESS OF USER SUB TO MULTIPLY BA BY CONTENTS
* OF BYTFS 0,1 — RESULT IN BA
0396 00 00  FDB    0          IF 0, COMPILER WILL GENERATE
*
* DIV - ADDRESS OF USER SUB TO DIVIDE BA BY CONTENTS OF
* BYTES 0,1 — QUOTIENT IN BA, REMAINDER IN 0,1
0398 00 00  FDB    0          IF 0, COMPILER WILL GENERATE
*
*

```

* LINBUF - ADDRESS OF LINE BUFFFR USED BY INBUFF
 039A AO 80 LINBUF FDB IB
 *
 039C 00 FCB O NOT USED
 *
 * NARROW - SET TO 1 IF PRINTER HAS 40 COLUMNS
 039D 00 NARROW FCB O
 *
 * GETCHR - JUMP TO USER KEYBOARD CHARACTER INPUT ROUTINE
 039E 7E AD 15 JMP CETCHR
 *
 * PLEN - NUMBER OF LINES OUTPUT AFTER FORMFEED
 03A1 39 FCB 57
 *
 * TMAR - NUMBER OF BLANK LINES BETWEEN FORMFEED AND TITLE
 03A2 02 FCB 2
 *
 03A3 00 FCB O NOT USED
 *
 * LINEIN - JMP TO USER KEYBOARD LINE INPUT ROUTINE
 03A4 7F AD 1B JMP INBUFF
 *
 * PTITLE - JNP TO USR SUB TO OUTPUT TITLE AT TOP
 * OF PAGE
 03A7 7F 4B 1F JMP PTITLE
 *
 * WRAPUP - JMP TO WRAPUP ROUTINE
 03AA 7F 48 44 JMP CLOSE
 *
 *
 * NOTE — THE FOLLOWING CODE IS VECTORED TO FROM LOCATIONS
 * 380-3AC, AND CAN BE REASSEMBLED ANYWHERE BY CHANGING THE
 * THE FOLLOWING ORIGIN:
 4800 ORG \$4800
 *
 *** NOTE: NEXT 2 INSTRUCTIONS FOR SWTBUG ONLY ***
 4800 CF E1 24 GPARMS LDX #SFE1 RESTORE NORMAL SWI'S
 4803 FF A0 12 STX SWIJMP
 *
 4806 7F 05 70 CLR INPOPT CLEAR OPTION FLAGS
 4809 7F 05 71 CLR PTOPT
 480C 7F 05 72 CLR OUTOPT
 480F 7F 05 73 CLR SYMOPT
 4812 7F 4B F3 CLR DELOPT
 *
 * PARSE THE COMMAND LINE
 4815 B6 AC 18 LDA A CURCHR
 4818 81 0D CMP A #CR
 481A 26 09 BNE CP10
 481C BD AD 2A JSR RSTRI0 INTERACTIVE KEYBOARD OPTION
 481F BD 4B 9E JSR ITITLE OUTPUT TITLE
 4822 7F 48 F4 JMP CP70

*

* SET DEFAULTS FOR DISK INPUT

4825 86 02	GP10	LDA A	#2	
4827 B7 05 70		STA A	INPOPT	INPUT FROM DISK
482A B7 05 71		STA A	PRTOPT	SOURCE PRINTOUT
482D 7C 05 72		INC	OUTOPT	PRODUCE BINARY

*

4830 7F 4B FE		CLR	INCLP	INCLUDE NEST=0
4833 7F 4B FF		CLR	REOF	READ EOF=FALSE
4836 7F 4C 00		CLR	PAGENO	PAGE NUMBER=0

*

* PARSE SOURCE FILE NAME

4839 CE 4C 03		LDX	#RFCB	
483C BD AD 2D		JSR	CETFIL	
483F 24 09		BCC	CP30	BRANCH IF OK
4841 BD AD 3F	ERROR	JSR	RPTERR	
4844 BD B4 03	CLOSE	JSR	FMSCLS	CLOSE ALL FILES
4847 7F AD 03		JMP	WARMS	

*

* OPEN SOURCE FILE

484A 86 01	GP30	LDA A	#TXTEXT	
484C BD AD 33		JSR	SETTEXT	DEFAULT EXT IS .TXT
484F 86 01		LDA A	#QSO4R	
4851 A7 00		STA A	XFC,X	
4853 BD B4 06		JSR	FMS	
4856 26 E9		BNE	ERROR	

*

* COPY SOURCE FILE NAME TO BINARY

4858 CF 4C 03		LDX	#RFCB	
485B FF 4B F4		STX	XTMP	
485E CF 4D 43		LDX	#WFCB	
4861 FF 4B F6		STX	XTMP2	
4864 BD 49 49		JSR	COPYFN	
4867 CF 4D 43		LDX	#WFCB	
486A 6F 0C		CLR	XFX,X	CLFAR EXTENSION
486C 6F 0D		CLR	XEX+1,X	
486E 6F 0E		CLR	XEX+2,X	

*

4870 BD AD 27		JSR	NXTCH	
4873 81 OD		CMP A	#CR	
4875 27 7D		BEQ	CP70	USF DEFAULTS
4877 81 2B		CMP A	#'+	
4879 27 16		BEQ	OPTLP	GET OPTIONS

*

487B FF AC 14		LDX	LINPTR	
487E 09		DEX		
487F FF AC 14		STX	LINPTR	RESET FOR CETFIL

*

* PARSE BINARY FILE NAME

4882 CE 4D 43		LDX	#WFCB	
4885 BD AD 2D		JSR	CETFIL	
4888 25 B7		BCS	ERROR	
488A BD AD 27		JSR	NXTCH	
488D 81 2B		CMP A	#'+	

488F 26 63		BNE	CP70	USE DEFAULTS
*				
* GET OPTIONS (+BYECAG)				
4891 BD AD 27	OPTLP	JSR	NXTCH	
4894 81 0D		CMP A	"CR	
4896 27 5C		BEQ	CP70	ALL DONE
4898 81 42		CMP A	"B	DON'T PRODUCE BINARY
489A 26 05		BNE	OPT1C	
489C 7F 05 72		CLR	OUTOPT	
489F 20 F0		BRA	OPTLP	
48A1 81 59	OPT10	CMP A	"Y	DELETE OLD BINARY
48A3 26 05		BNE	OPT20	
48A5 7C 4B F3		INC	DFLOPT	
48A8 20 E7		BRA	OPTLP	
48AA 81 45	OPT20	CMP A	"E	PRINT ERRORS ONLY
48AC 26 07		BNE	OPT30	
48AE 86 01		LDA A	#1	
48B0 B7 05 71	OPT25	STA A	PTOPT	
48B3 20 DC		BRA	OPTLP	
48B5 81 43	OPT30	CMP A	"C	FULL PRINTOUT WITH CODE
48B7 26 04		BNE	OPT40	
48B9 86 03		LDA A	#3	
48BB 20 F3		BRA	OPT25	
48BD 81 41	OPT40	CMP A	"A	PRINT ALL SYMCLS
48BF 26 07		BNE	OPT50	
48C1 86 02		LDA A	#2	
48C3 B7 05 73	OPT45	STA A	SYMOPT	
48C6 20 C9		BRA	OPTLP	
