Lisa Development System Manual

Updated by
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3/1/85

6, 22, 46-52, 57, 58

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Booting LISA

1. Normally the Lisa left plugged into the wall with power switch at power supply in the ON position. This will keep the 5 volt standby available to charge the Ni Cads which keep the clock alive.
2. Press power switch in front
3. Wait 2 seconds for click
4. Hold down command key and type a 2
5. Insert boot disk (if not already in)
6. Boot ROM should say Booting...
7. Screen will go white, disk will spin, ...

Booting the Mac Software

(1) Boot the machine using the disk marked PREBOOT:

(2) When the MAC ICON appears the disk will be ejected.

(3) Insert Mac System Disk

Booting the Monitor Development System

(1) Boot the machine using the disk marked BOOT:

(2) While system is booting turn on hard disk.

(3) If hard disk does not get mounted at boot time use Sys Mgr to mount the disk.

MONITOR Development System

The system consists of several large programs and a collection of small utilities. The main prompt line provides 1 key stroke access to the following

Editor

Compiler & code Generator

Filer

Linker

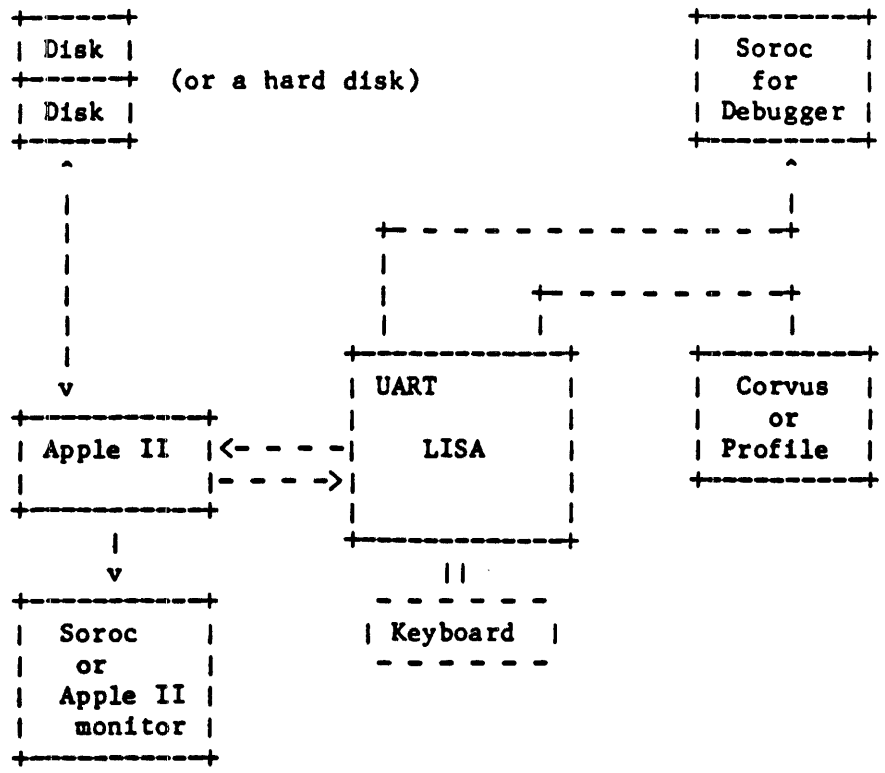
Assembler

Sys mgr

eXecution of a program

MONITOR

The Monitor is an operating system for the Lisa computer. Its user interface is patterned after that of the UCSD system on the Apple II. There are several possible system configurations. A standard one is:



The hard disk can be connected directly to the Lisa, or it can be accessed through the Apple II. It can also be omitted.

BOOTING THE MONITOR

To boot from a diskette based Apple II, first power up the Apple II with the male boot diskette in drive #4:. Insert the female boot in drive #5: and power up the Lisa. The female boot volume can also reside on a hard disk. SYSTEM.STARTUP on the male boot volume automatically executes MONBOOT, the program that starts up the Monitor on the Lisa. If you type space during the boot process, MONBOOT is not executed. If you type 'D' during the boot process, the debugging version of the Monitor is booted.

The Monitor comes up on the Lisa screen. If you want it to appear on the Apple II monitor or the Soroc connected to the UART port, change the MON.STARTUP program as follows:

1) for the Apple window: remove MON.STARTUP

2) for the Lisa window (the default): transfer MONSTART1.OBJ to MON.STARTUP

3) for the UART window: transfer MONSTART2.OBJ to MON.STARTUP

To move the Monitor around after booting, execute MOVESOROC. MOVESOROC simply asks you for the new source and destination for Monitor I/O: A(pple, L(isa, or U(art. Input always comes from the terminal to which output has been directed. WRITELNs used for debugging purposes appear on the Monitor screen, so you may not always want the application and Monitor screens to be together on the Lisa.

CONFIG.DATA tells the monitor how much RAM your system has. The default configuration assumes that you have a megabyte of RAM. For a 256K byte system, CONFIG.DATA should be a copy of NPC4.DATA. For a 512K byte system, use NPC8.DATA. NPC16.DATA is a copy of the default CONFIG.DATA, in case you ever need to back up. See CONFIGURE in the Utilities chapter if you want to change CONFIG.DATA to suit your own needs.

The monitor's keyboard driver supports the Lisa User Interface Keyboard layout. SHIFT [is {, SHIFT] is }, SHIFT . is >, and SHIFT , is <. NMI is the third key from the left in the upper row of the numeric keypad. Currently, the "4" key is backspace. The CODE key is in the upper left corner of the keyboard. CODE ; is |, CODE + is ~, CODE _ is \, and CODE " is `. ESCAPE is the upper left key of the numeric keypad. Control-S is the key in the upper right corner of the numeric keypad.

THE COMMAND LINE

The Monitor command line is:

Monitor: E(dit, C(ompile, F(ile, L(ink, A(ssemble, D(ebug, ? [0.1]

There are several hidden commands. Type ? to see them displayed.

E(dit	Lisa-style Editor
C(ompile	Pascal Compiler I-code generator
F(ile	Filer
I(ntrinsic	Intrinsic Unit Linker (release 8.0 and beyond)
L(ink	Linker
A(ssemble	Assembler
D(ebug	Symbolic Debugger
M(acsBug	LisaBug (low level debugger)
G(enerate	Pascal compiler OBJ file generator
U(CSD	UCSD Editor
X(ecute	Execute a program or an EXEC file

The Monitor recognizes male volumes and logs them off-line so that they cannot be accidentally overwritten. The volume MEMORY: is always available. MEMORY: allows you to use the Lisa RAM as a file storage area. Of course, anything in MEMORY: is lost when the power is turned off, or the system is rebooted. MEMORY: is mounted as unit #4:, and its default size is 10 blocks. Its size can be changed by the Z(ero command in the Filer, or by the CHANGEMEM program described in the Utilities section of this manual.

When X(ecuting a program, the monitor searches for the program filename as follows:

```
Filename
Filename.OBJ
*Filename
*Filename.OBJ
Filename.TEXT   (* as an exec file *)
```

When you invoke a program from the Monitor command line (F for Filer.Obj, for example), the Monitor looks first at the MEMORY: volume.

EXEC FILES

EXEC files can be used on the Monitor. They must be created in the Editor (there is no M(ake command). To execute such a file,

```
X(ecute <filename>
```

If an object file exists with the same name as that of the EXEC file, the object file is executed. The first character of an EXEC file (a textfile) defines the termination character. The first occurrence of two terminators marks the end of the EXEC file. Certain portions of the system (the compiler, for example) terminate an EXEC file if an error is encountered. If you X(ecute a .TEXT file, the monitor assumes that the file is an EXEC file. EXEC files cannot be nested, nor can parameters be passed to them.

LOW MEMORY LAYOUT

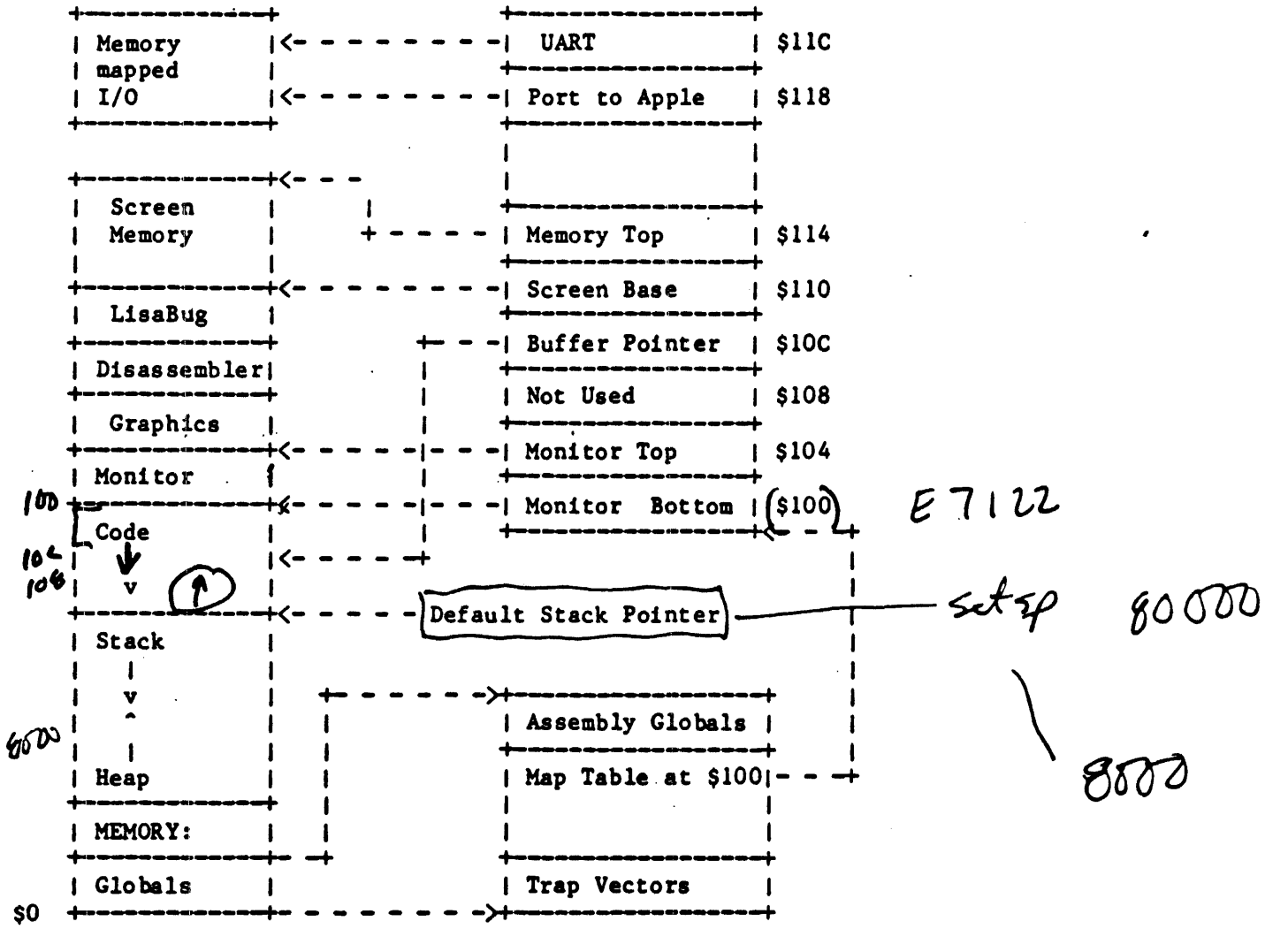
From	To	Description
0000	00FF	Exception vectors (see 68000 manual)
0100	01FF	Memory configuration map (see page ##)
0200	0300	Free space for user assembly globals
0300	0341	KCS numerics status information
0342	03FF	Free space
0400	07FF	LisaBug Globals
0800	08FF	Boot stack
0900	0AFF	LisaGraf Globals
0B00	0Bxx	Unit Table
0C00	0CFF	Pointer array
0D00	0Dxx	Syscom, miscinfo
0E00	0EFF	String buffer
0F00	0FFF	Unused (reserved) space
1000	17FF	User code buffer
1800	3FFF	User Jump Table
4000		Heap Bottom

Registers	Description
A7	Stack Pointer
A6	Stack frame Pointer
A5	Global Data Pointer
A3-A4	Used for code optimization
A2-A0	Scratch
D0-D3	Scratch
D4-D7	Used for code optimization

Registers D3 and A2 may someday be used by the compiler for code optimization.

MEMORY MAP

A set of very detailed memory maps can be found in the Linker chapter. We give below a general view of memory and a detailed view of the Monitor's Map Table.



THE MAP TABLE

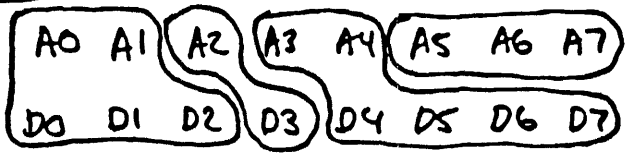
Monitor bottom	$100
Monitor top	$104
~~BOTTOM OF BUFFER~~	$108
Buffer ~~pointer~~	$10C
Screen base	$110
Memory top	$114
Port to Apple II	$118
UART	$11C
~~Ptr to Lisabug jump table~~	$120
~~Ptr to GOTOXY~~	$124
Ptr to Soroc driver	$128
~~Ptr to soft break table~~	$12C
Ptr to UART driver	$130
Ptr to ~~Cornus card~~ built in PIA	$134
Ptr to base of heap	$138
Default SP	$13C
Ptr to user's last ~~Local Frame~~	$140
~~Ptr to MEMORY:~~	$144
Ptr to Twiggy driver	$148
~~Ptr to hard disk Jump Table~~	$14C
Ptr to debug card	$150
Ptr to loader for IUs	$154
Ptr to 4 port card	$158
Ptr to external file system	$15C
Ptr to ~~Original~~ screen	$160
~~RW PAGE 1~~	$164
Apple net	$168
Apple net	$16C

Many of these vectors can be changed by the CONFIGURE program described in the Utility section of this manual. The main vector of interest is the default stack pointer ($13C). The utility program SETSP can be used to change the default stack pointer value temporarily. CONFIGURE can be used to change it permanently. Unused addresses are reserved for future use by the Monitor.

Rich Page
3/17/83

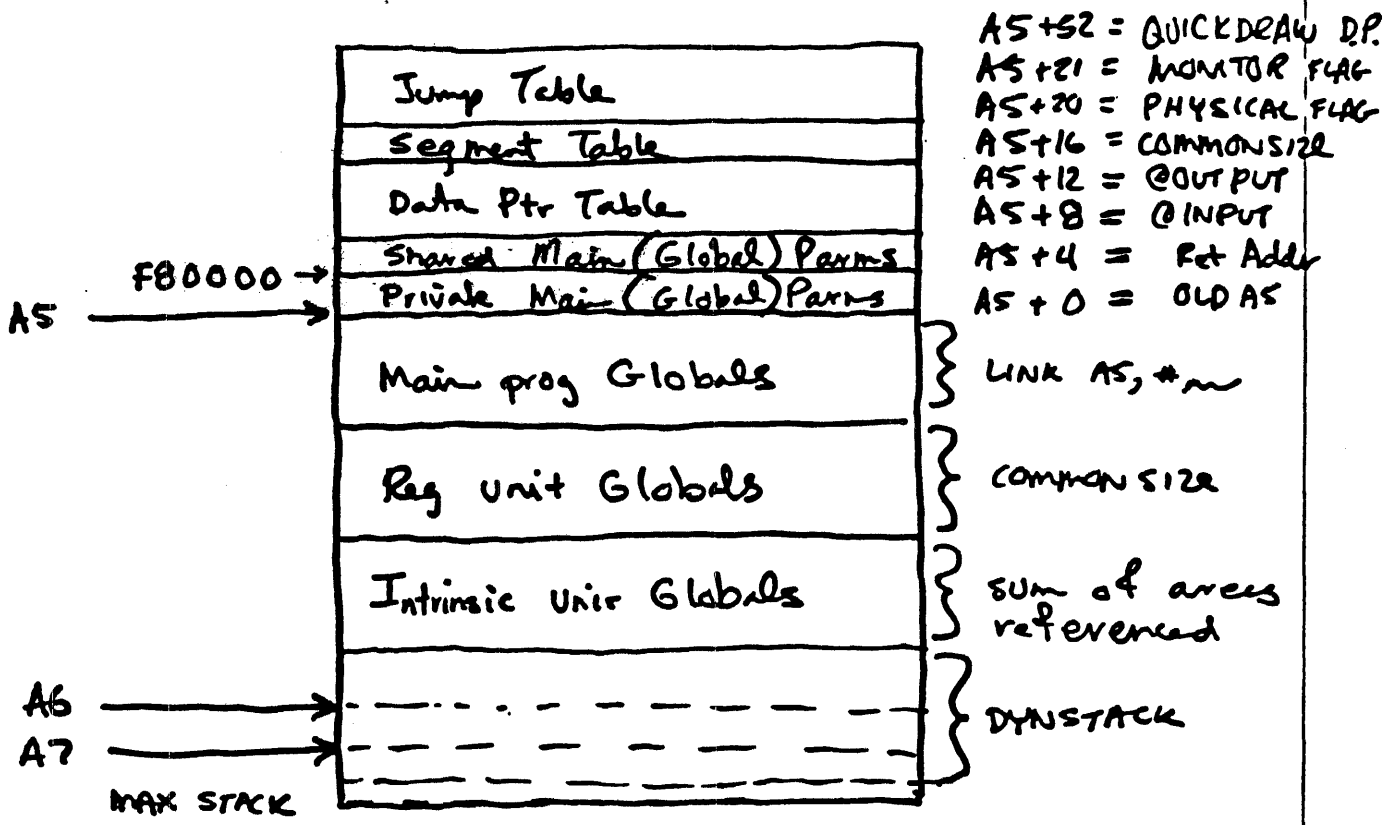
Execution Environment Assumed by the Compiler

Registers:

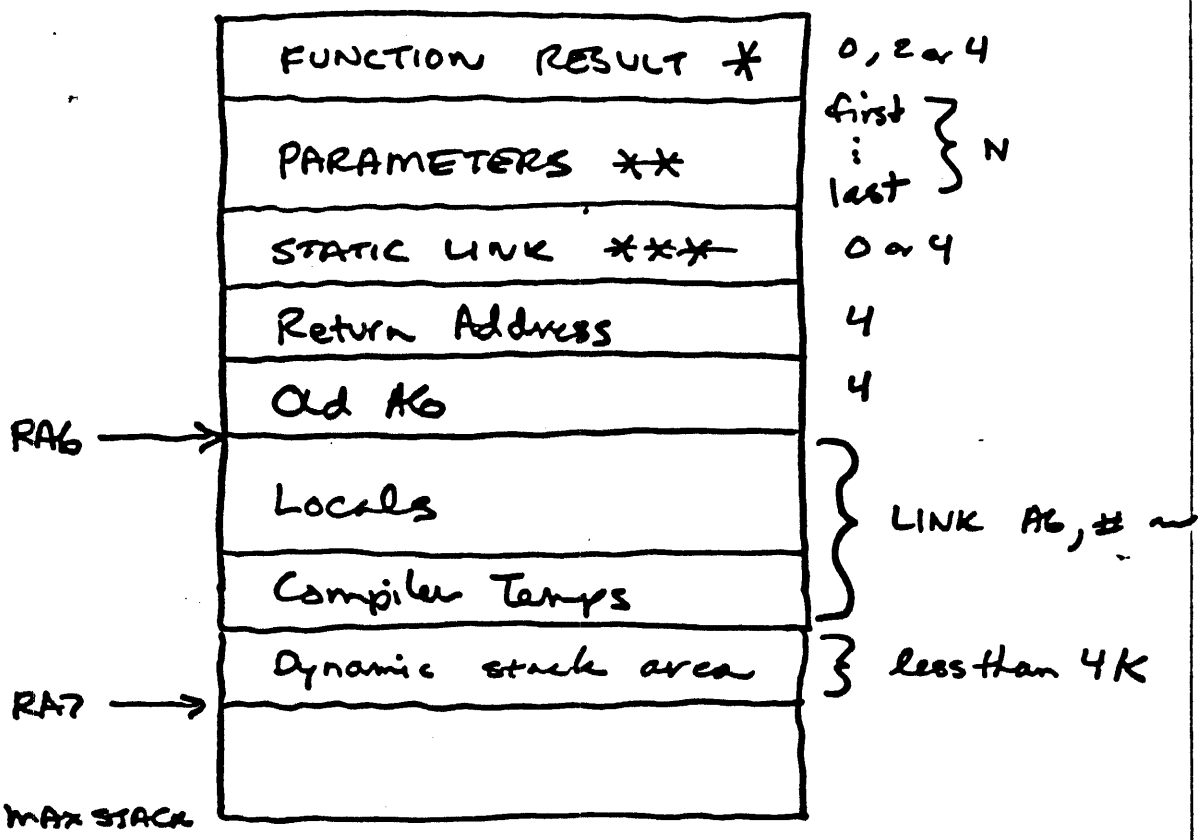


D0 - D2/A0 - A1	User temporaries
D0 - D3/A0 - A2	Compiler temporaries
D4 - D7/A3 - A4	Compiler uses for locals & ptrs
A5	Ptr to global frame
A6	Ptr to local frame
A7	Ptr to top of stack

Global Frame:



Local Frame:



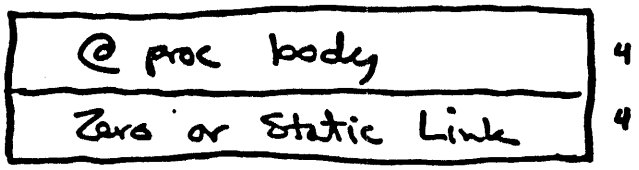
* 2 or 4 bytes if FUNCTION

** N bytes depending on parameter list

*** Present only for NON level 1 procs & funcs

Parametric Procedures & Functions:

parameter



Automatic Stack Expansion

```
TST.W     e(A7)                    dynamic + static
```

OR

```
MOVE.L    A7, A0
SUB.L     #size, A0                dynamic + static
TST.W     (A0)
```

misc Topics

IU Trap Handler

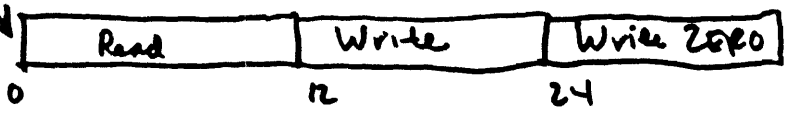
3 Flavors of 4 byte JSR, JMP, LEA, PEA

Set & String Constants

26½ bit Address Space

Mapping extra block(s) for code & data

($D00 - 176)



THE COMPILER

Files needed: COMPILER.OBJ
CODE.OBJ
MPASLIB.OBJ, NOFPLIB.OBJ, or IUPASLIB.OBJ

GENERAL INFORMATION

The compiler is split into two programs, COMPILER.OBJ and CODE.OBJ. COMPILER.OBJ (invoked by the Monitor's C(ompile option) parses the Pascal program text into semantically equivalent tree structures. CODE.OBJ (invoked by the G(enerate command) then turns these trees into 68000 code. The compiler follows the proposed ISO standard Pascal with some exceptions and extensions. A complete definition of Lisa Pascal can be found in the Pascal Language Reference Manual. The definition of I-code formats and MPaslib information can be found in the Development System Internal Documentation.

The compiler first asks for the

Input file -

The .TEXT extension is added, if necessary. In the following prompts, the bracketed text is used if you leave out that portion of the file names.

Listing file (<cr> for none) -
Output file [<input name>] [.I]
Debug file [<input name>] [.DBG] - NOT AVAILABLE

If you do not want a debug file created, type <ESC><cr>. <cr> always accepts the default setting. If you write both the .I file and the .DBG file to the same volume, use the [*] specification on the .I file to avoid space problems. The trouble arises when you have one large block on the volume. When the operating system allocates space for a file, it gives the file all of the largest block it can find unless you specify otherwise. If no other block of space exists and all of the existing block has been allocated to the .I file, you get a "no room on vol" error when the system attempts to open the .DBG file, even if there is plenty of room for both. The [*] specification tells the operating system to allocate only half of the largest available block to the file.

The Pascal run time support routines are in MPASLIB. If you do not need the floating point arithmetic routines, you can use NOFPLIB instead of MPASLIB. If you are using intrinsic units, use IUPASLIB.

COMPILER OPTIONS

$C+ or $C- - Turns code generation on (+) or off (-) on a procedure by procedure basis. The default is C+.

$D+ or $D- - If the $D option is on (the default), the compiler places procedure names in the object file. The object file is slightly larger, but LisaBug use becomes much more pleasant.

$DECL - Compile time variable declaration (conditional compilation). Compile time variables must be declared before they can be used (in $SETC), and all declarations must precede the first procedure or function definition in the program. The $DECL compiler option does not exist until the version 8.0 compiler.

$E filename - Starts logging compile time errors as they are encountered. This option is analogous to the $L option.

$ELSEC - Conditional compilation.

$ENDC - Conditional compilation.

$I filename - Includes the file 'filename' in the compilation. The filename cannot begin with a '+' or a '-'.

$IFC - Conditional compilation.

$L filename - Starts making a listing of the compilation in file 'filename'. If a listing is already in progress, that file is closed and saved before the new listing file is opened.

$L+++ or $L--- - The first +/- turns listing on (+) or off (-) during the first pass. The second +/-, if present, turns on or off the listing with object code offsets during the second pass. The third +/-, if present, controls the production of an interlisting during the second pass.

$R+ or $R- - Turns range checking on (+) or off (-). Currently, range checking is done in assignment statements, on array indexes, and for string value parameters. The default is $R+.

$S segment - Starts putting code modules into the segment named 'segment'. The default segment (' ') holds the main program and all built-in support code. All other code can be placed in any segment.

$SETC - Compile time variable declaration and assignment.

$U filename - Searches the file 'filename' for any subsequent units.

$X+ or $X- - Turns stack expansion code on (+) or off. The default is $X+.

$%+ or $%- - Allows the use of percent signs as legal characters in identifier names. The default is $%-. The % option should not be used by normal applications.

PACKING INFORMATION

Packed records are very expensive in terms of the number of bytes of code generated by the compiler to reference a field of a packed record. In general, you should avoid packing records unless there are many more instances of a particular record than there are references to it.

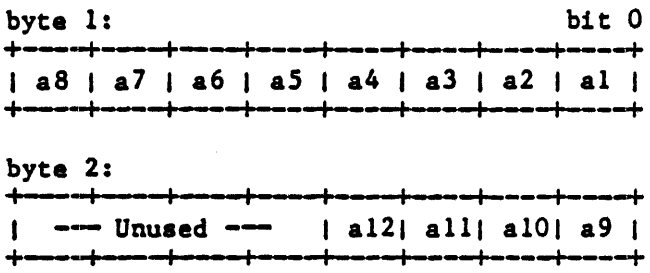
Packed arrays are also code-expensive, with one exception. Packed arrays of char are treated as a special case, and the code associated with them is compact.

To paraphrase von Neumann, anyone who needs to know the details of the packing algorithms is in a state of sin, but the following is provided for the sake of completeness.

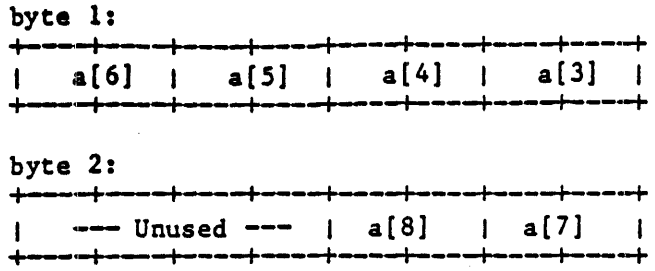
Elements of packed arrays are stored with multiple values per byte whenever more than one value can be fit into a byte. This only happens when the values require 4 bits or less. Values requiring 3 bits are stored into 4 bits.

The first value in a packed array is stored in the lowest numbered bit position of the lowest addressed (most significant) byte. Subsequent values are stored in the next available higher numbered bit positions within that byte. When the first byte is full, the same positions are used in the next higher addressed byte. Consider the following examples:

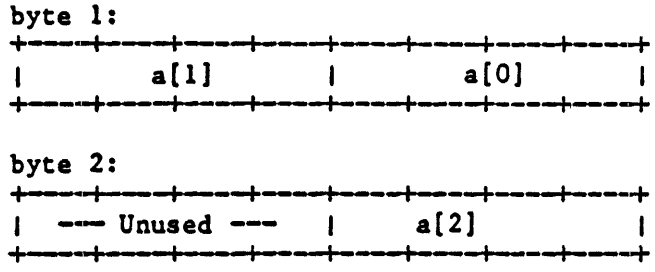
a: PACKED ARRAY[1..12] OF BOOLEAN



b: PACKED ARRAY[3..8] OF 0..3



c: PACKED ARRAY[0..2] OF 0..7
or
PACKED ARRAY[0..2] OF 0..15



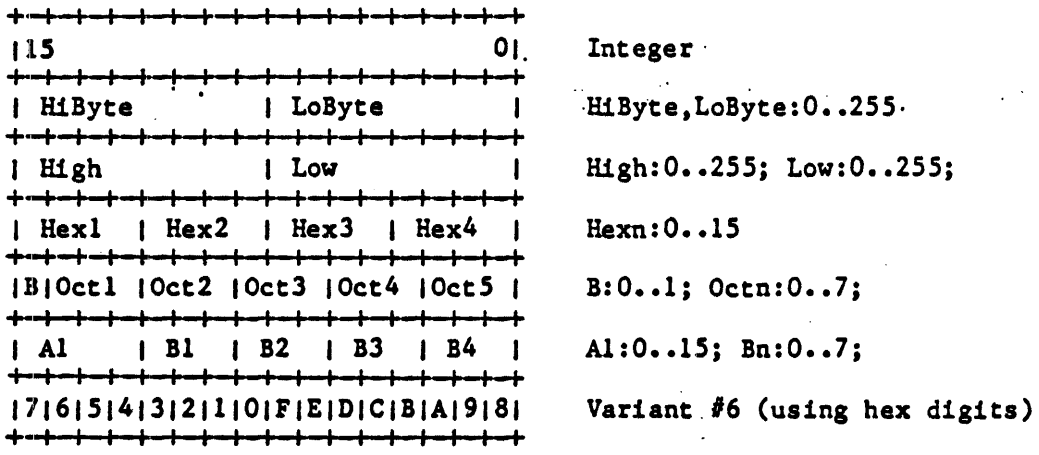
You can use the @ operator to poke around inside any packed value and thereby discover what the packing algorithm (probably) is. For example, to get the data given above, you can use a program like the following:

```
Program Test;
Var i:integer;
    p:^integer;
    boolArr:packed array [1..12] of boolean;
Begin
boolArr[1]:=true;       (* find out where lst bit is put *)
for i:=2 to 12 do boolArr[i]:=false;
p:=@boolArr;
WriteLn('equiv word is ',p^);
                        (* write the packed array as an integer *)
End.
```

Consider also the following program fragment:

```
BITE = 0..255;
WORDSWAP = PACKED RECORD
               CASE INTEGER OF
                   0:(HWord:INTEGER);
                   1:(HiByte,LoByte:BITE);
                   2:(High:BITE;
                      Low:BITE);
                   3:(Hex1,Hex2,Hex3,Hex4:0..15);
                   4:(Bool:0..1;
                      Oct1,Oct2,Oct3,Oct4,Oct5:0..7);
                   5:(A1:0..15;
                      B1:0..7;
                      B2:0..7;
                      B3:0..7;
                      B4:0..7);
                   6:(Bin:PACKED ARRAY[0..15] OF 0..1)
               END;
```

Each variant gets packed into 16 bits. The question then is, where in the 16 bits do the various portions of the variants get placed:



LISA PASCAL AND APPLE PASCAL

Lisa and Apple Pascal are quite similar. We give below a list of the major differences, and a section of hints for translation from Apple to Lisa Pascal. Full details can be found in the Pascal Language Reference Manual.

EXTENSIONS TO APPLE PASCAL

@ Operator
CASE OTHERWISE Clause
POINTER function
Hexadecimal constants
DISPOSE
ORD4 function
Global GOTO
Parametric Procedures and Functions

DELETIONS FROM APPLE PASCAL

Initialization block in UNIT declaration
PWROFTEN, TREESEARCH, BYTESTREAM, WORDSTREAM, KEYBOARD
Extended comparisons
Some Compiler options
SEGMENT Procedures and Functions

REPLACEMENTS FOR APPLE PASCAL FEATURES

Long Integers -- 32 bit integers
Scan -- ScanEq and ScanNe
TURTLEGRAPHICS and APPLESTUFF -- LisaGraf

TRANSLATION FROM APPLE PASCAL TO LISA PASCAL

Translation of Apple Pascal programs is usually not very difficult. The following hints may be of use to you if you find yourself saddled with the translation task. Thanks to Ken Friedenbach for the hints!

MOVELEFT(Source_Buf[i],Dest_Buf[k],n) can be translated into:

```
FOR LocalI:=0 TO n-1 DO Dest_Buf[LocalI+k]:=Source_Buf[LocalI+i];
```

It may be necessary to declare the local integer used as the FOR loop control variable.

MOVERIGHT(Source_Buf[i],Dest_Buf[k],n) becomes:

```
FOR LocalI:=n-1 DOWNTO 0 DO Dest_Buf[k+LocalI]:=Source_Buf[i+LocalI];
```

FILLCHAR(Buf[i],n,Ch) becomes:

```
FOR LocalI:=0 TO n-1 DO Buf[i+LocalI]:=ch;
```

i:=SCAN(n,<>ch,Buf[k]) becomes:

```
LocalI:=0;
IF n>0 THEN
  WHILE (LocalI<n) AND (Buf[k+LocalI]=ch) DO LocalI:=LocalI+1
ELSE
  WHILE (LocalI>n) AND (Buf[k+LocalI]=ch) DO LocalI:=LocalI-1;
i:=LocalI;
```

If SCAN is looking for =ch, just substitute <>ch in the loops above.

READ(KEYBOARD,ch) becomes:

```
UNITREAD(2,ChArr,1);
ch:=ChArr[0];
```

where chArr=packed array [0..1] of char.

EOLN(KEYBOARD)

can check the character read above. If ch=CHR(13) then EOLN is true.

KEYPRESS

is NOT UNITBUSY(2).

Strings must be given a length, non-local EXITs must be replaced with GOTOs.

ClearScreen and other such functions can be handled by Jim Merritt's CUSTOMIO unit. ClearScreen on the Lisa is presently WRITE(CHR(27),CHR(42));

If underbars are used in the Apple Pascal program, they must be used consistently (they are ignored by the Apple Pascal Compiler!).

If the Apple Pascal units have code in the intialization block, put it in a procedure called at the beginning of the program.

To force segments to be resident, build a chain of dummy procedure calls that forces the loader to keep them all in core. The main program then becomes a procedure called by the top of the chain. Say we have 3 segments called SEG1, SEG2, and SEG3, and have put our main program into a procedure named MAIN_PROGRAM. We can now force everything to be memory resident by adding the following procedures:

```
(*$S SEG1*)
Procedure Kludge3;
BEGIN
Main_Program;
END;

(*$S SEG2*)
Procedure Kludge2;
BEGIN
Kludge3;
END;

(*$S SEG3*)
Procedure Kludge1;
BEGIN
Kludge2;
END;

(*$S            *)
BEGIN
Kludge1;
END.           (* end of main program *)
```

THE LINKER

Files needed: LINKER.OBJ or IULINKER.OBJ

GENERAL INFORMATION

The Linker combines object files. Its input consists of commands and object files. Its output consists of object files, link-map information, and error messages. Partial links are allowed. The output of the compiler must be linked with some version of PASLIB.OBJ before it can be executed. Other object files, including libraries, partial links, and object files produced by the Assembler, can also be linked into the output object file.

The Intrinsic Unit Linker (IULINKER.OBJ) expects to find the file *INTRINSIC.LIB even if you are not using any intrinsic units. LINKER.OBJ ('The Linker' in this chapter) expects to find LOADER.IMAGE somewhere on the system.

