Not enough arguments supplied

The number of actual parameters in a procedure call is less than the number of formal parameters for that procedure.

Out of symbol table storage

The pass one symbol table is full. Break your program into smaller modules (or get more external memory).

Program too large (interfile1).

The pass one intermediate file is larger than .WORK. Increase the size of the .WORK file.

Program too large (variable space exceeds maximum).

The program uses more than 60K of variable space. Move large arrays to external memory.

Recursive attribute doesn't match forward ref

This procedure is defined to be recursive, but it's forward reference declaration does not include the attribute RECURSIVE, or visa versa.

RETURN statement not allowed

This RETURN statement does not occur within a procedure or a WHEN statement.

Statement outside of module body

This statement appears after the END of a module. Statements cannot appear outside a module.

String constant too long

This string constant is longer than 128 characters.

Subscript not allowed

A subscript appears in the declaration of an external variable, a label, a literal, a data array, a forward reference procedure, or a formal parameter of a procedure.

System error with disk configuration (.WORK is wrong length).

The length of .WORK is not a multiple of eight sectors. Recreate it with a sector length that is a multiple of eight.

System error with disk configuration (.WORK missing).

The file .WORK is not on the system device. Create a .WORK file on the system device.

Too many arguments supplied

The number of actual parameters in a procedure call is greater than the number of formal parameters for that procedure.

Too many END statements

There is an extra END statement. This is often caused by changing the compound statement of the THEN clause of an IF statement to a simple statement and forgetting to remove its corresponding END.

Too many digits in number

More than six octal digits appear in an octal constant or more than four hexadecimal digits appear in a hexadecimal constant or more than eight decimal digits appear to the left or to the right of the decimal point in a floating point constant.

Too many externals declared

More than 4096 external declarations appear in a single source file. Remove unnecessary external declarations.

Too many nested 'BEGIN' statements

BEGIN statements or procedures have been nested beyond the the compiler's capability to deal with them. Change any BEGINs that do not define new localization levels to DOs and unnest procedures.

Too many nested insert files

Insert files have been nested beyond the compiler's capability to deal with them. Redefine the insert file structure so it does not nest as deeply or construct a module from the lower level functions.

Too many numeric constants

The compiler has run out of floating point constant stack space. Use multiple statements and temporary variables to evaluate the expression.

Too many procedures/labels

There are too many procedures (or labels) defined in the source file. Break your program into smaller modules.

Undeclared procedure argument

A formal parameter of this procedure has not been declared.

Undefined symbol '<identifier>'

An attempt has been made to use an identifier before it is declared.

Warning: public variable declared inside a proc

A variable declared within a procedure has been declared to be PUBLIC. This is okay, but the public variable will be undefined if the procedure in which it is declared is never called by the program.

Warning: overwriting contents of data array

One or more elements of a DATA array are being overwritten; DATA arrays are meant to hold constants and should never be altered.

'WHEN' not allowed in procedure

This WHEN statement appears within a procedure. WHEN statements must appear at the outermost layer (i.e., not within a procedure).

Pass 2 Error Messages

Argument types do not match

The type of an actual parameter in this procedure call does not match the type of the corresponding formal parameter.

Expression too complicated at line <line #> (<info>)

The compiler has run out of stack space (<info> is 'push') or expression blocks (<info> is 'get') or automatic temporaries (<info> is 'too many temps in recursive proc'). Use multiple statements and temporary variables to evaluate the expression.

Floating point not allowed with fixed point

An attempt has been made to assign a floating point value to a fixed point variable (this includes decimal constants larger than 65535). Use the INT function if this was intended.

Program too large (pass 2 intermediate file).

The pass two intermediate file is larger than .WORK. Increase the size of the .WORK file.

Program too large (too many variables declared).

This program uses more than 60K of variable space (including temporaries allocated by pass two). Move large arrays to external memory.

Too many numeric constants

The compiler has run out of floating point constant stack space. Use multiple statements and temporary variables to evaluate the expression.

Too many procedures/labels

There are too many procedures (or labels) defined in the source file. Break your program into smaller modules.

Pass 3 Error Messages

Configuration mismatch: Library compiled with Model X processor [in <library name>] (defined in <library name>).

> This library was compiled for a later model processor than the one the main program is being compiled for. Recompile the source module for the same processor model that the main program is being compiled for.

Duplicate definition: <identifier> at line <line #> [in <library name>] (defined in <library name>).