48C8 81 47	OPT50	CMP A	"G	PRINT ONLY GLOBAL SYMBOLS
48CA 26 04		BNE	OPT60	
48CC 26 01		LDA A	#1	
48CF 20 F3		BRA	OPT45	
*				
48D0 CF 43 D9	OPT60	LDX	"ILLOPT	ILLEGAL OPTION
48D3 BD 4B 6C		JSR	OUTST2	
48D6 7F 43 44		JMP	CLOSE	
48D9 0D 0A	ILLOPT	FDB	\$ODOA	
48DB 49		FCC	'ILLFGAL OPTION SPECIFIED'	
48F3 04		FCB	4	
*				
48F4 7D 05 72	CP70	TST	OUTOPT	
48F7 26 01		BNE	CP75	
48F9 39		RTS		NO BINARY
*				
* OPEN BINARY FILE				
48FA CF 4D 43	CP75	LDX	"WFCE	
48FD 86 00		LDA A	"BINEXT	
48FF BD AD 33		JSR	STEXT	DEFAULT EXT IS .BIN
4902 86 02		LDA A	"QSO4W	
4904 A7 00		STA A	XFC,X	
4906 BD B4 06		JSR	FMS	
4909 26 05		BNE	CP80	
490B 86 FF		LDA A	#\$FF	
490D A7 3B		STA A	XSC,X	NO SPACE COMPRESSION

490F 39		RTS	ALL DONE WITH COMMAND LINE
* 4910 A6 01 GP80 LDA A XES,X GET ERROR 4912 81 03 CMP A #FFE EXISTS ALREADY? 4914 26 30 BNE ERRORO SOME OTHER ERROR 4916 7D 4B F3 TST DELOPT 4919 26 10 BNE GP90 DELETE OLD BINARY 491B CE 49 61 LDX #DELMSG 491E BD 4B 6C JSR OUTST2 4921 BD AD 15 JSR CETCHR 4924 81 59 CMP A #'Y 4926 27 03 BEQ GP90 4923 7E 48 44 JMP CLOSE ABORT			
* * DELETE OLD BINARY FILE 492B CF 4D 43 GP9C LDX #WFCE 492E FF 4B F4 STX XTMP 4931 CF 4E 83 LDX #IFCB 4934 FF 4B F6 STX XTMP2 4937 BD 49 49 JSR COPYFN USE INCL FCB AS TEMP 493A CF 4E 83 LDX #IFCB 493D 86 0C LDA A #QDEL DELETE DESTROYS FCB 493F A7 00 STA A XFC,X 4941 BD B4 06 JSR FMS 4944 27 B4 BEQ CP75 NOW GO OPEN IT 4946 7E 43 41 ERRORO JMP ERROR			
* * COPY FILENAME IN FCB(XTMP) TO (XTMP2) 4949 C6 0C COPYFN LDA B #12 494B FF 4B F4 CPLP LDX XTMP 494E A6 03 LDA A XUN,X 4950 02 INX 4951 FF 4B F4 STX XTMP 4954 FF 4B F6 LDX XTMP2 4957 A7 03 CPLP1 STA A XUN,X 4959 02 INX 495A FF 4B F6 STX XTMP2 495D 5A DEC B 495E 26 EB BNE CPLP 4960 39 RTS			
* 4961 0D 0A DELMSG FDB \$ODOA 4963 44 FCC 'DELFTE OLD BINARY (Y-N)? 497C 04 FCB 4			
* * READ SOURCE FROM DISK 497D 7D 4B FF DREAD TST REOF 4980 27 05 BEQ DREAD1 4982 CF 4C 03 LDX #RFCB 4985 20 63 BRA ERROR1 TRYING TO READ PAST EOF			
* 4987 8D 29 DRREAD1 ESR RFDF 4989 7D 4B FF TST REOF 498C 26 13 BNE RDONE READ FIRST BYTF OF SOURCE LINE END OF FILE? YES			

498F 81 23		CMP A	"#	
4990 27 5B		BEQ	INCL	CHECK FOR '#INCLUDE'
4992 8D 0F	DRFAD2	BSR	RDLINF	READ REMAINDER OF LINE
4994 C6 3D		LDA B	"SBFEND/256	CHECK FOR BUFFER OVERFLOW
4996 86 80		LDA A	"SBFEND	
4998 90 3F		SUB A	EUFEND+1	
499A D2 3E		SBC B	EUFEND	
499C 26 01		BNE	EH	
499F 4D		TST A		
499F 22 E6	BH	BHI	DREAD1	
49A1 39	RDONE	RTS		READ ENOUGH FOR NOW
	*			
49A2 DF 3E	RDLINE	LDX	BUFEND	
49A4 A7 00	RL05	STA A	0,X	ASSUMES ONE RBF0 BEFORE CALL
49A6 08		INX		
49A7 DF 3E		STX	BUFEND	
49A9 81 0D		CMP A	"CR	
49AB 27 04		BEQ	RL10	
49AD 8D 03		BSR	RF0D	
49AF 20 F3		BRA	RL05	
49B1 39	RL10	RTS		
	*			
	* READ BYTE FROM DISK			
49B2 FF 4B F4	RBF0	STX	X TMP	
49B5 CE 4C 03	RBF0	LDX	"RFCB	DEFAULT IS READ FCB
49B8 7D 4B FE		TST	INCLP	
49B9 27 03		BEQ	RBF0	
49BD CF 4E 83		LDX	"IFCB	SWITCH TO INCLUDE FCB
49C0 BD B4 06	RBF0	JSR	FMS	
49C3 27 1E		BEQ	ROK	
49C5 A6 01		LDA A	XES,X	
49C7 81 08		CMP A	"FE0F	EOI?
49C9 26 1F		BNE	FRR0R1	
49CB 7D 4B FE		TST	INCLP	YES, CHECK IF IN INCLUDE FILE
49CF 27 0E		BEQ	SEOF	
49D0 7F 4B FF		CLR	INCLP	YES, SWITCH BACK TO MAIN
49D3 86 04		LDA A	"QSCL	
49D5 A7 00		STA A	XFC,X	
49D7 BD B4 06		JSR	FMS	CLOSE INCLUDE FILE
49DA 26 0E		BNE	FRR0R1	
49DC 20 D7		BRA	FBF0	
49DE 86 01	SEOF	LDA A	"1	
49E0 B7 4B FF		STA A	REOF	
49E3 4D	ROK	TST A		
49E4 27 DA		BEQ	RBF0	IGNORE NULL CHARS
49E6 FF 4B F4		LDX	X TMP	
49E9 39		RTS		
49EA 7E 48 41	ERROR1	JMP	FRR0R	
	*			
49ED 8D C3	INCL	BSR	RBF0	
49EF 81 49		CMP A	"I	CHKS FOR JUST '#I'
49F1 27 0B		BEQ	INCLO5	
49F3 DE 3E		LDX	EUFEND	SOMETHING ELSE, RESTORE
49F5 C6 23		LDA B	"#"	

49F7	E7 00		STA B	0,X	
49F9	08		INX		
49FA	DF 3E		STX	BUFEND	
49FC	20 94		BRA	DREAD2	RET WITH 2ND CHAR IN ACCA
49FF	7D 4B FE	INCL05	TST	INCLP	
4A01	26 43		BNE	INCE	ERROR - NESTED INCLUDE
4A03	8D AD	INCL10	BSR	RBFD	
