BASIC XL

Cartridge System, Run Time & Tool Kit

Compatible !

Flexible !

Fast !

OSS ™

Precision Software Tools

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Revised by GoodByteXL

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A reference manual for

The BASIC XL Programming Environment

comprising

Cartridge Version
Run Time
Toolkit

A complete programming system designed
for your ATARI home computer system.

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comprising the BASIC XL environment
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This comprehensive information
provided by Atari enthusiasts
aims at the preservation of

The BASIC XL Programming Environment

1st revised edition (p) 2020

Preface

As tribute to OSS this fully edited version is provided to keep one of the best and fastest BASIC versions on ATARI 8-bit computers accessible to all being interested in this great piece of software.

BASIC XL was released by OSS in 1983.
OSS merged into a division of ICD, Inc. in 1988.
ICD sold their ATARI 8-bit product line to FTe in 1993.
FTe disappeared supposedly in 1996.
The author Bill Wilkinson passed away in November 2015.
The current status of BASIC XL is that the Wilkinson Family gave allowance to atariwiki.org to use OSS material.

Many of those famous A8 hardware and software products from OSS and ICD are still available thanks to a worldwide active A8 community. So is this manual.

My BASIC XL reference manual went through scanner and OCR process as the one about Action!.

The new BASIC XL manual in chapters 1 to 8 keeps the original layout for reference to the original paperback and of course for historical reasons. Nearly all entries from the original's table of contents are found on the same page.

The BASIC XL Toolkit including The BASIC XL Runtime Package was added to this manual as chapter 9 and is adapted to the layout as deemed necessary.

Therefore the appendices needed amendment and changes as well.

Typos and errors found were corrected and information concerning the XL/XE computers were added to the new BASIC XL manual.

BASIC XL and other OSS programming languages work best in conjunction with SpartaDOS X V. 4.47 or newer provided by DLT.

Enjoy BASIC XL ... and may your A8 always be with you!

GoodByteXL, March 2020

P.S.: Special thanks for help to Roland.

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Chapter 1:                                  Introduction
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1.1 Features of BASIC XL

Compatibility with Atari BASIC

Because BASIC XL uses the same tokens as Atari BASIC,
programs written in Atari BASIC which have been SAVEd
can be LOADed and RUN using BASIC XL.

FAST Program Execution

BASIC XL allows you to RUN your programs faster than
ever with the new FAST command, thus making games
written in BASIC almost as fast as arcade games.

Easy Program Formatting

Unlike other BASICs, BASIC XL does not care whether you
use upper or lower case letters when you enter your
programs. This alone makes programs more readable.
However, BASIC XL does even more. It will
automatically prompt you with line numbers or renumber
an entire program at your request. Also, the LIST
command has a program formatter built in, so your
programs are easier to follow, no matter how complex or
involved they are.

Built-in Functions

BASIC XL contains over 4Ø built-in functions covering a
wide range of applications. The chapter titled
FUNCTION LIBRARY explains these functions and their
usages.

Graphics

BASIC XL offers the same bit-map graphics manipulation
available in Atari BASIC, and allows amazing
flexibility in color choice and pattern variety.
Chapter 7 explains each command and gives examples of
the many ways to use each.

Player / Missile Graphics

BASIC XL allows you easy access to the player / missile
graphics available on the Atari through the use of
built-in functions and commands. With BASIC XL, p/m
graphics are as easy to control as common bit-map
graphics.

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Game Controllers

Not only does BASIC XL support the game controller
functions as Atari BASIC, but it also adds some other
game controller functions which make interpreting and
using the joysticks much easier.

Sound

The Atari Personal Computer is capable of emitting a
large variety of sounds including simulated explosions,
electronic music, and "raspberries", and BASIC XL
allows you to have control over these sounds available.

Wraparound and Keyboard Repeat

If you enter a program line which is longer than the
length of the screen, the line "wraps around" to the
next line so that you can view it. Also, if you hold
down any key for over 1/2 second, it will start
repeating.

Error Messages

If a data entry error is made, the screen display shows
an error message and the line on which the error
occurred (with the character at which the error
occurred highlighted). Most errors will also display a
short, descriptive message along with the error number.
Appendix A contains a list of all the error messages
and their explanations.

1.2 Special Notations used in this Manual

Line Format

The format of a line in a BASIC program includes a line
number (abbreviated to lineno) at the beginning of the
line, followed by a statement keyword, followed by the
body of the statement and ending with a line terminator
command (<RETURN> key). In an actual program, the four
elements might look like this:

```
              Statement   Statement
       lineno  Keyword       Body        Terminator
       ------  -------       ----        ----------
        1ØØ     PRINT     A/X*(Z+4.567)   <RETURN>
```

Several statements can be typed on the same line
provided they are separated by a colon (:).

Capital Letters

In this book, all keywords and functions are printed in uppercase to differentiate them from the other parts of a statement.

Lower Case Letters

In this manual, lower case letter are used to denote the various classes of items which may be used in a program, such as variables (var), expressions (exp), and the like.

Items in Brackets

Brackets ([]) contain optional items which may be used, but are not required, in the format of a statement. If the item enclosed in brackets is followed by three dots (e.g. [exp,...]), more than one of that item may be entered, but none are required.

Items Stacked Vertically in Bars

Items stacked vertically in bars indicate that anyone of the stacked items may be used, but that only one at a time is permissible. In the example below, type either the GOTO or the GOSUB.

```
        1ØØ | GOTO  | 2ØØØ
            | GOSUB |
```

Command abbreviations in headings

If a command or statement has an abbreviation associated with it, the abbreviation is placed in parentheses following the full name of the command in the heading (e.g., LIST (L.)).

1.3 Glossary and terminology
----

adata   (ATASCII Data) Any ATASCII character, ex-
           cluding commas .and carriage returns. (See
           Appendix C.)

aexp   (Arithmetic Expression) Generally composed
           of a variable,' function, constant, or two
           arithmetic expressions separated by an
           arithmetic operator. See section 2.3.2.

alphanumeric
           The letters A through Z (either lower or
           upper case) and the digits Ø through 9.

aop   (Arithmetic operator). See section 2.2.1.

Arrays and Array Variables
An array is a list of places where data can be filed for future use. Each of these places is called an element, and the whole array or any element is called an array variable. See section 2.1.2.

avar
(Arithmetic Variable) A location where a numeric value is stored. Variable names may be from 1 to 120 alphanumeric characters, but must start with an alphabetic character. All characters are normalized to upper case normal (i.e., not inverse) video.

BASIC
Beginner's All-purpose Symbolic Instruction Code.

Constant
A constant is a value expressed as a number rather than represented by variable name. For example, in the statement X = 100, X is a variable and 100 is a constant.

Command String
Multiple commands (or program statements) placed on the same numbered line separated by colons.

exp
Any expression, whether sexp or aexp. See section 2.3.

Expression
An expression is any legal combination of variables, constants, operators, and functions used together to compute a value. Expressions can be either arithmetic, or string (See aexp and sexp).

filespec
File Specification: A string expression that refers to a device such as the keyboard or to a disk file. It contains information on the type of I/O device, its number, a colon, an optional file name, and an optional filename extender. See section 5.1.

NOTE: BASIC XL allows you to omit the double quotes normally required in a literal string when the literal string is used as a filespec for any of the following commands:

DIR	LOAD	PROTECT	LVAR	RUN
ENTER	SAVE	RENAME	OPEN	XIO

CAUTION: when filespec is used this way, it must be the last thing on the program or

command line. Also, DIR, LVAR, and RUN must
always be the last command on the line.

Function   A function is a subroutine built into the
computer so that it can be called by the
user's program. A function is NOT a
statement. COS (Cosine), FRE (unused memory
space), and INT (integer) are examples of
functions. In many cases the value is simply
assigned to a variable (stored in a
variable) for later use. In other cases it
may be printed out on the screen
immediately. See chapter 6 for more on
functions.

Keyword   Any reserved word "legal" in the BASIC
language. May be used in a statement, as a
command, or for any other purpose. (See
Appendix A for a list of all "reserved
words" or keywords in BASIC XL.)

lineno   (Line Number) A constant that identifies a
particular program line in a deferred mode
BASIC program. Must be an integer from Ø
through 32767. Line numbering determines the
order of program execution.

Logical Line
A logical line consists of one to three
physical lines, and is terminated either by
a <RETURN> or when the maximum logical line
limit is reached. Each numbered line in a
BASIC program consists of one logical line
when displayed on the screen.

lop   (Logical Operator) See section 2.2.2.

mvar   (Matrix Variable) Also called a Subscripted
Variable. An element of an array or matrix.
The variable name for the array or matrix as
a whole may be any legal variable name. See
section 2.1.2.

Operator   Operators are used in expressions to tell
the computer how it should evaluate the
variables, constants, and functions in the
expression. There are two types of
operators arithmetic and logical. For more
information, see section 2.2.

Physical Line
One line of characters as displayed on a TV
or monitor screen.

sexp   (String Expression) Can consist of a string variable, string literal (constant), or a function that returns a string value. See section 2.3.3.

String   A string is a group of characters enclosed in quotation marks. "ABRACADABRA" is a string. So are "OSS IS THE BEST" and "123456789". A string is much like a numeric constant (e.g., 12.4), as it may be stored in a variable. A string variable is different in that its name must end in the character $. See section 2.1.3.

svar   (String Variable) A location where a string of characters may be stored. See 2.1.3 and 2.1.4.

var   (Variable) Any variable. May be mvar, avar, or svar. See section 2.1.

Variable   A variable is the name for a numerical or other quantity which may (or may not) change. Variable names may be up to 120 characters long. However, a variable name must start with" an alphabetic letter, and may contain only letters and digits. See section 2.1.

1.4 Operating Modes

Direct Mode

Uses no line numbers and executes instruction immediately after <RETURN> key is pressed.

Deferred Mode

Uses line numbers and delays execution of instruction(s) until the RUN command is entered.

Execute Mode

Sometimes called RUN mode. After the RUN command is entered, each program line is processed and executed.

Memo Pad Mode

A non-programmable mode that allows the user to experiment with the keyboard or to leave messages on the screen. Nothing written while in Memo Pad mode affects the RAM-resident program.

NOTE: this mode is only available on the Atari 4ØØ and 8ØØ.

Chapter 2:   VARIABLES, OPERATORS, EXPRESSIONS

2.1 Variables (var)

There are two basic types of variables in BASIC XL --
arithmetic variables and string variables. Also, there
are are three extensions to these —- arrays, matrices,
and string arrays.

Arithmetic, array, and matrix variables all store
numbers, and can only be used where a number is
required.

String and string array variables both store character
strings and can only be used where a character string
is required.

There are limits to the number of variables you may
use, and to the size and format of a variable name, as
follows:

>   1)   BASIC XL limits the user to 128 variable
>   names. To bypass this problem, use
>   individual elements of any array instead of
>   having separate variable names. To clear
>   the variable name table (possibly after an
>   error 4), you can save your program using
>   LIST, then type NEW, and then ENTER your
>   program back in.

>   2)   All variable names must start with an
>   alphabetic letter, followed by either
>   letters or digits. The name must be less
>   than 128 characters long. All string or
>   string array variable names must end in the
>   '$' (dollar sign) character.

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2.1.1 Arithmetic variables (avar)

Arithmetic variables are those which store a single
number, and are the most common variables used. The
following are examples of arithmetic variables:

        X
        THISISANARITHMETICVARIABLE
        TEMP
        CHARGE

Here are some examples of arithmetic variables in use:

        1ØØ LET X=76   :REM here's one use
        2ØØ FOR 1=1 TO 1ØØ :REM here's a second
        3ØØ PRINT X-2   :REM and a third
        4ØØ NEXT I
        5ØØ END

2.1.2 Array / Matrix Variables (mvar)

An array variable is a group of memory locations
(called elements or subscripts of the array). In each
one of these locations is a number: so, in essence, an
array is simply a group of arithmetic variables which
share a common name.

The manner in which you access a given element of an
array is simple -- you merely give the array name
followed by the element number in parentheses, as in
the following examples:

        A(3)   ARRAY(l4)   NUMLIST(4Ø)

The elements are numbered starting at Ø, and continue
through to the DIMensioned size of the array. "How do
I dimension the size?" It's easy. You use the DIM
statement as follows:

        DIM A(4Ø)   REM dimension 'A' as a 4Ø element
                        REM array.

        DIM NUMLIST(6Ø) REM dimension 'NUMLIST' as a 6Ø
                        REM array.

For more information on the use of DIM, see section
2.1.5.

A matrix is similar to an array, except that it is two
dimensional. This means that there are two numbers
required to specify a given element: a row number, and

1Ø

a column number. You can think of a matrix as a grid, with each box being one element. The following is a representation of a 5 by 5 matrix, where each of the boxes contains the subscripts used to access that box (element):

```
                        C   O   L   U   M   N
                      +-----+-----+-----+-----+-----+
Notice that the row   | Ø,Ø | Ø,1 | Ø,2 | Ø,3 | Ø,4 |
number   is   given   +-----+-----+-----+-----+-----+
first,  followed by  R| 1,Ø | 1,1 | 1,2 | 1,3 | 1,4 |
a  comma  and  then   +-----+-----+-----+-----+-----+
the  column number.  O| 2,Ø | 2,1 | 2,2 | 2,3 | 2,4 |
This  is  the  same   +-----+-----+-----+-----+-----+
order you would use  W| 3,Ø | 3,1 | 3,2 | 3,3 | 3,4 |
to access that ele-   +-----+-----+-----+-----+-----+
ment.                 | 4,Ø | 4,1 | 4,2 | 4,3 | 4,4 |
                      +-----+-----+-----+-----+-----+
```

Dimensioning the size of a matrix is very similar to dimensioning an array, but both the row dimension and column dimension are required, e.g.:

```
        DIM AMATRIX(4,4)   REM a 5 by 5 matrix; remember
                           REM that (Ø,Ø), not (1,1) is
                           REM the first element.
```

NOTE: for more information on DIM, see section 2.1.5.

When you use an element of an array or matrix, you are actually using a single number (which is what an arithmetic variable is). This means that an array or matrix element may be used wherever 'avar' can be used.

Examples:
```
        X=47.4
        ARRAY(7)=47.4
        MATRIX(4,3)=47.4

        IF ABS(X)<1ØØ THEN...
        IF ABS(ARRAY(7))<1ØØ THEN...
        IF ABS(MATRIX(4,3))<1ØØ THEN...
```

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2.1.3 String Variables (svar)

String variables are used to store literal strings of
characters. A literal string of characters is simply a
group of characters enclosed in double quotes:

```
"this is a literal string"
"numbers in quotes are strings: 34344.2"
```

String variable names are just like arithmetic variable
names, except that they must end with a '$', as in the
following examples:

```
STRING$
A$
```

To dimension the size of a string variable (i.e.,
define how many characters it may hold), you use the
DIM statement (also see 2.1.5):

```
DIM STRING$(66)
DIM A$(1Ø)
```

NOTE: BASIC XL will auto-dimension a string variable if
you don't manually DIMension it. See 3.15 for more info
on this feature.

With arrays and matrices the first element is the
zeroth, but with strings the first element is the
first, e.g.:

```
DIM A$(1Ø)
A$="A String"
```

A$(l)="A", and A$(Ø) generates an error because the
first element of a string is (1), not (Ø) (as in arrays
and matrices).

2.1.4 String Array Variables (svar)

A string array is very similar to a normal arithmetic
array (section 2.1.2), except that each element is a
string, not a number.

As with string variables, a string array variable must
have its name end with a '$', and it is dimensioned
using DIM. However, there are two quantities which need
to be dimensioned -- the number of elements and the
size of each element. The following examples show

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how to do this (also see section 2.1.5):

```
        DIM Strarray$(4,4Ø)
        DIM A$(1Ø,1ØØ)
```

The first example dimensions a string array called "Strarray$" with 4 elements. Each element is a string 4Ø characters long. The second example dimensions the string array "A$" to 1Ø elements, with each element being 1ØØ characters in length.

To access one of the elements of a string array you specify the element number (the first element is number 1, not Ø as in arithmetic arrays) followed by a semi-colon (:). An example follows:

```
        1ØØ DIM A$(3,6)
        2ØØ A$(l:)-"TEST"
        3ØØ A$(2: )="STRING"
        4ØØ A$(3: )="ARRAY"
```

2.1.5 DIM

```
 Format:  DIM svar(aexp[,aexp]) [,svar(aexp[,aexp])...]
          DIM mvar(aexp[,aexp]) r,mvar(aexp[,aexp])...]
```

```
 Example:  DIM A(1ØØ)
           DIM M(6,3)
           DIM B$(2Ø)
           DIM A$(2Ø,4Ø)
```

A DIM statement is used to reserve a certain number of locations in memory for an array, matrix, string, or string array.

The first example reserves l~l locations (each of which can contain any legal numeric quantity) for an array designated A.

The second example reserves 7 rows by 4 columns for a two-dimensional array (matrix) designated M.

The third example reserves 2Ø bytes for the string 'B$'.

NOTE: BASIC XL contains an auto DIMension capability for simple string variables only which you can control. For more info, see SET, section 3.15.