> This identifier defined (i.e., declared to be PUBLIC) in the specified library is redefined at this line in MAIN or in the specified library. Change one of the declarations to EXTERNAL.

Duplicate WHEN statement <when ID> [in <library name>] (defined in <library name>).

> A WHEN statement (specified by the number <when ID>) in the specified library (or MAIN) also appears in another library. Remove one of the WHENs or combine the two.

Library "<library name>" incompatible with current compiler. Please recompile it.

> This library was created by an outdated version of the compiler. Recompile its source module.

Memory conflict - starting RAM address is too low. For this program, the RAM area must be at or above location <#> decimal.

> An attempt has been made (with the RAM statement) to set the start of the variable area before the end of the object code. Set the RAM to start at location <#> or above.

Not enough external memory to run program.

> The swap file for this program is larger than the amount of external memory in this computer. For this program to run on this computer, change some swapping procedures to non-swapping.

Not enough memory for linker symbol table.

> There is not enough internal memory for the linker symbol table. This program cannot be compiled without external memory or more internal memory. Verify the configuration by running the CONFIGUR program.

Not enough memory for Pass3 intermediate file.

This computer does not have enough internal memory to run the XPL compiler. Verify the configuration by running the CONFIGUR program.

Object file too big for compilation.

The internal memory image for this program (or the size of the library being compiled) is larger than 64K; change some non-swapping procedures to swapping (or break this module into smaller pieces).

Program too large for compilation (libraries exceed work file length).

The pass three linker intermediate file is larger than .WORK. Increase the size of the .WORK file.

Program too large for compilation (too many external references).

The external relocation table is full. Redesign your modules to have fewer and tighter interfaces (or get more internal memory).

Program too large for compilation (too many keys).

There is not enough memory to compile this program.

Program too large for compilation (too much swapping scon).

There is not enough internal memory for the swapping string constant relocation table. Change some swapping procedures with many string constants to non-swapping or move some string constants in swapping procedures to DATA arrays.

Program too large (object file/IF collision).

The .WORK file is not large enough to hold both the object file and the intermediate file. Increase the size of .WORK.

Program too large (pass3 object file).

The .WORK file is not large enough to hold both the object file and the intermediate file. Increase the size of .WORK.

Specified library '<library name>' is not a relocatable binary.

The specified library is not the compiled version of a module (file type must be RELOC).

Specified library '<library name>' is zero-length.

The specified library is an empty file.

Specified library '<library name>' is too large.

The specified library is larger than 64K (and thus was not created by the compiler).

System file '.RTB-7' missing.

This file should be in .SYSTEM or top-level system catalog.

System file '.RTC-7' missing.

This file should be in .SYSTEM or top-level system catalog.

Too many public symbols defined.

The pass three symbol table is full. Redesign your modules to have fewer and tighter interfaces (or get more external memory).

Too many public symbols defined (symbol table overflow).

The pass three symbol table is full. Redesign your modules have fewer and tighter interfaces (or get more external memory).

Too many libraries referenced.

The pass three library table is full. Redesign your program to have fewer modules.

Too many libraries referenced (library table overflow).

The pass three library table is full. Redesign your program to have fewer modules.

Types don't match: <identifier> at line <line #>
[in <library name>] (defined in <library name>).

The type of this public identifier (or the parameter type list of this procedure) is different in the specified library (or MAIN) than it was in the defining library. This is usually caused by changing the parameters to a public procedure, but not recompiling all modules that include an external declaration for that procedure (whether they actually use it or not).

Unresolved reference: <identifier> at line <line #>
[in <library name>].

This identifier has been declared EXTERNAL in the specified library, but no corresponding PUBLIC declaration appears in the program.

.WORK not large enough to create swap file.

The combination of the pass three linker intermediate file and the swap file is larger than .WORK. Increase the size of the .WORK file.

Appendix E - Internal Representations

Fixed Point Numbers

Each fixed point data element is a 16-bit, single word quantity. Fixed point numbers can be interpreted as signed integers in the range of -32,768 to +32,767 or as unsigned integers in the range of 0 to 65,535. Both signed and unsigned integers are processed and stored identically inside the computer; the difference lies in the user interpretation of the bit patterns that are stored in memory.