4A05	81 OD		CMP A	#CR	
4A07	27 42		BEQ	INCE	ERROR - NO FILENAME
4A09	81 20		CMP A	#SPACE	IGNORE TO NEXT SPACE
4A0B	26 F6		BNE	INCL10	
4A0D	8D A3		BSR	RBFD	
4A0F	81 OD		CMP A	#CR	
4A11	27 38		BEQ	INCE	
4A13	FF 03 9A		LDX	LINBUF	
4A16	FF AC 14		STX	LINPTR	
4A19	A7 00	INCL20	STA A	0,X	COPY FILE SPEC INTO INPUT BUFFF
4A1B	08		INX		
4A1C	81 OD		CMP A	#CR	
4A1E	27 04		BEQ	INCL30	
4A20	8D 90		BSR	RBFD	
4A22	20 F5		BRA	INCL20	
4A24	CF 4E 83	INCL30	LDX	#IFCB	
4A27	BD AD 2D		JSR	GETFIL	PARSE INCLUDE FILE NAME
4A2A	25 14		BCS	INCO	
4A2C	86 01		LDA A	#TXTTEXT	
4A2E	BD AD 33		JSR	SETTEXT	DEFAULT EXT IS .TXT
4A31	86 01		LDA A	#QSO4R	OPEN INCLUDE FILE
4A33	A7 00		STA A	XFC,X	
4A35	BD B4 06		JSR	FMS	
4A38	26 06		BNE	INCO	
4A3A	7C 4B FE		INC	INCLP	
4A3D	7F 49 27		JMP	DREAD1	
4A40	CF 4A 54	INCO	LDX	#INCMSC	
4A43	BD 4B 6C		JSR	OUTST2	
4A46	CF 4E 83		LDX	#IFCB	
4A49	20 9F		BRA	ERROR1	
4A4B	CF 4A 54	INCF	LDX	#INCMSC	
4A4E	BD 4B 6C		JSR	OUTST2	
4A51	7E 48 44		JMP	CLOSE	
4A54	OD OA	INCMSC	FDB	\$ODOA	
4A62	23		FCC	'INCLUDE ERROR'	
4A64	04		FCB	4	
* * WRITE OBJECT BUFFER TO DISK					
4A65	DE 3C	DWRITE	LDX	BUFADR	POINTS TO OBJ BUF
4A67	A6 00		LDA A	0,X	GET RECORD TYPF
4A69	26 04		BNE	W03	
4A6B	7F 4B FB	W01	CLR	ISTRTR	STRT RECORD INITIALIZATION
4A6E	39		RTS		
4A6F	81 FF	W03	CMP A	#\$FF	
4A71	26 15		BNE	W10	
4A73	96 C0		LDA A	INTORG	END RECORD
4A75	27 F7		BEQ	W01	

4A77 36 16		LDA A	#TRNREC	GOTO BLOCK
4A79 BD 4B OD		JSR	WBTD	
4A7C B6 4B FC		LDA A	STRT	TRANSFER ADDR
4A7F BD 4B OD		JSR	WBTD	
4A82 B6 4B FD		LDA A	STRT+1	
4A85 7F 4B OD		JMP	WBTD	
*				
4A83 81 01	W10	CMP A	#1	
4A8A 26 F2		BNE	W01	
4A8C 08		INX		REGULAR OBJ RECORD (MAX 512 BYTES)
4A8D 08		INX		
4A8F 08		INX		
4A8F FF 4B F8		STX	CODE	SAVE PTR TO BEG OF CODE
4A92 D6 3E	W15	LDA B	EUFEND	
4A94 96 3F		LDA A	EUFFND+1	
4A96 BC 4B F9		SUB A	CODE+1	
4A99 F2 4B F8		SBC B	CODE	BA HAS LENGTH - 1
4A9C 26 5B		BNE	WSEC	IF >128 BYTES, SPLIT UP
4A9E 81 80		CMP A	#\$80	
4AA0 24 57		BHS	WSEC	
4AA2 7D 4B FB		TST	ISTRRT	
4AA5 26 13		BNE	WBLK	
4AA7 81 02		CMP A	#2	
4AA9 26 0F		BNE	WBLK	
4AAB F6 00		LDA B	0,X	
4AAD C1 7E		CMP B	#\$7E	DUMMY JUMP ONLY?
4AAF 26 09		BNE	WBLK	DON'T OUTPUT JUST 7F C000
4AB1 5F		CLR B		
4AB2 F1 01		CMP B	1,X	
4AB4 26 04		BNE	WBLK	
4AB6 E1 02		CMP B	2,X	
4AB8 27 3E		BFQ	WRTS	
4AEA E7 4B FA	WEWK	STA A	COUNT	
4AED 86 02		LDA A	#BINRFC	BINARY BLOCK
4ABF BD 4C		BSR	WBTD	
4AC1 DF 3C		LDX	EUFADR	
4AC3 A6 01		LDA A	1,X	
4AC5 7D 4B FB		TST	ISTRRT	
4AC8 26 03		BNE	W20	
4ACA E7 4B FC		STA A	STRT	REMEMBER INITIAL STRT ADDR
4ACD 8D 3E	W20	BSR	WBTD	WRITE STRT ADDR
4ACF A6 02		LDA A	2,X	
4AD1 7D 4B FB		TST	ISTRRT	
4AD4 26 03		BNE	W30	
4AD6 B7 4B FD		STA A	STRT+1	
4AD9 8D 32	W30	BSR	WBTD	
4ADB 86 01		LDA A	#1	
4ADD E7 4B FB		STA A	ISTRRT	
4AE0 7C 4B FA		INC	COUNT	NORMALIZE LENGTH
4AE3 B6 4B FA		LDA A	COUNT	
4AF6 8D 25		BSR	WBTD	WRITE LENGTH
4AE3 FF 4B F2		LDX	CODE	
4AFB A6 00	WLOOP	LDA A	0,X	WRITE CUT CODE
4AED 8D 1E		BSR	WBTD	

4AFF 08		INX		
4AFO 7A 4B FA		DEC	COUNT	
4AF3 26 F6		BNE	WLOOP	
4AF5 FF 4B F8		STX	CODE	SAVE PTR TO NEXT BYTE
4AF9 3C	WRTS	RTS		
*				
4AF9 86 7F	WSEC	LDA A	"\$7F	WRITE A SECTION (128 BYTES)
4AFB 8D BD		BSR	WBLK	
4AFD DF 3C		LDX	EUFADR	
4AFF E6 01		LDA B	1,X	
4B01 A6 02		LDA A	2,X	
4B03 8B 80		ADD A	"\$80	ADD 128 TO START ADDR
4B05 C9 00		ADC B	"0	
4B07 E7 01		STA B	1,X	
4B09 A7 02		STA A	2,X	
4B0B 20 85		BRA	W15	
*				
* WRITE BYTE TO DISK				
4B0D FF 4B F4	WBTD	STX	XTMP	
4B10 CF 4D 43		LDX	"WFCB	
4B13 BD B4 06		JSR	FMS	
4B16 26 04		BNE	FRROR2	
4B18 FE 4B F4		LDX	XTMP	
4B1B 3C		RTS		
4B1C 7F 48 41	FRROR2	JMP	FRROR	
*				
* OUTPUT TITLE AT TOP OF PAGE				
4B1F CF 4C 03	PTITLE	LDX	"RFCE	
4B22 C6 08		LDA B	"FNLEN	LENGTH OF FILE NAME
4B24 A6 04	PTTL05	LDA A	XFN,X	CET CHAR OF FN
4B26 26 02		BNE	PTTL10	
4B28 86 20		LDA A	"SPACE	PAD
4B2A BD AD 18	PTTL10	JSR	PUTCHR	
4B2D 08		INX		
4B2F 5A		DEC B		
4B2F 26 F3		BNE	PTTL05	