The fourth example reserves a string array of 2Ø elements, with each string element being 4Ø characters long.

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2.2 Operators

BASIC XL has two types of operators:

        1) Arithmetic Operators
        2) Logical (relational) Operators

As you will see in the expressions sections, either of
these two types of operators may be used in arithmetic
expressions, while neither may be used in a string exp-
ression.

2.2.1 Arithmetic Operators (aop)

BASIC XL uses 8 arithmetic operators:

+   addition (also unary plus: e.g., +5)
-   subtraction (also unary minus: e.g., -5)
*   multiplication
/..division
^   exponentiation
&   bitwise "AND" of two positive integers (both <= 65535)
!   bitwise "OR" of two positive integers (both <= 65535)
%   bitwise "EOR" of two positive integers (both <= 65535)

The first four are straightforward enough, but the last
four require some explanation.

The operator "^" is used to raise a number to a
specified power. The following examples should clarify
this:

                Exponent   Expanded   Result
                --------   --------   ------
                  4^2   4*4   16
                  5^3   5*5*5   125

                                         Bit-wise And
& tests two bytes bit by bit, Bit A Bit B   Result
     returning a value based   1   1   1
     on this table: Ø   1   Ø
                                   Ø   Ø   Ø
                                   1   Ø   Ø

     Example: 5 & 39 -- ØØØØØ1Ø1 (equals 5 decimal)
                        ØØ1ØØ111 (equals 39 decimal)
                  & ----------
                        ØØØØØ1Ø1 (result of & is 5)

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```
                                          Bit-wise Or
%  returns a value depen-      Bit A   Bit B   Result
     dent on this table:         1       1       1
                                 Ø       1       1
                                 Ø       Ø       Ø
                                 1       Ø       1


     Example: 5 % 39 -- ØØØØØ1Ø1  (5)
                        ØØ1ØØ111  (39)
                    % ----------
                        ØØ1ØØ111  (result of % is 39)


                                          Bit-wise XOR
!  returns a value depen-      Bit A   Bit B   Result
     dent on this table:         1       1       Ø
                                 1       Ø       1
                                 Ø       Ø       Ø
                                 Ø       1       1


     Example: 5 ! 39 -- ØØØØØ1Ø1  (5)
                        ØØ1ØØ111  (39)
                    ! ----------
                        ØØ1ØØØ1Ø  (result of ! is 34)
```

2.2.2 Logical Operators (lop)

The logical operators consist of three types: rela-
tional, unary, and binary.

The rest of the binary operators are relational.

```
<    The first expression is less
                          than the second expression.
>    The first expression is greater than the second.
=    The expressions are equal to each other.
<=   The first expression is less
                          than or equal to the second.
>=   The first expression is greater
                          than or equal to the second.
<>   The two expressions are not equal to each other.
```

Examples:

```
        X >= 7
        X <> INT(Y)
```

These operators are most frequently used in IF/THEN
statements (i.e., in relational tests), but may also be
used in arithmetic expressions. When used in this way,
a 1 results the logical test proved true, and a Ø
results if the test proved false.

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The unary operator is NOT, and the binary operators
are:

                AND -- Logical AND
                OR -- Logical OR

Examples:

1Ø IF A=12 AND T=Ø THEN PRINT "GOOD"   Both expressions
                                       must be true before GOOD
                                       is printed (that is, A
                                       must equal 12 and T must
                                       equal Ø).

1Ø A=(C>1) AND (N<1)   If both expressions true,
                              A = +1; otherwise A = Ø.

1Ø A = (C+1) OR (N-1)   If either expression true,
                              A = +1; otherwise A = Ø.

1Ø A = NOT(C+1)   If expression is false,
                              A = +1; otherwise A = Ø.

2.2.3 Operator Precedence

Operators require some kind of precedence, a defined
order of evaluation, or we wouldn't know how to
evaluate expressions like:

                    4+5*3

Is this equal to (4+5)*3 or 4+(5*3)? Without operator
precedence it's impossible to tell. BASIC XL's normal
precedence is very precise, as shown in the following
table. The operators are listed in order of highest to
lowest precedence. Operators on the same line are
evaluated left to right in an expression.

()	Parentheses
< > = <= >= <>	Relational Operators when used to evaluate strings in arithmetic expressions
NOT + -	NOT, Unary Plus and Minus
^	Exponentiation
% ! &	bitwise EOR, OR, AND
* /	Multiplicative Operations
+ -	Additive Operations
< > = <= >= <>	Relational Operators
AND	Logical 'and'
OR	Logical 'or'

Examples showing the above precedence in use can be
found in section 2.3.2.

2.3 Expressions (exp)

Expressions are constructions which obtain values from
variables. constants, and functions using a specific
set of operators. In BASIC XL there are two types of
expressions -- arithmetic and string. Each of these is
dealt with separately. but before going into the
expressions themselves something needs to be said about
the constant numbers used in arithmetic expressions.

2.3.1 Numbers

All numbers in BASIC XL are BCD floating point, but
there are two ways to enter them in decimal or
hexadecimal.

Decimal numbers may either be whole integers.
fractions, or scientific notation. The following are
examples of each:

Integers:	Fractions:	Sci. Notation:
4Ø27	-67.254	4.33E2
-2	325.Ø4	23.4E-14

The 'E' in the scientific notation examples stands for
"exponent". The number following it is the power of
ten (e.g., 4.33E2 means "4.33 multiplied by 1Ø
squared").

Hexadecimal numbers can only be integers. and the
digits must be preceded by a '$', as in the following
examples:

$4A3Ø	-$ØA	$6FF
-$E	-$AØØØ	$FFFF

The maximum hexadecimal value allowed is $FFFF.

Internal Format of Numbers

Numbers are represented internally in 6 bytes. There is
a 5 byte mantissa containing 1Ø BCD digits and a one
byte exponent.

The most significant bit of the exponent byte gives the
sign of the mantissa (Ø for positive, 1 for negative).
The least significant 7 bits of the exponent byte gives
the exponent in excess 64 notation. Internally, the
exponent represents powers of 1ØØ (not powers of 1Ø).

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Example:
        $0.02 = 2 * 10^{-2} = 2 * 100^{-1}$

exponent   = $-1 + 40 = 3F$

   0.02 = 3F 02 00 00 00 00

The implied decimal point is always to the right of the
first byte. An exponent less than hex 40 indicates a
number less than 1. An exponent greater than or equal
to hex 40 represents a number greater than or equal to
1.

Zero is represented by a zero mantissa and a zero
exponent.

In general, numbers have a 9 digit precision. For
example, only the first 9 digits are significant when
INPUTing a number. Internally the user can usually get
10 significant digits in the special case where there
are an even number of digits to the right of the
decimal point (0,2,4,...).

2.3.2 Arithmetic Expressions (aexp)

Arithmetic expressions are those which evaluate to a
number. Following is a list of expression elements
which are considered to be numbers:

      1) a constant number

      2) an avar (including subscripted mvars)

      3) a function which returns a number

      4) two sexps compared using a relational operator

The first three are straightforward, but the fourth
requires an example:

      100 S$="ABC"
      200 PRINT S$< "DEF"
      300 END

prints out:
                1

because the logical comparison of the two strings is
true.

An arithmetic expression can simply be one of the
above, or two or more of the above separated by

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operators   (either   arithmetic   or   logical).   The
following   are   examples   of   arithmetic   expressions,
including the order of the operators' evaluation (in
any) and the result:

Expression	evaluation Order	Result
3*(4+(21/7)*2)	/,*,+,*	3Ø
"ABC">"DEF"+7*(ASC("A"))	>,ASC,*,+	455
X=1ØØ : Y=2		
INT(X*Y/3)	*,/,INT	66

2.3.3 String Expressions (sexp)

String expressions are much simpler than arithmetic
expressions since there are fewer things they can be.
The   following   list   shows   all   the   valid   string
expression possibilities:

        1) a string constant

        2) an svar (including subscripted string arrays)

        3) a function which returns a string

        4) a substring of an svar or string array

This is the first time we've seen the word "substring"
used, so we need to define and to explain it.

String	Definition when Destination String	Definition when Source String
S$	the entire string 1 thru DIM value	from 1st thru LEN character
S$(n)	from nth thru DIMth character	from nth thru LENgth character
S$(n,m)	from the nth thru the mth character	from the nth thru the mth character
SA$(e;)	same as S$, except string is eth element of SA$	same as S$, except string is eth element of SA$
SA$(e;n)	same as S$(n), except string is eth element of SA$	same as S$(n), except string is eth element of SA$

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```
              Definition when        Definition when
String        Destination String      Source String
------        ------------------      ---------------


SA$(e;n,m)  same as S$(n,m)         same as S$(n,m)
            except string is        except string is
            eth element of SA$      eth element of SA$
```

A destination string is one to which something is being
assigned. Any other string is a source string. In

```
        X$=Y$       READ X$     INPUT X$
        RPUT Y$     PRINT Y$    etc.
```

X$ is the destination string, Y$ is the source string.

An error occurs if either the first or last specified
character (n and m, above), or the element number (in
the case of string arrays) is outside the DIMensioned
size. Also, an error occurs if the last character
position given (explicitly or implicitly) is less than
the first character position.

Source Example: (Assume A$ = "VWXYZ")

```
        1) PRINT A$(2)      prints: WXYZ

        2) PRINT A$(3,4)    prints: XY

        3) PRINT A$(5,5)    prints: Z

        4) PRINT A$(7)
           is an error because A$ has a length of 5.
```

Destination Example: (Assume DATA "VWXYZ")

```
        1) READ D$
           PRINT D$         prints: VWXYZ
```

20

```
--------------------------------------------------------
Chapter 3:              PROGRAM DEVELOPMENT COMMANDS
--------------------------------------------------------
```

Some of the commands available in BASIC XL are designed
specifically to aid in quick and effective program
development. The operations these commands execute are
too diverse to describe in detail here, so we'll simply
give their names and refer you to the section in which
the particular command is discussed:

```
            BYE         LIST        RENUM
            CLR         LOMEM       RUN
            CONT        LVAR        SET
            DEL         NEW         STOP
            DOS         NUM         TRACE
            FAST        REM         TRACEOFF
```

3.1 BYE (B.)

```
        Format:  BYE

        Example: BYE
```

The function of the BYE command is to exit BASIC XL and
put the computer in Memo Pad mode. This allows you to
experiment with the keyboard or to leave messages on
the screen without disturbing any BASIC XL program in
memory. To return to BASIC XL, press <SYSTEM RESET>.

3.2 CLR

```
        Format:  CLR

        Example: 2ØØ CLR
```

This command clears the memory of all previously
dimensioned strings, arrays, and matrices so the memory
and variable names can be used for other purposes. It
also clears the values stored in undimensioned
variables. If a matrix, string, or array is needed
after a CLR command, it must be redimensioned with a
DIM command.

3.3 CONT (CON.)

          Format: CONT

          Example: CONT
                     1ØØ CONT

In direct mode, this command resumes program execution
after a STOP statement, a <BREAK> key abort, or any
stop caused by an error.

CAUTION: Execution resumes on the line following the
halt, so any statements following the halt (and on the
same line as the halt) will not be executed.

In deferred mode, CONT may be used for error trap
handling.

Example:
          1Ø TRAP 1ØØ
          2Ø OPEN #1,12,Ø,"D:X"
          3Ø
          ..
          ..
          1ØØ IF ERR(Ø)=17Ø THEN
               OPEN #l,8,Ø,"D:X":CONT

In line 2Ø we attempt to open a file for updating. If
the file does not exist, a trap to line 1ØØ occurs. If
the "FILE NOT FOUND" error occurred, the file is opened
for output (and thus created) and execution continues
at line 3Ø via "CONT".

3.4 DEL

          Format: DEL line[,line]

          Example: DEL 1ØØØ,1999

DEL deletes program lines currently in memory. If two
line numbers are given (as in the example), all lines
between the two numbers (inclusive) are deleted. A
single line number deletes a single line.

Example:
          1ØØ DEL 1ØØØ,1999
          11Ø SET 9,1:TRAP 1ØØØ
          12Ø ENTER "D:OVERLAY1"
          1ØØØ REM These lines are deleted by line 1ØØ.
          1Ø1Ø REM Presumably they will be overlaid by
          1998 REM the program ENTERed in line 12Ø.
          1999 REM See 'ENTER' and 'SET' for more info.

3.5 DOS

        Format: DOS

        Example: DOS

The DOS command is used to go from BASIC XL to the Disk
Operating System (DOS). If the Disk Operating System
has not been booted into memory, the computer will go
into Memo Pad mode and the user must press <SYSTEM
RESET> to return to Direct mode. If the Disk Operating
System has been booted, control is given to DOS. To
return to BASIC XL, press 'CAR' <RETURN> for OS/A+ or
DOS XL, or press 'B' <RETURN> for Atari DOS.

NOTE: The command CP is exactly equivalent to DOS.

DOS is usually used in Direct mode; however, it may be
used in a program. For more details on this, see your
DOS manual.

3.6 FAST

        Format: [lineno] FAST

        Example: FAST
                 1ØØ FAST

During normal program execution BASIC XL must search
(from the beginning) for a specified line number
whenever it encounters a GOTO, GOSUB, FOR, or WHILE
(this is how most of the other BASICs do it too).
However, you can change this by using the FAST command.

When BASIC XL sees 'FAST', it does a precompile of the
program currently in memory. During the precompile
BASIC XL changes every line number to the address of
that line in memory. Now, when a GOTO, GOSUB, FOR, or
WHILE is executed, no line number search is needed,
since BASIC XL can simply jump right to the specified
line's address.

NOTE: if the lineno used in the GOTO or GOSUB is not a
constant (i.e., is a variable or an expression), then
that lineno will not be affected by FAST, and so will
RUN at normal speed.

3.7 LIST (L.)

        Format: LIST [lineno[,lineno]]
                 LIST ["filespec"[,lineno[,lineno]]]

        Examples:

                LIST
                LIST 1Ø
                LIST 1Ø,1ØØ
                LIST 1Ø,
                LIST "P:"
                LIST "D:DEMO.LST"
                LIST "P:",2Ø,1ØØ

LIST causes the program currently in memory to be
displayed. You can display a single line by giving the
line number after the 'LIST', or display a group of
lines by giving the starting line number and ending
line number (separated by a comma) after the 'LIST'.

If you give the starting line number, a comma, and no
end address, the ending line number is assumed to be
the last line in the program.

If no line number(s) is given, the entire program is
displayed.

You can also redirect the display to a file by entering
the filespec enclosed in double quotes immediately
after the 'LIST'. You can then add any of the line
number specifications described above to list only what
you want to that file.

LIST can be used in Deferred mode as part of an error
trapping routine (See TRAP in Section 4).

NOTE: the quotes around the filespec are required for
LIST, unless of course a string variable is used.

3.8 LOMEM

        Format: LOMEM addr

        Example: LOMEM DPEEK(128)+1Ø24

This command is used to reserve space below the normal
program space. You could then use this space for
screen display information or assembly language
routines. The usefulness of this may be limited,
though, since there are other more usable reserved
areas available.

CAUTION: LOMEM wipes out any user program currently in memory.

3.9 LVAR (LV.)

        Format: LVAR [filespec]

        Example: LVAR P:

This statement will list (to any file) all variables currently in use. Each variable is followed by a list of the lines on which that variable is used. The example above will list the variables to the printer. If no filespec is used then LVAR lists to the screen.

NOTE: strings are denoted by a trailing '$', arrays by a trailing '('.

WARNING: LVAR must be the last (or only) command on a line.

3.1Ø NEW

        Format: NEW

        Example: NEW

This command erases the program stored in RAM. Therefore, before typing NEW, either SAVE or CSAVE any programs to be recovered and used later. NEW clears BASIC's internal symbol table so that no arrays (See Section 8) or strings (See Section 7) are defined. NEW is normally used in Direct mode but is sometimes useful in deferred mode as an alternative to END.

3.11 NUM

        Format: NUM [start][,increment]

        Example: NUM
                 NUM 5Ø
                 NUM ,1
                 NUM 5Ø,1

The NUM command enables BASIC XL's automatic line numbering facility. This facility can increase your program entry speed because it puts in the program line numbers for you.

If no start or increment is given (first example), NUM will start numbering from the last line number currently in the program in increments of 1". If there

is no current program, NUM will start with line number
1Ø.

If the starting line number alone is given (second
example), NUM will start numbering from that line
number in increments of 1Ø.

If the increment alone is given (third example), NUM
will start numbering from the last line currently in
the program, incrementing by the number you gave it as
an increment.

If both the starting line number and the increment are
given (last example), NUM will start numbering from the
given line number and increment by the given increment
value.

Three things cause the automatic line numbering to
stop:

    1) If you press <RETURN> immediately following
        the line number.

    2) If a syntax or similar error is encountered on
        a program line you type in.

    3) If the next automatic line number is the same
        as a line number already in the program. This
        keeps you from overwriting previously written
        parts of your program.

    NOTE: If the starting line number you give already
    exists, then the automatic line numbering will not
    begin.