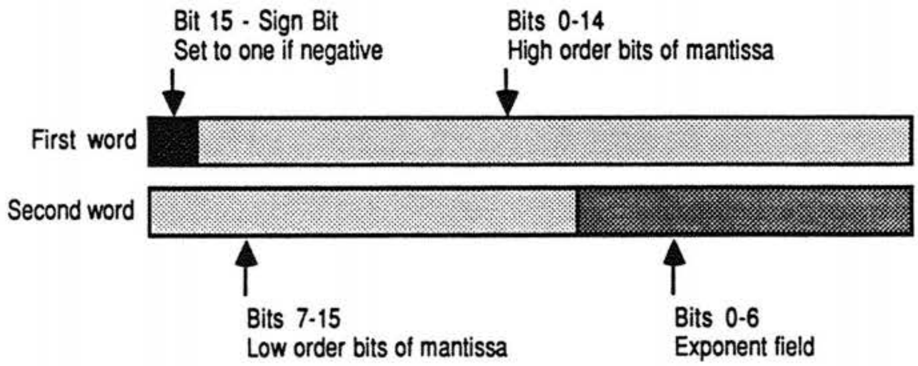
The bits that make up a fixed point number are labeled 0 through 15 as shown in the following diagram.

Negative integers are stored in memory in two's complement form. Bit 15 is the sign bit and will be set to a one in the case of a negative quantity. To obtain the negative value of a number in two's complement form, take the one's complement of the number (invert each bit) and then add one. Two's complement numbers are defined in such a way that when a positive number is added to its negative counterpart the result is a 16-bit word of all zeros. Note the following examples:

```
0000000000000011  =   3
0000000000000010  =   2
0000000000000001  =   1
0000000000000000  =   0
1111111111111111  =  -1
1111111111111110  =  -2
1111111111111101  =  -3
```

Floating Point Numbers

Floating point numbers are signed reals in the range of plus and minus 5.5 E-20 to 9.0 E18. They are stored in two consecutive locations of memory in a compacted form as shown in the following diagram:



Floating point variables are stored in terms of a sign bit, a 24-bit mantissa, and a 7-bit exponent field. The sign bit is a zero in the case of a positive number, or a one in the case of a negative number. To prevent multiple representations of the same number, the mantissa is always normalized so that its most significant bit is a one, except in the case of the number zero where the sign, mantissa, and exponent field are all zeros. The binary point is always located to the left of the most significant bit of the mantissa.

The exponent field represents a power of two exponent that is used to scale the mantissa up to 64 places left or right. The exponent field is stored in excess-64 notation so that an exponent field of all zeros represents -64 and all ones represents +63.

For example, the floating point number -25.0 is represented internally as follows:

```
-25.0000 = 1110010000000000
           0000000001000101
```

and is interpreted (in binary) like this:

```
Sign bit = 1
Mantissa = .110010000000000000000000
Exponent = 1000101
```

Computing the decimal equivalent of this number is done in the following way:

```
Mantissa = (1*0.5) + (1*0.25) + (1*0.03125) = 0.78125
Exponent = 69 - 64 = 5
Mantissa with exponent = 0.78125 * 32 = 25.00
Result with sign bit = -25.00
```

The following table presents the internal bit format for some floating point numbers.

Number	Internal Format
0.000000	0000000000000000 0000000000000000
1.000000	0100000000000000 0000000001000001
0.500000	0100000000000000 0000000001000000
25.00000	0110010000000000 0000000001000101
0.100000	0110011001100110 0110011000111101

Character Strings

Character strings can be stored in fixed point arrays, using a special format that makes manipulating strings convenient for the programmer. An array that contains ASCII characters has the string length stored in the first word (element zero), and the string characters stored in the rest of the array, starting with element one. The zeroeth element of the array contains the number of used 8-bit bytes in the array, with each byte of the array representing one ASCII character. Each 16-bit array element therefore contains two bytes (two characters), the lower half being an even byte, and the upper half being an odd byte:

Array (0)	Character length of string	
Array (1)	Byte 1	Byte 0
Array (2)	Byte 3	Byte 2
Array (3)	Byte 5	Byte 4
etc.		

Character strings in this standard format can be easily read from and written to the terminal using the LINPUT and PRINT statements. There are also two built-in functions (BYTE and PBYTE) that are used to process textual string information.

Appendix F - Memory Layout

This appendix describes the layout of internal and external memory while an XPL program is executing, and how that program can access and use different areas of memory. There are three basic categories of information in this appendix: the disk image of a program, the internal memory structure, and the external memory structure.