*				
4B31 CF 4B BB		LDX	"TITLE0	
4B34 BD 4B 5F		JSR	OUTSTR	
4B37 B6 03 9D		LDA A	NARROW	40 CHAR PRINTOUT?
4B3A 27 08		BEQ	PTTL12	NO
4B3C CF 4B CO		LDX	"TITLF2	
4B3F BD 4B 5F		JSR	OUTSTR	
4B42 20 06		BRA	PTTL15	
4B44 CF 4B C5	PTTL12	LDX	"TITLE3	OUTPUT COMPILER VERSION
4B47 BD 4B 5F		JSR	OUTSTR	
4B4A BD 4B 82	PTTL15	JSR	DATE	OUTPUT DATE
4B4D CF 4B EA		LDX	"PAGE	
4B50 BD 4B 5F		JSR	OUTSTR	
4B53 7C 4C 00		INC	PAGENO	
4B56 B6 4C 00		LDA A	PAGENO	
4B59 BD 4B 78		JSR	ONEDEC	OUTPUT PAGE NUMBER
4B5C 7F AD 24		JMP	PCRLF	
*				

* SAME AS PSTRNC EXCEPT NO INITIAL CRLF

4B7F A6 00	OUTSTR	LDA A 0,X
4B61 81 04		CMP A #4
4B63 27 06		BEQ OSRTS
4B65 BD AD 18		JSR PUTCHR
4B63 08		INX
4B69 20 F4		BRA OUTSTR
4B6B 39	OSRTS	RTS

*

* SAME AS OUTSTR EXCEPT USES OUTCH2

4B6C A6 00	OUTST2	LDA A 0,X
4B6F 81 04		CMP A #4
4B70 27 F9		BEQ OSRTS
4B72 BD AD 12		JSR OUTCH2
4B75 08		INX
4B76 20 F4		BRA OUTST2

*

* OUTPUT ONE BYTE IN DECIMAL

4B78 E7 4C 02	ONEDEC	STA A DGT+1
4B7B CF 4C 01		LDX #DGT
4B7F 5F		CLR B
4B7F 7F AD 39		JMP OUTDEC

NO LEADING SPACES

*

* OUTPUT DATE

4B82 B6 AC 0E	DATF	LDA A MONTH
4B85 BD 4B 78		JSR ONEDFC
4B83 86 2D		LDA A #---
4B8A BD AD 18		JSR PUTCHR
4B8D B6 AC OF		LDA A DAY
4B90 BD 4B 78		JSR ONEDFC
4B93 86 2D		LDA A #---
4B95 BD AD 18		JSR PUTCHR
4B93 B6 AC 10		LDA A YEAR
4B9B 7F 4B 78		JMP ONEDFC

*

* TITLE FOR INTERACTIVE USE

4B9F BD AD 24	ITITLE	JSR PCRLF
4BA1 B6 03 9D		LDA A NARROW
4BA4 26 0C		BNE ITTL10
4BA6 CF 4B BB		LDX #TITLE0
4BA9 BD 4B 5F		JSR OUTSTR
4BAC CF 4B BC		LDX #TITLE1
4BAF BD 4B 5F		JSR OUTSTR
4BB2 CF 4B C5	ITTL10	LDX #TITLE3
4BB5 BD 4B 5F		JSR OUTSTR
4BB3 7E AD 24		JMP PCRLF

*

4BBB 20	TITLE0	FCC	.
4BEC 20	TITLE1	FCC	.
4BC0 20	TITLE2	FCC	.
4BC4 04		FCB	4
4BC5 52	TITLE3	FCC	SPL/M COMPILER VFRSION 1.2
4BF9 04		FCB	4
4BFA 20	PAGE	FCC	PAGE

4BF2 04	*	FCB	4
4BF3 00	DFLCPT	FCB	C
4BF4 00 00	XTMP	FDB	O
4BF6 00 00	XTMP2	FDB	O
4BF3 00 00	CODE	FDB	O
4BFA 00	COUNT	FCB	O
4BFB 00	ISTRRT	FCB	O
4BFC 00 00	STRT	FDB	O
4BFF 00	INCLP	FCB	O
4BFF 00	REOF	FCB	O
4C00 00	PAGENO	FCB	O
4C01 00 00	DGT	FDB	O
	*		
4C03	RFCB	RMB	320
4D43	WFCB	RMB	320
4E83	IFCE	RMB	320
	*		
4FC3	PGEND	EQU	*
		END	

NO ERROR(S) DETECTED

SYMBOL TABLE:

BH	499F	BINEXT	0000	BINREC	0002	BUFAADR	003C	BUFFEND	003E
CLOSE	4844	CODE	4BF8	COPYFN	4949	CCOUNT	4BFA	CPLP	494B
CPLP1	4957	CR	000D	CURCHR	AC18	DATE	4B82	DAY	ACOF
DELMMSG	4961	DEFLOPT	4BF3	DGT	4C01	DRFAD	497D	DREAD1	4937
DRAD2	4992	DWRITF	4A65	EOF	0008	EFE	0003	ERROR	4841
ERRORO	4946	ERROR1	49FA	ERROR2	4B1C	FMS	B4C6	FMSCLS	B403
FNLEN	0008	GFTCHR	AD15	GFTFIL	AD2D	GP10	4825	GP30	434A
GP70	48F4	GP75	48FA	GP80	4910	GP90	492B	GPARMS	4300
IB	A080	IFCB	4E83	IILOPT	48D9	INBUFF	AD1B	INCE	4A4B
INCL	49FD	INCLO5	49FE	INCL10	4A03	INCL20	4A19	INCL30	4A24
INCLP	4BFE	INCMSC	4A54	INCO	4A40	INPOPT	0570	INTORG	00C0
ISTRRT	4RFB	ITITLF	4B9E	ITTL10	4BB2	LINBUF	039A	LINPTR	AC14
MO TH	ACOE	NARROW	039D	NXTCH	AD27	ON DEC	4B78	OPT10	48A1
OPT20	48AA	OPT25	48B0	OPT30	48B5	OPT40	48BD	OPT45	48C3
OPT50	43C8	OPT60	48D0	OPTLP	4891	OSRTS	4B6B	OUTCH2	AD12
OUTDEC	AD39	OUTOPT	0572	OUTST2	4B6C	OUTSTR	4B5F	PAGF	4BEA
PAGENO	4C00	PCRLF	AD24	PGEND	4FC3	PRTOPT	0571	PTITLE	4B1F
PTTL05	4B24	PTTL10	4B2A	PTTL12	4B44	PTTL15	4B4A	PUTCHR	AD18
QDEL	000C	QSCL	0004	QSO4R	0001	QSO4W	0002	RBF	49B2
RBFDO	49B5	RFID1	49C0	RDLINE	49A2	RDONE	49A1	REOF	4BFF
RFCB	4C03	RL05	49A4	RL10	49B1	ROK	49F3	RPTFRR	AD3F
RSTRI0	AD2A	SBFEND	3D80	SEOF	49DF	SETTEXT	AD33	SFE1	E124
SPACF	0020	STRT	4BFC	SWIJMP	A012	SYMOPT	0573	TITLE0	4BBB
ITLF1	4BBC	TITLE2	4BC0	TITLE3	4BC5	TRNRFC	0016	TXTEXT	0001
W01	4A6E	WC3	4A6F	W10	4A88	W15	4A92	W20	4ACD
W30	4AD9	WARMS	AD03	WBK	4ABA	WEVD	4B0D	WFCB	4D43
WLOOP	4AEB	WRTS	4AF3	WSFC	4AF9	XFS	0001	XEX	000C
XFC	0000	XFN	0004	XSC	003B	XTMP	4BF4	XTMP2	4BF6
XUN	0003	YFAR	AC10						

		PAGE B.1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

APPENDIX B

SPL/M DOS Library Routines