3.12 REM (R.)

          Format: REM text

          Examples: 1Ø REM ROUTINE TO CALCULATE X
                    2Ø GOSUB 3ØØ : REM Find Totals

REM stands for "remark" and,is used to put comments
into a program. This command and the text following it
on the same line are ignored by the computer. However,
it is included in a LIST along with the other numbered
lines. Since all characters following a REM are
treated as part of the REMark, no statements following
it (on the same logical line) will be executed.

3.13 RENUM

         Format: RENUM [start][,increment]

         Examples: RENUM
                   RENUM 1ØØ
                   RENUM ,3Ø
                   RENUM 1ØØØ,5

RENUM renumbers the entire program as it currently
resides in memory. The first line in memory is given
the line number specified by 'start', and each
subsequent line number is one 'increment' greater than
the last.

All line number references (e.g., in GOTO, GOSUB, etc.)
are also renumbered IF the line numbers are absolute
numbers. Line number expressions (e.g., GOTO
1ØØØ+lØ*INDEX) will NOT be renumbered.

If no 'start' line number is given, RENUM assumes a
starting line number of 1Ø. If no 'increment' is given,
RENUM will renumber lines in increments of 1Ø. (That
is, just typing 'RENUM' is equivalent to typing 'RENUM
1Ø,1Ø'.)

As noted in the examples above, both start and
increment are separately optional.

WARNING: If you use LIST in deferred mode (i.e., in a
program) the lineno values you want to list will not be
RENUMbered.

WARNING: RENUM will not renumber absolute linenos after
a lineno expressed as an expression. Example:

         ON X GOSUB 1ØØ,3*Y,2ØØ

In this example 1ØØ will be RENUMbered, but 2ØØ will
not, since it follows a lineno expressed as an
expression (3*Y).

3.14 RUN

         Format: RUN [filespec]

         Examples: RUN
                   RUN D:MENU

This command causes the computer to begin executing a
program. If no filespec is specified, the current RAM-
resident program is executed. If a filespec is
included, the computer retrieves the tokenized program

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from the specified file, executes a FAST command (see
section 3.6), and then executes the program.

Before execution begins all variables (including
arrays, strings, and matrices) are set to zero, all
open files (channels) are closed, and all sounds are
turned off.

Unless the TRAP command is used, an error will cause
the execution to halt and an error message will' be
displayed.

RUN can also be used in Deferred mode.

Examples: 1Ø PRINT "OVER AND OVER AGAIN."
               2Ø RUN

Type RUN and press <RETURN>. To end, press <BREAK>.

To begin program execution at a point other than the
first line number, type GOTO followed by the specific
line number, then press <RETURN>. CAUTION: arithmetic
variables, arrays, and strings are neither cleared or
initialized by GOTO.

NOTE: RUN must be the last (or only) command on a line.

3.15 SET

        Format: SET aexp1,aexp2

        Example: 1ØØ SET 1,5

SET is a statement which allows you to exercise control
over a variety of BASIC XL system level functions. The
table below summarizes the various SET table parameters
(default values are given in parentheses).

aexp1		aexp2	Meaning
Ø	(Ø)	Ø	- BREAK key functions normally
		1	- User hitting BREAK cause an error to occur (TRAPable)
		128	- BREAKs'are ignored
1	(lØ)	1 thru 128	- Tab stop setting for the comma in PRINT statements.
2	(63)	Ø thru 255	- Prompt character for INPUT (default is "?").

```
     aexp1    aexp2   Meaning
     -----    -----   -------
       3   (Ø)    Ø    - FOR...NEXT loops always execute at
                         least once (ala ATARI BASIC).
                   1    - FOR loops may execute zero times
                         ANSI standard)


       4   (Ø)    Ø     - On a multiple variable INPUT, if
the
                         user enters too few items, he is
                         reprompted (e.g., with "??")
                   1    - Instead of reprompting, a TRAPable
                         error occurs.


       5   (1)    Ø    - Lower case and inverse video
                         characters remain unchanged without
                         causing syntax errors (BASIC XL
                         allows mixed case program entry).
                   1    - For program entry ONLY, lower case
                         letters are converted to upper case
                         and inverse video characters are
                         uninverted. EXCEPTION: characters
                         between quotes remain unchanged.

                         CAUTION: this conversion applies to
                         REMarks  and  DATA  statements  also.
                         For total compatibility with Atari
                         BASIC, it might be best to use SET
                         5,Ø.

       6   (Ø)    Ø    - Print error messages along with
                         error numbers (for most errors)
                   1    - Print only error numbers.


       7   (Ø)    Ø    - Missiles (in Player / Missile
                         Graphics), which move vertically to
                         the edge of the screen, roll off
                         the edge and are lost.

                   1    - Missiles wraparound from top to
                         bottom and visa versa.


       8   (Ø)    Ø    - Don't push (PHA) the number of
                         parameters to a USR call on the
                         stack [advantage: some assembly
                         language· subroutines not expecting
                         parameters may be called by a
                         simple USR(addr) ].
                   1    - DO push. the count of parameters
                         (ATARI BASIC standard).
```

```
aexp1    aexp2   Meaning
-----    -----   -------
  9  (Ø)   Ø    - ENTER statements return to the
                   READY prompt level on completion.
           1    - If a TRAP is properly set, ENTER
                   will execute a GOTO the TRAP line
                   on end-of-entered-file.

 1Ø  (Ø)   Ø    - The four missiles act separately;
                   that is, as four missiles.
           1    - The four missiles are grouped into
                   a fifth player. To move this
                   player, you need only do a PMMOVE
                   of one of the missiles since they
                   are all grouped together.

 11  (4Ø)  1    - BASIC XL will DIM a string to this
          thru    size if you do not use a DIM
          255     statement to otherwise dimension
                   it.

           Ø    - BASIC XL works like Atari BASIC

 12  (1)   Ø    - The program LIST formatter does not
                   indent when you use structured
                   statements (FOR, WHILE, etc.).
           1    - The LIST formatter does indent when
                   you use structured statements.
```

NOTE: The SET parameters are reset to the system
defaults on execution of a NEW statement.

Examples:

```
       1) SET 1,4 : PRINT 1,2,3,4

          The number will be printed every
          four columns.

       2) SET 2, ASC(">")

          Changes the INPUT prompt from "?" to ">".

       3) 1ØØ SET 9,1 : TRAP 12Ø
          11Ø ENTER "D:OVERLAY.LIS"
          l2Ø REM execution continues here after
          l3Ø REM entry of the overlay

       4) 1ØØ SET Ø,l : TRAP 2ØØ
          11Ø PRINT "HIT BREAK TO CONTINUE"
          12Ø GOTO 11Ø
          2ØØ REM come here via BREAK KEY
```

```
     5) 1ØØ SET 3,1
        11Ø FOR I = 1 TO Ø
        12Ø PRINT THIS LINE WON'T BE EXECUTED"
        13Ø NEXT I
```

3.16 STOP

        Format: STOP

        Example: 1ØØ STOP

When the STOP command is executed in a program, BASIC
XL displays the message STOPPED AT LINE 1ineno,
terminates program execution, and returns to Direct
mode. The STOP command does not close files or turn
off sounds (as does END), so the program can be resumed
by typing CONT <RETURN> (see section 3.3 for more info
on CONT).

3.17 TRACE and TRACEOFF

        Formats: TRACE
                  TRACEOFF

        Examples: 1ØØ TRACE
                  TRACEOFF

These statements are used to enable or disable the line
number trace facility of BASIC XL. When in TRACE mode,
the line number of a line about to be executed is
displayed on the screen surrounded by square brackets.

Exceptions: The first line of a program does not have
             its number traced. The object line of a
             GOTO or GOSUB and the looping line of FOR
             or WHILE may not be traced.

NOTE: A direct statement (e.g., RUN) is TRACED as
having line number 32768.

This chapter explains the commands associated with
loops, conditional and unconditional branches, error
traps, and subroutines. It also explains the means of
accessing data and the optional command used for
defining variables.

The following commands are described in this chapter:

```
     Assignment Statement     LET
     END                      MOVE
     FOR...TO...STEP/NEXT     ON...GOTO/GOSUB
     GOSUB...RETURN           POP
     GOTO                     RESTORE
     IF...THEN                TRAP
     IF...ELSE...ENDIF        WHILE...ENDWHILE
```

4.1 Assignment Statement

```
        Format:   avar=aexp
                  mvar(aexp)=aexp
                  svar(aexp;)=sexp[,sexp...]
                  svar=sexp[,sexp...]


        Example:  X=9
                  I=X+7*9
                  ARRAY(7)=23.75
                  A$(4;)="A STRING ARRAY ELEMENT"
                  S$="THIS IS A STRING"
                  M$="CONCATENATED"
                  C$=S$," WHICH IS ",M$
```

The assignment statement is used to assign a value to a
variable, and can be used with arithmetic, matrix
(array), or string variables (including string arrays).

The first and second examples given simply equate an
avar to an aexp. If you insert a 'PRINT I' statement
after the second example, 72 (the value of I) will be
printed. The third equates one element of a mvar to an
aexp.

The fourth example is somewhat more complicated; it
equates one element of a string array to a sexp (in
this case a string constant).

The fifth and sixth examples equate svars to sexps.

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String concatenation may be accomplished via the form
shown in the last example above. Note that

        A$=B$,C$

is exactly equivalent to

        A$=B$
        A$(LEN(A$)+1)=C$

From this you can see that C$ in the last example is
equal to "THIS IS A STRING WHICH IS CONCATENATED".

Here is another example:

        1ØØ DIM A$(1ØØ),B$(1ØØ)
        2ØØ A$="123"
        3ØØ B$="ABC"
        4ØØ A$=A$,B$,A$
        5ØØ REM At this point A$ = "123ABC123ABC"
        6ØØ A$(4,9)="X",STR$(3*7),"X"
        7ØØ REM At this point, A$="123X21X23ABC"
        8ØØ A$(7)=A$(1,3)
        9ØØ REM Finally, A$="123X2ll23"

NOTE: for   more   information   on   variables   and
expressions, see chapter 2.

4.2 END

        Format: END

        Example: 1ØØØ END

This command is used to terminate the execution of a
program. In addition to this, it also closes all files
and turns off any sounds. It does not change the
GRAPHICS mode, however. END is not required in most
programs because BASIC XL automatically closes all
files and turns off any sounds after the last program
line has executed.

If you have any subroutines following the main program
you should put an END at the end of the main program;
otherwise the subroutines will be executed as part of
the main program.

END may also be used in Direct mode to close files and
turn off sounds.

4.3 FOR(F.)...TO...STEP / NEXT(N.)

          Format: FOR avar = aexp1 TO aexp2 [STEP aexp3]
                     NEXT avar

          Examples: FOR X = 1 TO 1Ø
                     NEXT X

                     FOR Y = 1Ø TO 2Ø STEP 2
                     NEXT Y

                     FOR INDEX = Z TO 1ØØ * Z
                     NEXT INDEX

The FOR statement is used to repeat a group of
statements a specified number of times. It does this by
initializing the loop variable (avar) to the value of
aexp1. Each time the NEXT avar statement is
encountered, the loop variable is incremented by the
amount specified by aexp3 in the 'STEP' option. aexp3
can be either positive or negative, either a fraction
or a whole number. If the 'STEP' option is not used,
the loop increments by one. When the loop completes the
limit as defined by aexp2, it stops and the program
proceeds to the statement immediately following the
NEXT statement.

FOR loops can be nested, one within another. In this
case, the innermost loop is completed before returning
to the outer loop. The following example illustrates a
nested loop program.

    1Ø FOR X=1 TO 3   : REM START OF OUTER LOOP
    2Ø PRINT "OUTER LOOP"
    3Ø Z=Ø
    4Ø Z=Z+2
    5Ø FOR Y=1 TO 5 STEP Z   : REM START OF INNER LOOP
    6Ø PRINT" INNER LOOP"
    7Ø NEXT Y   : REM END OF INNER LOOP
    8Ø NEXT X   : REM END OF OUTER LOOP
    9Ø END

The outer loop will complete three passes (X = 1 to 3).
However, before this first loop reaches its NEXT X
statement, the program gives control to the inner loop.
Note that the NEXT statement for the inner loop must
precede the NEXT statement for the outer loop. Tn the
example, the inner loop's number of passes is
determined by the STEP statement (STEP Z). In this
case, Z has been defined as Ø, then redefined as Z+2.
Using this data, the computer must complete three
passes through the inner loop before returning to the

outer loop. The following is the output of the program
when it is RUN:

```
   OUTER LOOP
      INNER LOOP
      INNER LOOP
      INNER LOOP
   OUTER LOOP
      INNER LOOP
      INNER LOOP
      INNER LOOP
   OUTER LOOP
      INNER LOOP
      INNER LOOP
      INNER LOOP
```

The return addresses for the loops are placed in a
special group of memory addresses referred to as a
stack. The information is "pushed" on the stack and
when used, the information is "popped" off the stack
(see POP).

4.4 GOSUB (GOS.) / RETURN (RET.)

```
        Format:   GOSUB lineno1
                  lineno1
                     :
                     :
                  lineno2 RETURN
```

```
        Example: 100 GOSUB 2000
                 2000 PRINT "SUBROUTINE"
                 2010 FOR X=1 TO 10
                 2020 PRINT X,X*X
                 2030 NEXT X
                 2040 RETURN
```

A subroutine is a program or routine used to compute a
certain value,etc. It is generally used when an
operation must be executed several times within a
program sequence using the same or different values.
This command allows the user to "call" the subroutine,
if necessary. The last line of the subroutine must
contain a RETURN statement: The RETURN statement goes
back to the physical line following the GOSUB
statement.

Generally, a subroutine can do anything that can be
done in a program. It is used to save memory and
program-entering time, and to make programs easier to
read and debug.

Like the preceding FOR/NEXT command, the GOSUB/RETURN
command uses a stack for its return address. If the
subroutine is not allowed to complete normally; e.g., a
GOTO lineno before a RETURN, the GOSUB address must be
"popped" off the stack (see POP) or it could cause
future errors.

To prevent accidental triggering of a subroutine (which
normally follows the main program), place an END
statement preceding the subroutine. The following
program demonstrates the use of subroutines.

```
10 PRINT CHR$(125)   :REM this clears the screen
20 REM EXAMPLE USE OF GOSUB/RETURN
30 X=100
40 GOSUB 1000
50 X=120
60 GOSUB 1000
70 X=50
80 GOSUB 1000
90 END
1000 Y=3*X
1010 x=x+y
1020 PRINT X,Y
1030 RETURN
```

In the above program, the subroutine, beginning at line
1000, is called three times to compute and print out
different values of X and Y. Below are the results of
executing this program.

```
    400        300
    400        360
    200        150
```

4.5 GOTO (G.)

        Format: [lineno) GOTO aexp

        Examples: 100 GOTO 50
                  500 GOTO (X+y)

The GOTO command is an unconditional branch statement
just like the GOSUB command. They both immediately
transfer program control to a target line number or
arbitrary expression. However, You cannot RETURN from
a GOTO, as you can with a GOSUB. If the target line
number is non-existent, an error results. Any GOTO
statement that branches to a preceding line may result
in an "endless" loop. Statements following a GOTO
statement will not be executed. Note that a
conditional branching statement (see IF/THEN) can be

used to break out of a GOTO loop. The following program
illustrates uses the GOTO statement twice.

```
10 FINISH=70
20 PRINT :PRINT "ONE"
30 PRINT "TWO"
40 PRINT "THREE"
50 PRINT "FOUR"
60 PRINT "FIVE"
65 GOTO 100
70 PRINT "$$$$$$$$$$$$$$$$$"
80 PRINT "/./././././././././././././."
90 PRINT "????????????????"
95 END
100 PRINT "SIX"
110 PRINT "SEVEN"
120 PRINT "EIGHT"
130 PRINT "NINE"
140 PRINT "TEN"
150 GOTO FINISH
```

Upon execution, the numbers in the above listing will
be listed first followed by the three rows of symbols.
The symbols listed on lines 70, 80, and 90 are ignored
temporarily while the program executes the GOTO 100
command. It proceeds with the printing of the numbers
"SIX" through "TEN", then executes the second GOTO
statement which transfers program control back to line
70. (This is just an example. This program could be
rewritten so that no GOTO statements were used.) The
program, when executed, looks like the following:

```
ONE
TWO
THREE
FOUR
FIVE
SIX
SEVEN
EIGHT
NINE
TEN
$$$$$$$$$$$$$$$$$
/./././././././././././././.
????????????????
```

NOTE: using anything other than a constant will make
renumbering the lineno in the GOTO (using RENUM)
difficult. However, readability may be markedly
improved.

4.6 IF/THEN

```
      Format:   IF aexp THEN lineno
                IF aexp THEN statement [:statement...]


      Examples: IF X = 1ØØ THEN 15Ø
                IF A$ = "ATARI" THEN 2ØØ
                IF AA = 145 and BB = 1 THEN PRINT
                                              AA,BB
                IF X = 1ØØ THEN X = Ø
```

See also IF...ELSE...ENDIF discussion in the following section.

The IF/THEN statement is a conditional branch statement. This type of branch occurs only if certain conditions are met. These conditions may be either arithmetical or logical. If the aexp following the IF statement is true and/or non-zero, the program executes the THEN part of the statement. If, however, the aexp is false and/or zero, the rest of the statement is ignored and program control passes to the next numbered line.