Every ABLE computer has some amount of internal memory, from 16K up to 64K words. The internal memory size of your computer must be specified for the Monitor with the CONFIGUR program. External memory can be purchased as an option and does not need to be specified in the system configuration. The computer simply uses external memory if it finds it in the system. Note that a program which requires external memory (i.e., one that has swapping procedures) will not run on a system that does not have external memory.

If you are going to use the information in this section for programming purposes, you must have a copy of the -XPL programming library on your system. The -XPL file SYSLITS (:-XPL:SYSLITS) contains the system literals that will allow you to access sections of memory during program execution. This programming library can be obtained from New England Digital Customer Service.

It is important to use the system literals in SYSLITS for all programs that access memory. The actual locations used to store things in memory often change with new software releases and SYSLITS is updated to accommodate these changes. Always use the version of -XPL that is compatible with the software version you are running to make sure you are accessing the correct memory locations.

SYSLITS provides the basic information needed to use the system literals. For additional information, refer to the manual "ABLE Series Operating System Reference Manual".

The Configuration Table

The configuration table is a special area of memory that contains information about the system. There is a copy of the configuration table resident in internal memory at all times. There is also a configuration table stored on disk with every program. The table contains information such as how much memory is in the system and what storage devices are attached to the system. When a program is run, the system's configuration is copied into the program's configuration table.

The format of the configuration table is outlined in the -XPL file SYSLITS. The format of the table is the same on disk as it is in memory. There is a pointer to the start of the configuration table which can be obtained by using the literal C#CONTAB. Using this pointer, all the information stored in the table is available by using other literals. For example, the literal C#STKLEN can be used to find out how much internal memory is used for the program's runtime stack.

The Swap File

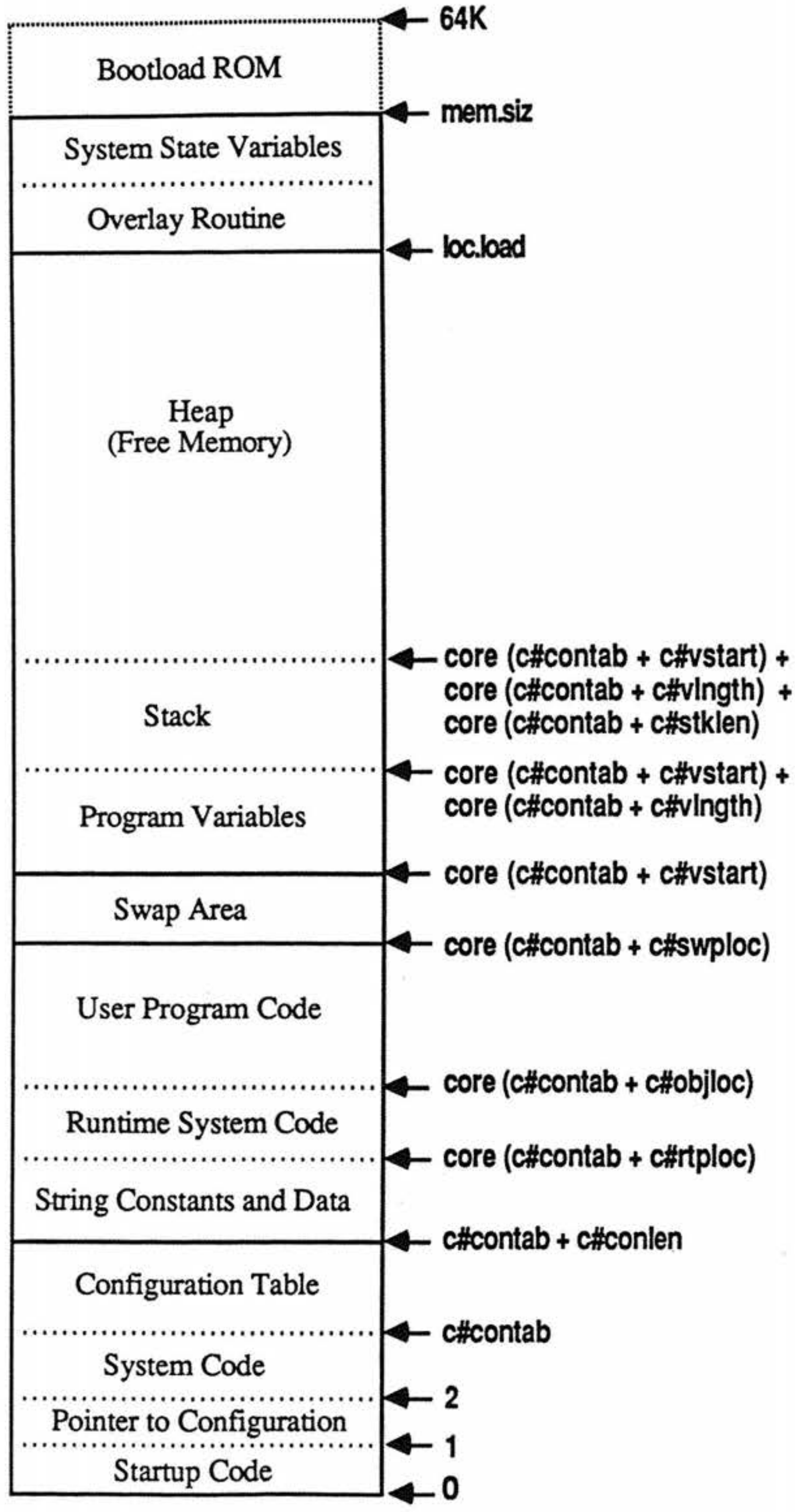
All procedures that are declared to be swapping are stored in external memory until they are needed by the program. When a program is compiled, the last section of the compiled code contains the swap file for the program. The swap file contains the code for all the swapping procedures, as well as a lookup table with the location of each swapping procedure (the swap lookup table).