```
#NOLIST
/* SPLM LIBRARY 'SPLM.LIB' —
DOS INTERFACE Routines

FLEX VERSION 1.0 6-9-79 */

/* THESE ROUTINES CAN BE USED BY AN
SPLM PROGRAM TO INTERFACE WITH
THE DOS. PARAMETERS NORMALLY
PASSED IN REGISTERS ARE PLACED
IN GLOBAL VARIABLES INSTEAD.
```

SEE THE FLEX 2.0 "ADVANCED PROGRAMMERS GUIDE" FOR A DETAILED DESCRIPTION OF EACH OF THE ROUTINES.

THE VERSION NUMBER OF THE PROGRAM MUST BE DECLARED AS A SYMBOLIC CONSTANT BEFORE INCLUDING THIS FILE. THE STARTING ADDRESSES AND ANY GLOBAL VARIABLES NOT ON PAGE 0 (SUCH AS ARRAYS) SHOULD ALSO BE DECLARED BEFORE THE LIBRARY INCLUDES, E.G.

```
0A1COH:;
DCL VERSION LIT '1';

0A840H: DCL RFCE (320) BYTE;
#INCLUDE SPLM.LIB
#INCLUDE SPLMREAD.LIB
```

VARIABLES DECLARED AFTER THE INCLUDES WILL BE PLACED ON PAGE 0 UNLESS PRECEDED BY AN ORIGIN. */

```
/* GENERATE VERSION NUMBER */
GEN(/*BRA 1*/2001H,VERSION);

/* OVERLAY FOR PART OF DOS MEMORY MAP */
0AO80H: DCL LINEBUF (128) BYTE;
0AC02H: DCL FOLCHR BYTE;
0AC0EH: DCL SMONTH BYTE, SDAY BYTE, SYEAR BYTE;
0AC11H: DCL LASTTERM BYTE;
0AC14H: DCL LINPTR ADDR;
0AC18H: DCL CURCHR BYTE, PREVCHR BYTE;

DCL TRUE LIT 'OFFH';
DCL FALSE LIT 'O';
DCL CRLF LIT 'ODOAH';

/* SYMBOLIC CONSTANTS FOR DISK IO */
DCL XFC LIT 'O'; /* FCB OVERLAY */
DCL XES LIT '1';
```

```
DCL XUN LIT '3';
DCL XFN LIT '4';
DCL XEX LIT '12';
DCL XFS LIT '15';
DCL XNC LIT '59';
DCL QSRW LIT '0'; /* FUNCTION DEFS */
DCL QSO4R LIT '1';
DCL QSO4W LIT '2';
DCL QSO4U LIT '3';
DCL QSCLS LIT '4';
DCL QSREW LIT '5';
DCL EEOF LIT '8'; /* ERROR STATUS */
DCL DXBIN LIT '0'; /* DEFAULT EXTENSIONS */
DCL DXTXT LIT '1';
DCL DXCMD LIT '2';
DCL DXSYS LIT '4';
DCL DXBAK LIT '5';
DCL DXOUT LIT '11';

WARMS:PROC;
    GEN(/*JMP*/7EH,OADO3H);
END;

10H:DCL CHAR BYTE;
/* READ ONE BYTF INTO CHAR */
GETCHR:PROC;
    CALL /*CFTCHR*/OAD15H;
    GEN(/*STA*/097H,.CHAR);
END;
/* WRITF ONE BYTE FROM CHAR */
PUTCHR:PROC;
    GEN(/*LDA*/096H,.CHAR);
    CALL /*PUTCHR*/OAD18H;
END;
/* OUTPUT A SPACE */
SPACE:PROC;
    GEN(/*LDA*/086H,' ');
    CALL /*PUTCHR*/OAD18H;
END;

DCL INBUFF LIT 'OAD1BH';
DCL MSGA ADDR;
/* OUTPUT STRING WHOSE ADDRESS
   IS IN MSGA */
PSTRNG:PROC;
    GEN(/*LDX*/ODEH,.MSGA);
    CALL /*PSTRNG*/OAD1FH;
END;

DCL FRROR BYTE;
/* CLASSIFY CHAR; ERROR = TRUE
   IF NOT ALPHANUMERIC */
CLASS:PROC;
    ERROR = OFFH;
```

```
        GEN(/LDAAB*/96H,.CHAR);
        CALL /*CLASS*/OAD21H;
        GEN(/BCC*/24H,1); RETURN;
        ERROR = 0;
END;
DCL PCRLF LIT 'OAD24H';
/* GET NEXT BUFFER CHARACTER
   INTO CHAR */
NXTCH:PROC;
    CALL /*NXTCH*/OAD27H;
    GEN(/STAA*/97H,.CHAR);
END;
DCL RSTRIO LIT 'OAD2AH';