LINKER PROMPTS

The linker first prompts for the names of the input files:

```
Input file [.OBJ] -
```

It continues to ask for input files until you type <cr>. The next request is for the

```
Listing file -
```

Type <cr> if you don't want any listing file. The last request is for the name of the

```
Output file [.OBJ] -
```

LINKER COMMAND FILES

The Linker can read commands from a text file. At any time you can switch to such a file by typing '<' followed by the name of the file in which the commands reside. If there is a blank line in the file, the Linker assumes that this line is equivalent to the <cr> typed to end input file input. The line after the blank line (if any) is the listing file name, and the line after that is the output file name. These two files need not be given in the command file.

LINKER OPTIONS

Linker options can be entered at any time in response to the prompt for an input file. The options do not have any effect until the link begins. In particular, segment names cannot be mapped to several different names.

The Intrinsic Unit Linker has the following options:

+A Alphabetical listing of symbols. The default is -A.

+D Debug information. The default is -D.

+H num +H sets the maximum amount of heap space the Operating System can give a program before allowing it to die. Here, as in the other options, 'num' can be either decimal or hexadecimal.

-H num -H sets the minimum amount of heap space needed by a program.

+L Location ordered listing of symbols. The default is -L. The location is the segment name plus offset.

+M fromName toName
+M maps all occurrences of the segment 'fromName' to the segment 'toName'. This allows you to map several small segments into a single larger segment. You can thereby postpone the segmentation decision until link time by using many segment names in the source code.

+P Production link. The default is -P. +P produces a 'production' .OBJ file. A production object file does not contain information used by the debugger and the linker, and intrinsic unit files do not contain a jump table. The production object file can be executed, but cannot be handled by the linker or the debugger.

+S num
+S sets the starting dynamic stack size to 'num'. The default is currently 10000.

+T num
+T sets the maximum allowed location of the top of the stack to 'num'. The default is 128K.

? Prints the options available and their current values.

The Linker has the following options:

? Print out the options and their current values

Q Use Quick_Load blocks in place of Executable blocks. The Monitor has never supported this option.

P Do a Physical (+P) or Logical (-P) link. +P is the default. The logical link uses the MMU's to map logical addresses into physical memory. The physical link maps all of memory linearly. A logically linked program is more sensitive to uninitialized pointer problems than a physicaly linked program. If a physical link is performed, the linker and the executable program it produced must execute with the default stack pointer set to the same location. The default stack pointer value is $80000.

THE LINKER OUTPUT FILE

If no errors occur during the link, the output file contains the result of the link. If all external references are resolved and a starting location is specified, the output file is an executable object file. You must link in MPASLIB.OBJ or its equivalent to resolve all external references.

ERROR MESSAGES

The Linker reacts in three general ways to dubious usage. It gives a warning message if some action cannot be performed. This kind of message can be distinguished from the others by carefully noting that it begins with:

*** Warning

In order to recover from the error, simply reenter the command correctly, and all will proceed as though no error had occurred.

An error that makes it impossible for the Linker to complete the link successfully causes a message that begins:

*** Error

The link process can be continued, however, so that any further problems can be discovered.

A fatal error causes the link to be terminated immediately and sends a message beginning with:

*** Fatal Error

See the section on errors for a complete list of the Linker error messages.

EXTERNAL NAMES

An external name is a symbolic entry point into an object module. All such names are visible at all times--there is no notion of the nesting level of an external name. External names can be either global or local. A local name begins with a $ followed by 1 to 7 digits. No other characters are allowed. A global name is any name which is not a local name.

The scope of a global name is the entire program being linked. Unsatisfied references to global names are allowed. Only one definition of a given global name may occur in a given link.

The scope of the local name is limited to the file in which it resides. When a partial link is done, global names are passed through to the output file unmodified, but local names are renamed so that no conflicts occur between local names defined in more than one file. All references to a given local name must occur within the same input file.

MODULE INCLUSION

The first file presented to the Intrinsic Unit Linker must be either a main program file to be linked, or an unlinked intrinsic unit file. You cannot have both intrinsic unit and main program files in a single link. All modules from a non-library file are included in the output file. Only those modules which are needed in the link, however, are taken from a library file. The Linker considers a module to be needed if:

1) it defines an unresolved global name, or

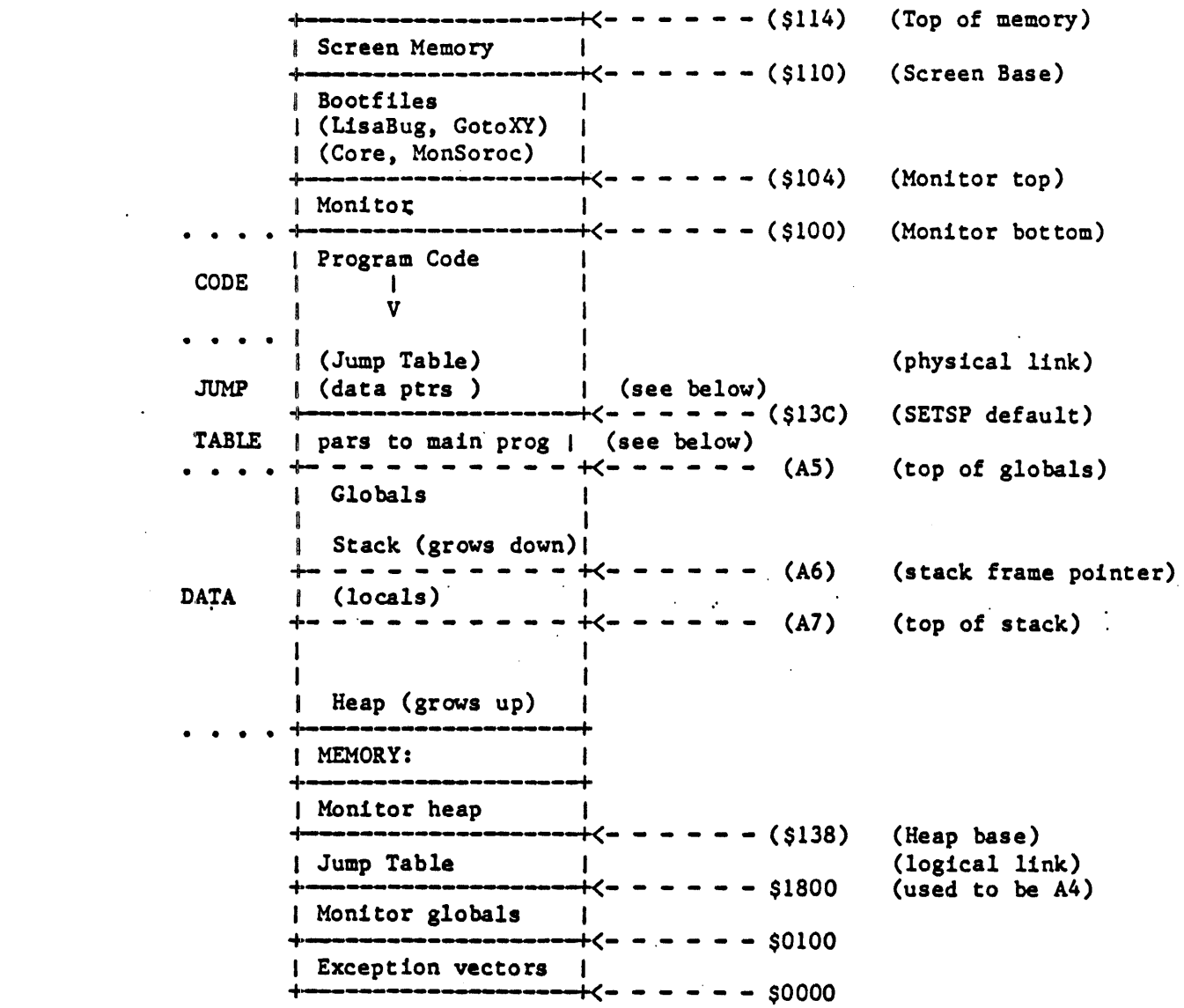
2) it is referenced by a module in the same library file that is included in the output file.

A module is not included simply because it references an already defined global name. Thus, the inclusion of a library module is dependent on the order in which files are specified to the Linker--the module must be specified after the modules that reference it. You can easily use an alternate module to one in a library by including the alternate prior to specifying the library file.

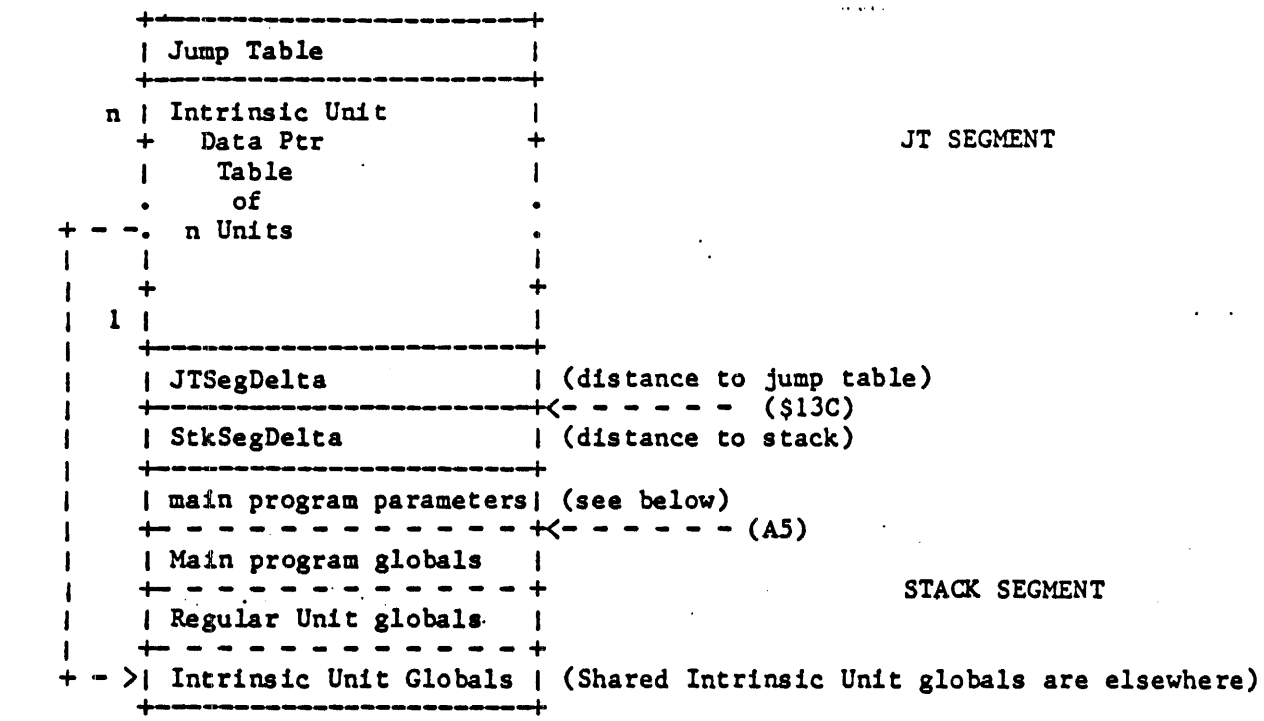
After linking an intrinsic object file and before referring to it in another link, ypou must update the segment and unit tables in *INTRINSIC.LIB with the IUMANAGER utility. IUMANAGER is described in the Utilities Chapter of this manual.

STRUCTURE OF AN EXECUTING PROGRAM

When a program is executing, the Lisa memory map is:

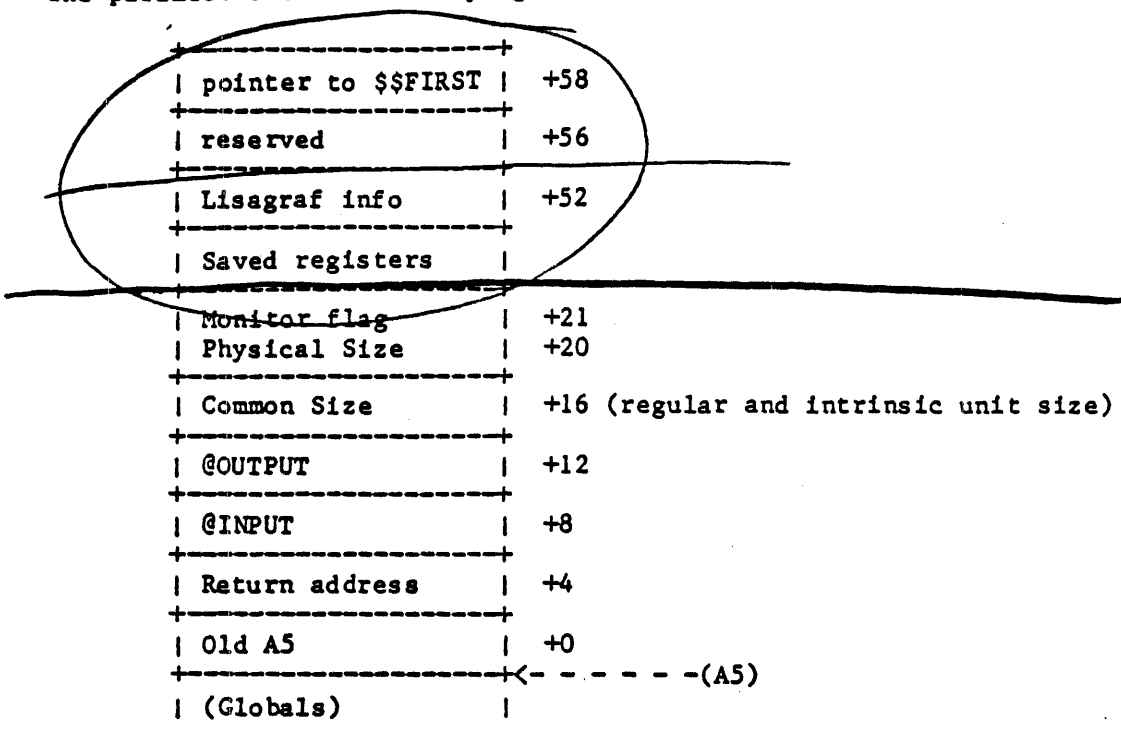


A physical link places the Jump Table above A5, but a logical or Intrinsic Unit link places the Jump Table at $1800 to free up A4 for code optimization. Even when placed at $1800, the Jump Table is logically above A5. The program globals are located below A5. The details of the portion of memory addressed by offsets from A5 is:

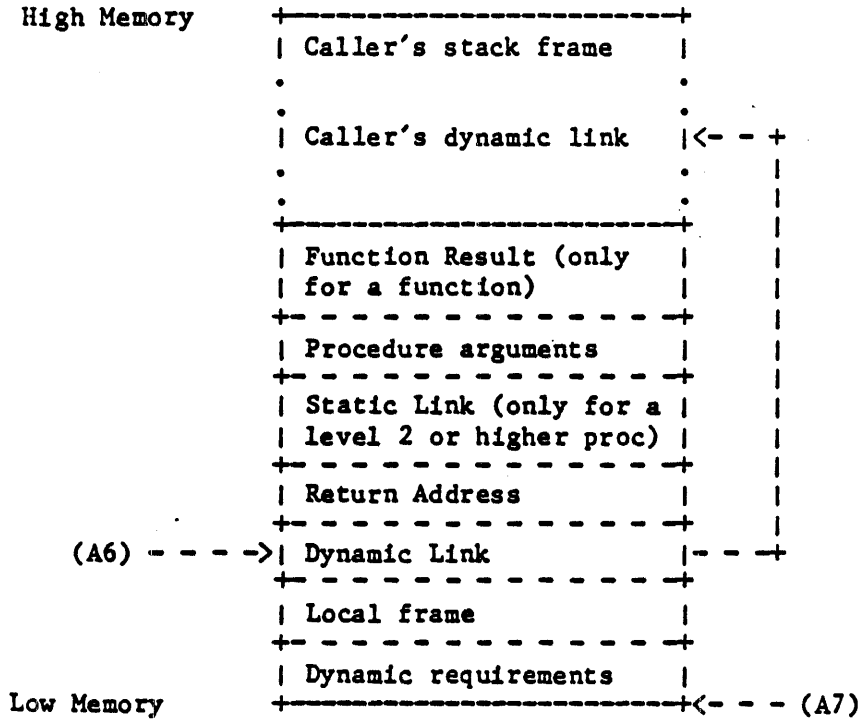


If the program is using shared intrinsic units, some of the intrinsic unit data pointers point to locations in the Shared Data Segment which contains global data used by all processes. The JT Segment is read-only and grows up. The stack segment is read-write and grows down.

The parameters to the main program are:



A6 is the stack frame pointer. The stack frame of a procedure is:



THE 68000 ASSEMBLER

Files Needed: ASSEMBLER.OBJ
N68K.OPCODES
N68K.ERRORS

GENERAL INFORMATION

The Assembler is derived from the TLA Assembler on the Apple II. When invoked, it asks first for

```
Input file [.TEXT] -
```

You can reset the values of the options displayed, or give the name of the assembly source file. The next prompts are:

```
Listing file ( <CR> for none) -
Output file [inputname] [.OBJ[*] ] -
Symbols file [inputname] [.SYMBOLS] ( <ESC> for none) -
```

The symbols file is sometimes used during debugging, although the compiler D+ option provides a similar service with less hassle. The symbol table is discussed in more detail below in the section 'Communication with Pascal'.

If you specify a file, rather than PRINTER: or CONSOLE: as the listing file, it is probably wise to specify that the listing file take only half of the largest area on the volume by adding [*] to the file name. If this is not done, the first opened file may take up all the free area on the volume, and later attempts to open a file will fail. The assembler uses a temporary work file, so even if you do not ask for a listing file, the system may complain about not being able to find room on the volume. If you specify a size, be certain the size is not too small for the listing file.

If an error is encountered and the file N68K.ERRORS is on your prefix volume, the Assembler gives an error message as well as the error number. The error messages are also given in the Errors chapter of this manual.

The 68000 opcodes are described in the Motorola MC68000 Microprocessor User's Manual. The assembler has two variant mnemonics for branches (BHS for BCC and BLO for BCS). The variant names are more indicative of how the instruction is being used after unsigned comparisons. The default radix is decimal. It should be noted that the Assembler accepts generic instructions and assembles the correct form. The instruction ADD, for example, is assembled into ADD, ADDA, ADDQ, or ADDI, depending on the context.

```
ADD     D3,D5
```

becomes `ADDA    D3,D5`.

MOVE, CMP, and SUB are handled in a similar manner.