In the format,   IF aexp THEN lineno

lineno must be a constant (not an expression) specifying the line number to go to if the expression is true. If several statements occur after the THEN, separated by colons, then they will be executed if and only if the expression is true. Several IF statements may be nested on the same line. For example:

```
        1ØØ IF X=5 THEN IF Y=3 THEN R=9: GOTO 2ØØ
```

The statements R=9 : GOTO 2ØØ will be executed only if X=5 and Y=3. The statement Y=3 will be executed if X=5. The following program demonstrates the IF/THEN statement:

```
   1ØØ GRAPHICS Ø : PRINT
   11Ø PRINT ,,"IF DEMO"
   12Ø PRINT : PRINT "ENTER A"; : INPUT A
   13Ø IF A=1 THEN 15Ø : REM Multiple Statements
   here will never be executed!!!
   14Ø PRINT : PRINT "A IS NOT 1, "EXECUTION
   CONTINUES HERE WHEN EXPRESSION IS FALSE."
   15Ø IF A=1 THEN PRINT : PRINT "A=1?" : PRINT
   "YES, IT IS REALLY 1." : REM Multiple statements
   here will be executed only if A=1!!!
   16Ø PRINT : PRINT "EXECUTION CONTINUES HERE IF
   A <> 1 OR AFTER 'YES, IT IS REALLY 1' IS DISPLAYED."
   17Ø GOTO 1ØØ
```

Output of the above program is:

                    IF DEMO

   ENTER A ?   (entered 2)
   A IS NOT 1.   EXECUTION CONTINUES HERE WHEN
   THE EXPRESSION IS FALSE.
   EXECUTION CONTINUES HERE IF A<>l OR AFTER
   'YES', IT IS REALLY 1' IS DISPLAYED.

   ENTER A ?   (entered 1)

   A=l
   YES, IT IS REALLY 1.
   EXECUTION CONTINUES HERE IF A <> 1 OR AFTER
   'YES, IT IS REALLY 1' IS DISPLAYED.

4.7 IF...ELSE...ENDIF

        Format: IF aexp; statement [:statements...]
                   [ELSE: [statements...]]
                   ENDIF

        Examples: 2ØØ IF A>1ØØ:PRINT "TOO BIG"
                  21Ø A=1ØØ
                  22Ø ELSE:PRINT "A-OK"
                  23Ø ENDIF

                  1ØØØ IF A>C : B=A : ELSE : B=C : ENDIF

BASIC XL makes available an exceptionally powerful
conditional capability via IF...ELSE...ENDIF.

In the format given, if the expression is TRUE
(evaluates as non-zero) then all statements between the
following colon and the corresponding ELSE (if it
exists) or ENDIF (if no ELSE exists) are executed; if
ELSE exists, the statements between it and ENDIF are
skipped.

If the expression is FALSE (evaluates to zero), then
the statements (if any) between the colon and ELSE are
skipped and those between ELSE and ENDIF are executed.
If no ELSE exists, all statements through the ENDIF are
skipped.

CAUTION: The colon following the aexp IS REQUIRED and
MUST be followed by a statement. The word THEN is NOT
ALLOWED in this format.

There may be any number (including zero) of statements
and lines between the colon and the ELSE and between
the ELSE and the ENDIF.

The second example above sets B to the larger of the
values of A and C.

This IF structure may also be nested, as follows:

```
    100 IF A>B : REM SO FAR A IS BIGGER
    110   IF A>C : PRINT "A BIGGEST"
    120   ELSE: PRINT "C BIGGEST"
    130   ENDIF
    140 ELSE
    150   IF B>C : PRINT "B BIGGEST"
    160   ELSE: PRINT "C BIGGEST"
    170   ENDIF
    180 ENDIF
```

4.8 LET

          Format: [LET] <assignment statement>

          Example: LET GOTO=3.5
                     LET LETTER$="a"
                     LET AND$="*",AS,A$,A$,A$,A$

LET is an optional keyword which allows you to assign a
value to a variable name which starts with or is
identical to a reserved name. For example:

```
    10 LET GOSUBBER = 5
    20 LET PRINT = 7
    30 LET LET = PRINT + GOSUBBER
    40 PRINT PRINT,LET,GOSUBBER
```

will print out:
                    7   12   5

There are a few keywords which CANNOT be used as
variable names through the use of LET, including any
function name and the NOT unary operator.

Here is is an example of what will happen if you try to
use one of the above as a variable name:

```
    10 CSHARP = 37
    20 LET NOTE = CSHARP
    30 PRINT NOTE
```

will print out: 1

If you LIST the program out you will see why. It lists
"30 PRINT NOTE" as

                    30 PRINT NOT E

because the interpreter does not allow NOT to start a
variable name.

4.9 MOVE

        Format: MOVE aexp1,aexp2,aexp3

        Example: MOVE $0999, $8999, $499

CAUTION: be careful with this command!!

MOVE is a general purpose byte move utility which will
move any number of bytes from any address to any
address at assembly language speed. NO ADDRESS CHECKS
ARE MADE!!

aexp1 is the starting address of the block you want to
move, aexp2 is the starting address of the place where
you want the block moved to, and aexp3 is the length of
the block.

The sign of the third aexp (the length) determines the
order in which the bytes are moved, as follows:

     If the length is positive:
        (from) -> (to)
        (from+1) -> (to+1)
         ...   ...
        (from+len-1) -> (to +len-1)

When the length is positive, the destination block can
overwrite lower part of the source block.

     If the length is negative:
        (from+len-1) -> (to+len-1)
        (from+len-2) -> (to+len-2)
         ...   ...
        (from+1) -> (to +1)
        (from) -> (to)

When the length is negative, the destination block can
overwrite the upper part of the source block.

      4.1Ø ON...

              Format: ON aexp |GOTO | lineno [,lineno...]
                                 |GOSUB|

            EXAMPLES: 1ØØ ON X GOTO 2ØØ,3ØØ,4ØØ
                      1ØØ ON A GOSUB 1ØØØ,2ØØØ
                      1ØØ ON SQR(X) GOTO 3Ø,1Ø,1ØØ

      NOTE: GOSUB and GOTO may not be abbreviated when used
      in conjunction with ON.

      These two statements are also conditional branch
      statements like the IF/THEN statement. However, these
      two are more powerful. The aexp must evaluate to a
      positive number which is then rounded to the nearest
      positive integer (whole number) value up to 255. If the
      resulting number is 1, then program control passes to
      the first lineno in the list following the GOSUB or
      GOTO. If the resulting number is 2, program control
      passes to the second lineno in the list, and so on.

      If the resulting number is Ø or is greater than the
      number of linenos in the list, the conditions are not
      met and program control passes to the next statement
      which may or may not be located on the same line. With
      ON/GOSUB, the selected subroutine is executed and then
      program control passes to the statement following the
      ON/GOSUB.

      The following routine demonstrates the ON/GOTO
      statement:

         1Ø X-X+1
         2Ø ON X GOTO 1ØØ,2ØØ,3ØØ,4ØØ,5ØØ
         3Ø IF X>5 THEN PRINT "COMPLETE.":END
         4Ø GOTO 1Ø
         5Ø END
         1ØØ PRINT "NOW WORKING AT LINE 1ØØ":GOTO 1Ø
         2ØØ PRINT "NOW WORKING AT LINE 2ØØ":GOTO 1Ø
         3ØØ PRINT "NOW WORKING AT LINE 3ØØ":GOTO 1Ø
         4ØØ PRINT "NOW WORKING AT LINE 4ØØ":GOTO 1Ø
         5ØØ PRINT "NOW WORKING AT LINE 5ØØ":GOTO 1Ø

      When the program is executed, it looks like the
      following:

         NOW WORKING AT LINE 1ØØ
         NOW WORKING AT LINE 2ØØ
         NOW WORKING AT LINE 3ØØ
         NOW WORKING AT LINE 4ØØ
         NOW WORKING AT LINE 5ØØ
         COMPLETE

4.11 POP

        Format: POP

        Example: 1ØØØ POP

In the description of the FOR/NEXT statement, the stack
was defined as a group of memory addresses reserved for
return addresses. The top entry in the stack controls
the number of loops to be executed and the RETURN
target line for a GOSUB. If a subroutine is not
terminated by a RETURN statement, the top memory
location of the stack is still loaded with some
numbers. If another GOSUB is executed, that top
location needs to be cleared. To prepare the stack for
a new GOSUB, use a POP to clear the data from the top
location in the stack.

The POP command could be used in the following ways:

    1) In a FOR or WHILE statement, when you wish jump
       out of the loop before it has executed its
       specified number of times (e.g., if you are
       searching through a lot of data for a specific
       item, you can leave the loop early by POPping
       the stack, and then using GOTO to continue
       execution after the NEXT). Example:

```
1Ø FLAG = 1
2Ø WHILE FLAG
3Ø    INPUT FLAG
4Ø    IF FLAG < Ø THEN POP : GOTO 7Ø
5Ø    PRINT "IN THE WHILE LOOP"
6Ø    ENDWHILE
7Ø END
```

    2) After a subroutine (GOSUB) which does not give
       control back to the main program through the use
       of a RETURN. The following example illustrates
       this instance:

```
1ØØ REM POP Demo
11Ø N = 1 : GOSUB 8ØØ
12Ø N = 2 : GOSUB 8ØØ
13Ø END
8ØØ PRINT "At Line 8ØØ"
81Ø GOSUB 9ØØ
82Ø PRINT "At Line 82Ø"
83Ø RETURN
9ØØ PRINT "At Line 9ØØ"
91Ø IF N = 2 THEN POP
92Ø RETURN
```

4.12 RESTORE (RES.)

          Format: RESTORE [aexp]

          Example: 1ØØ RESTORE
                   22Ø RESTORE X+2

BASIC XL contains an internal "pointer" that keeps
track of the DATA statement item to be read next. When
used without the optional aexp, the RESTORE statement
resets that pointer to the first DATA item in the
program. When used with the optional aexp, the RESTORE
statement sets the pointer to the first DATA item on
the line specified by the value of the aexp.

This statement permits repetitive use of the same data,
as shown in the following example:

    1Ø FOR N=2 TO 1 STEP -1
    2Ø RESTORE 8Ø+N
    3Ø READ A,B
    4Ø M=A+B
    5Ø PRINT "TOTAL EQUALS ";M
    6Ø NEXT N
    7Ø END
    81 DATA 3Ø,15
    82 DATA 1Ø,2Ø

On the first pass through the loop, A will be 1Ø and B
will be 2Ø so the total in line 5Ø will print: TOTAL
EQUALS 3Ø, but on the second pass, A will equal 3Ø and
B will equal 15, so the PRINT statement in line 58 will
display: TOTAL EQUALS 45.

4.13 TRAP (T.)

          Format: TRAP aexp

          Example: 1ØØ TRAP 12Ø

The TRAP statement is used to direct the program to a
specified line number if an error is detected. Without
a TRAP statement, the program stops executing when an
error is encountered and displays an error message on
the screen.

TRAP works for any error that may occur after it (the
TRAP statement) has been executed, but once an error
has been detected and trapped, it is necessary to reset
the error trapping with another TRAP statement. This
TRAP statement should be placed at the beginning of the
section of code that handles input from the keyboard so
that the TRAP is reset after each error.

You can find out the error number using the ERR
function with an argument of Ø, and find out the lineno
on which the error occurred by using the ERR function
with an argument of 1 (see section 6.6.4 for a more
detailed discussion of ERR).

Alternatively, PEEK(195) will give you the error
number, and DPEEK(186) will give you the number of the
line where the error occurred.

A TRAP may be disabled by executing a TRAP statement
with an aexp whose value is zero (Ø), or between 32768
and 65535 (e.g., TRAP 4ØØØØ).

4.14 WHILE...ENDWHILE

        Format: WHILE aexp : <statements> ENDWHILE

        Example: 1ØØ A=3
                 11Ø WHILE A : PRINT A
                 l2Ø A=A-1 : ENDWHILE

With WHILE, the BASIC XL user has yet another powerful
control structure available. So long as the aexp of
WHILE remains non-zero, all statements between WHILE
and ENDWHILE are executed.

        Examples: WHILE 1 : ...
                  The loop executes forever

                  WHILE Ø : ...
                  The loop will never execute

CAUTION: Do not GOTO out of a WHILE loop or a nesting
error will likely result (unless you use POP first).

NOTE: The aexp is only tested at the top of each
passage through the loop.

```
-------------------------------------------------------
Chapter 5:              INPUT/OUTPUT COMMANDS AND DEVICES
-------------------------------------------------------
```

This chapter describes the input/output devices and how
data is moved between them. The commands explained in
this chapter are those that allow access to the
input/output devices. The input commands are those
associated with putting data into RAM and the devices
geared for accepting input. The output commands are
those associated with retrieving data from RAM and the
devices geared for generating output.

The commands described in this chapter are:

```
BGET       DIR         LPRINT      PROTECT     SAVE
BPUT       ENTER       NOTE        PUT         STATUS
CLOAD      ERASE       OPEN        READ        TAB
CLOSE      GET         POINT       RENAME      UNPROTECT
CSAVE      INPUT       PRINT       RGET        XIO
DATA       LOAD        PRINT       RPUT
                       USING
```

5.1 Comments and Notations

The Atari Personal Computer considers everything except
the guts of the computer (i.e. the RAM, ROM, and
processing chips) to be external devices. Some of these
devices come with the computer, for example the
Keyboard and the Screen Editor. Some of the other
devices are Disk Drive, Program Recorder (cassette),
and Printer. The following is a list of the devices,
ordered according to the name used as 'filespec' in the
BASIC XL commands:

C: The Program Recorder -- handles both Input
            and Output. You can use the recorder as
            either an input or output device. but never
            as both simultaneously.

D1: - D8:   Disk Drive(s) -- handles both Input and
            Output. Unlike C:, disk drives can be used
            for input and output simultaneously. Floppy
            disks are organized into a group of files, so
            you are required to specify a file name along
            with the device name (see your DOS manual for
            more information).

            NOTE: if you use D: without a drive number,
            D1: is assumed.
            NOTE by GBXL: If the DOS used can handle
            current drives like e.g. SpartaDOS, it will
            refer to the current drive instead.

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E: Screen Editor -- handles both Input and
            Output. The screen editor simulates a text
            editor/word processor using the keyboard as
            input and the display (TV or Monitor) as
            output. This is the editor you use when
            typing in a BASIC XL program. When you
            specify no channel while doing I/O, E: is
            used because the channel defaults to Ø, which
            is the channel BASIC XL opens for E:.

K: Keyboard -- handles Input only. This allows
            you access to the keyboard without using E:.

P: Parallel Port on the 85Ø Module -- handles
            Output only. Usually P: is used for a
            parallel printer, so it has come to mean
            'Printer' as well as 'Parallel Port'.

NOTE by GBXL: P: also refers to SIO direct connect
printers. Atari printers can use P1 to P4; see manual.

R1: - R4:   The four RS-232 Serial Ports on the Atari 85Ø
            Interface -- handle both Input and Output.
            These devices enable the Atari system to
            interface to RS-232 compatible serial devices
            like terminals, plotters, and modems.

            NOTE: if you use R: without a device number,
            R1: is assumed.

S: The Screen Display (either TV or Monitor) --
            handles both Input and Output. This device
            allows you to do I/O of either characters or
            graphics points with the screen display. The
            cursor is used to address a screen position.

Each of these devices is used for I/O of some type,
although only a few of them can do both Input and
Output (you wouldn't want to input data from a
Printer). Because the way in which they work is
different, each device has to tell the computer how it
operates. This is done through the use of a device
handler. A device handler for a given device gives
information on how the computer should input and output
data for that device.

One of the sub-systems in the computer in the Central
Input Output processor (CIO). It's CIO's job to find
out if the device you specify exists, and then look up
I/O information in that device's handler. This makes it
easy for you, since you don't need to know anything
about given handler.

To let CIO know that a device exists (i.e., is
available for I/O) you need to OPEN (section 5.16) the
device on one of the CIO's eight channels (numbered

Ø-7). When you then want to do I/O involving the OPENed
device, you use the channel number instead of the
device name.

When you see 'filespec' in the following sections, it
refers simply to the device (and file name in the case
of D:) in a character string. The string may either be
a literal string (i.e., enclosed in quotes), a string
of characters (not in quotes), or a string variable.

If IOCB #7 is in use, it will prevent LPRINT or some of
the other BASIC I/O statements from being performed.

```
+----------------------------------------------------+
| In the examples in the following sections, you will |
| often  see  the wildcard characters * and ?  in the |
| filespec.  For information on the use of these, see |
| your DOS manual.                                    |
+----------------------------------------------------+
```

5.2 BGET

        Format: BGET 'channel, aexp1, aexp2

        Example: (see below)

BGET gets "aexp2" bytes from the device or file
specified by "channel" and stores them at address
"aexp1".

NOTE: The address may be a memory address. For example,
a screen full of data could be displayed in this
manner. Or the address may be the address of a string.
In this case BGET does not change the length of the
string, this is the user's responsibility.