DCL FCBA ADDR;
/* GET FILE SPFC INTO FCB WHOSE
   ADDRESS IS IN FCBA.  NORMALLY
   ONLY CALLED BY LIBRARY ROUTINES
   RDOPEN AND WTOPEN */
GETFIL:PROC;
    ERROR = OFFH;
    GEN(/LDX*/ODEH,.FCBA);
    CALL /*GETFIL*/OAD2DH;
    GEN(/BCC*/24H,1); RETURN;
    ERROR = 0;
END;
DCL LOAD LIT 'OAD30H';
DCL DEFFXT BYTE;
/* SET DEFAULT FXTENSION
   CONTAINED IN DEFFXT */
SETEXT:PROC;
    GEN(/LDAAB*/96H,DEFFXT);
    GEN(/LDX*/CDEH,.FCBA);
    CALL /*SETEXT*/OAD33H;
END;

DCL DGTA ADDR, LDSPC BYTE;
/* OUTPUT DECIMAL NUMBER WHOSE
   ADDRESS IS IN DGTA.  LEADING
   SPACES WILL BE PRINTED IF
   LDSPC = TRUE */
OUTDEC:PROC;
    GEN(/LDAB*/OD6H,LDSPC);
    GEN(/LDX*/ODEH,.DGTA);
    CALL /*OUTDFC*/OAD39H;
END;
/* OUTPUT HFX BYTE WHOSE
   ADDRESS IS IN DGTA */
OUTHFX:PROC;
    GEN(/LDX*/CDEH,.DGTA);
    CALL /*OUTHFX*/OAD3CH;
END;
/* REPORT DOS ERRORS.  NORMALLY
```

```
ONLY CALLED FROM DISK I/O
LIBRARY ROUTINES */
RPTERR:PROC;
    GEN /*LDX*/ODEH,.FCBA);
    CALL /*RPTERR*/OAD3FH;
END;

DCL NUM ADDR, ANYDGTS BYTE;
/* GET HEX NUMBFR INTO NUM.
   ERROR SET TRUE IF NOT HEX.
   DGTS SET <> 0 IF ANY DIGITS
   FOUND. */
GETHFX:PROC;
    NUM=0; FRROR=OFFH; ANYDGTS=0;
    CALL /*CFTHEX*/OAD42H;
    GEN /*BCC*/24H,1); RETURN;
    FRROR=0;
    GEN /*STX*/CDFH,.NUM);
    GEN /*STAB*/OD7H,.ANYDGTS);
END;
/* OUTPUT 2 HEX BYTES WHOSE
   ADDRESS IS IN DCTA */
OUTADR:PROC;
    GEN /*LDX*/ODEH,.DGTA);
    CALL /*OUTADR*/OAD45H;
END;
/* INPUT DECIMAL NUMBER INTO NUM.
   ERROR SET IF INVALID NUMBER.
   DGTS SET <> 0 IF ANY DIGITS
   FOUND. */
INDEC:PROC;
    NUM=0; FRROR=OFFH; ANYDGTS=0;
    CALL /*INDEC*/OAD48H;
    GEN /*BCC*/24H,1); RETURN;
    FRROR=0;
    GEN /*STX*/CDFH,.NUM);
    GEN /*STAB*/OD7H,.ANYDGTS);
END;

DOCMND:PROC;
    CALL /*DOCMND*/OAD4EH;
    GEN /*STAB*/OD7H,.ERROR);
END;
FMS:PROC;
    /* SET ERROR = OFFH WITHOUT
       DESTROYING CHAR IN ACCA */
    ERROR = 0; FRROR = FRROR-1;
    GEN /*LDX*/ODEH,.FCBA);
    CALL /*FMS*/OB406H;
    GEN /*BEQ*/27H,1); RETURN;
    ERROR = 0; /* ACCA STILL HAS CHAR */
END;
DCL FMSCLS LIT 'OB403H';
#LIST
```

```
#NOLIST
/* SPLM LIBRARY 'SPLMREAD.LIB' —
   READ ROUTINES

   FLFX VERSION 1.0 6-9-79 */

/* THESE ROUTINES CAN BE USED BY AN
   SPLM PROGRAM TO READ A SEQUENTIAL
   FILE. A FILE CONTROL BLOCK NAMED
   'RFCB' MUST BE DECLARED BEFORE
   THE LIBRARY INCLUDE, E.G.:

   OA840H: DCL RFCB (320) BYTE;
   #INCLUDE SPLM.LIB
   #INCLUDE SPLMREAD.LIB      */

/* RDCLOSE — CLOSE A FILE PREVIOUSLY
   OPENED FOR READING */

RDCLOSE:PROC;
   RFCB(XFC) = QSCLS;
   FCBA = .RFCB;
   CALL FMS;
   IF ERROR THEN DO;
      CALL RPTERR;
      CALL WARMS;
   END;
END;

/* RDFF — HANDLE FATAL READ ERRORS */

RDER:PROC;
   FCBA = .RFCB;
   CALL RPTERR;
   CALL RDCLOSE;
   CALL WARMS;
END;

/* RDOPEN — OPEN A FILE FOR READING.
   ON ENTRY, (GLOBAL) DEFEXT MUST
   CONTAIN THE DEFAULT EXTENSION
   TYPF — SEE 'SPLM.LIB' FOR
   SYMBOLIC CONSTANTS TO USE.
   SPACE COMPRESSION IS ALWAYS
   INHIBITED BY DEFAULT */

RDOPEN:PROC;
   FCBA = .RFCE;
   CALL GETFIL;
   IF FRROR THEN DO;
      CALL RPTERR;
      CALL WARMS;
   END;
```

```
RFCE(XFC) = QS04R;
CALL SETEXT; /* DEFFXT MUST BE SET UP */
CALL FMS;
IF ERROR THEN DO;
    CALL RPTERR;
    CALL WARMS;
END;
/* INHIBIT SPACE COMP */
RFCB(XNC) = TRUE;
FND;

/* RBFT - READ ONE BYTE FROM DISK
   INTO (GLOBAL) CHAR.
   ON EXIT, REOF = TRUE IF END OF
   FILE, ELSE REOF = FALSE */

DCL REOF BYTE;
RBFD:PROC;
    REOF = TRUE;
    RFCB(XFC) = QSRW;
    FCBA = .RFCB;
    CALL FMS;
    GEN(/*STAA*/97H,.CHAR);
    IF ERROR THEN DO;
        IF RFCB(XES) = FEOF THEN RETURN;
        ELSE CALL RDER;
    END;
    REOF = FALSE;
END;