ASSEMBLER OPTIONS

The Assembler has three options:

M	toggles whether detailed Pass2 information is printed
S	toggles whether information about available space is printed
C	determines whether a .CODE or .OBJ file is created. +C produces a .CODE file (for male byte sex machines). -C (the default) produces a .OBJ file.

The current value of each option is displayed when the Assembler is invoked.

ASSEMBLER SYNTAX

$	= hex
@	= local label
_	is a legal identifier character
%	A legal identifier character except inside a macro definition. In a macro definition, %n is a reference to the nth parameter of the macro.
.	is a legal character
#	immediate operand
'	delimits strings
;	begins comments
*	current location

The size of an operation (byte, word, or long) is specified by appending either .B, .W, or .L to the instruction. The default operation size is word. To cause a short forward branch, append a .S to the instruction. The default branch size is Long.

Only the first eight characters of identifier names are meaningful to the assembler. The first character must be alphabetic; the rest must be alphanumeric, period, underbar, or percent sign.

Labels begin in column one. They can be followed by a colon, if you like. Local labels can be used to avoid using up the storage space required by regular labels. The local label stack can handle 21 labels at a time. It is cleared every time a regular label is encountered. Local labels in this assembler start with the character @.

All quantities are 32 bits in size unless constrained by the instruction. Expressions are evaluated from left to right with no operator precedence. Angle brackets can be used to control expression evaluation. The following operators are available:

+	unary or binary addition
-	unary minus or subtraction
~	ones complement (unary operator)
^	exclusive or
*	multiplication
/	division (DIV)
\	MOD
|	logical OR
&	logical AND
=	equal (used only by .IF)
<>	not equal (used only by .IF)

The following is a summary of the addressing mode syntax for the 68000:

Mode	Register	Syntax	Meaning	Extra Words
0	0..7	Di	Data direct	0
1	0..7	Ai	Address direct	0
2	0..7	(Ai)	Indirect	0
3	0..7	(Ai)+	Postincrement	0
4	0..7	-(Ai)	Predecrement	0
5	0..7	e(Ai)	Indexed	1
6	0..7	e(Ai,Ri)	Offset indexed	1
7	0	e	Absolute short address	1
7	1	e	Absolute long address	2
7	2	e	PC Relative	1
7	3	e(Ri)	PC Relative indexed	1
7	4	#e	Immediate	1 or 2

Notes:

1) The indexed and PC relative indexed modes are determined by the opcode.
2) The absolute address and PC relative address modes are determined by the type of the label (absolute or relative).
3) The absolute short and long address modes are determined by the size of the operand. Long mode is used only for long constants.
4) The number of extra words for immediate mode is determined by the opcode (.W or .L).

To specify which registers are affected by Move Multiple (MOVEM), specify ranges of registers with "-", and specify separate registers with "/". For example, to push registers D0 through D2, D4, and A0 through A4 onto the top of the stack:

```
MOVEM.L   D0-D2/D4/A0-A4,-(A7)
```

ASSEMBLER DIRECTIVES

The Assembler directives (pseudo-ops) are:

```
.PROC   <identifier>[,Expr]     begin procedure with Expr args
.FUNC   <identifier>[,Expr]     begin function with Expr args
.END                            end of entire assembly

.ASCII  '<character-string>'    place ASCII equivalents of chars in code
.BYTE   <value-list>            allocate a byte in code for each value
.BLOCK  <length>[,value]        allocate length bytes of value
.WORD   <value-list>            allocate a word for each value
.LONG   <value-list>            allocate a long word for each value
.ORG    <value>                 place next byte at <value>
.EQU    <value>                 set label equal to <value>

.MACRO  <identifier>            begin macro definition
.ENDM                           end macro definition

.IF     <expr>                  begin conditional assembly
.ELSE                           optional alternate to .IF block
.ENDC                           end conditional assembly

.DEF    <identifier-list>       make identifiers externally available
.REF    <identifier-list>       declare external identifiers that will be used

.LIST                           turn on assembly listing
.NOLIST                         turn off assembly listing
.PAGE                           issue a page feed in listing
.TITLE  '<title>'               title of each page in listing

.INCLUDE <filename>             insert <filename> into assembly
```

COMMUNICATION WITH PASCAL (.PROC and .FUNC)

Pascal programs can call assembly language procedures in a manner similar to that found in the UCSD system. The Pascal program declares the assembly language procedure or function to be EXTERNAL. If the assembly routine does not return a value, use .PROC. If .FUNC is used, space for the returned value is inserted on the stack just before the function parameters, if any. The amount of space inserted depends on the type of the function. A LongInt or Real function result takes two words, a Boolean result takes one word with the result in the high order byte, and other types take one word. In the following example, we link a bit-twiddling assembly language routine into a Pascal program. The Pascal host file is:

```
PROGRAM BITTEST;
VAR I,J: INTEGER;
FUNCTION  Iand( i, j : INTEGER ) : INTEGER;
    EXTERNAL;              (* external = Assembly language *)

BEGIN
  i := 255;
  j := 33;
  WRITELN (I,J,' AND = ',Iand (I, J));
  END.
```

The Assembler file is:

```
        .FUNC   IAND,2                  ; two arguments
        RORG    0
        MOVE.L  (A7)+,A0                ; return address
        MOVE.W  (A7)+,D0                ; J
        MOVE.W  (A7)+,D1                ; I
        AND.W   D1,D0                   ; I AND J
        MOVE.W  D0,(A7)
        JMP     (A0)
        .END
```

In the example given above we have made little attempt to make the assembly language procedure mimic the structure of a procedure generated by the Pascal Compiler. A complete description of this structure requires some preliminary discourse.

Automatic stack expansion code makes procedure entries a little complicated. To ensure that the stack segment is large enough before the procedure is entered, the compiler emits code to 'touch' the lowest point that will be needed by the procedure. If we 'touch' an illegal location (outside the current stack bounds), the MMU hardware signals a bus error which causes the 68000 to generate a hardware exception and pass control to an exception handler. This code, provided by the operating system, must be able to restore the state of the world at the time of the exception, and then allocate enough extra memory to the stack that the original instruction can be re-executed without problem. To be able to back up, the instruction that caused the exception must not change the registers, so a TST.W instruction with indirect addressing is used.

In the normal case, the procedure's LINK instruction should be preceded by a TST.W e(A7) which attempts to reach the stack location that can accomodate the static and dynamic stack requirements of the procedure. If the static and dynamic stack requirements of your assembly language procedurez are less than 256 bytes, you can assume that the compiler's fudge factor will protect the assembly language procedure, so the TST.W can be omitted. If the requirements are greater than 32K bytes, e(A7) may not be sufficient because only 16 bits of addressability are available (the 68000 does call a 16-bit processor). In this case, the compiler currently emits code something like:

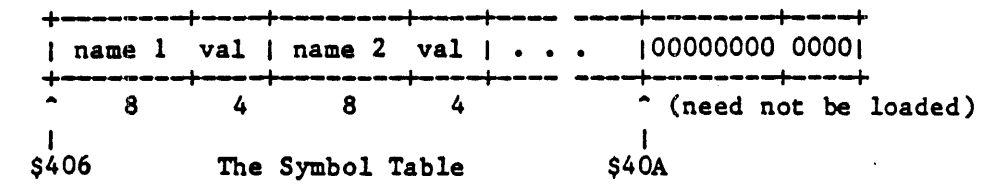
```
MOVE.L  A7,A0
SUB.L   #Size,A0        ;#size=dynamic + static requirements
TST.W   (A0)
```

If the compiler option D+ is in effect (the default), the first eight bytes of the data area following the final RTS or JMP (A0) contain the procedure name. LisaBug gets the procedure name from this block, making debugging much more pleasant. The following example is provided to show how an assembly language programmer can provide LisaBug with all the information it needs to perform fully symbolic low level debugging.

```
;
;   ASSEMBLY LANGUAGE EXAMPLE
;
DEBUGF  .EQU    1               ; true => allow debugging with proc names

;
;   HEAD -- This MACRO can be used to signal the beginning of an assembly
;   language procedure.  HEAD should be used when you do not want to
;   build a stack frame based on A6, but do want debugging information.
;
;   No arguments

        .MACRO  HEAD
        .IF     DEBUGF
        LINK    A6,#0           ; fancy NOP just for debugging purposes
        MOVE.L  (A7)+,A6
        .ENDC
        .ENDM

;
;   TAIL -- This MACRO can be used as a generalized exit sequence.  There
;   are two cases.  First, if you build a stack frame, TAIL can be used
;   to undo the stack frame, delete the parameters (if any) and return.
;   Second, if you do not want to build a stack frame based on A6,
;   this MACRO can be used to signal the end of an assembly language
;   procedure.  In either case if DEBUGF is true, the Procedure_name
;   is dropped by the MACRO as an 8 character name.
;
```

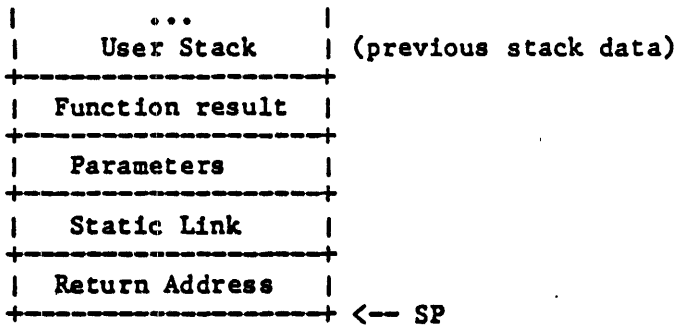
```
;   Three arguments:
;
;         1) Number of bytes of parameters to delete
;         2) Procedure_Name (maximum of 8 chars, no trailing blanks)
;         3) Number of blanks needed to complete 8 character name
;
;   If the 7.0 assembler is used the .BLOCK kludge can be removed.
;   The previous assembler (good old TLA) removes trailing blanks from
;   strings passed as arguments to a MACRO
;
        .MACRO  TAIL
        UNLK    A6
        .IF     %1 = 0
          RTS                           ; 0 bytes of parameters
        .ELSE
          .IF   %1 = 4
            MOVE.L  (A7)+,(A7)          ; 4 bytes of parameters
            RTS
          .ELSE
            MOVE.L  (A7)+,(A0)          ; 2 or >4 bytes of parameters
            ADD.W   #%1,A7              ; asm ADDQ.W or ADDA.W
            JMP     (A0)
          .ENDC
        .ENDC
        .IF     DEBUGF
        .ASCII  %2
        .BLOCK  %3,$20
        .ENDC
        .ENDM
;
;   The following example demonstrates the use of the TAIL macro for the
;   purpose of debugging.  The example assumes that you want to build
;   a stack frame based on A6.  In a real assembly language procedure the
;   zeroes below would be replaced by the local size and parameter size.

        .PROC   SIMPLE,0
        LINK    A6,#0               ; zero here indicates zero bytes of locals
        NOP                         ; body of procedure
        TAIL    0,'SIMPLE',2        ; zero here indicates zero bytes of parameters

        .END
```

These macros are sufficient for the programmer writing small assembly language routines to be called from Pascal. If, however, you want the debugger to be able to handle symbols in a single huge .PROC (an interpreter, or an operating system, for example), you need to set up the symbol table yourself. The Assembler can create a .SYMBOLS file for you. Each entry in the file (and in the symbol table) contains 12 bytes. The first 8 bytes are the symbol name, left justified and padded with trailing spaces. The last 4 bytes are the symbol's value. The debugger uses location $406 to find the first entry in the table. Location $40A points to the first free entry (just past the last entry in the table).



To load your symbol table, load the .SYMBOLS file into memory, offset each of the symbol values by the loading address of your program, and reset the pointers in $406 and $40A to point to the new location of the table. The debugging version of the Monitor loads M.SYMBOLS into memory in exactly this manner so that the debugger can provide symbolic disassembly of the Monitor. If the symbols for the registers (RD0..RD7, and so on) are not in the table, the debugger appends them to the table when it is first invoked.

Upon entry to the assembly routine, the stack is:



D0-D2/A0-A1:	Scratch registers (can be clobbered)
D3,A2	Scratch registers, but should be preserved
D4-D7/A3,A4	Used for code optimization
A5:	Pointer to user globals (must be preserved)
A6:	Pointer to base of stack (must be preserved)
SP:	Top of stack

Registers D3 and A2 may be used at some time in the future by the compiler for code optimization, so the assembly language programmer should preserve them also.

The function result is present only if the Pascal declaration is for

a function. It is either one or two words. If the result fits in a single byte (a boolean, for example), the most significant half (the lower addressed half) gets the result value.

Parameters are present only if there are parameters. They are pushed on the stack in the order of declaration. All reference parameters are represented as 32 bit addresses. Value parameters less than 16 bits in size always occupy a full word. All non-set value parameters larger than 4 bytes are passed by reference. It is the procedure's responsibility to copy them. All large set value parameters are pushed onto the stack by the calling routine.

The static link is present only if the external procedure's level of declaration is not global. The link is a 4 byte pointer to the enclosing static scope.

It is the responsibility of the assembly language procedure to deallocate the return address, the static link (if any), and the parameters (if any). The SP must point to the function result or to the previous top of the stack upon return. Registers D4 through D7 and A3 through A7 must be preserved. It is recommended that you also preserve D3 and A2.

SPACE ALLOCATION DIRECTIVES

The space allocation directives are .ASCII, .BYTE, .WORD, .LONG, and .BLOCK.

```
        .ASCII  'string'
```

converts 'string' into the equivalent ASCII byte constants and places the bytes in the code stream. The string delimiters must be single quotes. To insert a single quote into the code:

```
        .ASCII  'AB'
        .BYTE   $27     ;ASCII equivalent of single quote
        .ASCII  'CD'
```

assembles the string AB'CD.

```
        .BYTE   <values>
```

allocates a byte of space in the code stream for each of the values given. Each value must be between -128 and 255.

```
        .BLOCK  <length>[,value]
```

allocates <length> bytes for each value listed. If no value is given, a block of zeros is allocated.

```
        .WORD   <values>
```

allocates a word of space in the code stream for each of the values listed. The values must be between -32768 and 65535. For example,

```
TEMP    .WORD   0,65535,-2,17
```

creates the assembled output:

```
        0000
        FFFF
        FFFE
        0011
```

```
        .LONG   <values>
```

allocates two words of space for each value in the list. For example,

```
STUFF   .LONG   0,65535,-2,17
```

creates the output:

```
        00000000
        0000FFFF
        FFFFFFFE
        00000011
```

```
<label>  .EQU   <value>
```

assigns <value> to <label>. <value> can be an expression containing other labels.

```
        .ORG    <value>
```

puts the next byte of code at <value> relative to the beginning of the assembly file. Bytes of zero are inserted from the current location to <value>.

```
        .RORG
```

is similar to .ORG. It indicates that the code is relocatable. Because the loader does not support the .ABSOLUTE pseudo-op, RORG is mostly cosmetic.

RORG (without the leading period) is the same as .RORG. Similarly, END = .END, EQU = .EQU, PAGE = .PAGE, LIST = .LIST, NOL = .NOLIST, and TTL = .TITLE. The TLA directives .INTERP and .ABSOLUTE have not been implemented. The TLA directives .PRIVATE, .PUBLIC, and .CONST are currently unimplemented.

MACRO DIRECTIVES

A macro consists of a macro name, optional arguments, and a macro body. When the assembler encounters the macro name, it substitutes the macro body for the macro name in the assembly text. Wherever %n occurs in the macro body (where n is a single decimal digit), the text of the n-th parameter is substituted. If parameters are omitted, a null string is used in the macro expansion. A macro can invoke other macros up to five levels deep. In the assembly listing, macros are shown fully expanded and marked with a '#' in the left margin.

```
.MACRO  <identifier>
.
.
.ENDM
```

defines the macro named <identifier>. The macros HEAD and TAIL are defined above. As a further example, consider:

```
.MACRO Help
MOVE    %1,D0
ADD     D0,%2
.ENDM
```

If 'Help' is called in an assembly with the parameters 'Alpha' and 'Beta', the listing created would be:

```
        Help    Alpha,Beta
#       MOVE    Alpha,D0
#       ADD     D0,Beta
```

CONDITIONAL ASSEMBLY DIRECTIVES

The conditional assembly directives .IF, .ELSE, and .ENDC are used to include or exclude sections of code at assembly time based on the value of some expression.

```
.IF     <expression>
```

identifies the beginning of a conditional block. <expression> is considered to be false if it evaluates to zero. Any non-zero value is considered true. The expression can also involve a test for equality (using <> or =). Strings and arithmetic expressions can be compared. If <expression> is false, the Assembler ignores code until a .ELSE or .ENDC is found. The code between the optional .ELSE and .ENDC is assembled if <expression> is false. Otherwise it is ignored. Conditionals can be nested. The macros HEAD and TAIL given above provide examples of the use of conditionals. The general form is:

```
.IF     <expression>
.               ;assembled only if <expression> is true
.
[.ELSE]         ;optional
.               ;assembled only if <expression> is false
.
.ENDC
```

EXTERNAL REFERENCE DIRECTIVES (.REF and .DEF)

Separate routines can share data structures and subroutines by linkage between assembly routines using .DEF and .REF. These directives cause the Assembler to generate link information that allows separately compiled assembly routines to be linked together. .DEF and .REF associate labels between assembly routines, not between assembly routines and Pascal. The Linker resolves the references.

```
.DEF    <identifier-list>
```

identifies labels defined in the current routine as available to other assembly routines through matching .REFs. The .PROC and .FUNC directives also generate a .DEF with the same name, so assembly routines can call external .PROCs and .FUNCs with .REFs.

```
        .PROC Simple,1
        .DEF Alpha, Beta
        .
        .
        BNE     Beta
        .
        .
Alpha   MOVE
        .
        RTS
Beta    MOVE
        .
        RTS
        .END
```

This example defines two labels, Alpha and Beta, which another assembly routine can access with .REF.

```
        .REF    <identifier-list>
```

identifies the labels in <identifier-list> used in the current routine as available from some other assembly routines which used .DEFs.

```
        .PROC Simple
        .REF Alpha
        .
        .
        JSR     Alpha
        .
        .END
```

uses the label 'Alpha' declared in the .DEF example.