        Example: 1Ø DIM A$(1Ø25)
                 2Ø BGET #5,ADR(A$),1Ø24
                 3Ø A$(1Ø25) = CHR$(Ø)

This program segment will get 1Ø24 bytes from the file
or device associated with file number 5 and store it in
A$. Statement 3Ø sets the. length of A$ to 1Ø25.

NOTE: No error checking is done on the address or
length so care must be taken when using this statement.

For another example using BGET, see section 5.31.

5.3 BPUT

       Format: BPUT #channel, aexp1, aexp2

       Example: BPUT #5, ADR(A$), LEN(A$)

BPUT outputs a block of data to the device or file
specified by "channel". The block of data starts at
address "aexp1" for a length of "aexp2".

NOTE: The address may be a memory address. For example,
the whole screen might be saved. Or the address may be
the address of a string obtained using the ADR
function.

The example above writes the block of data contained in
the string A$ to the file or device associated with
channel number 5.

NOTE: Nothing is written to the file which indicates
the length of the data written. You are advised to
write fixed-length data to make the rereading process
simpler.

5.4 CLOAD

       Format: CLOAD

       Examples: CLOAD
                 100 CLOAD

This command can be used in either Direct or Deferred
mode to load a program from cassette tape into RAM for
execution. On entering CLOAD, one bell rings to
indicate that the PLAY button needs to be pressed
followed by <RETURN>. However, do not press PLAY until
the tape has been positioned. Specific instructions for
CLOADing a program are contained in the ATARI Program
Recorder Manual.

5.5 CLOSE (CL.)

       Format: CLOSE #channel

       Example: CLOSE #4
                 100 CLOSE #1

The CLOSE command is used to close a CIO channel which
has been previously OPENed to allow I/O with some
device. After you CLOSE a channel, you can then reOPEN
it to some other device, and thus associate that
channel number with a different device.

NOTE: You should CLOSE all channels you have OPENed
when you are finished using them.

NOTE: END will also close all channels (i.e., files).

5.6 CSAVE (CS.)

        Format: CSAVE

        Example: CSAVE
                 1ØØ CSAVE
                 1ØØ CS.

This command is usually used in Direct mode to save a
RAM-resident program onto cassette tape. CSAVE saves
the tokenized version of the program. On entering CSAVE
two bells ring to indicate that the PLAY and RECORD
buttons must be pressed followed by <RETURN>. Do not,
however, press these buttons until the tape has been
positioned. It is faster to save a program using this
command rather than a SAVE "C:" (See SAVE) because
short inter-record gaps are used.

NOTE: Tapes saved using the two commands SAVE and CSAVE
are not compatible.

NOTE: Due to a flaw in the Atari OS ROMs, it may be
necessary on some machines to enter a LPRINT (See
LPRINT) before using CSAVE. Otherwise, CSAVE may not
work properly.

For specific instructions on how to connect and operate
the hardware, cue the tape, etc., see the ATARI Program
Recorder Manual.

5.7 DATA (D.)

        Format: DATA adata [,adata]

        Example: 1ØØ DATA 12,13,14,15,16
                  2ØØ DATA GEORGE, EVELYN,MIKE,BECKY
                  3ØØ DATA "DATA with a comma, in quotes"

The DATA command is used in conjunction with the READ
command (see section 5.22) to access elements in a data
list. A DATA command may be anywhere in a program, but
it must contain as many pieces of data as there are
defined in the READ command; otherwise an "out of data"
error is displayed on the screen.

NOTE: All characters except comma and <RETURN> are
allowed. However, if you put the data in quotes, then
all characters except double quote and <RETURN> are
legal.

5.8 DIR

       Format: DIR [filespec]

       Example: DIR D:*.COM
                DIR FILE$
                DIR "D2:TEST*.B*"

The DIR command is used to list the contents of a disk
directory to the screen. It is very similar to the
OS/A+ and DOS XL 'DIR' command. If no filespec is
given, all files on D1: are displayed.

The first example will display all files on D1: which
end with .COM.

The second example shows a string variable being used
as a filespec. This is legal, but the string variable
must contain a valid filespec, otherwise an error will
occur.

The third example will display all files on disk drive
2 which match TEST*.B*.

NOTE: DIR must be used as the last (or only) command on
a line.

5.9 ENTER (E.)

       Format: ENTER filespec

       Examples: ENTER "C:"
                 ENTER D2:DEMOPR.INS
                 ENTER FILE$

The ENTER command allows you to read in a program you
have saved using the LIST command, and will not work
with programs which have been SAVEd or CSAVEd. To use
this command, you simply need to give the filespec of
the program.

NOTE: whereas both LOAD and CLOAD clear the old program
from memory before reading in the new one, ENTER does
not, and so is useful when trying to merge programs
together.

ENTER can be modified using the SET command. For an
example of this, see section 3.15, example 3.

5.1Ø ERASE

        Format: ERASE filespec

        Example: ERASE "D:*.BAK"
                 ERASE D2:TEST?.SAV

ERASE will erase any unprotected files which match the
given filespec. The first example above would erase
all .BAK (back-up) files on disk drive 1. The second
example would erase all files matching TEST?.SAV on
disk drive 2. This command is similar to the OS/A+ and
DOS XL ERAse, but there are no default file specifiers.

5.11 GET

        Format: GET #channel,avar

        Example: 1ØØ GET #Ø,X

The GET command is used to input one byte of data from
an open channel. This byte of information is stored in
'avar'.

For a program example using GET, see section 5.31.

5.12 INPUT (I.)

        Format: INPUT [#chan,] |avar [,(avar)...]|
                                | svar |

        Examples: 1ØØ INPUT X
                  1ØØ INPUT N$
                  1ØØ INPUT X,Y,Z(4)
                  1ØØ INPUT ARRSTR$(5;)
                  1ØØ PRINT "ENTER THE VALUE OF X"
                  11Ø INPUT X

INPUT is used to read in various data. With it you can
input either one or more numbers, or a string. If you
are inputting a group of numbers, the first number will
go into the first avar specified, the second number
into the second avar, and so on.

NOTE: In BASIC XL the avar may be an array element, and
the svar may be a string array element.

If a channel number is specified (followed by a comma),
then no "?" prompt is given. This allows you to
create your own prompts, as shown in the following
example:
        1ØØ PRINT "command>> ";
        11Ø INPUT #Ø, COMMAND$

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The statement 'INPUT #Ø, COMMAND$' inputs a string from channel Ø (E:), without printing out a '?' first.

NOTE: If the user's sole response to an INPUT prompt is <CTRL>C <RETURN>, a special error (number 27) will be issued by INPUT. This can be useful in data entry manipulations.

If an INPUT request is made for more than one numeric variable, the user may respond with several values separated by commas or may type in single number on each line, followed by <RETURN>.

In the latter case, BASIC XL will prompt with a double question mark to indicate that more input is needed. When a string is requested, it must be typed on a line by itself (or, if combined with numeric input, as the last item on the line).

OSS strongly recommends that:

1) no more than one variable be used on each INPUT line.

2) INPUT and PRINT should not be used for disk data file access (RGET and RPUT are suggested instead).

5.12.1 Advanced use of INPUT

        Format: INPUT "string", var [,var...]

        Example: 1ØØ INPUT "3 VALUES>> ",V(1),V(2),V(3)

BASIC XL allows you to include a prompt with the INPUT command to produce easier to use programs, without having to use the ";" option mentioned in the previous section. The string given in the above format ALWAYS replaces the default "?" prompt.

NOTE: No channel number may be used when the literal prompt is present.

NOTE: In the example above, if the user typed in only a single value followed by a <RETURN>, he would be reprompted by BASIC XL with a "??", but see chapter 3 for variations available via SET.

5.13 LOAD (LO.)

        Format: LOAD filespec

        Example: LOAD D1:GAME1.BXL
                 1ØØ LOAD "C:"

LOAD allows you to load the SAVEd version of a program
into memory from any device. It will not work properly
with programs saved using LIST or CSAVE, as they have
their own loading commands (see ENTER and CLOAD).

5.14 LPRINT (LP.)

        Format: LPRINT [exp][|;| exp...]
                               |,|

        Example: LPRINT "PROGRAM TO CALCULATE X"

This statement causes the computer to print data on the
line printer rather than on the screen. It can be used
in either Direct or Deferred mode, and requires no
device specifier, no OPEN, or no CLOSE statement.

NOTE: The semi-colon and comma options are discussed in
section 5.18, PRINT.

CAUTION: With most printers, LPRINT cannot successfully
be used with a trailing comma or semi-colon. If
advanced printing capabilities are required, we
recommend using PRINT # on a channel previously OPENed
to the printer (P:).

5.15 NOTE (NO.)

        Format: NOTE #chan,avar,avar

        Example: 1ØØ NOTE #1,X,Y

This command is used to store the current disk sector
number in the first avar and the current byte number
within the sector in the second avar. This is the
current read or write position in the specified file
where the next byte to be read or written is located.

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5.16 OPEN (O.)

        Format: OPEN #chan,aexp1,aeaxp2,filespec

        Example: 100 OPEN #2,8,0,"C:"
                  100 A$ = "D1:TEST.DAT"
                  110 OPEN #2,8,0,A$

As mentioned in section 5.1, a device must be OPENed on
a specific channel before it can be accessed. This
"opening" process links a specific channel to the
appropriate device handler, initializes any CIO-related
control variables, and passes any device-specific
options to the device handler.

The parameters for the OPEN command are defined as
follows:

chan   This is the number of the channel which you
          want to associate with the the device
          'filespec'. Also, this is the number you use
          when you later want to do I/O involving the
          specified device (using INPUT, PRINT, etc.).

aexp1   This is the I/O mode you want to associate
          with the above channel. The number codes are
          described in the following table:

                  aexp1   Meaning
                  -----   -------
                    4   Input only
                    6   Read disk directory only
                    8   Output only
                    9   Output Append. This mode allows
                           you to append to already exis-
                           ting disk files.
                   12   Input and Output

aexp2   Device-dependent auxiliary code. See your
          device manual to see if it uses this number.
          If not, use a zero.

filespec The device (and file name, if required) you
          want to be associated with the specified
          channel.

5.17 POINT (P.)

        Format: POINT #chan,avar,avar

        Example: 100 POINT #2,A,B

This command is used when reading a file into RAM. The
first avar specifies the sector number and the second
avar specifies the byte within that sector where the
next byte will be read or written. Essentially, it
moves a software-controlled pointer to the specified
location in the file. This gives the user "random"
access to the data stored on a disk file. The POINT
and NOTE commands are discussed in more detail in your
DOS Manual.

5.18 PRINT (PR or ?)

        Format: PRINT [#chan] |,| exp...] |,|
                                |,| |,|

        Examples: PRINT
                  PRINT X,Y,Z,A$
                  100 PRINT "THE VALUE OF X IS ";X
                  100 PRINT "COMMAS","CAUSE","COLUMNS"
                  100 PRINT #3,A$
                  100 PRINT ,0:"$";HEX(X);" IS ";X

The PRINT command is used in either Direct or Deferred
mode to output data. In Direct mode, this command
prints whatever information is contained between the
quotation marks exactly as it appears. In the second
example, PRINT X,Y,Z,A$, the screen will display the
current values of X,Y,Z, and A$ as they appear in the
RAM-resident program. In the fifth example, A$ is
PRINTed out to the device associated with channel 3.

The comma option causes tabbing to the next tab
location. Several commas in a row cause several tab
jumps. A semi-colon causes the next aexp or sexp to be
placed immediately after the preceding expression with
no spacing. Therefore, in the third example a space is
placed before the ending quotation mark so the value of
X will not be placed immediately after the word "IS".

If no comma or semi-colon is used at the end of a PRINT
statement, then a <RETURN> is output and the next PRINT
will start on the following line.

5.19 PRINT USING

        Format: PRINT [#ch;)USING sexp,exp [,exp...]

        Example: (see below

PRINT USING allows the user to specify a format for the
output to the device or file associated with "ch" (or
to the screen). The format string "sexp" contains one
or more format fields. Each format field tells how an
expression from the expression list is to be printed.
Valid format field characters are:

        # & * + - $, . % ! /

Non-format characters terminate a format field and are
printed as they appear.

        Example 1) 1ØØ PRINT USING "## ###X#",12,315,7

                2) 1ØØ DIM A$(1Ø) : A$="## ###X#"
                   2ØØ PRINT USING A$,12,315,7

                Both 1) and 2) will print

                12 315X7

Where a blank separates the first two numbers and an X
separates the last two.

Numeric Formats

The format characters for numeric format fields are:

        # & * + - $, .

DIGITS (# & *)

Digits are represented by:

        # & *

- Indicates fill with leading blanks
& - Indicates fill with leading zeroes
* - Indicates fill with leading asterisks

If the number of digits in the expression is less than
the number of digits specified in the format then the
digits are right justified in the field and preceded
with the proper fill character.

NOTE: In all the following examples b is used to represent a blank.

Examples:

Value	Format Field	Print Out
1	###	bb1
12	###	b12
123	###	123
1234	###	234
12	&&&	Ø12
12	***	*12

DECIMAL POINT (.)

A decimal point in the format field indicates that a decimal point be printed at that location in the number. All digit positions that follow the decimal point are filled with digits. If the expression contains fewer fractional digits than are indicated in the format, then zeroes are printed in the extra positions. If the expression contains more fractional digits than indicated in the format, then the expression is rounded so that the number of fractional digits is equal to the number of format positions specified.

A second decimal point is treated as a non-format character.

Examples:

Value	Format Field	Print Out
123.45	###.##	123.46
6	###.##	bb4.7Ø
4.7	##.##.	12.35.
12.35		

COMMA (,)

A comma in the format field indicates that a comma be printed at that location in the number. If the format specifies a comma be printed at a position that is preceded only by fill characters (Ø b *) then the appropriate fill character will be printed instead of the comma.

The comma is a valid format character only to the left of the decimal point. When a comma appears to the right of a decimal point, it becomes a non-format character. It terminates the format field and is printed like a non-format character.

Examples:

Value	Format Field	Print Out
5216	##,###	b5,216
3	##,###	bbbbb3
4175	**,***	*4,175
3	&&,&&&	ØØØØØ3
42.71	##.##,	42.71,

SIGNS (+ -)

A plus sign in a format field indicates that the sign of the number is to be printed. A minus sign indicates that a minus sign is to be printed if the number is negative and a blank if the number is positive.

Signs may be either fixed, floating or trailing.

A fixed sign must appear as the first character of a format field.

Examples:

Value	Format Field	Print Out
43.7	+###.#	+b43.7
-43.7	+***.*	-b43.7
23.58	-&&&.&&	bØ23.58
-23.58	-&&&.&&	-Ø23.58

Floating signs must start in the first format position and occupy all positions up to the decimal point. This causes the sign to be printed immediately before the first digit rather than in a fixed location. Each sign after the first also represents one digit.

Examples:

Value	Format Field	Print Out
3.75	++++.##	bb+3.75
3.75	----.##	bbb3.75
-3.75	----.##	bb-3.75

A trailing sign can appear only after a decimal point. It terminates the format and prints the appropriate sign (or blank).

Examples:

Value	Format Field	Print Out
43.71	***.**+	*43.17+
43.71	&&&.&&-	Ø43.17b
-43.71	###.##+	b43.17-

DOLLAR SIGN ($)

A dollar sign can be either fixed or floating, and indicates that a $ is to be printed.

A fixed dollar sign must be either the first or second character in the format field. If it is the second character then + or - must be the first.

Examples:

Value	Format Field	Print Out
34.2	$##.##	$34.2Ø
34.2	+$##.##	+$34.2Ø
-34.2	+$###.##	-$b34.2Ø

Floating dollar signs must start as either the first or second character in the format field and continue to the decimal point. If the floating dollar signs start as the second character then + or - must be the first. Each dollar sign after the first also represents one digit.

Examples:

Value	Format Field	Print Out
34.2	$$$$.##	bb$34.2Ø
34.2	+$$$$.##	+bb$34.2Ø
1572563.41	$$,$$$,$$$.##+	$1,572,563.41+

NOTE: There can only be one floating character per format field.

NOTE: +, - or $ in other than proper positions will give strange results.

String Formats

The format characters for string format fields are:

   % - Indicates the string is to be right justified.
   ! - indicates the string is to be left justified.

If there are more characters in the string than in the format field, than the string is truncated.

Examples:

Value	Format Field	Print Out
ABC	%%%%	bABC
ABC	!!!!	ABCb
ABC	%%	AB
ABC	!!	AB

ESCAPE CHARACTER (/)

The escape character (/) does not terminate the format field but will cause the next character to be printed, thus allowing the user to insert a character in the middle of the printing of a number.

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```
Example:        PRINT USING "###/-####",2551472
                prints 255-1472

Example:        100 AREA = 400
                200 NUM = 2551472
                300 PHONE = (AREA*1E+7)+NUM
                400 DIM F$(20)
                500 F$ = "(###/)###/-####"
                600 PRINT USING F$,PHONE
                700 END

        the result:     (498)255-1472
```

NOTE: Improperly specified format fields can give some very strange results.

NOTE: The function of "," and ";" in PRINT are overridden in the expression list of PRINT USING, but when file number "ch" is given then the following "," or ";" have the same meaning as in PRINT. So to avoid an initial tabbing, use a semi-colon (;).