/* RBFDF - READ ONE BYTE FROM DISK
   INTO (GLOBAL) CHAR. END OF
   FILE HANDLED AS FATAL ERROR */

RBFDF:PROC;
    CALL RBFD;
    IF REOF THEN CALL RDER;
END;
#LIST
```

```
#NOLIST
/* SPLM LIBRARY 'SPLMWRIT.LIB' —
   WRITF ROUTINES

   FLFX VERSION 1.0 6-9-79 */

/* THESE ROUTINES CAN BE USED BY AN
   SPLM PROGRAM TO WRITE A SEQUENTIAL
   FILE. A FILE CONTROL BLOCK NAMED
   'WFCB' MUST BE DECLARED BEFORE
   THE LIBRARY INCLUDES, E.G.:

100H: DCL RFCB {320} BYTF,
      DCL WFCB {320} BYTF;
#INCLUDE SPLM.LIB
#INCLUDE SPLMREAD.LIB
#INCLUDE SPLMWRIT.LIB           */

/* WTCLOSE - CLOSE A FILE PREVIOUSLY
   OPENED FOR WRITING */

WTCLOSE:PROC;
    WFCB(XFC) = QSCLS;
    FCBA = .WFCE;
    CALL FMS;
    IF ERROR THFN DO;
        CALL RPTERR;
        CALL WARMS;
    END;
END;

/* WTER - HANDLE FATAL READ ERRORS */

WTER:PROC;
    FCBA = .WFCE;
    CALL RPTERR;
    CALL WTCLOSF;
    CALL WARMS;
END;

/* WTOPEN - OPEN A FILE FOR WRITING.
   ON ENTRY, (GLOBAL) DEFEXT MUST
   CONTAIN THE DEFAULT EXTENSION
   TYPF - SEE 'SPLM.LIB' FOR
   SYMBOLIC CONSTANTS TO USE.
   SPACE COMPRESSION IS ALWAYS
   INHIBITED BY DEFAULT */

WTOPEN:PROC;
    FCBA = .WFCE;
    CALL CFTFIL;
    IF ERROR THEN DO;
        CALL RPTERR;
```

```
        CALL WARMS;
FND;
WFCB(XFC) = QSO4W;
CALL SETEXT; /* DEFFEXT MUST BE SET UP */
CALL FMS;
IF FRROR THEN DO;
    CALL RPTERR;
    CALL WARMS;
    FND;
/* INHIBIT SPACE COMP.*/
WFCB(XNC) = TRUE;
END;

/* WBTD - WRITE ONE BYTE FROM (GLOBAL)
CHAR TO DISK. */

WBTD:PROC;
    WFCB(XFC) = QSRW;
    FCEA = .WFCB;
    GEN(/*LDAA*/96H,.CHAR);
    CALL FMS;
    IF ERROR THEN CALL WTER;
END;
#LIST
```


		PAGE C.1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

APPENDIX C

"Size" Program (SPL/M Source)

```
0001 /* SIZE — DISPLAYS SECTOR COUNT,      */
0002 /* LENGTH IN DECIMAL AND HEX,          */
0003 /* NUMBER OF LINES (CR'S), PLUS        */
0004 /* CHECKSUM AND CREATION DATE OF      */
0005 /* A FILE.                           */
0006 /*
0007 /*           FLEX VERSION 1.0          */
0008 /*           6-11-79                  */
0009
010 OA100H:;
011 DCL VERSION LIT '1';
012
013 OAB40H:DCL RFCB (320) BYTE;
014
015 /* #INCLUDE SPLM.LIB      — LIBRARIES INCLUDED HERE
016   #INCLUDE SPLMREAD.LIB    */
017
023 DATE:PROC;      /* OUTPUT DATE AS MM-DD-YY */
024   DCL MONTH LIT '25', DAY LIT '26', YEAR LIT '27';
025   DCL DGT ADDR;
026   LDSPC = FALSE;
027   IF RFCB(MONTH) < 10 THEN CALL SPACE;
028   DCTA = .DGT;
029   DCT = RFCB(MONTH); CALL OUTDEC;
030   CHAR = '-'; CALL PUTCHR;
031   DGT = RFCB(DAY); CALL OUTDEC;
032   CHAR = '-'; CALL PUTCHR;
033   DCT = RFCB(YEAR); CALL OUTDEC;
034   IF RFCB(DAY) < 10 THEN CALL SPACE;
035   CALL SPACE;
036 END;
037
038 ASIZE:PROC;      /* OUTPUT SIZE AND CHECKSUM INFO FOR A FILE */
039   DCL BYTES$CTR ADDR, LINE$CTR ADDR, CHKSUM BYTE;
040   DCL TBYTE$CTR ADDR, FLAG FYTE;
041   DCL XSIZ LIT '21'; /* LOC OF SECTOR SIZE IN FCB */
042   DCL CR LIT 'ODH';
043
044   BYTES$CTR = 0; LINE$CTR = 0; FLAG = FALSE; CHKSUM = 0;
045   CALL RBFD;
046   DO WHILE NOT REOF;
047     IF FLAG AND (CHAR <> 0) THEN FLAG = FALSE;
048     IF NOT FLAG AND (CHAR = 0) THEN DO;
049       FLAG = TRUE;
050       /* MARK LAST NON-ZERO BYTE */
051       TBYTE$CTR = BYTES$CTR;
052     END;
053     CHKSUM = CHKSUM + CHAR;
054     BYTES$CTR = BYTES$CTR + 1;
055     IF CHAR = CR THEN LINE$CTR = LINE$CTR + 1;
056     CALL REFD;
057 END;
```