When a .REF is encountered, the assembler generates a short absolute addressing mode for the instruction (the opcode followed by a word of 0's). The assembler's second pass transforms each of these into a short external reference with an address pointer to the word of 0's following the opcode. If the referenced label and the reference are in the same segment module, the Linker changes the addressing mode from short absolute to single word PC relative. If, however, the referenced procedure is in a different segment, the Linker converts the reference to an indexed addressing mode (off A5) and the word of zeros is converted into the proper entry offset in the jump table. If the referenced procedure is in an intrinsic unit (and therefore in a different segment), the IUJSR, IULEA, IUJMP, and IUPEA instructions are used (see page ##). The Linker blindly assumes that the word immediately before the word of zeros is an opcode in which the low order 6 bits are the effective address. Thus, a .REF label cannot be used with any arbitrary instruction. The .REF labels are intended for JSR, JMP, PEA, and LEA instructions.

LISTING CONTROL DIRECTIVES

The directives that control the Assembler's listing file output are .LIST, .NOLIST, .PAGE, and .TITLE. If you do not specify a name for the listing file in response to the Assembler's prompt:

```
Listing file (<cr> for none) -
```

the listing directives are ignored.

.LIST and .NOLIST

can be used to select portions of the source to be listed. The listing goes to the specified output file when .LIST is encountered. .NOLIST turns off the listing. .LIST and .NOLIST can occur any number of times during an assembly.

.PAGE

inserts a page feed into the listing file.

.TITLE '<title>'

specifies a title for the listing page. <title> can contain up to 80 characters.

```
.TITLE 'Interpreter'
```

places the word, Interpreter, at the head of each page of the listing.

FILE DIRECTIVE

The pseudo-op

```
.INCLUDE <filename>
```

causes the contents of <filename> to be assembled at the point of the .INCLUDE. <filename> need not specify the .TEXT suffix. The last character of the filename must be the last non-space character on the line--do not put a comment on this line. An included file cannot itself contain a .INCLUDE statement.

LISABUG

LisaBug allows you to examine, disassemble, and change the contents of memory, set breakpoints, and do immediate assemblies. If the compiler D option is on (the default), procedure names are available to the debugger, and Lisabug uses the symbols wherever appropriate.

Type M to the Monitor command prompt to invoke LisaBug. It asks:

What file?

You can type <cr> to enter LisaBug without any file. If you type a file name, that code file is loaded into LisaBug. The LisaBug command prompt is '>'. The default radix is hexadecimal.

You can drop into LisaBug by hitting the NMI key which is currently the third key from the left in the top row of the numeric keypad.

A FEW EXAMPLES

If you type a file name, LisaBug starts up with the program counter at the start of the program. To see one instruction disassembled (say at 32F96), type

>ID 32F96

(followed by RETURN, of course). ID stands for Immediate Disassemble. Each subsequent ID command, if given without any address, disassembles the next instruction found. In addition to printing the value of each byte, LisaBug prints the ASCII equivalent of that value, if a printable one exists. If none exists, it prints a period.

To disassemble 20 consecutive addresses, type

>IL

IL (Immediate Disassemble Lines) can also be followed by an address. Subsequent IL commands disassemble successive blocks of 20 consecutive locations in memory.

If the object file being examined was compiled with the D+ compiler option, the procedure names are available in LisaBug and can be used in any expressions. For example,

>IL Foo 5

disassembles the first 5 lines of procedure 'Foo'.

>BR Foo+40

sets a break point 40 bytes into procedure 'Foo'.

You can also use labels in immediate assemblies:

```
>sy Ken 6000
>A Ken NOP
```

assembles a NOP instruction at the address 'Ken'.

```
>A 6000 <cr>
>Rich: TAS $100
> <cr>
```

enters the immediate assembler at 6000, defines the label 'Rich', and assembles a TAS instruction.

THE SYMBOL TABLE

The symbol table is the union of the user symbol table and the distributed procedure names. The user symbol table contains the user declared symbols (like 'KEN' in the example above) and the predefined symbols (RDO and friends). Each entry contains twelve bytes. The first eight bytes are the symbol name, and the last four bytes are the symbol's value. Location $406 gives the beginning of the symbol table, and $40A points to the end of the table. The section 'Communication with Pascal' in the Assembler chapter of this manual contains more information about the symbol table.

LISABUG COMMANDS

Definitions:

Constant	A constant in the default base
$Constant	A hex constant
&Constant	A decimal constant
'ASCII String'	An ASCII string
Name	A symbol in the symbol table
RegName	RD0..RD7, RA0..RA7, PC, US, or SS. A predefined symbol in the symbol table with a value set by LisaBug. The value is equal to the value of the register in question. LisaBug automatically updates the values of these symbols. The 'R' is appended to distinguish the register names from hexadecimal numbers.
Expr	An expression. Expressions can contain names, regnames, strings, and constants. Legal operators are + - * /. Expressions are evaluated left to right: * and / take precedence over + and -. (and) can be used to indicate indirection. < and > can be used to nest expressions. In those cases where an odd value is probably a mistake, LisaBug warns you that you are trying to use an odd address. If you decide to go ahead, it subtracts one from the address given. If the compiler option D+ is used, procedure names are also legal in expressions.
Exprlist	A list of expressions separated by blanks.
Register	D0..D7, A0..A7, PC, SR, US, or SS. Note that A7 is SP (the stack pointer).

Moving the LisaBug Window:

P expr Set port number to expr. Valid port numbers are:

0	Lisa keyboard and screen (default)
1	UART Port A (farthest from Power Supply)
2	UART Port B

If you move the port to a UART, you must have a modem eliminator connected to that port.

Symbols and Base Conversion:

SY	Display the values of all symbols
SY name	Display the value of the symbol name
SY name expr	Assign expr to the symbol name
CV exprlist	Display the value of each expression in hex and decimal.
SH	Set the default radix to hex
SD	Set the default radix to decimal

Assembly and Disassembly:

A expr statement

A expr

Assemble one statement (instruction) at expr. If you use the form A expr, LisaBug asks you for the statement to be assembled. You can continue assembling instructions into consecutive locations. Type <cr> to exit the immediate assembler.

ID	Disassemble one line at the next address
ID expr	Disassemble one line at expr
IL	Disassemble 20 lines at the next address
IL expr	Disassemble 20 lines starting at expr
IL expr1 expr2	Disassemble expr2 lines starting at expr1

Upon entering LisaBug, the 'next address' is the current PC.

Set, Display, and Find Memory:

SM exprl exprlist
Set memory with exprlist starting at exprl. SM assumes that each element of exprlist is 32 bits long. To load different length quantities, use SB or SW described below. If the expression given is longer than 32 bits, SM takes just the upper 32. For example, if we ask LisaBug to:

```
SM 1000 'ABCDE'
```

it deposits the ASCII equivalent of 'ABCD' starting at 1000.

SB exprl exprlist
Set memory in bytes with exprlist starting at exprl

SW exprl exprlist
Set memory in words with exprlist starting at exprl

SL exprl exprlist
Set memory in long words with exprlist starting at exprl. For example,

```
SL 100 1
```

is equivalent to

```
SM 100 0000 0001
```

DM expr
Display memory at expr. DM RA3+10, for example, displays the contents of memory from the address pointed to by A3 for 10 bytes. DM (110) displays the contents of the memory location addressed by the contents of location 110.

DM exprl expr2
Display memory. If exprl < expr2, then display memory from exprl to expr2. Otherwise, display memory for expr2 bytes starting at exprl.

DB expr
Display memory as bytes.

DW expr
Display memory as words.

DL expr
Display memory as long words.

FB starting_addr count data
Find Byte.
Find the byte or bytes 'data' in memory between 'starting_addr' and 'starting_Addr'+'count'.

FM starting_addr count data
Find Memory

FW starting_addr count data
Find Word

FL starting_addr count data Find Long

Set and Display Registers:

TD Display the Trace Display at the current PC

register Display the current value of the register. D0, for example, is a command to LisaBug to display the current value in the register D0. RD0, on the other hand, is a name automatically placed in the symbol table to give you a handle on the contents of D0 in an expression.

register expr Set the register to expr

Memory Management:

LP expr Convert logical address to physical address.

D0 expr Set the SEG1/SEG2 bits. These bits determine the hardware domain number. If the Status Register shows that you are in supervisor state, then the effective domain is zero, and the domain number returned by LisaBug is the domain which would be active if the SR were changed to user state.

WP 0 or 1 Diable (0) or Enable (1) Write Protection. The default is 1.

MM start [end_or_count]
MM with one or two arguments displays information about the MMU registers. The second argument defaults to 1. If the starting address is greater than the second argument, the second argument is a count of the number of MMU registers to be displayed. If the starting address is less than the second argument, the second argument is the last register displayed.

MM 70

displays

Segment[70] Origin[000] Limit[00] Control[C]

These values are the Segment Origin, Limit, and Control bits stored by the hardware for each MMU register. As can be seen from a careful perusal of the hardware documentation, a Control value of C means the segment in question is unused (invalid). If the Control value is valid (F, for example), the debugger also displays the Physical Start

and Stop addresses of the segment.

```
MM &100 8
```

displays the MMU register information for the 8 registers starting at register 64 (decimal 100).

MM num org lim cntrl

The MM command followed by four arguments sets the MMU information for segment 'num'. The Origin, Limit, and control bits can be changed. The Monitor uses the first 16 registers, so it is safer not to mess with them.

```
MM 70 100 ff 7
```

sets the Origin of segment 70 to 100 and the control bits to 7 (a regular segment). The segment limit of -1 makes the segment 512 bytes long.

Breakpoints, Patchpoints, Traces, Calls:

BR Display the breakpoints currently set. Up to 16 breakpoints can be handled by LisaBug. Break points are displayed both as addresses and as symbols. An asterisk marks the point of the breakpoint in the disassembly. Patch points are marked with '!'.

BR exprlist Set each breakpoint in exprlist. Symbols are legal, of course, so we can:

```
BR Ralph+4
```

if Ralph is a known symbol.

PA insertion_addr destination_addr

Insert a Patch. PA can be used to insert a sequence of code terminated by a TRAP #$f into another sequence of code. Lisabug maintains a table of patches and return addresses to implement this facility. The trace command works with patches. It displays the next instruction to be executed and its environment. You can have up to 16 patches. A patch can be removed by using the CL (Clear) command with the patch insertion address.

PA Display patch addresses

CL Clear all breakpoints and patchpoints

CL exprlist Clear each breakpoint or patchpoint in exprlist

G	Start running at the current PC
G expr	Starting running at expr
T	Trace one instruction at the current PC
T expr	Trace one instruction at expr
CA expr	Call a subroutine in the debugger's environment.
SC expr	Stack Crawl. Display the user call chain. Expr sets the depth of the display. It can be omitted.
Q	Exit LisaBug, if it was called from Talk
RM	Return to the Monitor. RM checks the interrupt level, stops exec files, and sets the domain to zero. If you are in an interrupt handler, RM may refuse to do anything. If the SR shows 2nxx where n is not zero, you are in an interrupt handler. To get back to the monitor, type G, hit NMI, and try RM again. With any luck, you will escape eventually.
RB	Reboot. The Lisa is reset. Reboot the Apple II and the Lisa should also reboot automatically.

Overcome Inadequate Hardware:

DU expr	Disk unclamp. The Twiggy may not reliably eject the disk at the right time. If you have trouble, try the DU command followed by the drive number. Valid drive numbers are 1 and 2.
DC expr	Disk Clamp. If the Twiggy refuses to suck up the disk and clamp it in place, try the DC command followed by the drive number (1 or 2).
RS	Display the patch Return address Stack

If you have the debug card,

DR	Display index or ranges of dump RAM.
MR	Set a value level #5 interrupt on a word change.

```
register                Display the current value of the register.
register expr           Set the register to expr
A  expr statement
A  expr                 Assemble one statement (instruction) at expr.
BR                      Display the breakpoints currently set.
BR exprlist             Set each breakpoint in exprlist.
CA expr                 Call a LisaBug subroutine
CL                      Clear all breakpoints and patchpoints
CL exprlist             Clear each breakpoint or patchpoint in exprlist
CV exprlist             Display the value of each expression in hex and decimal.
DB expr                 Display memory as bytes.
DC expr                 Disk Clamp.
DL expr                 Display memory as long words.
DM expr1 expr2          Display memory.
DO expr                 Set the SEG1/SEG2 bits.
DR                      Display index or ranges of dump RAM.
DU expr                 Disk unclamp.
DW expr                 Display memory as words.
FB starting_addr count data          Find Byte.
FL starting_addr count data          Find Long
FM starting_addr count data          Find Memory
FW starting_addr count data          Find Word
G                       Start running at the current PC
G expr                  Starting running at expr
ID                      Disassemble one line at the next address
ID expr                 Disassemble one line at expr
IL .                    Disassemble 20 lines at the next address
IL expr                 Disassemble 20 lines starting at expr
IL expr1 expr2          Disassemble expr2 lines starting at expr1
LP expr                 Convert logical address to physical address.
MM expr1 expr2          Display MMU information
MM num org lim ctrl     Set MMU information
MR                      Set a value level #5 interrupt on a word change.
P  expr                 Set port number to expr.
PA insrtaddr destaddr   Insert a Patch.
PA                      Display patch addresses
Q                       Exit LisaBug, if it was called from Talk
RB                      Reboot.
RM                      Return to the Monitor.
RS                      Display the patch Return address Stack
SB expr1 exprlist       Set memory in bytes with exprlist starting at expr1
SC expr                 Stack Crawl.
SD                      Set the default radix to decimal
SH                      Set the default radix to hex
SL expr1 exprlist       Set memory in long words with exprlist starting at expr1.
SM expr1 exprlist       Set memory with exprlist starting at expr1.
SW expr1 exprlist       Set memory in words with exprlist starting at expr1
SY                      Display the values of all symbols
SY name                 Display the value of the symbol name
SY name expr            Assign expr to the symbol name
T                       Trace one instruction at the current PC
T  expr                 Trace one instruction at expr
TD                      Display the Trace Display at the current PC
WP 0 or 1               Diable (0) or Enable (1) Write Protection.
```

THE FILER

File Needed: FILER.OBJ

INTRODUCTION

The Filer is modeled after the UCSD P-system's Filer and provides a similar set of functions. However, there are some small but important differences between the two.

The Monitor Filer requires that a colon follow a volume name in every case. It provides access to as many as 20 on-line volumes. The maximum number of files in a volume directory is 77.

All "workfile" commands and workfile-oriented features of the UCSD Filer have been omitted from the Monitor Filer. The functions of the Monitor utility programs Flipdir and Verify are provided by the Filer commands "S(ex" and "V(erify," respectively.

The UCSD Filer's "V(olume" command has been changed to "O(n-line" in the Monitor Filer. The UCSD Filer's "eX(amine" command is not available in the Monitor Filer.

The Monitor Filer's "T(ransfer" command performs automatic verification of all transfers between blocked devices.

ESCAPE aborts the currently executing function. When a wildcard R(emove or C(hange is aborted, you are asked whether to update the directory. A response of ESCAPE to this question is interpreted as 'No'.

The Monitor Filer includes a volume manager subsystem that permits you to maintain and manage the volume population on a Corvus drive. This subsystem, accessible through the "M" command, replaces the old VMGR utility.

FILER COMMANDS

The following is a list of commands that are recognized by the Filer. Filer commands are invoked by pressing the key which corresponds to the first letter of the command name.

B(ad-blocks - Scans for and reports bad blocks on blocked device.

C(hange - Changes a volume or file name on a blocked device. "Wildcard" file name specifications are recognized.

D(ate - Sets or changes the system date.

E(xtended directory listing - Provides a detailed list of the contents of a blocked volume. "Wildcard" file names specify the display of a directory subset. You can write a directory to a printer with E #4:,PRINTER:

K(runch - Creates the largest possible block(s) of contiguous space on a blocked volume by relocating existing files on that volume. It's a good idea to scan a volume for bad blocks before any attempts are made to Krunch it. Do not Krunch a volume that has bad blocks.

L(ist directory - Provides an summary of the contents of a blocked volume. See "E(xtended directory listing," above.

N(ew - Creates a directory entry with the specified file name. Any volume name used to prefix the file name must be that of an on-line, blocked device. You can attach a size-specification suffix to the end of the file name. This suffix indicates the number of blocks to be occupied by the new file. The suffix consists of a non-negative integer constant or an asterisk ("*"), enclosed in square brackets ("[]"). For example,

```
FARLEY:MYFILE.TEXT[40]
XRAY.OBJ[*]
```

The new file is placed on the specified volume in the first empty space that is large enough to hold it. The asterisk indicates that the file should fill half the largest free area on the volume, or all of the second-largest area, whichever is larger. In the absence of a size specification, the newly-created file occupies the largest area of contiguous free blocks on the volume. Files created with N(ew are stamped with the current system date, while the storage areas to which they correspond are left unaltered. N(ew permits the creation of zero-length files.

O(n-line - Provides a list of all volumes that are on-line.

P(refix - Changes the system prefix volume name.

Q(uit - Exits the Filer.

R(emove - Deletes entries from the directory of a blocked volume on a single-file or "wildcard" basis.

S(ex - Performs sexual reassignment of a blocked volume's directory. This command corresponds to the FLIPDIR utility. The Lisa is a female machine, whereas the Apple II is a male machine.

T(ransfer - Copies and transfers information between volumes. Single-file or multiple-file wildcard transfers are allowed. You can also transfer between blocked and unblocked volumes. Transfers between blocked volumes are automatically verified, but transfers involving unblocked volumes are not.

V(erify - Compares blocked files for equality. You can compare single-files or multiple files common to two blocked volumes. Wildcard specifications can be used to name the comparands, so subsets of the files on one volume can be compared with a congruent subset of files on another volume. Verify detects and reports the following situations:

* The "source" and "destination" files match;
* The source differs from the destination in date-stamp, size, and/or contents (contents are always compared if sizes match, whether or not dates match);
* No counterpart to a given source file exists on the destination volume.

The report produced by Verify can be redirected to a device or file other than the console by following the destination file/volume name specification with a comma, then the name of the desired output device or file. For example,

```
Verify what file/vol  ? VOL1:,VOL2:,PRINTER:
```

is equivalent to:

```
Verify what file/vol  ? VOL1:
Against what file/vol ? VOL2:,PRINTER:
```

The verification report in either of these cases is diverted to the PRINTER: device.