```
Example:        PRINT #5; USING A$,B
```

will print B in the format specified by A$ to the file or device associated with file number 5.

```
Example:        PRINT USING "## /* #=###,12,5,5*12

                12 * 5=60

Example:        PRINT USING "TOTAL=##.#+",72.68

                TOTAL-72.7+

Example:        100 DIM A$(10) : A$="TOTAL="
                200 DIM F$(10) : F$="!!!!!!##.#+"
                300 PRINT USING F$,A$,72.68

                TOTAL=72.7+
```

NOTE: If there are more expressions in the expression list than there are format fields, the format fields will be reused.

```
Example:        PRINT USING "XX##",25,19,7

        will print      XX25XX19XXb7
```

WARNING: A format string must contain at least one format field. If the format string contains only non-format characters, those characters will be printed repeatedly in the search for a format field.

5.2Ø PROTECT

        Format: PROTECT filespec

        Examples: PROTECT D:*.COM
                  1ØØ PROTECT "D2:JUNK.BXL"

The PROTECT allows you to protect your programs stored
on disk from being erased or overwritten. This command
is very similar to the OS/A+ and DOS XL PROtect command,
except that there are no default file specifications.

5.21 PUT (PU.)

        Format: PUT #chan,aexp

        Examples: 1ØØ PUT #6,ASC("A")
                  2ØØ PUT #Ø,4*13

PUT is the opposite of GET in that it outputs a single
byte of information whereas GET inputs a single byte of
information. The data output is aexp, and it is put to
the device specified by chan.

NOTE: for a program example using PUT, see section 5.31

5.22 READ

        Format: READ var [,var...]

        Examples: 1ØØ READ A,B,C,D,E
                  11Ø DATA 12,13,14,15,16

                  1ØØ READ A$,B$,C$,D$,E$
                  11Ø DATA EMBEE, EVELYN, CARLA

The READ command is always used in conjunction with the
DATA command. Its function is simply to read the next
piece of data out of the DATA list and put it into one
of the variables specified. If a group of variables are
used, then the first piece of available data (see
RESTORE, 4.12) i. put into the first variable given,
the second piece of data into the second variable
given, and so on.

The type of the variable in the READ statement (svar or
avar) must correspond to the type of the data which in
being read.

If the second example above was executed as a program
with no additional lines, an error would result since
there are fewer data items than variables to be READ.

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The following program totals a list of numbers in a
DATA statement:

```
1Ø FOR N=1 TO 5
2Ø READ D
3Ø M=M+D
4Ø NEXT N
5Ø PRINT "SUM TOTAL EQUALS ";M
6Ø END
7Ø DATA 3Ø,15,1Ø6,87,17
```

The program, When executed, will print the statement:

        SUM TOTAL EQUALS 255.

NOTE: A Direct mode READ will only read data if a DATA
statement exists in the program or on the line
following the READ.

5.23 RENAME

        Format: RENAME "filespec,filename"

        Example: RENAME "D2:NEW.DAT,OLD.BAK"

RENAME allows you to rename file(s) from BASIC XL. Note
that the comma shown MUST be imbedded in the string
used as the file parameter.

CAUTION: It is strongly suggested that wild cards (*
and ?) NOT be used when RENAMEing. Also, the second
filename may NOT include the disk specifier (Dn:).

5.24 RGET

        Format: RGET #ch, | svar [,svar...] |
                           | avar [,avar...] |
        Example: (see below)

RGET allows the user to retrieve fixed length records
from the device or file associated with file number
"ch" and assign the values to string or numeric
variables.

NOTE: The type of the element in the file must match
the type of the variable' (i.e., they must both be
strings or both be numeric).

        Example: 1) 1ØØ RPUT #3,C

                  2) 2ØØ RGET #1,A$

If 1) is a statement in a program used to generate a file and 2) is a statement in another program used to read the same file, an error will result, since 'C' is a numeric variable and 'A$' is a string variable.

NOTE: When the type of element is string, then the DIMensioned length of the element in the file must be equal to the DIMensioned length of the string variable.

```
Example:  1)   1ØØ DIM A$(1ØØ)
                   :
               8ØØ RPUT #3,A$

          2)   1ØØ DIM X$(2ØØ)
                   :
               8ØØ RGET #2,X$
```

If 1) is a section of a program used to write a file and 2) is a section of another program used to read the same file, then an error will occur as a result of the difference in DIM values.

NOTE: RGET sets the correct length for a string variable (the length of a string variable becomes the actual length of the string that was RPUT not necessarily the DIM length).

```
Example:  1)   1ØØ DIM A$(1Ø)
               2ØØ A$ = "ABCDE"
                   :
               8ØØ RPUT #4,A$

          2)   1ØØ DIM X$(1Ø)
               2ØØ X$ = "HI"
                   :
               8ØØ RGET #6,X$
               9ØØ PRINT LEN(X$),X$
```

If 1) is a section of a program used to create a file and 2) is a section of another program used to read the file then it will print:

```
                  5 ABCDE
```

5.25 RPUT

        Format: RPUT #ch, exp [,exp...]

        Example: (see below)

RPUT allows the user to output fixed length records to the device or file associated with "ch". Each "exp" creates an element in the record.

NOTE: A numeric element consists of one byte which indicates a numeric type element and 6 bytes of numeric data in floating point format.

A string element consists of one byte which indicates a string type element 2 bytes of string length, 2 bytes of DIMensioned length, and then X bytes where X is the DIMensioned length of the string.

```
        Example:  100 DIM A$(6)
                  200 A$ = "XY"
                  300 RPUT #3,B,A$,10
```

puts 3 elements to the device or file associated with file number 3. The first element is numeric (the value of B). The second element is a string (A$) and the third is a numeric (10). The record will be 25 bytes long, (7 bytes for each numeric, 5 bytes for the string header and 6 bytes (the DIM length) of string data).

5.26 SAVE (S.)

```
        Format:    SAVE filespec

        Examples: SAVE D1:YVONNE.PAT
                  100 SAVE "C:"
```

The SAVE command allows you to save the tokenized form of a BASIC XL program to any device. A file saved using this command may then be read back into program memory using the LOAD command or loaded and automatically executed using the RUN command.

5.27 STATUS (ST.)

```
        Format:  STATUS #chan,avar

        Example: 350 STATUS #1,Z
```

The STATUS command calls the STATUS routine for the specified device (chan). The status of the STATUS command (see ERROR MESSAGES, Appendix B) is stored in the specified variable (avar). This may be useful for devices such as the RS-232 interface.

5.28 TAB

```
        Format:  TAB [#ch,] aexp

        Example: TAB #2,20
```

TAB outputs spaces to the device or file specified by ch (or the screen) up to column number "aexp". The first column is column 0.

NOTE: The column count is kept for each device and is reset to zero each time a carriage return is output to that device. The count is kept in AUX2 of the IOCB. (See OS documentation).

NOTE: If "aexp" is less than the current column count, a carriage return is output and then spaces are put out up to column "aexp".

5.29 UNPROTECT (UNP.)

        Format: UNPROTECT filespec

        Examples: 1ØØ UNPROTECT "D2:JUNK.BAS
                  UNP. D:JUNK

The UNPROTECT command allows you to unprotect disk files which have been protected using the PROTECT command. This command is very similar to the OS/A+ and DOS XL command UNProtect, but there are no default file specifications in the BASIC XL version.

5.3Ø XIO (X.)

        Format: XIO cmdno, #chan,aexp1,aexp2,filespec

        Example: XIO 18,#6,Ø,Ø,"S:"

The XIO command is a general input/output statement used for special operations. The parameters for this command are defined as follows:

cmdno Command Number stands for the particular command to be performed.

cmdno	operation	example
3	OPEN	Same as BASIC OPEN
5	GET RECORD	| These 4 commands are
7	GET CHARACTERS	| similar to BASIC INPUT,
9	PUT RECORD	| GET, PRINT, and PUT,
11	PUT CHARACTERS	| respectively.
12	CLOSE	Same as BASIC CLOSE
13	STATUS REQUEST	Same as BASIC STATUS
17	DRAW LINE	Same as BASIC DRAWTO
18	FILL	See Section 9
32	RENAME	XIO 32,#1,Ø,Ø,"D:TEMP,CAROL"
33	DELETE	XIO 33,#1,Ø,Ø,"D:TEMP.BAS"
35	LOCK FILE	XIO 35,#1,Ø,Ø,"D:TEMP.BAS"
36	UNLOCK FILE	XIO 36,#1,Ø,Ø,"D:TEMP.BAS"
37	POINT	Same as BASIC POINT
38	NOTE	Same as BASIC NOTE
254	FORMAT	XIO 254,#1,Ø,Ø,"D2:"

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chan   Device number (same as in OPEN). Most of the
          time it is ignored, but must be preceded by
          #.

aexp1   Two auxiliary control bytes. Their usage
aexp2   depends   on   the   particular   device   and
          command. In most cases, they are unused and
          are set to Ø.

filespec string expression that specifies the device.
          Must be enclosed in quotation marks. Although
          some commands do not look at the filespec, it
          must still be included in the statement.

NOTE: It is highly recommended that the BASIC XL user
avoid XIO cmdno's 3,5,7,9,11,12,17,37 and 38. BASIC XL
users should find all these, as well as cmdno's 32 thru
36, totally unnecessary.

5.31 An Example Program

The following subroutine reads in a binary file using
OPEN, GET, BGET, CLOSE, and PRINT.

NOTE: lines 1Ø2Ø through 1Ø3Ø test the file to see if
it is segmented, so you can load in multi-segment files
with this subroutine.

```
1ØØØ TRAP 1Ø9Ø
1Ø1Ø OPEN #1,4,Ø,"D:FILE.OBJ"
1Ø2Ø GET #1,L:GET #1,H
1Ø3Ø IF L=$FF AND H=$FF THEN GET #1,L:GET #1,H
1Ø4Ø START=H*256+L
1Ø5Ø GET #1,L:GET #1,H
1Ø6Ø FINISH=H*256+L
1Ø7Ø BGET #1,START,FINISH-START+1
lØ8Ø GOTO 1Ø2Ø
1Ø9Ø IF ERR(Ø)=136 THEN CLOSE:RETURN
11ØØ PRINT "UNEXPECTED ERROR #":ERR(Ø);" AT LINE "; ERR(1)
111Ø STOP
```

```
        --------------------------------------------------------
Chapter 6:                                    FUNCTION LIBRARY
        --------------------------------------------------------
```

A function performs a computation and returns the
result (usually a number) for either a print-out or
additional computational use. Each function described
in this chapter may be used in either Direct or
Deferred mode.

This chapter describes the following functions:

```
    Arithmetic Functions            Trigonometric Functions
    --------------------            -----------------------
     ABS    INT    RND                 ATN        RAD
     CLOG   LOG    SGN                 COS        SIN
     EXP    RANDOM SQR                 DEG

     String Functions             Game Controller Functions
     ------------------           -------------------------
     ASC    LEFT$   RIGHT$         HSTICK  PTRIG  VSTICK
     CHR$   LEN     STR$           PADDLE  STICK
     FIND   MID$    VAL            PEN     STRIG

Player/Missile Functions        Special Purpose Functions
-----------------------         -------------------------
       BUMP   PMADR              ADR    ERR   PEEK  TAB
                                 DPEEK  FRE   POKE  USR
                                 DPOKE  HEX$  SYS
```

6.1 Arithmetic Functions

6.1.1 ABS

        Format: ABS(aexp)

        Example: 1ØØ AB =ABS(-19Ø)

Returns the absolute value of a number without regard
to whether it is positive or negative. The returned
value is always positive.

6.1.2 CLOG

        Format: CLOG (aexp)

        Example: 1ØØ C = CLOG(83)

Returns the logarithm to the base 1Ø of the variable or
expression in parentheses. CLOG(Ø) gives an error, and
CLOG(l) is a Ø.

6.1.3 EXP

        Format: EXP(aexp)

        Example: 1ØØ PRINT EXP(3)

Returns the value of e (approximately 2.71828283), raised to the power specified by the expression in parentheses. In the example given above, the number returned is 2Ø.Ø855365.

6.1.4 INT

        Format: INT(aexp)

        Examples: 1ØØ I = INT(3.445) : REM I now = 3
                  1ØØ X = INT(-14.66778) : REM X now = -15

Returns the greatest integer less than or equal to the value of the expression. This is true whether the expression evaluates to a positive or negative number. Thus, in our first example above, I is used to store the number 3. In the second example, X is used to store the number -15 (the first whole number that is less than or equal to -14.66778). This INT function should not be confused with the function used on calculators that simply truncates all decimal places.

6.1.5 LOG

        Format: LOG(aexp)

        Example: 1ØØ L = LOG(67.89/2.57)

Returns the natural logarithm of the number or expression in parentheses. LOG(Ø) gives an error, and LOG(1) is Ø.

6.1.6 RANDOM

        Format: RANDOM(aexp1[,aexp2])

        Examples: 1Ø X = RANDOM(99)
                  1Ø Y = RANDOM(2Ø,3Ø)

The RANDOM function allows you access to a random number generator which does more than return a number between Ø and 1, as RND does. When used with one aexp (as in the first example), the value returned will be between Ø and the aexp value, inclusive. When used with two aexps (as in the second example), the value returned will be between the value of the first aexp and the value of the second aexp, inclusive.

6.1.7 RND

        Format: RND(aexp)

        Example: 1Ø A = RND(Ø)

Returns a hardware-generated random number between Ø
and 1, but never returns 1. The variable or expression
in parentheses following RND is a dummy and has no
effect on the numbers returned. However, the dummy
expression must be included.

6.1.8 SGN

        Format: SGN(aexp)

        Example: 1ØØ X = SGN(-199) : REM -1 is returned

Returns a -1 if aexp evaluates to a negative number; a
Ø if aexp evaluates to Ø, or a 1 is aexp evaluates to a
positive number.

6.1.9 SQR

        Format: SQR(aexp)

        Example: 1ØØ PRINT SQR(1ØØ) : REM 1Ø is printed

Returns the square root of the aexp which must be
positive.

6.1.1Ø An Example Program

The following program prints out some information on an
INPUTted number, using the arithmetic functions ABS,
INT, SQR, CLOG, LOG, and EXP.

```
1ØØ GRAPHICS 1 : REM set up screen
11Ø PRINT "Number to Manipulate> ";
12Ø INPUT #Ø, X : REM get the number
13Ø PRINT #6; ASC$(125) : REM clear screen
14Ø PRINT #6; "ABS.: ";ABS(X) : REM absolute value
15Ø PRINT #6
16Ø PRINT #6; "INT.: ";INT(X) : REM integer value
17Ø PRINT #6
18Ø PRINT #6; "SQRT: ";SQR(ABS(X)) : REM square root
19Ø PRINT #6
2ØØ PRINT #6; "CLOG: ";CLOG(ABS(X)) : REM common log
21Ø PRINT #6
22Ø PRINT #6; "NLOG: ";LOG(ABS(X)): REM natural log (ln)
23Ø PRINT #6
24Ø PRINT #6; "EXP.: ";EXP(X) : REM exponential (e^X)
25Ø GOTO 11Ø
```

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6.2 Trigonometric Functions

6.2.1 ATN

        Format: ATN(aexp)

        Example: 1ØØ X = ATN(1.Ø)

Returns the arctangent of the variable or expression in
parentheses. If in DEG mode (see section 6.2.3), the
returned value is given is degrees, otherwise it is
given in radians.

6.2.2 COS

        Format: COS(aexp)
        Example: 1ØØ C = COS(X+Y+Z)

Returns the trigonometric cosine of the expression in
parentheses. The expression is evaluated as an angle
in radian terms unless the DEG command has been used.

6.2.3 DEG and RAD

        Format: DEG
                   RAD

        Examples: 1ØØ DEG
                  1ØØ RAD

These two statements allow the programmer in specify
degrees or radians for trigonometric· function
computations. The computer defaults to radians unless
DEG is specified. Once the DEG statement has been
executed, RAD must be used to return to radians.

See Appendix E for the additional trigonometric
functions that can be derived.

6.2.4 SIN

        Format: SIN(aexp)

        Example: 1ØØ X = SIN(Y)

This function returns the trigonometric sine of aexp.
The expression is evaluated as an angle in radian terms
unless the DEG command has been used.

6.2.5 An Example Program

The following program demonstrates the use of DEG, COS,
and SIN by plotting three concentric circles on the
screen.