```
0358 IF FLAG THEN      /* STRING OF NULLS AT END */
0359     BYTE$CTR = TBYTE$CTR;
0360
0361 LDSPC = TRUE;
0362 DCTA = .RFCB+XSIZ; CALL OUTDEC; /* SECTOR SIZE */
0363 CALL SPACE;
0364
0365 DCTA = .BYTE$CTR; CALL OUTDEC; /* BYTE COUNT */
0366 CALL SPACE; CALL SPACE;
0367
0368 CALL OUTADR;           /* IN HEX */
0369 CALL SPACE;
0370
0371 DCTA = .LINE$CTR; CALL OUTDEC; /* LINE COUNT */
0372 CALL SPACF; CALL SPACF;
0373
0374 DCTA = .CHKSUM; CALL OUTHFX; /* CHECKSUM */
0375
0376 END;
0377 /* MAIN */
0378 DCL HEADER DATA (' DATE      NS    DEC    HEX LINES  CS',
0379                   CRLF,CRLF,4);
0380
0381 DFFEXT = DXTXT;
0382 CALL RDOPFN;
0383
0384 MSGA = .HFADFR; CALL PSTRNG;
0385 CALL DATE;
0386 CALL ASIZE;
0387
0388 CALL RDCLOSE;
0389 CALL WARMS;
0390
0391 LVL 00
001C ANYDGTS BYTE
A2A8 ASIZE PROC
AC18 CURCHR BYTE
^DOA CRLF LIT
0010 CHAR BYTF
A12~ CLASS PROC
0000 DXBIN LIT
0001 DXTXT LIT
0002 DXCMD LIT
0004 DXSYS LIT
0005 DXBAK LIT
000B DXOUT LIT
0016 DFFEXT BYTE
0017 DCTA ADDR
A19E DOCMNT PRCC
A253 DATE PROC
```

AC02	FOLCHR BYTE
0008	FFOF LIT
0013	ERROR BYTF
0000	FALSE LIT
0014	FCBA ADDR
A1A4	FMS PROC
B403	FMSCLS LIT
A10A	GETCHR PROC
A138	GETFIL PROC
A164	GETHEX PROC
A366	HEADER BYTE
AD1B	INBUFF LIT
A184	INDEC PROC
A080	LINBUF BYTE
AC11	LASTTERM BYTE
AC14	LINPTR ADDR
AD30	LOAD LIT
0019	LDSPC BYTE
0011	MSGA ADDR
A132	NXTCH PROC
001A	NUM ADDR
A150	OUTDEC PROC
A158	OUTHEX PROC
A17E	OUTADR PRCC
AC19	PREVCHR BYTE
A110	PUTCHR PROC
A11C	PSTRNG PROC
AD24	PCRLF LIT
0000	QSRW LIT
0001	QS04R LIT
0002	QS04W LIT
0003	QS04U LIT
0004	QSCLS LIT
0005	QSREW LIT
A840	RFCB BYTF
AD2A	RSTTRIO LIT
A15E	RPTERR PROC
A1B6	RDCLOSE PROC
A1D	RDER PROC
A1E1	RDOOPEN PROC
001D	RFOF BYTE
A216	RFID PROC
A244	REFDE PROC
AC0F	SMONTH BYTE
AC0F	SDAY EYTF
AC10	SYEAR BYTF
A116	SPACE PROC
A148	SETEXT PROC
00FF	TRUE LIT
0001	VFRSION LIT
A106	WARMS PROC
0000	XFC LIT

SIZE

SPL/M COMPILER VERSION 1.2

6-12-79 PAGE C.5

0001 XFS LIT
0003 /XUN LIT
0004 XFN LIT
000C XFX LIT
000F XFS LIT
003B XNC LIT

0391 EOF

***** NO ERRORS

HIGH ADDR USED: 44D6

		PAGE D.1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

APPENDIX D

SPL/M Reserved Words

		PAGE D.20F
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

SPL/M Reserved Words

ADDR	LIT
ADDRESS	LITERALLY
AND	* LOW
** BASED	* MEM
BREAK	* MEMA
** BY	** MINUS
EYTE	MOD
CALL	** MONITOR
DATA	NOT
DCL	OR
DECLARE	** PLUS
DO	PROC
ELSE	PROCEDURE
END	RETURN
EOF	THEN
GEN	** TO
GENERATE	WHILE
* HIGH	XOR
IF	

* - Reserved word in Version 1 only

** - Reserved word in future versions;
illegal in Version 1

		PAGE E.1 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

APPENDIX E

Grammar For SPL/M

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

Grammar for SPL/H V1.1

```

<program> ::= <init> <main> EOF
<init> ::= <istmt list> ; <origin> ; <istmt list>
<istmt list> ::= <istmt> | <istmt list> <istmt> | NIL
<istmt> ::= <decl stmt> ; | <proc def> ; | <gen stmt> ;
<origin> ::= <number>;
<proc def> ::= <proc head> <stmt list> END
<proc head> ::= <identifier>: PROCEDURE ;
                  | <identifier>: PROC ;
                  | <origin> <proc head>
<main> ::= <stmt list> ; <origin> <stmt list>
<stmt list> ::= <stmt> | <stmt list> <stmt> | NIL
<stmt> ::= <basic stmt> | <if stmt>
<basic stmt> ::= <assignment> ;
                  | <group> ;
                  | <call stmt> ;
                  | RETURN ;
                  | BREAK ;
                  | <decl stmt> ;
                  | <gen stmt> ;
<if stmt> ::= <if clause> <stmt>
                  | <if clause> <basic stmt> ELSE <stmt>
<if clause> ::= IF <expr> THEN
<group> ::= <group head> <stmt list> END
<group head> ::= DO ;
                  | DO WHILE <expr> ;
<call stmt> ::= CALL <identifier> | CALL <number>

```

		PAGE E.3 OF
SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

```

<decl stmt> ::= DECLARE <decl element>
                | DCL <decl element>
                | <decl stmt> , <decl element>
                | <origin> <decl stmt>

<decl element> ::= <identifier> <type>
                  | <identifier> ( <number> ) <type>
                  | <identifier> DATA <data list>
                  | <identifier> LITERALLY '<number>'
                  | <identifier> LIT '<number>'

<type> ::= BYTE | ADDRESS | ADDR

<data list> ::= <data head> <constant> )
<data head> ::= ( | <data head> <constant> ,
<gen stmt> ::= GENERATE <data list>
                | GEN <data list>

<assignment> ::= <variable> = <expr>

<expr> ::= <logical factor>
           | <expr> OR <logical factor>
           | <expr> XOR <logical factor>

<logical factor> ::= <logical secondary>
                      | <logical factor> AND <logical secondary>

<logical secondary> ::= <logical primary>
                        | NOT <logical primary>

<logical primary> ::= <arith expr>
                      | <arith expr> <relation> <arith expr>

<relation> ::= = | < | > | <> | <= | >= | ><= | <= >

<arith expr> ::= <term>
                  | <arith expr> + <term>
                  | <arith expr> - <term>

<term> ::= <secondary>
           | <term> * <secondary>
           | <term> / <secondary>
           | <term> MOD <secondary>

```

SYSTEM NAME	SYSTEM NUMBER	CATALOGUE NUMBER
PROGRAM NAME	PROGRAM NUMBER	DATE DOCUMENTED

```

<secondary> ::= <primary>
   | - <primary>

<primary> ::= <constant>
   | <variable>
   | ( <expr> )
   | HIGH ( <expr> )
   | LOW ( <expr> )

<variable> ::= <identifier>
   | <identifier> ( <expr> )
   | MEM ( <expr> )
   | MEMA ( <expr> )

<constant> ::= <number> | '<string>' | .<identifier>

<identifier> ::= <letter>
   | <identifier> <dec digit>
   | <identifier> <letter>
   | <identifier> $

<letter> ::= A | B | C ... | Z

<number> ::= <dec number> | <hex number> H

<dec number> ::= <dec digit>
   | <dec num> <dec digit>
   | <dec num> $

<hex number> ::= <dec digit>
   | <hex num> <hex digit>
   | <hex num> $

<dec digit> ::= 0 | 1 | 2 ... | 9

<hex digit> ::= <dec digit> | A | B | C | D | E | F

<string> ::= <str element> | <string> <str element>

<str element> ::= <ASCII char> | "

```