Z(ero - Erases and initializes the directory area of a blocked volume. If the volume already has a directory prior to the Z(ero, you have the option of retaining the old volume name and/or volume size. Z(ero can be used to increase or decrease the size of the virtual volume MEMORY:. Caution should be exercised, however, because it is possible to specify a volume size that is much larger than the LISA memory complement permits. In this case, a "memory overflow" is reported, and you should again invoke Z(ero to shrink MEMORY: to a reasonable size. Do not leave the Filer or attempt to use MEMORY: after receiving the "memory overflow" message!

Remember that Z(ero produces an empty directory. Therefore, to change the size of MEMORY: without erasing the directory, you must still use the CHANGEMEM utility.

vM(gr - Enters the volume manager (vMgr) subsystem, which presents its own sub-menu, and offers the following commands:

L(ist - List the hard disk Volumes (like Filer's O(n-line command). From time to time, you may destroy the directory of one or more volumes that reside on the hard disk. The vMgr

subsystem assigns temporary names to these "bad" volumes so that you can be warned of their contamination, and can also manipulate them, if necessary. The form of such temporary names is BAD*n, where n is an integer (e.g., BAD*1, BAD*10, etc). Temporary names for "bad" volumes are effective only within the vMgr subsystem.

M(ount - M(ount assigns a hard disk volume to a specific Monitor device number, taken from the set [4,5, 9..20]. You can specify the device number to which a volume is associated, or you can accept the default selected by the vMgr. When vMgr picks a default unit number, it chooses the highest number that is not currently in use.

N(ew - N(ew creates new volumes. You can accept the default values for volume size and location as offered by the vMgr, or specify your own.

Q(uit - Leave vMgr subsystem. If you have made any changes to the volume table you must confirm whether or not they should be made permanent in the default mount table. If you respond with any character other than 'Y', any changes made are temporary -- when the system is rebooted, the original settings will take effect.

R(emove - R(emove unmounts and destroys a volume. You can R(emove a M(ounted volume, but to do so you must approve the U)nmounting of that volume.

U(nmount - U(nmount is comparable to removing a floppy from a drive. It disassociates the volume from the unit on which it was mounted. The U(nmounted volume and the data it contains still exist on the hard disk drive, but can not be accessed through any Monitor device.

W(rite-protect - W(rite-protect toggles the write-protection status for a volume. The contents of a write-protected volume cannot be changed. This command changes the default mount table. Newly-created volumes are not write-protected.

See the Apple Pascal Operating System Reference Manual for further information.

THE EDITOR

File needed: EDITOR.OBJ
LISA:EDITOR.FONT
LISA:EDITOR.MENUS
LISA:SYSTEM.FONT

INTRODUCTION

The mouse oriented editor is invoked by the monitor command E. Unlike the UCSD editor (invoked by U), this editor adheres to the Lisa User Interface. When invoked, it displays its menu, a portion of the Scrap folder, and a dialog box which asks you for the name of the file to be edited:

Get Document named?

Type the name of the desired file, followed by <RETURN>. The editor opens a folder and displays the first portion of the file. To open an empty folder (to start a new file), type just <RETURN> to the request for a document name.

The arrow or I-beam shows the current position of the mouse. The blinking vertical bar marks the insertion point. Activity takes place at the insertion point even if that point is not visible. If, for example, you open a folder, scroll to the end of the file, then start typing, the characters you type are inserted at the start of the file (where the cursor is), rather than at the end of the file (which you are merely looking at).

To mark text to be deleted or copied, set the insertion point to the start of the text (move the mouse there and click), then drag the mouse through the text to be acted upon. Selected text is displayed in inverse video. Click twice to select a word, three times to select an entire line. To select large pieces of text, put the cursor at the start of the text, move the mouse to the end of the text, and shift click at that point.

At any time you can,

Open a new folder
(select the PULL item in the DESKTOP menu)

Start editing in any folder on the screen
(select the desired folder from the tray icon menu, or click in the body of the desired folder)

Move the folder around on the screen
(drag the folder's tab)

Make the folder larger or smaller
(drag the grow box. The grow box is the square in the lower right corner of the folder)

Scroll up a line
(click the up arrow box in the lower right corner. To scroll continuously, hold the button down in the box)

Scroll down a line
(click the down arrow box in the upper right corner. To scroll continuously, hold the button down in the box)

Jump back a windowful
(click in the grey area above the elevator. Hold the button down in this area to continue flipping pages. The elevator is the empty box in the vertical scroll bar)

Jump forward a windowful
(click in the grey area below the elevator. Hold the button down to continue flipping pages)

Jump to certain place in the folder
(drag the elevator to the position in the scroll bar that corresponds roughly to the desired position in the file)

Cut out the selected text and place it in the Scrap
(select the CUT item in the EDIT menu, or type Command-Z)

Paste the Scrap contents into the folder at the selection point
(select PASTE in the EDIT menu, or type Command-X)

Copy the selected text into the Scrap
(select COPY in the EDIT menu, or type Command-C)

Adjust the selected text right one space
(select ADJUST RIGHT in the EDIT Menu, or type Command-R)

Adjust the selected text left one space
(select ADJUST LEFT in the EDIT Menu, or type Command-L)

Save all your edits and close the folder
(select PUT BACK in the DESKTOP menu)

Save all your edits, but remain in the folder
(select ACCEPT ALL EDITS in the DESKTOP menu)

Write the current folder contents to another file
(select CROSSFILE TO... in the EDIT Menu. CrossFile asks you for the file name to cross file to. If that file already exists, you are given a chance to change your mind before the old file is overwritten. CrossFile does not change the file name used by Accept All Edits or Put Back. If you do not want to crossfile after all, type <RETURN> as the filename).

Cancel all the editing done since the last save command
(Select UNDO ALL EDITS from the DESKTOP menu. The editor gives you a chance to change your mind before it cancels all your edits).

Exit from the Editor
(Select EXIT EDITOR from the DESKTOP menu. If there are unsaved edits in the folder, the editor asks you if these should be thrown away. The prompts force you to answer "Y" then "N" or vice versa to be able to get out, which is less than friendly.)

Set tab stops
(select SET TABS... from the EDIT Menu. You can change the number of spaces between tab stops. The default is eight)

Find some target string starting from the current selection
(select FIND... from the SEARCH Menu. The default search ignores case and is token oriented. To change either of these, select the appropriate item in the SEARCH menu. FIND asks you for the target string. To find the same thing again, select FIND SAME. FIND & PASTE ALL performs a global find and replace. FIND can be invoked by Command-F, and FIND SAME can be invoked by Command-S. Only the first eight characters of a token-oriented search target are significant).

To move text from one folder to another, select and COPY the text from the source folder, activate the destination folder, set the cursor to the desired insertion point, and select PASTE.

CUSTOMIZING THE EDITOR

The editor uses whatever font it finds in the file LISA:EDITOR.FONT to display the folder contents. The suggested fonts are:

TITLE12R12S.F	20 lines x 82 chars
SARA8.F	26 lines x 83 chars
TILEX.F	32 lines x 82 chars (default)
TILE7R15S.F	32 lines x 94 chars
TILE5R18S.F	37 lines x 132 chars

Sysmgr

The system manager is a collection of commands to let the user manage the Lisa hardware and the devices (ie. disks and printers). The commands available are as follows:

Contrast	Allows the user to adjust the screen contrast.
Device	Lists all devices currently mounted and identifies which device is the working device.
Mount	Allows the user to mount a disk device.
Off	Allows the user to turn off the Lisa.
Printer	Allows the user to mount a printer. Use &3 thru &7 for parallel printers. Use &8 for serial printers.
Unmount	Allows a user to unmount a disk. This MUST be done before attaching a different disk to the same port. Note: the working device cannot be unmounted. Use the work command to make some other device be the working device first.
Work	Allows the user to make a device (floppy or hard disk) be the working device.
Apple	Allows the user to connect the Lisa to an Apple II
Flip	Used in conjunction with the Apple command to select memory or floppy as volume #4.
dIm	Sets the time before the screen dims.
Lisa	Tells the user about the Lisa.
scReen	Used to move the prompt, readln & writelns to the other screen (ie. primary <--> alternate).
Set time	Sets the date & time.
Time	Tells the user the time and day.
Volume	Allows the user to adjust the speaker volume.
Zero	Allows the user to ZERO the contents of a hard disk.
Quit	Quit the SysMgr and return to the Monitors prompt line.

Files & File names

Files are held contiguously on the disk (or in memory) within a physical hierarchy of volumes. This hierarchy consists of the following:

Devices

Volumes

Files

A fully specified name is of the form:

device / volume : name . suffix

max 7 max 7 max 15

The name of file can be abreviated in many ways by leaving off the ① device name, or ② device & volume or ③ suffix

A device name can be specified by either a 7 character (alphanumeric mix) name or a device number. Device numbers are small integers preceded by &

Device numbers are assigned as follows:

&1	upper floppy (ie. Twiggy)
&2	lower floppy (ie. Twiggy/Sony)
&3	parallel port (ie. disk or printer)
&4..&7	ports on 4 port card
&0	serial port (printer only)

A volume name can be specified by either a 7 character name or a volume number. Volume numbers are small integers (ie range 1 to 20) preceded by #.

Volume numbers are assigned as follows:

#1	Console	with echo
#2	"	without echo
#3	Reserved	
#4	Memory	volume
#5	Disk	volume
#6	Printer	
#7	Reserved	
#8	Reserved	
#9 ... #20	Disk	volumes

If you wish to refer to volumes such as console, memory or printer by name use:

CONSOLE:

MEMORY:

PRINTER:

File names may have a suffix.
The suffix is like the
3 character extension of CPM
or the FileType of CMS.

A suffix can be of any length
(ie. much less than 15) but are
typically a few characters long.
Some typical file suffixes
are as follows:

.TEXT	ascii file
.I	compiler intermediate
.OBJ	object file
.F	font files

UTILITY PROGRAMS

IUMANAGER

IUMANAGER modifies the file INTRINSIC.LIB used by the intrinsic unit Linker and loader to find the intrinsic unit files. INTRINSIC.LIB is essentially a directory of unit names, segment names, and file names. When executed, IUMANAGER asks for the input and output files to be modified. The default name for both files is *INTRINSIC.LIB. The intrinsic unit manager has three modes: Manage Segments, Manage Units, and Manage Files. Each mode operates on an associated table of information used by the loader to properly link intrinsic unit code and data into an executing program.

Manage Segments Mode operates on the Segment Table which contains a list of segment names with information about each segment for the loader and linker. Manage Units operates on the Unit table which contains the unit names and information used by the loader and linker to build the data pointer table. Finally, Manage Files operates on the File Table which contains a list of files indexed by a file number. The loader uses the file number to find the intrinsic units and segments on the disk.

IUMANAGER has the following commands:

Q(uit	Write the output file and exit from IUMANAGER.
S(egments	Enter the Segment Manager and list the contents of the Segment Table.
U(nits	Enter the Unit Manager and list the contents of the Unit Table.
F(iles	Enter the File Manager and list the contents of the File Table.

In each of the modes you can:

L(ist	List the contents of the currently active table. If you have more than 32 entries in the table, you can stop the listing with Control-S (the '=' key on the numeric keyboard).
R(emove	Remove an entry from the currently active table.
C(hange	Modify information in the currently active table. The Change command prompts you for the value of each field. A response of <cr> accepts the default.
N(ew	Create an entry in the currently active table. The New command prompts you the value of each field. A response of <cr> accepts the default value.

In the File Manager you have one further command choice:

I(nstall	Install (update) the segment and unit tables from a linked object file. The Install command prompts you for the file number of the entry to be updated.

CHANGESEG

CHANGESEG changes the segment name in the modules in an object file. The first prompt asks for the object file you want to change:

```
File to change:
```

Changes are made in place (the file itself is changed). You are next asked:

```
Map all Names (Y/N)
```

If you want to change segment names in all modules, respond Y. If you want to be prompted for the new segment name for each module, type N. A response of <cr> accepts the default name.

SEGMAP

SEGMAP produces a segment map of one or more object files. The first prompt:

```
Files to Map ?
```

accepts either an object file name or a command file name. A command file must be preceded with a <. SEGMAP adds the .TEXT suffix to the command file name. The next prompt:

```
Listing File ?
```

directs the map information to the file given. A response of #1: or CONSOLE:, for example, send the map information to the screen. The map information includes the object file name, the name of the unit in the file, the names of the segments used in that unit (if any), and the new segment names.

CONFIGURE

CONFIGURE modifies some of the vectors in the Monitor Map Table. These vectors are stored in CONFIG.DATA on the male boot volume and are used by the Monitor to configure your system when it is booted. To use CONFIGURE, copy CONFIG.DATA from the male side to a female volume, or flip the sex of the boot diskette. X(ecute CONFIGURE. CONFIGURE asks you whether it should Go or Quit. Type G to run CONFIGURE, Q to return to the Monitor command line. CONFIGURE asks you for the file containing the vectors you want to change. If you do not give a volume name, it look on the prefix volume. If you give just the volume name, it looks for CONFIG.DATA on that volume. CONFIGURE can change the following vectors:

```
dE(bug pointer           [$150]
D(efault Stack pointer   [$13C]    (* most important *)
H(eap pointer            [$138]
C(orvus pointer          [$134]
U(art pointer            [$11C]
A(pple port              [$118]
M(emory top              [$114]
S(creen base             [$110]
B(uffer pointer          [$10C]
```

The old and new value of each vectors is also displayed. Type the capitalized letter of the vector you want to change. Lower case is allowed in hexadecimal numbers. When you are done, type Q to Quit. At this point you are asked where to save the new values. You can write the changes back to CONFIG.DATA, exit without making any changes, and so on.

A memory map is given in the Monitor chapter showing the relationship of these vectors. Do not place the start of the heap above the stack pointer. Because CHANGEMEM sets aside heap space, it is safer to set the stack pointer before grabbing a lot of the heap with CHANGEMEM.

Once you have finished modifying CONFIG.DATA, transfer it back to the male boot volume so that it can take effect when the system is rebooted.

CONTRAST

CONTRAST changes the contrast setting of your screen without changing the default setting. It is a simple program that should be self-explanatory. Like CONFIGURE, it first asks whether to G(o or Q(uit. If you type G, some alphanumeric characters are scattered around the screen for reference. You can type '>' or '.' to increase and '<' or ',' to decrease the screen contrast.

SETSP

SETSP sets the address at which the stack pointer starts. Memory above that address is then reserved for code, and memory below it is the stack and heap space. If your program requires a great deal of room for data, set the stack pointer to a high address. If the program requires a great deal of code, set the SP to a low address. The Monitor default SP starting address depends on the version of CONFIG.DATA on your male boot volume. The highest possible address is the bottom of the Monitor.

All SETSP I/O is in hex. When X(ecuted, it displays the current stack pointer value. Type 0 to exit the program. The optimal value to give SETSP may not be obvious at first, since code swapping can change your memory requirements. It is quite possible that a program will run happily for hours, then die with a Loader Error when a piece of code couldn't be fit in memory. If this happens, set the stack pointer to a lower starting address, and try again.

CHANGEMEM

CHANGEMEM changes the size of the predeclared RAM-resident volume MEMORY:. Its interface is identical to that of SETSP. The default size of MEMORY: is 10 blocks. Space for the MEMORY: volume is taken from the available heap space.

FLIP4

Volume #4: is normally the RAM-based volume MEMORY:. The Disk drive that would usually be #4: is hidden from the monitor to avoid overwriting the male boot volume. If you want access to that disk drive from the monitor, run FLIP4. FLIP4 executes a simple loop until you tell it to Quit. After asking whether to continue or to quit, FLIP4 gives you a chance to toggle the state of #4:. #4: is either MEMORY: or the disk drive. Remember to remove the male boot volume before writing to #4:.

MOVESOROC

MOVESOROC (also sometimes known as MS) determines where the Pascal WRITELN output goes. It normally is sent to the Lisa screen. When an application is running on this screen, however, debugging WRITELNs mess up the program's pretty output. MOVESOROC redirects this output to either the Apple monitor, the UART (serial port #2), or back to the Lisa. Monitor input always comes from the terminal to which output has been directed.

FILEDIV and FILEJOIN

It is often necessary to distribute files that are too large to fit onto a single floppy diskette. FILEDIV can be used to break a large file into several diskette-sized pieces. FILEDIV can then be used to rejoin these pieces at the file's destination. These two programs replace the TRANSFER program.

To divide a large text or object file, execute FILEDIV.

```
Input file:  <give the name of the file to be divided>
Output file: <give the name to be used for the output files>
```

Do not include the suffix in the file name. If, for example, you want to divide TEMP.TEXT, give TEMP as the input file, and TEMP (or whatever) as the output file. FILEDIV will create a group of files named TEMP.1.TEXT, TEMP.2.TEXT, and so on, until TEMP.TEXT is completely divided up. If you use the drive number (#9:, for example), rather than the volume name, the new files can be written to multiple diskettes. When space on a diskette is exhausted, FILEDIV asks you to insert another diskette.

To rejoin the pieces of the file, execute FILEJOIN. Using the example given above, we can rejoin TEMP.1.TEXT and friends into TEMP.TEXT by responding:

```
Input file: TEMP              <will read TEMP.1.TEXT, etc>
Output file: TEMP             <will create TEMP.TEXT>
```

FILEDIV and FILEJOIN use regular directories, so a spurious sex change cannot destroy your file. Files are verified in both directions.

DIFF

DIFF is a program for comparing ".TEXT" files, in the LISA Pascal development environment. DIFF is strongly oriented toward use with Pascal or Assembler source files.

DIFF is not sensitive to upper/lower case differences. All input is shifted to a uniform case before comparison is done. This is in conformance with the language processors, which ignore case differences.

DIFF is not sensitive to blanks. All blanks are skipped during comparison. This is a potential source of undetected changes, since some blanks are significant (in string constants, for instance). However, DIFF is insensitive to "trivial" changes, such as indentation adjustments, or insertion and deletion of spaces around operators.

DIFF does not accept a matching context which is "too small". The current threshold for accepting a match is 3 consecutive matches. The M option allows you to change this number. This has two effects:

> Areas of the source where almost "every other line" has been changed will be reported as a single change block, rather than being broken into several small change blocks.
>
> Areas of the source which are "entirely different" are not broken into different change blocks because of trivial similarities (such as blank lines, lines with only "begin" or "end", etc.)

DIFF makes a second pass through the input files, to report the changes detected, and to verify that matching hash codes actually represent matching lines. Any spurious match found during verification is reported as a "JACKPOT". The probability of a JACKPOT is very low, since two different lines must hash to the same code at a location in each file which extends the longest common subsequence, and in a matching context which is large enough to exceed the threshold for acceptance.