When a program is run, the swap file is copied into external memory. A section of internal memory called the swap area is reserved to hold any procedure that is swapped into internal memory. The swap area is as large as the largest swapping procedure. Only one swapping procedure is resident in internal memory at any one time.

Memory Image: Internal

On the following page is a detailed diagram of internal memory while a program is executing. Located out to the right of each section are the system literals you would use to find each area during program execution. The pointer to the configuration table is found by using the literal C#CONTAB.

The word size of useable internal memory in your system is set up automatically in the variable MEM.SIZ when you insert :-XPL:SYSLITS into a program. For example, if you have the full 60K in your system, MEM.SIZ will be 61440 words (60*1024).


64K
Bootload ROM
mem.siz
System State Variables
Overlay Routine
loc.load
Heap
(Free Memory)
core (c#contab + c#vstart) +
core (c#contab + c#vlngth) +
core (c#contab + c#stklen)
Stack
core (c#contab + c#vstart) +
core (c#contab + c#vlngth)
Program Variables
core (c#contab + c#vstart)
Swap Area
core (c#contab + c#swploc)
User Program Code
core (c#contab + c#objloc)
Runtime System Code
core (c#contab + c#rtploc)
String Constants and Data
c#contab + c#conlen
Configuration Table
c#contab
System Code
2
Pointer to Configuration
1
Startup Code
0

The upper part of useable memory is reserved for the system state variables and the overlay routine. The system state variables contain information about the current file, the current system and user catalogs, and other information that needs to be preserved when overlaying from one program to another. The literals for accessing these system variables are in SYSLITS.