DIFF can handle files with up to 2000 lines.

DIFF first prompts you for two input file names: the "new" file, and the "old" file. DIFF appends ".TEXT" to these file names, if it is not present. DIFF then prompts you for a filename for the listing file. Type carriage-return to send the listing to the console.

DIFF does not (currently) know about INCLUDE files. However, DIFF does allow the processing of several pairs of files to be sent to the same listing file. Thus, when DIFF is finished with one pair of files, it prompts you for another pair of input files. To terminate DIFF, simply type carriage-return in response to the prompt for an input file name.

The output produced by DIFF consists of blocks of "changed" lines. Each block of changes is surrounded by a few lines of "context" to aid

in finding the lines in a hard-copy listing of the files.

There are three kinds of change blocks:

INSERTION -- a block of lines in the "new" file which does not appear in the "old" file.

DELETION -- a block of lines in the "old" file which does not appear in the "new" file.

REPLACEMENT -- a block of lines in the "new" file which replaces a corresponding block of different lines in the old file.

Large blocks of changes are printed in summary fashion: a few lines at the beginning of the changes and a few lines at the end of the changes, with an indication of how many lines were skipped.

DIFF has three options which allow you to change the number of context lines displayed (+C), the number of lines required to constitute a match (+M), and the number of lines displayed at the beginning of a long block of differences (+D). To set one of these numbers, type the option name followed by the new number to the prompt for the first input file name. +D 100, for example, causes DIFF to print out up to 100 lines of a block of differences before using an ellipsis. The maximum number of context lines you can get is 8.

FINDID

FINDID searches code files for an identifier. It provides a service similar to that of the editor's literal search, but the search can cover any number of files of any size. When executed, it asks first for the name of the file which contains the list of files through which you want to search. For example, if you want to search the files CODE.TEXT, CODE1.TEXT, and CODE2.TEXT, make a file which contains:

```
Code.Text
Code1.Text
Code2.Text
```

and give FINDID this file's name. FINDID then asks for the identifier you want to search for. Only the first eight characters are significant. The search is always literal--any identifier beginning with the specified eight characters is considered a match. FINDID's last prompt asks whether the search should ignore case differences. FINDID then grovels through files in the list reporting any occurrences of the identifier. To get out of FINDID, hit NMI, then type RM to LisaBug.

PRETTY LIST

Pretty List scans a listing produced by the Assembler, and replaces the asterisks in the displacement portion of branch instructions with the actual forward reference value. When you X(ecute PRETTY, you are asked for the Input File (the Assembler listing file). Because this file can be either a data file or a text file (with a .TEXT extension), the next prompt is:

```
If input file is a text file (file.text) type 1 else type 0 --
```

Pretty List then asks for the output file name.

If the listing file contains:

```
0360|                    CHKLO   BSR4    CHKMEM
0360| 49FA ****   #             LEA     @1,A4
0364| 6000 ****   #             BRA     CHKMEM
0362* 0006
```

Pretty list produces:

```
0360|                    CHKLO   BSR4    CHKMEM
0360| 49FA 0006   #             LEA     @1,A4
0364| 6000 005A   #             BRA     CHKMEM
```

PASCALREF

Pascalref is a cross reference utility for Lisa Pascal programs. It can perform partial or complete cross references, can handle USES and INCLUDE statements correctly, and imposes no limit on the size of the target program.

Pascalref assumes that the program or unit to be referenced (target program) has been compiled without syntax errors. It also assumes that the font BOLD10V and the file MPMENUFILE.TEXT are available on your prefix volume or the boot volume (#5:).

THE USER INTERFACE

ACTION	SEARCHOPTIONS	FINDTYPES	YN-TF	<-- The Menu Bar
Setup Files	Interactive	Declared	Yes-True	
Set Scope	Reloffsets	Modified	No-False	
Begin Pascalref	Procdic	Accessed		
	Widepaper	Stnd PFT		
	Used Unit Int			
	Out Scope Vars			

The line in capitals at the top represents the menus in the menu bar. The lower case names are the items in each pull down menu. A shaded menu item shows that the option represented by that item is active. To change the 'Procdic' option, for example, use the mouse to select 'Procdic' then select either True or False. You can also type SP, then enter Y(es or T(rue, N(o or F(alse. When you have all your options set up, select 'Begin Pascalref'.

OPTIONS

Setup Files

You are asked for the names of the listing file, source file, and output file.

Set Scope

Pascalref allows you to set the scope to be a single procedure. Only identifiers within that procedure and its local procedures are referenced. Of course, accesses to any variables global to the procedure are included in the OUT OF SCOPE section. The default scope is the whole program. Currently, when referencing a Unit by itself, only set the scope to the whole unit. Also, don't set the scope to a FORWARD procedure or a procedure in the interface of a unit.

Begin Pascalref

Start the cross reference.

SEARCHOPTIONS

Interactive

When Interactive is true (the default), Pascalref looks only for those names that occur in the list of variables that you type in.

When a particular reference is finished, Pascalref asks you 'Look at more identifiers?'. If you answer yes, PascalRef returns to the options setting routine with the same files set up. You can change the options and the files on each pass if you want to.

When Interactive is false, Pascalref cross references all identifiers within the specified scope.

Reloffsets

Next to each occurrence of an identifier is the line number it occurs on. When Reloffsets is true (the default), the line numbers are listed relative to the procedure the occurrence is in.

When Reloffsets is false, offsets are given relative to the beginning of the program.

Procdic

If Procdic is true, Pascalref creates a procedure dictionary listing each Procedure with the line it starts on. The default for ProcDic is false. The program or outermost procedure in the scope is procedure #1. Nested procedures are indented.

In the case of forward procedures and procedures declared in the interface of a unit, the procedure number listed reflects where the procedure declaration occurs. '=Forward Proc' appears in the procedure dictionary after the 'STARTING LINE #'. The ordered location of the procedure name and the starting line number within the procedure dictionary reflect where the header to the body part of the procedure occurs.

Widepaper

The default value (False) should be used when sending output to the console or to standard 8-1/2 inch wide paper. When printing on 132 column paper, set Widepaper to true.

Used Unit Int

The default value of True causes the INTERFACE parts of USED units to be included in the PASCALREF scan. This allows you to see where every identifier used by a Pascal program is defined. If you are not interested in the INTERFACE of a unit, set 'Used Unit Int' to false.

Out Scope Vars

When a program accesses a identifier that has not been defined, that access shows up in the OUT OF SCOPE VARIABLES OR PROCEDURES section of the PASCALREF listing. This part of the listing is present when 'Out Scope Vars' is true (the default).

FINDTYPES

The three 'Find Types' are DECLARED, MODIFIED and ACCESSED. The default value of each type is true. Each type can be set independently. When all are true, all occurrences of an identifier are listed. If, for example, only ACCESSED is true, PascalRef lists only places where a variable is accessed. MODIFIED flags places where a variable occurs to the left of :=, and where it is passed as the actual parameter to a formal VAR parameter. DECLARED lists places where an identifier is declared.

Stnd PFT lists occurrences of standard procedures, functions and types. Its default is false.

YN-TF

This menu gives you an option for answering Yes-No and True-False questions. Choosing Yes-True is the same as entering a 'Y' or 'T' from the keyboard and choosing No-False is the same as entering a 'N' or 'F'.

OUTPUT FORMAT

LISTING (Pascalref can produce a listing identical to that produced by the compiler)

PROCEDURE DICTIONARY:

```
  PROC #,  PROC NAME,                                  STARTING LINE #

    1:     MAINPROGRAM                                    0
    3:       NESTEDPROC                                  80
    4:         FURTHERNESTEDPROC                        120
    5:       PROC                                       200
    2:       FORWARDPROCWHOSEBODYCOMESAFTERPROC          40=Forward Loc
    6:         PROCNESTEDINBODYOFFORWARDPROC            280
    7:       LASTGLOBALPROC                             300
```

```
The identifier we are referencing
|            The procedures it occurs in
|            |           The occurrences within those procedures
|            |           |
IDENTIFIER   PROCEDURE   OCCURRENCE  (D=defined, A=accessed, M=modified,
----------   ---------   ----------   V=Var param def, P=passed to Var param)

I            PROCA       D    10, P    45, A    50, A    60.
             PROCB       D    16, A    20, A    30,

STRNG        PROCA       D    12, M    41, M    62, A    50, A    58,
                         A    60,
             PROCC       V    75, M    80, A    82.
```

OUT OF SCOPE VARIABLES OR PROCEDURES

These are listed in the same format as that of the regular identifiers, but represent items that are global to the chosen scope. To find out what global variables a procedure and its nested procedures access, set the scope to the procedure, set INTERACTIVE to false and look at the resulting OUT OF SCOPE items.

GENERAL NOTES ON THE USE OF PASCALREF

Pascalref does not store information about variable types or record structures. If you have both a stand alone variable named AVAR and a record field named AVAR, PascalRef lists both as the same identifier.

Include commands are recognized by Pascalref and the INTERFACE parts of units USED by the target program are included in the

reference if the scope is set to the whole program.

To find variables that are declared but no longer used by a program, do a reference of the whole program. Variables that have a 'D' occurrence and no others can often be removed from the program.

Occurrences of a particular identifier are always exactly in order when interactive is true. When interactive is false, occurrences are grouped by the procedures where the identifier is declared locally. In the case where interactive is false, you may notice the following:

```
I           PROCA       D    10, P    45, A    50, A    60.
            PROCB       D    16, A    20, A    30,
```

The variable 'I' was declared and accessed in PROCA and declared and accessed in PROCB. The accesses in PROCA occur after the declaration and accesses in proc B but they are listed first.

If 'I' were not defined in PROCB, it would look like:

```
I           PROCA       D    10,
            PROCB       A    20, A    30,
            PROCA       P    45, A    50, A    60.
```

If the first example were done in interactive mode, it would look like:

```
I           PROCA       D    10,
            PROCB       D    16, A    20, A    30,
            PROCA       P    45, A    50, A    60.
```

Procedures and Functions as parameters are currently not fully implemented in Pascalref. They are parsed by Pascalref, but Variables passed to a procedure or function that is a parameter are always marked as modified in that occurrence.

DUMPOBJ

DUMPOBJ is a disassembler for 68000 code. It can disassemble either an entire file, or specific modules (procedures) within the file. DUMPOBJ replaces DUMPMCODE.

DUMPOBJ first asks for the input file which should be an unlinked object file. The output (listing) file defaults to CONSOLE:. You are asked whether you want to dump

A(ll, S(ome, or P(articular modules.

If you respond S(ome, DUMPOBJ asks you for confirmation before dumping each module. A response of <ESC> gets you back to the top level. If you respond P(articular, DUMPOBJ asks you for the particular module(s) you want dumped.

The next question is: 'Dump file positions [N]?' The file position is a number of the form [0,000] where the first digit is the block number (decimal) within the file and the second number is the byte number (hexadecimal) within the block at which the module starts. This information can be used in conjunction with the PATCH program. Finally, DUMPOBJ asks if you want the object code disassembled.

DUMPHEX

DumpHex provides a textual representation of the contents of any file. The file dump is block-oriented with the hexadecimal representation on the left and the corresponding ASCII representation on the right. If a byte cannot be converted to a printable character, a dot is substituted.

When DumpHex is X(ecuted, it asks you for the name of the output file. A .TEXT extension is added if necessary. To direct the output to the console, type carriage return. After getting a valid output file name, DumpHex asks for the input file to be dumped. No extensions are appended, so give the full filename. Once a file has been completely dumped, DumpHex asks you for the next file to dump. Type carriage return to exit the program.

After opening the input file, DumpHex asks you which block to dump. The default (carriage return) is block 0. If the output is going to a file, you are asked which block is the last you want dumped. The default here (carriage return) is the last block in the file.

The format of the console output depends on the number of lines your screen has. If fewer than 33 lines are available, the output is displayed only a half block at a time. Between blocks or block halves you have the option to

Type <space> to continue, <escape> to exit.

Escape returns to the prompt for an input file.

PATCH

Patch allows you to examine and change the contents of any file. The display of the file's contents is exactly like that of DumpHex. With Patch, however, you can use the cursor control keys to move around in the block and change the value of any byte using either the hexadecimal representation on the left or the ASCII representation on the right.

After X(ecuting Patch you are asked for the full name of the file to patch. Carriage return exits Patch. No extension is appended to the file name. You are then asked for the number of the block you want to mess around with. Carriage return here returns you to the file name prompt.

The block is displayed with the cursor in the upper left corner at word 0 of the block. The arrow keys can be used to move around in the block. If you move the cursor up from the top line, you get the bottom line of the preceding block. Similarly, if you move down from the bottom line, you move into the top line of the next block.

When the cursor is on the hexadecimal side of the display, you can change any byte by typing the new hexadecimal value. Any non-hex characters are ignored. You can impress your friends by pointing out that the change is reflected automatically in the ASCII portion of the display. When the cursor is on the ASCII side, type any character to replace the value of the byte. Until you move out of the block you can undo any changes by typing <escape>.

OBJDIFF

OBJDIFF performs a comparison of two object (.OBJ) files. The two files being compared should be very similar. OBJDIFF uses procedure boundaries to get itself back in sync after a difference is found.

BYTEDIFF

BYTEDIFF compares any binary files, but once it finds a difference between the two files, it does not always find where the differences end.

GXREF

GXREF lists all the modules which call a given procedure, and all the modules which that procedure calls. It provides a global cross reference of subroutines and modules.

LISATEST

LISATEST is a package of hardware test routines. The DIAG: diskette which contains these programs can be obtained from Rich Castro. To use the programs, boot the Apple II with the Lisa in the power-on reset state, then X(ecute LISATEST. You have eight choices:

1) Apple-Lisa Interface Test
2) Memory Test (RAMTEST)
3) Display Memory Test Results
4) UART Wrap Around Test
5) Video Latch Test
6) MMU Test
7) Keyboard Test
9) Quit

The tests are, for the most part, self-explanatory. For a complete description of each test, its prompts, error messages, and options please see the Lisa Production Tests documentation by Rich Castro. A short description of each test is given below.

Apple-Lisa Interface Test

The Interface Test attempts to use the parallel port interface between the Apple II and the Lisa to verify that the two systems can communicate with each other.

Memory Test

The Memory Test program tries to single out bad or marginal memory chips and provides trouble shooting information about other memory board problems. It is essentially an updated and easy to use version of RAMTEST.

Display Memory Test Results

After running the Memory Test, you can have the results of that test redisplayed by the Display Memory Test Results program.

UART Wrap Around Test

The UART Test checks the UART on the CPU board that controls the RS-232 port #1 (the one on the left as you face front of the machine). To run the test you need a specially wired wrap around DB-25 male connector.

Video Latch Test

The Video Latch Test checks the operation of the video page latch on the MCU board.

MMU Test

The MMU Test tries to verify that the MMU is working properly. It sets up the base and limit registers in the MMU with various values and then attempts to access the corresponding memory segments.

Keyboard Test

The Keyboard Test checks the keyboard and mouse buttons to verify that the COPS interfaces are functioning properly.

PERFORM

Perform monitors the execution performance of a program. After X(ecuting Perform, you are asked for the listing file's name. A carriage return directs output to the console. If necessary, .TEXT is appended to the listing file name. You are next asked for the name of the program you want to analyze. If necessary, the extension .OBJ is added to the file name. The program file must be executable and must be linked with the corresponding .DBG files.

Perform scans the program file for procedure entry points, listing them as they are found. It then waits for you to type a space before executing the program. Every 1/60 second the program's program counter is checked to find out which routine is executing at that moment. When the program terminates, Perform produces a listing of the routines it found executing ordered according to the amount of time spent in each routine. Routines that were never caught executing are listed separately. Perform may miss the execution of short or rarely called routines.

The longer the program runs, the more trustworthy the analysis. Routines that are synchronous with the 60 Hz clock are not measured correctly. If M.SYMBOLS is included, PERFORM also gives information on the amount of time spent in the monitor (MPASLIB).

COVERAGE ANALYSIS

The CA program provides a coverage analysis of a Lisa Pascal program. Branch counters are inserted into the source (.TEXT file) of the program under test. The output of the CA program is then compiled and linked. At the end of the program's execution, a text file is produced giving the branch numbers and the number of times each branch was executed.

To run the coverage analysis program you need to get the sources of any of the units and programs you want to analyze and the .OBJ versions of any other units that are required to link the program. You should be able to compile and link these sources without error. To add counters to a unit or program:

X(ecute CA

CA first asks for the name of the source file:

Input file -

Give it the name of the file you want analyzed. The output of CA is another source file containing the original source modified by the addition of the counters and the analysis machinery. The output file can be very large, so give it plenty of room.

Output file -

The name you give here is the name of the new source (with the branch counters added in).

The next prompt is:

Count B(ranches, P(rocedures, O(ne unit

You can count every branch (every THEN, ELSE, CASE branch, REPEAT, DO, etc), just procedure entries, or just report on the branch counters in a unit that has already been run through CA. If you ask that every branch be counted, CA also asks:

Routine to skip (<cr> for none):

The compiler has a fixed code buffer size. If a procedure in the original program is close to the size limit, it may be impossible to add counters to every branch and still compile that procedure. The compiler error is #350, "procedure too large". If you add the counters and the compiler complains about some procedure, run CA again, and give the offending procedure name here. If more than one procedure is too large, either complain to the developers, or ask someone to make the 'routine-to-skip' code take a list of names.

The next prompt was Pete Cressman's idea:

Enable tracing?

Type 'y' and every time the program is executed you will be asked if you want to be informed about every procedure entry during execution of the program. This avalanche of names can be very tedious to watch. If you respond "n", the tracing machinery is omitted from the program and you are never asked whether it should be activated.

The next prompt is:

```
Data file -
```

The data file is the file containing the coverage analysis after the program has executed. It is a text file, so you can read it with the mouse editor. You can match each counter number up with the code it is counting by examining the output file that CA produces. At each branch you will find a procedure call of the form:

```
_CA_Inc(n);
```

where n is the counter number. All objects added by CA to the program start with the the four letters '_CA_' to try to avoid naming conflicts.

Finally, you are given a chance to place some arbitrary sequence of text in the header of the data file (date of the test, or whatever). Type <cr> to end the comments.

If you are adding counters to a unit, some of these questions are omitted because they are irrelevant.

Once CA has added the counters, you must compile the output file, generate the .OBJ file, and link it with all the units it requires. If all goes well, each time you execute the program the data file is updated. If the data file does not exist, it is created. If it does exist, the counter data it contains are added to the current counter values. The resulting data file therefore contains a record of an arbitrary number of program executions.

If you get the Linker warning:

```
Segment <mumble> too large
```

you will have to break that segment into two pieces, write a procedure to force the new segment to be resident whenever the old one was, and start over with the CA program. The problem here is that a segment can contain no more than 32 Kbytes of code or data. There is no way the CA program can tell when a segment is close to the limit. If a segment is right on the borderline, it is not inconceivable that the branch counters will cause it to overflow.

The counters pin at 32767. Programs that run in the Window Manager-OS environment are recognized, and theoretically correct code is issued, but no promises are made yet. CA increases the size of both the source .TEXT file and the final .OBJ file by about 30 percent. It may slow execution rates noticeably.

SCRIPT

SCRIPT is Colin McMaster's text formatting program. SCRIPT commands are:

Name	Default	Example	Effect
Page Length	66	^pl N	Define page length to be N lines
Page Number	1	^pn N	Start page numbering at N
Page Break	--	^bp	Start a new page
Need Lines	--	^ne N	Make sure at least N lines remain on page
Line Space	1	^ls 1	Set single or double spacing
Space	1	^sp N	Space N lines
Break Line	--	^br	Start a new line
Page Offset	0	^po N	Start leftmost printing at column N
Indent	0	^in N	Indent N columns from page offset
Temporary Indent	0	^ti N	Indent N columns for next line only
Right Margin	72	^rm N	Set line length to N characters
Fill	--	^fi	Set filling mode to true
No Fill	--	^nf	Set filling mode to false
Justify	--	^ad	Justify text to right margin
No Justify	--	^na	Turn justification off
Center	1	^ce N	Center next N lines
Text	--	^tx 'N	Display N literally
Change command	--	^cc N	Change SCRIPT command character to N
Title	--	^tl 'L'C'R	Print titles Left, Center, Right
Margin 1	4	^m1 N	Set number of lines above and including header
Margin 2	2	^m2 N	Set number of lines below header
Margin 3	2	^m3 N	Set number of lines above and including footer
Margin 4	4	^m4 N	Set number of lines below footer
Header	--	^he 'L'C'R	Place headers Left, Center, Right
Even Header	--	^eh 'L'C'R	Place even headers Left, Center, Right
Odd Header	--	^oh 'L'C'R	Place odd headers Left, Center, Right
Footer	--	^fo 'L'C'R	Place footers Left, Center, Right
Even Footer	--	^ef 'L'C'R	etc
Odd Footer	--	^of 'L'C'R	
Source	--	^so 'File'	Begin printing text of File
Zero Slash	--	^zs	Turn on zero slashing
No Zero Slash	--	^nz	Turn off zero slashing
Keywords	--	^kw	Underline Pascal keywords
No Keywords	--	^nk	Do not underline Pascal keywords
Define Macro	--	^de V0	Begin definition of macro V0
Terminate Macro	--	^^	End definition of macro
Append Macro	--	^am V0	Append to macro V0
Delete Macro	--	^dm V0	Delete macro V0

SCRIPT OPTIONS (specified when SCRIPT is executed)

```
-cC     Change command character to C
-fFILE  Send output to FILE (.TEXT is not appended for you)
-k      Underline Pascal keywords
-l      Assume output is going to a Printronix-style printer
-nN     Start page numbering at N
-oLIST  Output only the pages given in LIST
-p      Assume printer has full control of page
-q      Assume output is going to a Qume-like printer
-s      Stop printing after each page and wait for <cr> or <ESC>
-zN     Set page offset to N
```

This version of Script does not attempt to return to its top level when it has finished with a file. Because it is trying to exit the program from a unit, it usually quits with 'fatal error 1'. Do not use the options that refer to printers. To see your formatted text, use either -S or -F.

More complete documentation is available from Publications.

TERMINAL EMULATOR

Files needed: TERM.OBJ
LISA:SYSTEM.FONT
LISA:TERM.MENUS
LISA:SARA8F

The terminal emulator (TERM) provides a Lisa folder which is a full duplex virtual terminal. The terminal control commands implemented here are similar to those of the Hewlett-Packard 2640 and 2645, the DataMedia, Perkin-Elmer Fox and Owl, Beehive, and the DEC VT-52 terminals, as well as the "VT52" modes of the DEC VT-100 and HeathKit H19 terminals.

The terminal emulator works only with the "new" Lisa hardware. In addition, you must make a hardware modification to your Lisa: open the back of the machine and find the three large chips in the center of the visible board (the IO board). The chip nearest the power supply should already have the 10th pin from the bottom on the power supply side raised. For the terminal emulator, the 9th pin from the bottom on the same side should also be raised.

To invoke the emulator, copy the files given above, and X(ecute TERM. The emulator has three menus and a tray icon. The Speed menu sets the baud rate. Available speeds are 300, 600, 1200, 2400, 4800, 9600, and 19200 baud. 600 baud is not available on Port #1. The default speed is 300 baud.

The Port Menu determines which serial port is connected to the modem. Port #1 is the connector in the center. Port #2 is the connector nearest the power supply. The default port is #2.

The control menu has four items: Record, Play Back, Debug, and Quit. If you select Record, all characters received by the UART are saved in the file RECORD.TEXT. If you select Play Back, the contents of the file PLAYBACK.TEXT are sent to the UART just as if they had been typed. If you want to see exactly what characters are being received, including control characters and escape sequences, select Debug. To exit the terminal emulator, select Quit.

The control commands are:

Ctrl-G	Bell (screen flashes)
Ctrl-H	Backspace
Ctrl-I	Tab (8 spaces)
Ctrl-J	Linefeed
Ctrl-M	Carriage return
Ctrl-[	Start Escape Sequence (see below)
Escape-@	Enter Insert Character Mode
Escape-A	Cursor Up
Escape-B	Cursor Down
Escape-C	Cursor Right
Escape-D	Cursor Left
Escape-E	Clear screen
Escape-H	Cursor home (top left corner)

Escape-I	Scroll down
Escape-J	Clear to end of screen
Escape-K	Clear to end of line
Escape-L	Insert line position
Escape-M	Delete line position
Escape-N	Delete character position
Escape-O	Leave Insert Character Mode
Escape-P	Insert character position
Escape-Y	Absolute character positioning (Y+31, X+31)
Escape-b	Clear to beginning of screen
Escape-j	Save Cursor position
Escape-k	Restore saved cursor position
Escape-l	Erase line
Escape-o	Clear to beginning of line
Escape-p	Stand out (bold characters)
Escape-q	Reset Stand Out (normal characters)
Escape-z	Initialize terminal

All other Escape and Control sequences are ignored.

ERROR MESSAGES

There are several error categories--I/O errors, Loader errors, trap handler errors, and Pascal Compiler errors. In most cases, you can type SPACE to return to the Monitor command line. Since nothing in the Monitor is tied to the user stack pointer, the Monitor can usually recover from errors that are fatal in the Apple II UCSD system. The Monitor's globals are hidden beneath the heap, and the Monitor code itself sits above your code space, so both are somewhat protected from inadvertent destruction.

I/O ERRORS

0	No error
1	Bad Block (Parity error)
2	Bad device number
3	Bad mode (Illegal operation)
4	Undefined hardware error
5	Lost device
6	Lost file
7	Bad file name
8	No room
9	No device
10	No file
11	Duplicate file
12	File not closed before open.
13	File not open
14	Bad format
15	Ring buffer overflow
16	Write-protect error
64	Device error

loadseg
resdve
getAStack
getAHeap

LOADER ERRORS

0	Unknown segment
1	No room in memory
2	Bad block
3	Can't read code file
4	Jump table overflow
5	SetSP at wrong place (after a physical link)
6	This loader does not handle intrinsic units
7	Too many units
8	Bad unit number
9	No INTRINSIC.LIB file
10	No unit location table
11	No segment location table
12	Cannot open intrinsic segment file
13	Cannot read file names block
14	Bad Segment #
15	NO unpack translation Table
16	Bad UNPACK VERSION # or UnPack Failed,
17	cannot load physcal in background
18	couldn't [illegible] the process no memory no domain
19	Can't open INPUT / OUTPUT
20	NO IULOADER
21	Too many objects files
22	programs
23	code segs

FATAL ERRORS

0	Illegal index at trap handler
1	Stack Overflow
2	Programmed Halt
3	Range value error
4	Illegal string index
5	Can't read Root Volume
6	can't grow heap
7	can't get space for directory

PASCAL COMPILER ERRORS

Lexical Errors:

```
  10  Too many digits
  11  Digit expected after '.' in real
  12  Integer overflow
  13  Digit expected in exponent
  14  End of line encountered in string constant
  15  Illegal character in input
  16  Premature end of file in source program
  17  Extra characters encountered after end of program
  18  End of file encountered in a comment
```

Syntactic Errors:

```
  20  Illegal symbol
  21  Error in simple type
  22  Error in declaration part
  23  Error in parameter list
  24  Error in constant
  25  Error in type
  26  Error in field list
  27  Error in factor
  28  Error in variable
  29  Identifier expected
  30  Integer expected
  31  '(' expected
  32  ')' expected
  33  '[' expected
  34  ']' expected
  35  ':' expected
  36  ';' expected
  37  '=' expected
  38  ',' expected
? 39  '*' expected
  40  ':=' expected
  41  'program' expected
  42  'of' expected
  43  'begin' expected
  44  'end' expected
  45  'then' expected
  46  'until' expected
  47  'do' expected
  48  'to' or 'downto' expected
? 49  'file' expected
? 50  'if' expected
  51  '.' expected
  52  'implementation' expected
  53  'interface' expected
  54  'intrinsic' expected
  55  'shared' expected
```

Semantic Errors:

100 Identifier declared twice
101 Identifier not of the appropriate class
102 Identifier not declared
103 Sign not allowed
104 Number expected
105 Lower bound exceeds upper bound
106 Incompatible subrange types
107 Type of constant must be integer
108 Type must not be real
109 Tagfield must be scalar or subrange
110 Type incompatible with with tagfield type
111 Index type must not be real
112 Index type must be scalar or subrange
113 Index type must not be 'integer' or 'longint'
114 Unsatified forward reference
115 Forward reference type identifier cannot appear in variable declaration
116 Forward declaration - repetition of parameter list not allowed
117 Forward declared function - repetition of result type not allowed
118 Function result type must be scalar, subrange, or pointer
119 File value parameter not allowed
120 Missing result type in function declaration
121 F-format for real only
122 Error in type of standard function parameter
123 Error in type of standard procedure parameter
124 Number of parameters does not agree with declaration
125 Illegal parameter substitution
? 126 Result type of parameteric function function does not agree with declaration
127 Expression is not of set type
128 Only tests on equality allowed
129 Strict inclusion not allowed
130 File comparison not allowed
131 Illegal type of operand(s)
132 Type of operand must be Boolean
133 Set element type must be scalar or subrange
134 Set element types not compatible
135 Type of variable is not array or string
136 Index type is not compatible with declaration
137 Type of variable is not record
138 Type of variable must be file or pointer
139 Illegal type of loop control variable
140 Illegal type of expression
141 Assignment of files not allowed
142 Label type incompatible with selecting expression
143 Subrange bounds must be scalar
144 Type conflict of operands
145 Assignment to standard function is not allowed
? 146 Assignment to formal function is not allowed
147 No such field in this record
? 148 Type error in read

149 Actual parameter must be a variable
150 Multidefined case label
151 Missing corresponding variant declaration
? 152 Real or string tagfields not allowed
153 Previous declaration was not forward
? 154 Substitution of standard proc/func is not allowed
155 Multidefined label
156 Multideclared label
157 Undefined label
158 Undeclared label
159 Value parameter expected
160 Multidefined record variant
? 161 File not allowed here
162 Unknown compiler directive (not 'external' or 'forward')
163 Variable cannot be packed field
164 Set of real is not allowed
165 Fields of packed records cannot be var parameters
166 Case selector expression must be scalar or subrange
167 String sizes must be equal
168 String too long
169 Value out of range
170 Address of standard procedure cannot be taken
171 Assignment to function result must be done inside that function
172 Loop control variable must be local

190 No such unit in this file

Conditional Compilation:

260 New compile-time variable must be declared at global level
261 Undefined compile-time variable
262 Error in compile-time expression
263 Conditional compilation options nested too deeply
264 Unmatched ELSEC
265 Unmatched ENDC
266 Error in SETC
267 Unterminated conditional compilation option

Compiler Specific Limitations:

300 Too many nested record scopes
301 Set limits out of range
302 String limits out of range
303 Too many nested procedures/functions
304 Too many nested include/uses files
305 Includes not allowed in interface section
306 Pack and unpack are not implemented
307 Too many units
308 Set constant out of range

350 Procedure too large
351 File name in option too long

I/O Errors:

400 Not enough room for code file
401 Error in rereading code file
402 Error in reopening text file
403 Unable to open uses file
404 Error in reading uses file
405 Error in opening include file
406 Eror in rereading previously read text block
407 Not enough room for i-code file
408 Error in writing code file
409 Error in reading i-code file
410 Unable to open listing file
420 I/O error on debug file

Code Generation Errors:

1000+ Code generator errors - should never occur

2000	End of I-code file not found
2001	Expression too complicated, code generator ran out of registers
2002	Code generator tried to free a register that was already free
2003-2005	Error in generating address
2006-2010	Error in expressions
2011	Too many globals
2012	Too many locals

Verification Errors:

4000 Bad verification block format
4001 Source code version conflict
4002 Compiler version conflict
4003 Linker version conflict

4100 Version in file less than minimum version supported by program
4101 Version in file greater than maximum version supported by program

ASSEMBLER ERRORS

0.
1. undefined label
2. operand out of range
3. must have procedure name
4. number of parameters expected
5. extra garbage on line
6. input line over 80 characters
7. not enough .IF's
8. must be declared in .ASECT before used
9. identifier previously declared
10. improper format
11. .EQU expected
12. must .EQU before use if not to a label
13. macro identifier expected
14. word addressed machine
15. backward .ORG currently not allowed
16. identifier expected
17. constant expected
18. invalid structure
19. extra special symbol
20. branch too far
21. variable not PC relative
22. illegal macro parameter index
23. not enough macro parameters
24. operand not absolute
25. illegal use of special symbols
26. ill-formed expression
27. not enough operands
28. cannot handle this relative expression
29. constant overflow
30. illegal decimal constant
31. illegal octal constant
32. illegal binary constant
33. invalid key word
34. macro stack overflow - 5 nested limit
35. include files may not be nested
36. unexpected end of input
37. this is a bad place for an .INCLUDE file
38. only labels & comments may occupy col 1
39. expected local label
40. local label stack overflow
41. string constant must be on one line
42. string constant exceeds 80 characters
43. illegal use of macro parameter
44. no local labels in .ASECT
45. expected key word
46. string expected
47. bad block, parity error (CRC)
48. bad unit number
49. bad mode, illegal operation
50. undefined hardware error
51. lost unit, unit is no longer on-line

52. lost file, file is no longer in directory
53. bad title, illegal file name
54. no room, insufficient space on disk
55. no unit, no such volume on-line
56. no file, no such file on volume
57. duplicate file
58. not closed, attempt to open an open file
59. not open, attempt to access a closed fil
60. bad format, error in reading real or int
61. nested macro definitions illegal
62. '=' or '<>' expected
63. may not EQU to undefined labels
64. must declare .ABSOLUTE before 1st .PROC
65.
66.
67.
68.
69.
70. Not even a register
71. Not a Data Register.
72. Not an Address Register
73. Register Expected
74. Right Paren Expected
75. Right Paren or Comma Expected
76. Unrecognizable Operand
77. Odd location counter
78. Unimplemented Motorola directive
79. Comma Expected.
80. One operand must be a data register.
81. Dn,Dn or -(An),-(An) expected.
82. No longs allowed.
83. First operand must be immediate.
84. First operand must be Dn or #E
85. (An+),(An+) expected
86. Second operand must be an An
87. Second operand must be a Dn
88. #<data>,Dn expected.
89. first operand must be a Dn.
90. An,#<displacement> expected
91. An is not allowed with byte
92. only alterable addressing modes allowed
93. only data alterable addr modes allowed
94. An is not allowed
95. USP, SR, and CCR not allowed
96. Cannot move from CCR
97. Dx,d(Ay) or d(Ay),Dx expected.
98. Only memory alterable addr modes allowed
99. Only control addressing modes allowed
100. Must branch backwards to label

To: Lisa Users
From: One who has been bitten
Date: October 5, 1982
Subject: Register usgae conventions

For those who are writing assembly language routines to be used with Pascal code, there are register usgae conventions you should be following. These conventions insure that you do not trash the Pascal runtime enviorment and bring down the entire machine, not just your program!. The conventions are as follows:

You can clobber: A0, A1
D0, D1, D2

these registers are usable by anyone. Do not put data in them which you expect to be preserved over the course of a JSR; somebody else may have changed them.

You must preserve: A2
D3

but assume that the information will be clobbered. These two registers are special because the Pascal enviorment currently does not maintained these registers, but will in the future. Therefore, if you stick information into these registers now, there is no guarantee that the information will be there after a JSR completes. In the future, information could be safely be stored in these registers. By saving these registers before a JSR and restoring them after the JSR you will not have to change you assembly code later when the Pascal enviorment changes.

You must preserve: A3, A4, A5, A6, A7
D4, D5, D6, D7

these are registers maintained by the Pascal system. If you do not maintain them, your Pascal runtime enviorment will not run properly. Plain and Simple. For those who do not know what these registers are, here is a brief explanation:

A7	- top of stack pointer
A6	- stack frame pointer
A5	- top of globals pointer
A3..A4	- code optimization registers
D3..D7	- code optimization registers

For those whoses assembly langauage routines save all the registers A0..A7/D0..D7 and then uses them with the expectation that those registers will be restored at the end of the routine, you are flirting with disaster. If your assembly language routine dies for some reason and does do not restore the registers that must be preserved, A2..A7/D3..D7 (particularly A5..A7), you will be bring down the whole system. Dying within LisaGraf (QuickDraw) or OSlib could does this, and may be a problem within the system. Beware!!!