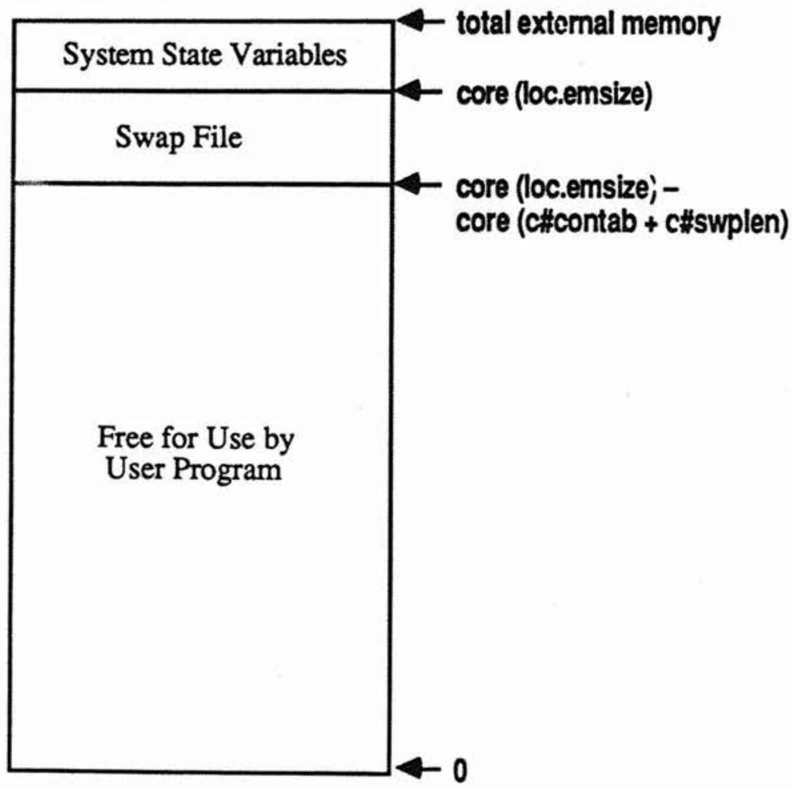
The internal memory not explicitly used by the program (the heap) can be used by the user program. Access to this memory is faster than access to external memory, so the heap is often used as a transfer buffer for copying files from one place to another or as a data storage area when time consuming operations are being performed. The following program segment figures out how much free memory is available and uses that area as a buffer.

```
insert ':-xpl:syslits'; /* get the system literals */

dcl free_start fixed;   /* start of free memory */
dcl free_end   fixed;   /* end   of free memory */
...

/* The start of the heap is found by starting at the program
   variable area, adding the length of the variable area to
   that, then adding the length of the stack.  */

free_start = core (c#contab + c#vstart) +
             core (c#contab + c#vlngth) +
             core (c#contab + c#stklen);

free_end   = loc.load; /* end of free memory */

total_free = free_end - free_start; /* word length of heap */
sectors = shr (total_free, 8);  /* sector length of heap */

/* Recompute the word length of heap so that it is a
   multiple of a sector boundary (for using it with READDATA
   and WRITEDATA) */

total_free = shl (sectors, 8);

/* The following call to READDATA uses the LOCATION function
   to read data from disk into free memory. */

call readdata (ms_sec, ls_sec, loc (free_start), total_free);
```

Memory Image: External

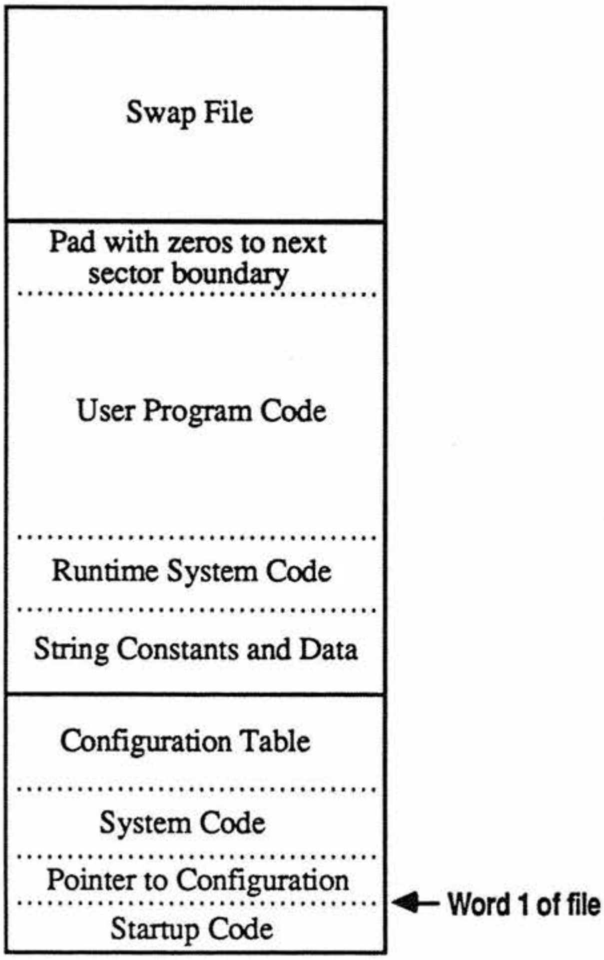
The diagram below shows the layout of external memory while a program is executing. As with internal memory, a small area at the end is reserved for system state variables. Unlike internal memory, where locations and lengths are specified in words, external memory is divided into sectors. The literal LOC.EMSIZE is used to find the number of useable sectors of external memory.

All of external memory except for the state variable area and the swap file is free for user applications, starting at sector zero. There are several built-in routines that are provided for reading from and writing to external memory. See the appendix "Built-in Functions" for descriptions of how to use these routines.



Disk Image

All compiled programs on disk are stored in a particular format. This format is similar to the structure of internal memory while a program is running. The following diagram illustrates this format:



The configuration table for a program can be examined by looking at the first sector of the program. Currently the configuration pointer for a program is located in the word at address one (check SYSLITS to make certain this is the case for your version of software). By using this pointer and the rest of the configuration literals in SYSLITS, information about the memory requirements of the program can be obtained. The literal C#OBJLEN can be used to get the length of the code up to the end of the user program code.

The following program segment reads the first sector of a program on disk, then uses SYSLITS to find out the length of the swap file for that program.

```
insert ':-xpl:syslits';

dcl buf (255)      fixed;   /* buffer for first sector of file */
dcl contab         pointer; /* pointer to configuration table */
dcl swap_sectors fixed;     /* number of sectors for swap file */
...

/* read the first sector of the program saved on disk */
call readdata (f#ms_sector, f#ls_sector, buf, 256);

contab = buf (1); /* get pointer to the config table */

/* The sector length of the swap file is located in a word
   offset defined by C#SWPLEN.  So by adding C#SWPLEN to the
   start of the configuration table, we find the length of
   the swap table.  */

swap_sectors = buf (contab + c#swplen);
```

Appendix G - D4567 Operation

The Hardware Multiply/Divide Unit (D4567) can be used with the READ function and the WRITE statement to perform multiplications and divisions of unsigned integers at a higher rate than is possible with the multiply (*) and divide (/) operators. This is possible because there is no sign correction that is required when using unsigned integers, while the sign correction routine is automatically invoked with * and /. Of course, this feature is only available when the optional Hardware Multiply/Divide Unit is connected to the computer.

The computer accesses the Multiply/Divide Unit by using READ function and the WRITE statement specifying devices 4, 5, 6, and 7. For programming purposes, the Hardware Multiply/Divide Unit can be viewed as two sixteen bit registers that can be loaded, read, and operated on by the computer. These two registers are called the A register and the B register and each can be read or written by the computer specifying device addresses 4 and 5, respectively. The A register (device 4) is cleared whenever the B register (device 5) is loaded in order to speed up both the multiplication and division operations. The advantage of this feature will become evident shortly.

Device addresses 6 and 7 are used to issue commands to the unit. Writing a fixed point number to device 6 directs the multiplier section to multiply the unsigned 16-bit number in the B register (device 5) by the unsigned 16-bit number that is being written to device 6. An unsigned 32-bit product is first formed and then added to the contents of the A register (device 4). The upper 16 bits of the result can then be accessed by reading the A register (device 4), while the lower 16 bits of the result are available in the B register (device 5).

If the programmer is only using the lower 16 bits of the result (device 5), then the computed number is correct for both signed and unsigned integers as long as the two operands were within range. No sign correction is required in this case.

A division is performed by first loading a 32-bit divisor into the A register (MS word) and B register (LS word), then writing a fixed point number to device 7. An integer unsigned division is performed in 1.8 microseconds producing a quotient in the B register (device 5) and a remainder in the A register (device 4). The following program segments demonstrate the use of the Multiply/Divide Unit.

```
declare (i, j) fixed;

write (5) = i;   /* load B register and clear A  */
write (4) = 2;   /* load A register with addend  */
write (6) = j;   /* multiply I times J and add 2 */
i = read (4);    /* upper 16 bits in A register  */
j = read (5);    /* lower 16 bits in B register  */

write (5) = j;   /* for divide, always load lower bits first */
write (4) = i;   /* load upper 16 bits of divisor */
write (7) = 100; /* write dividend to device 7 */
i = read (5);    /* quotient in the B register */
j = read (4);    /* remainder in the A register */
```

Warning: There is a limitation in the D4567 that requires the programmer to read the result out of register B (device 5) between commands, whether the result is needed or not. The following sequence is illegal and will produce erroneous results:

```
/* evaluate i*7/12 in full 32-bit resolution */

write (5) = i;
write (6) = 7;
write (7) = 12;
i = read (5);   /* pick up result */
```

The correct sequence is:

```
write (5) = i;
write (6) = 7;
i = read (5);   /* this must be here !! */
write (7) = 12;
i = read (5);   /* pick up result */
```

INDEX