```
1Ø GRAPHICS 7 : REM set up screen
2Ø DEG : REM degree mode for trig functions
3Ø   FOR J=1 TO 3 : REM 3 circles
4Ø   COLOR J : REM each circle a different color
5Ø     FOR I=1 TO 36Ø : REM plot each point in a full
                                          circle
6Ø     PLOT 8Ø+INT(J*lØ*COS(I)), 4Ø+INT(J*1Ø*SIN(I))
7Ø       NEXT I
8Ø   NEXT J
```

6.3 String Functions

6.3.1 ASC

        Format: ASC(sexp)

        Example: 1ØØ A = ASC(A$)

This function returns the ATASCII code number for the
first character of the string expression (sexp). This
function can be used in either Direct or Deferred mode.

If A$="ABC", then

        ASC(A$) produces 65
        ASC(A$(2)) produces 66

6.3.2 CHR$

        Format: CHR$(aexp)

        Examples: 1ØØ PRINT CHR$(65)
                  1ØØ A$ = CHR$(65)

This character string function returns the character,
in string format, represented by the ATASCII code
number in parentheses. Only one character is returned.
In the above examples, the letter A is returned. Using
the ASC and CHR$ functions, the following program
prints the upper case and lower case letters of the
alphabet:

```
1Ø FOR I=Ø TO 25
2Ø PRINT CHR$(ASC("A")+I);CHR$(ASC("a")+I)
3Ø NEXT I
```

NOTE: There can be only one STR$ and only one CHR$ in a

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logical comparison. (This is because BASIC XL uses a
buffer in a fixed location to create the temporary
string which both of these functions produce, and there
is only one such buffer.)

6.3.3 FIND

        Format: FIND(sexp1,sexp2,aexp)

        Example: PRINT FIND ("ABCDXXXXABC","BC",N)

FIND is an efficient, speedy way of determining whether
any given substring is contained in any given master
string.

FIND will search sexp1, starting at position aexp, for
sexp2. If sexp2 is found, the function returns the
position where it was found, relative to the beginning
of sexp1. If sexp2 is not found, a Ø is returned.

In the example above, the following values would be
PRINTed:

        2 if N=Ø or N=1
        9 if N>2 and N<1Ø
        Ø if N>=1Ø

More Examples:

    1)   1Ø DIM A$(1)
          2Ø PRINT "INPUT A SINGLE LETTER:
          3Ø PRINT "Change/Erase/List"
          4Ø INPUT "CHOICE ?",A$
          5Ø ON FIND("CEL",A$,Ø) GOTO 1ØØ,2ØØ,3ØØ

An easy way to have a vector from a menu choice:

    2)   1ØØ DIM A$(1Ø): A$="ABCDEFGHIJ"
          11Ø PRINT FIND (A$,"E",3)
          12Ø PRINT FIND (A$(3),"E",Ø)

Line 11Ø will print "5" while 12Ø will print "3".
Remember, the position returned is relative to the
start of the specified string.

    3)   1ØØ INPUT "2Ø CHARACTERS, PLEASE:",A$
          11Ø ST=Ø
          12Ø F=FIND(A$,"A",ST):IF F=Ø THEN STOP
          13Ø IF A$(F+1,F+1)<>"B" AND A$(F+1,F+1)<>"C"
                  THEN ST=F+1:GOTO 12Ø
          14Ø PRINT "FOUND 'AB' OR 'AC'"

This illustrates the importance of the aexp's use as a
starting position.

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6.3.4 LEFT$

        Format: LEFT$ (svar,aexp)

        Examples: 1ØØ A$=LEFT$("ABCDE",3)

                  1ØØ PRINT LEFT$("ABCD",5)

The LEFT$ function returns the leftmost 'aexp'
characters of the string 'svar'. If aexp is greater
than the number of characters in svar, no error occurs
and the entire string svar is returned.

In the first example, A$ is equated to "ABC"x, and in
the second example, the entire string "ABCD" is
printed.

6.3.5 LEN

        Format: LEN(sexp)

        Example: 1ØØ PRINT LEN(A$)

This function returns the length in bytes of the
designated string. This information may then be
printed or used later in a program. The length of a
string variable is simply the index for the character
which is currently at the end of the string. Strings
have a length of Ø until characters have been stored in
them. It is possible to store into the middle of the
string by using subscripting. However, the beginning
of the string will contain garbage.

The following routines illustrate the use of the LEN
function:

1Ø A$="ATARI"   1Ø DIM AR$(3,Ø
2Ø PRINT LEN(A$)   2Ø AR$(2;)="ATARI"
                           3Ø PRINT LEN(AR$(2;))

The result of running either of the above programs
would be 5.

6.3.6 MID$

        Format: MID$(svar,aexp1,aexp2)

        Example: A$=MID$("ABCDEFG",2,4)

MID$ allows you to get a substring from the middle of
another string. The substring starts at the 'aexp1'th
character of svar, and is 'aexp2' characters long.

If aexp1 equals Ø an error occurs (since there is no
zeroeth character of a string), but if aexp1 is greater
than the length of svar no error occurs (and no
characters are returned).

aexp2 is allowed any positive number (including Ø), but
if its value makes the substring go beyond the length
of svar, then the substring returned ends at the end of
svar.

In the above example, A$ is equated to "BCDE".

6.3.7 RIGHT$

        Format: RIGHT$(svar,aexp)

        Example: A$=RIGHT$("123456",4)

This function is used to return the rightmost 'aexp'
characters of 'svar'. If aexp is greater than the
number of characters in svar, then the entire string
'svar' is returned.

In the above example, A$ is equated to "3456".

6.3.8 STR$

        Format: STR(aexp)

        Example: A$=STR$(65)

This function returns the string form of the number in
parentheses. The above example would return the actual
number 65, but it would be recognized by the computer
as a string.

NOTE: There can only be one STR$ and only one CHR$ in a
logical comparison. For example, A=STR$(1>STR$(2) is
not valid and will not work correctly.

6.3.9 VAL

        Format: VAL(sexp)

        Example: 1ØØ A=VAL(A$)

This function is the opposite of the STR$ function, in
that it returns the number represented by a string,
providing that the string is indeed a string
representation of a number. Using this function, the

computer can perform arithmetic operations on strings
as shown in the following example program.

```
1Ø DIM B$(5)
2Ø B$="1ØØØØ"
3Ø B=SQR(VAL(B$))
4Ø PRINT "THE SQUARE ROOT OF ",B$," IS ",B
```

Upon execution, the screen displays:

        THE SQUARE ROOT OF 1ØØØØ IS 1ØØ.

It is not possible to use the VAL function with a
string that does not start with a number, or that
cannot be interpreted by the computer as a number. It
can, however, interpret floating point numbers (e.g.,
VAL("1E9") would return the number 1ØØØØØØØØØ).

6.3.1Ø An Example Program

The following program inputs a three word string, cuts
it up into the separate words through the use of LEFT$,
MID$, and RIGHT$, and then prints out the ATASCII value
of each letter in each word using ASC. Note that this
program also uses the LEN and FIND functions.

```
1ØØ PRINT "Give me a three word string with each"
11Ø INPUT "word separated by a space> ",S$
12Ø POS1=FIND(S$," ",Ø) : REM find end of 1st word
13Ø L$=LEFT$(S$,POS1-1) : REM fill 1st word string
14Ø POS2=FIND(S$," ",POS1) : REM find 2nd word
15Ø M$=MID$(S$,POS1+l,POS2-POS1-1) : REM fill 2nd word string
16Ø R$=RIGHT$(S$,LEN(S$)-POS2) : REM fill 3rd word string
17Ø PRINT "*** ",L$ : REM print 1st word
18Ø   FOR I=1 TO LEN(L$) : REM print ASC value of each letter
19Ø   PRINT ,L$(I,I); ": "; ASC(L$(I))
2ØØ   NEXT I
21Ø PRINT "*** ",M$ : REM print 2nd word
22Ø   FOR I=1 TO LEN(M$) : REM print ASC value of each letter
23Ø   PRINT ,M$(I,I); ": "; ASC(M$(I))
24Ø   NEXT I
25Ø PRINT "*** ",R$ : REM print 3rd word
26Ø   FOR I=1 TO LEN(R$) : REM print ASC value of each letter
27Ø   PRINT ,R$(I,I); ": "; ASC(R$(I))
28Ø   NEXT I
298 GOTO 1ØØ
```

NOTE: Lines 13Ø, 15Ø, and 16Ø could have been coded as
follows:

        13Ø L$=S$(1,POS1-1)
        156 M$=S$(POS1+1,POS2-1)
        16Ø R$=S$(POS2+1)

6.4 Game Controller Functions

6.4.1 HSTICK

        Format: HSTICK(aexp)

        Example: 1ØØ IF HSTICK(Ø)>Ø THEN PRINT "MOVE RIGHT"

The HSTICK function returns an easily usable code for
horizontal movement of a given joystick. aexp is
simply the number of the joystick port (Ø-3), and the
values returned (and their meanings) are as follows:

        +1 if the joystick is pushed right
        -1 if the joystick is pushed left
         Ø if the joystick is horizontally centered

6.4.2 PADDLE

        Format: PADDLE (aexp)

        Example: PRINT PADDLE(3)

This function returns the current value of a particular
paddle. a.xp is the number of the paddle port (Ø-7).
The value returned will be between 1 and 228, with the
number   increasing   as   the   knob   is   turned
counterclockwise.

6.4.3 PEN

        Format: PEN(aexp)

        Example: PRINT "light pen at X=";PEN(Ø)

The PEN function simply ready the ATARI light pen
registers and returns their contents to the user. The
number specified by aexp is interpreted as follows:

        PEN(Ø) reads the horizontal position register
        PEN(l) reads the vertical position register

6.4.4 PTRIG

        Format: PTRIG(aexp)

        Example: 1ØØ IF PTRIG(1)=Ø8 THEN PRINT "MISSILES FIRED!"

The PTRIG function returns a status of Ø if the trigger
button of the designated paddle is pressed. Otherwise,
it returns a value of 1. The aexp must be a number
between Ø and 7 as it designates the paddle.

6.4.5 STICK

        Format: STICK(aexp)

        Example: 1ØØ PRINT STICK(3)

This function works exactly the same way as the PADDLE
command, but is used with the joystick controllers.
aexp is the number of the joystick port (Ø-3). The
following diagram shows the value. returned by this
function.

```
              14
        1Ø    |    6
          \   |   /
       11 ——— 15 ——— 7
          /   |   \
        9     |    5
             13
```
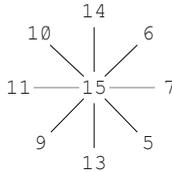
COMMENT: This function was the only means given to
access the joystick with original Atari BASIC. For most
purposes, HSTICK and VSTICK are much easier to use and
to work with.

6.4.6 STRIG

        Format: STRIG(aexp)

        Example: 1ØØ IF STRIG(1)=Ø THEN PRINT "FIRE TORPEDO"

The STRIG function works the same way as the PTRIG
function, except that it is used with the joysticks
instead of the paddles.

6.4.7 VSTICK

        Format: VSTICK(aexp)

        Example: IF VSTICK(Ø)<Ø THEN PRINT "MOVE DOWN"

The VSTICK function returns an easily usable code for
vertical movement of a given joystick. aexp is simply
the number of the joystick port (Ø-3), and the values
returned (and their meanings) are as follows:

        +1 if the joystick is pushed up
        -1 if the joystick is pushed down
         Ø if the joystick is vertically centered

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6.4.8 An Example Program

The following program creates a simple GRAPHICS mode 5
sketchpad using the game controller functions HSTICK,
VSTICK, and STRIG to move and draw.

```
100 GRAPHICS 5 : REM set up screen
110 COL=40 : RBM middle of screen
120 ROW=20
130 COLOR 2 : REM drawing a cursor color
140 PLOT COL, ROW : REM plot cursor
150 FOR I=1 TO 15 : NEXT I : REM delay loop
160 IF STRIG(0)=1 THEN COLOR 0:PLOT COL,ROW:REM don't draw point
170 COL=COL+HSTICK(0) : REM check for movement
180 ROW=ROW-VSTICK(0)
190 IF COL<0 THEN COL=0 : REM screen bounds checking
200 IF COL>79 THEN COL=79
210 IF ROW<0 THEN ROW=0
220 IF ROW>39 THEN ROW=39
230 FOR I=1 TO 25 : NEXT I : REM delay loop
240 GOTO 130 : REM repeat
```

6.5 Player/Missile Functions

For examples showing the use of the P/M functions, see
section 8.13.

6.5.1 BUMP

        Format: BUMP (pmnum,aexp)

        Example: IF BUMP(4,1) THEN B=BUMP(0,0)

BUMP accesses the collision registers of the Atari and
returns a 1 (collision occurred) or 0 (no collision
occurred) as appropriate for the pair of objects
specified. Note that the second parameter (the aexp)
may be either a player number or playfield number (see
section 8.2 for the appropriate number).

Valid BUMPs: PLAYER to PLAYER (0-3 to 0-3)
                MISSILE to PLAYER (4-7 to 0-3)
                PLAYER to PLAYFIELD (0-3 to 8-11)
                MISSILE to PLAYFIELD (4-7 to 8-11)

NOTE: BUMP (p,p), where the p's are 0 through 3 and
identical, always returns 0.

NOTE: It is advisable to reset the collision registers
if you have not checked them in a long time or after
you are through checking them at any given point in a

program. You can do this by using the following
statement:

```
POKE 53278,Ø
```

6.5.2 PMADR

        Format: PMADR(aexp)

        Example: PØ=PMADR(Ø)

This function may be used in any arithmetic expression
and is used to obtain the memory address of any player
or missile. It is useful when you wish to MOVE, POKE,
BGET, etc. data to (or from) a player area. (See
section 8.13 for examples of its use, and section 8.2
for a description of the aexp values.)

NOTE: PMADR(m) -- where m is a missile number (4
through 7) returns the same address for all missiles.

6.6 Special Purpose Functions

6.6.1 ADR

        Format: ADR(svar)

        Examples: ADR(A$)
                  ADR(B$(5;))

Returns the decimal memory address of the string
specified by the expression in parentheses. Knowing the
address enables the programmer to pass the information
to USR routines, etc. (See USR and Appendix D).

6.6.2 DPEEK

        Format: DPEEK(aexp)

        Example: PRINT "variable table is at ";:DPEEK(13Ø)

The DPEEK functions is very similar to the PEEK
function, except that it allows you to look two
consecutive bytes of information. This is especially
useful when looking at two byte locations containing
address information, as in the above example. If you
did this example using PEEKs, it would look like:

```
PRINT "variable name table is at ";
PRINT PEEK(13Ø)+(PEEK(131)*256)
```

It is easy to see that using DPEEK is much easier.

6.6.3 DPOKE

        Format: DPOKE aexp1,aexp2

        Example: DPOKE 88,32768

DPOKE is similar to POKE, except that it allows you to
put two bytes of data into memory instead of one. aexp1
is the address where you want the data to go, and aexp2
is the data itself. In the above example, the address
of the upper left-hand corner of the screen (this
address is stored at locations 88 and 89) is changed to
32768. To do this using POKEs, you would need to do an
amazing amount of math to get the right number into
each of the two bytes.

6.6.4 ERR

        Format: ERR(aexp)

        Example:
        PRINT "ERROR ":ERR(Ø);" OCCURRED AT LINE ":ERR(1)

This function in conjunction with TRAP, CONT, and GOTO
allows the BASIC XL programmer to effectively diagnose
and dispatch virtually any run-time error.

        ERR(Ø) returns the last run-time error number
        ERR(1) returns the line number where the error
        occurred

Example:
        1ØØ TRAP 2ØØ
        11Ø INPUT "A NUMBER, PLEASE >>",NUM
        12Ø PRINT "A VALID NUMBER" : END
        2ØØ IF ERR(Ø)=8 THEN GOTO ERR(1)
        21Ø PRINT "UNEXPECTED ERROR #";ERR(Ø)

6.6.5 FRE

        Format: FRE(aexp)

        Examples: PRINT FRE(Ø)
                  1ØØ IF FRE(Ø)<1ØØØ THEN PRINT "MEMORY
                      CRITICAL"

This function returns the number of bytes of user RAM
left. Its primary use is in Direct mode with a dummy
variable (Ø) to inform the programmer how much memory
space remains for completion of a program. Of course
FRE can also be used within a BASIC program in Deferred
mode.

6.6.6 HEX$

        Format: HEX$(aexp)

        Examples: 1ØØ PRINT HEX$(X+7)
                  2ØØ A$=HEX$(83)
                  21Ø PRINT "$";A$(3,4)

This function will convert aexp to a four digit
hexadecimal number.

The second example shows how you can obtain a two digit
hex number for printing or other manipulation.

NOTE: no "$" is placed in front of the number.

6.6.7 PEEK

        Format: PEEK(aexp)

        Examples: 1ØØ IF PEEK (4ØØØ) = 255 THEN PRINT "255"
                  1ØØ PRINT "LEFT MARGIN IS";PEEK(82)

Returns the contents of a specified memory address
location (aexp). The address specified must be an
integer or an arithmetic expression that evaluates to
an integer between e and 65535 and represents the
memory address in decimal notation (not hexadecimal).
The number returned will also be a decimal integer with
a range from e to 255. This function allows the user
to examine either RAM or ROM locations. In the first
example above, the PEEK is used to determine whether
location 4~el!l (decimal) contains the number 255. In
the second example, the PEEK function is used to
examine the left margin.

6.6.8 POKE

        Format: POKE aexp1,aexp2

        Examples: POKE 82,1Ø

                  1ØØ POKE 82,2Ø

Although this is not a function, it is included in this
section because it is closely associated with the PEEK
function. This POKE command inserts data into the
memory location or modifies data already stored there.
In the above format, aexp1 is the decimal address of
the location to be poked and aexp2 is the data to be
poked. Note that this number is a decimal number
between Ø and 255. POKE cannot be used to alter ROM
locations. In gaining familiarity with this command it
is advisable to look at the memory location with a PEEK

and write down the contents of the location. Then, if
the POKE doesn't work as anticipated, the original
contents can be poked back into the location.

The above Direct mode example changes the left screen
margin from its default position of 2 to a new position
of 1Ø. In other words, the new margin will be 8 spaces
to the right. To restore the margin to its normal
default position, press <SYSTEM RESET>.

6.6.9 SYS

        Format: SYS(aexp)

        Example: 1ØØ IF SYS(Ø)=Ø THEN SET Ø,128

The SYS function is used to find out the status of a
given BASIC XL system function. These system functions
can be changed using the SET command, and SYS allows
you to find out what any current value is. aexp is the
number of the system function as defined in the SET
section (3.15).

6.6.1Ø TAB

        Format: TAB(aexp)

        Example: PRINT #3;"columns:";TAB(2Ø);2Ø;TAB(3Ø);3Ø

The TAB function's effect is identical with that of the
TAB statement (section 5.28). The difference is that,
for PRINT USING statements, an imbedded TAB function
simplifies the programmers task greatly.

TAB will output ATASCII space characters to the current
PRINT file or device (#3 in our example). Sufficient
spaces will be output so that the next item will print
in the column specified (only if TAB is followed by a
semi-colon, though). If the column specified is less
than the current column, a RETURN will be output first.

CAUTION: The TAB function will output spaces on some
device whenever it is used; therefore, it should be
used ONLY in PRINT statements.

6.6.11 USR

        Format: USR(aexp1 [,aexp2][aexp3...])

        Example: 1ØØ RESULT = USR(ADD1,A*2)

This function returns the results of a machine-language
subroutine. The first expression, aexp1, must be an
integer or arithmetic expression that evaluates to an

integer that represents the decimal memory address of
the machine language routine to be performed. The
input arguments aexp2,aexp3,etc., are optional. These
should be arithmetic expressions within a decimal range
of Ø through 65535. A non-integer value may be used;
however, it will be rounded to the nearest integer.

These values will be converted from BASIC's Binary
Coded Decimal (BCD) floating point number format to a
two-byte binary number, then pushed onto the hardware
stack.

The arguments are pushed in the reverse of the order
given, so the assembly language program may then pull
them in proper forward order. Additionally, the
one-byte count of parameters is pushed onto the stack
and MUST be popped by the USeR routine (except see
section 3.15, the SET command).

Also, if all arguments are properly pulled from the
stack, then the USeR routine may return to BASIC XL by
simply executing an RTS instruction. And, finally, the
routine may return a single 16-bit value to BASIC XL
(as the "value" of the USeR function) by placing a
result in FRØ and FRØ+l ($D4 and $D5) before returning.

Example: The following example uses a USR call to XOR
         two numbers (the arguments to the USR routine)
         and then return that value to BASIC XL.

BASIC XL statement:

        PRINT HEX$(USR($68Ø,$3FFA,$2972))

USR routine at $68Ø:

```
   FRØ = $D4
       *= $68Ø
       PLA       ; get number of arguments
       CMP #2    ; see if it's 2
       BNE *     ; loop forever if wrong num. of args.
       PLA       ; get high byte of arg #1
       STA FRØ+1 ; store high byte
       PLA       ; get low byte of arg #1
       STA FRØ   ; store low byte
       PLA       ; get high byte of arg #2
       EOR FRØ+1 ; XOR it with high byte of arg #1
       STA FRØ+1 ; store result of XOR
       PLA       ; get low byte of arg #2
       EOR FRØ   ; XOR it with low byte of arg #1
       STA FRØ   ; store result of XOR
       RTS       ; end of USR routine
```

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6.6.12 An Example Program

The following program uses the system timer located at
$12, $13, and $14 to create a countdown clock. This is
done by poking Ø into the low byte of the timer and
waiting until it is greater than or equal to 6Ø.

Note: On PAL systems remember to use 5Ø; see line 2ØØ.

```
1ØØ GRAPHICS 2
11Ø PRINT #6; CHR$(125) : REM Clear Mode 2 area
12Ø PRINT : PRINT : PRINT
13Ø PRINT "COUNTDOWN TIME? ";
14Ø INPUT #Ø,X
15Ø POKE $14,Ø : REM set clock = Ø
16Ø PRINT #6; "TIME -";
17Ø   WHILE X>Ø : REM start the countdown
18Ø   POSITION 7,1 : REM get ready to print the new time
19Ø   PRINT #6; USING "##",X; : REM print time left
2ØØ     WHILE PEEK($14)<=6Ø : REM wait until a second has passed
21Ø     ENDWHILE
22Ø   POKE $14,Ø : REM reset the clock for the next second
23Ø   X=X-1 : REM decrement number of seconds left
24Ø   ENDWHILE : REM end of countdown loop
25Ø PRINT CHR$(253) : REM ring the bell
26Ø GOTO 11Ø : REM do the whole thing over again
```

Chapter 7:   SCREEN GRAPHICS AND SOUND

This chapter describes the BASIC XL commands used to
manipulate the wide variety of screen graphics
available on the Atari personal computers. It also
describes the BASIC XL command used to manipulate the
sound generating mechanism of the Atari computers.

7.1 GRAPHICS (GR.)

          Format: GRAPHICS aexp

          Example: GRAPHICS 2

This command is used to select one of the graphics
modes. The table below summarizes the modes and the
characteristics of each.

The GRAPHICS command automatically opens the graphics
area of the screen (S:) on channel #6. As a result of
this, it is not necessary to specify a channel number
when you want to PRINT to the text window, since it is
still open on channel #Ø.

NOTE: aexp must be positive.

Graphics modes 8, 9, 1Ø, and 11 are full-screen display
while modes 1 through 8 and 12 to 15 are split screen
displays. To override the split-screen, add 16 to the
mode number (aexp) in the GRAPHICS command. Adding 32
prevents the graphics command from clearing the screen.

To return to graphics mode Ø in Direct mode, press
<SYSTEM RESET> or type GR.Ø and press <RETURN>.

Gr. Mode	Mode Type	Cols	(split) Rows	(full) Rows	Num of Colors	
Ø	TEXT	4Ø	N/A	24	2	
1	TEXT	2Ø	2Ø	24	5	
2	TEXT	2Ø	1Ø	12	5	
3	GRAPHICS	4Ø	2Ø	24	4	
4	GRAPHICS	8Ø	4Ø	48	2	
5	GRAPHICS	8Ø	4Ø	48	4	
6	GRAPHICS	16Ø	8Ø	96	2	
7	GRAPHICS	16Ø	8Ø	96	4	
8	GRAPHICS	32Ø	16Ø	192	1 ½	
9	GRAPHICS	8Ø	N/A	192	16	
1Ø	GRAPHICS	8Ø	N/A	192	9	
11	GRAPHICS	8Ø	N/A	192	16	
12	TEXT	4Ø	2Ø	24	5	(XL/XE)
13	TEXT	4Ø	1Ø	12	5	(only)
14	GRAPHICS	16Ø	16Ø	192	2	(- " -)
15	GRAPHICS	16Ø	16Ø	192	4	(- " -)

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7.1.1 GRAPHICS Mode Ø

This mode is the 1-color, 2-luminance (brightness) default mode for the ATARI Personal Computer. It contains a 24 line by 4Ø character screen matrix. The default margin settings at 2 and 39 allow 38 characters per line. Margins may be changed by poking LMARGN and RMARGN (82 and 83).

Some systems have different margin default settings. The color of the characters is determined by the background color. Only the luminance of the characters can be different. This full-screen display has a blue display area bordered in black (unless the border is specified to be another color). To display characters at a specified location, use the following method:

```
 POSITION aexp1,aexp2 : REM Puts cursor at location
 PRINT sexp          :   REM specified by aexp1 and aexp2.
```

GRAPHICS Ø is also used as a clear screen command either in Direct mode or Deferred mode. It terminates any previously selected graphics mode and returns the screen to the default mode (GRAPHIC Ø).

7.1.2 GRAPHICS Modes 1 and 2

These two 5-color modes are text modes. However, they are both split-screen modes.

Characters printed in Graphics mode 1 are twice the width of those printed in Graphics Ø, but are the same height.

Characters printed in Graphics mode 2 are twice the width and height of those in Graphics mode Ø.

In the split-screen mode, a PRINT command is used to display characters in either the text window or the graphic window. To print characters in the graphic window, specify channel #6 after the PRINT command.

```
        Example: 1ØØ GR. 1
                 11Ø PRINT #6;"A MODE 1 TEST"
```

The default colors depend on the type of character input, as defined in the following table:

Character Type	Color Register	Default Color
Upper case alphabetic	Ø	Orange
Lower case alphabetic	1	Light Green
Inverse upper case alphabetic	2	Dark Blue
Inverse lower case alphabetic	3	Red
Numbers	Ø	Orange
Inverse numbers	2	Dark Blue

NOTE: See SETCOLOR to change character colors.

Unless otherwise specified, all characters are displayed in upper case non-inverse form. To print lower case letters and graphics characters, use a POKE 756,226. To return to upper case, use POKE 756,224.

In graphics modes 1 and 2, there is no inverse video, but it is possible to get all the rest of the characters in four different colors (see end of SETCOLOR section).

7.1.3 GRAPHICS Modes 3, 5 and 7

These three 4-color graphics modes are also split screen displays in their default state, but may be changed to full screen by adding 16 to the mode number. Modes 3, 5, and 7 are alike except that modes 5 and 7 use more points (pixels) in plotting, drawing, and positioning the cursor; the points are smaller, thereby giving a much higher resolution.

7.1.4 GRAPHICS modes 4,6

These two 2-color graphics modes are split-screen displays and can display in only two colors while the other modes can display 4 and 5 colors. The advantage of a two-color mode is that it requires less RAM space. Therefore, it is used when only two colors are needed and RAM is getting crowded. These two modes also have a higher resolution which means smaller points than Graphics mode 3.

7.1.5 GRAPHICS mode 8

This graphics mode gives the highest resolution of all
the other modes. As it takes a lot of RAM to obtain
this kind of resolution, it can only accommodate a
maximum of one color and two different luminances, as
mode Ø.

7.1.6 GRAPHICS modes 9, 1Ø, and 11

GRAPHICS modes 9, 1Ø, and 11 are the GTIA modes, and
are somewhat different from all the other modes. Note
that these modes do not allow a text window.

Mode 9 is a one color, 16 luminance mode. The main
color is set by the background color, and the luminance
values are determined by the information in the screen
memory itself. Each pixel is four bits wide, allowing
for 16 different values. These values are interpreted
as the luminance of the base color for that pixel.

Mode 11 is similar to mode 9 in that the color
information is in the screen memory itself, but the
information for each pixel is interpreted as a color
instead of a luminance. Thus there are 16 colors, all
of the same luminance. The luminance is set by the
luminance of the background color (default = 6).

Mode 1Ø is somewhat of a crossbreed of the other two
GTIA modes and the normal modes in that it offers lots
of colors (like the GTIA modes) and uses the color
registers (like the normal modes). However, since mode
1Ø allows 9 colors, it must use the player color
registers as well as the other color registers. Below
is a table showing how the pixel values relate to the
color registers and what BASIC XL command may be used.

VALUE	REGISTER	REG. ADDRESS	COMMAND
Ø	PCOLRØ	7Ø4	PMCOLOR Ø
1	PCOLR1	7Ø5	PMCOLOR 1
2	PCOLR2	7Ø6	PMCOLOR 2
3	PCOLR3	7Ø7	PMCOLOR 3
4	COLORØ	7Ø8	SETCOLOR Ø
5	COLOR1	7Ø9	SETCOLOR 1
6	COLOR2	71Ø	SETCOLOR 2
7	COLOR3	711	SETCOLOR 3
8	COLOR4	712	SETCOLOR 4

7.1.7 GRAPHIC modes 12 and 13

These are 5-color split-screen text modes.

The characters in mode 12 have the same height as in mode Ø, but only four pixels get displayed instead of eight.

In mode 13 the characters are double the size of mode Ø characters, while only four pixels are displayed.

Since both modes display only four bits in each line of the character definition, the color of the activated pixel depends on the bit pair in the byte being addressed:

```
        Bit Pair   Color   RAM Location
           ØØ       BAK       712
           Ø1       PFØ       7Ø8
           1Ø       PFl       7Ø9
           11       This depends on bit 7 of the byte.

                    If bit 7 = Ø, then use PF2 (at 71Ø),
                                   else use PF3 (at 711).
```

Each line in a character set definition (eight lines, one byte wide, form one character) can have different color combinations. Since bit pairs (one color clock) are displayed, the normal character set becomes unrecognizable. In order to use these modes, you should build a character set in which each character is half a letter and can be combined for display. Or build a 7x7 character set with a blank row and column between each character.

The characters displayed are only one half of the ATASCII set, depending on the value in location 756: 224 for uppercase, 226 for lowercase. The lower seven bits (Ø-6) are used for character data (range from Ø to 127), while the high bit is the color modifier (see table above).

7.1.8 GRAPHIC modes 14 and 15

GRAPHICS 14 is a two-color mode with half the horizontal resolution of GRAPHICS 8. Each screen line is one scan line high.

GRAPHICS 15 is a four-color mode with screen lines being one scan line high. Only the first two bits of a screen byte identify the byte color.

NOTE: Graphic modes 12-15 are not available from BASIC XL on 4ØØ/8ØØ machines.

7.2 COLOR (C.)

       Format: COLOR aexp

       Examples: 11Ø COLOR ASC("A")
                11Ø COLOR 3

The value of the expression in the COLOR statement
determines the data to be stored in the display memory
for all subsequent PLOT and DRAWTO commands until the
next COLOR statement is executed. The value must be
positive and is usually an integer from Ø through 255.
Non-integers are rounded to the nearest integer. The
graphics display hardware interprets this data in
different ways in the different graphics modes.

In text modes Ø through 2, the number can be from Ø
through 255 (8 bits) and determines the character to be
displayed and its color. (The two most significant
bits determine the color. This is why only 64 different
characters are available in these modes instead of the
full 256-character set.)

Graphics modes 3 through 8 are not text modes, so the
data stored in the display RAM simply determines the
color of each pixel. Two-color or two-luminance modes
require either Ø or 1 (1-bit) and four-color modes
require Ø, 1, 2, or 3. (The expression in the COLOR
statement may have a value greater than 3, but only one
or two bits will be used.)

The actual color which is displayed depends on the
value in the color register which corresponds to the
data of Ø, 1, 2, or 3 in the particular graphics mode
being used. This may be determined by looking in the
table at the end of the SETCOLOR section. This table
gives COLOR and SETCOLOR relationships for all the
GRAPHICS modes.

Note that when BASIC XL is first powered up, the color
data is Ø. and when a GRAPHICS command (without +32) is
executed, all of the pixels are set to Ø. Therefore,
nothing seems to happen to PLOT and DRAWTO in GRAPHICS
3 through 7 when no COLOR statement has been executed.
Correct this by doing a COLOR 1 first.

7.3 DRAWTO (DR.)

        Format: ·DRAWTO aexp1, aexp2

        Example: 1ØØ DRAWTO 1Ø,8

This statement causes a line to be drawn from the last
point displayed by a PLOT (see PLOT) to the location by
aexp1 and aexp2. The first expression represents the X
coordinate (column) and the second represents the
Y-coordinate (row). The color of the line is the same
color as the point displayed by the PLOT.

7.4 LOCATE (LOC.)

        Format: LOCATE aexp1,aexp2,avar

        Example: 15Ø LOCATE 11,15,X

This command positions the invisible graphics cursor at
the   specified   location   in   the   graphics   window,
retrieves the data at that pixel, and stores it in the
specified   arithmetic   variable.   This   gives   a   number
from Ø to 255 for Graphics modes Ø through 2, a Ø or 1
for the 2-color graphics modes, and a Ø, 1, 2, or 3 for
the   4-color   modes.   The   two   arithmetic   expressions
specify the X and Y coordinates of the point. LOCATE
is equivalent to:

        POSITION aexp1,aexp2:GET#6,avar

Doing a PRINT after a LOCATE or GET from the screen may
cause the data in the pixel which was examined to be
modified. This problem is avoided by repositioning the
cursor and putting the data that was read back into
the pixel   before   doing   the   PRINT.   The   following
program illustrates the use of the LOCATE command:

        1Ø GRAPHICS 3+16
        2Ø COLOR 1
        3Ø SETCOLOR 2,1Ø,8
        4Ø PLOT 1Ø,15
        5Ø DRAWTO 15,15
        6Ø LOCATE 12,15,X
        7Ø PRINT X

On   execution,   the   program   prints   the   data   (1)
determined by the COLOR statement which was stored in
pixel 12,15.

7.5 PLOT (PL.)

        Format: PLOT aexp1,aexp2

        Example: 10Ø PLOT 5,5

The PLOT command is used in graphics modes 3 through 8
to display a point in the graphics window. aexp1
specifies the X-coordinate and aexp2 specifies the
Y-coordinate. The color of the plotted point is
determined by the hue and luminance in the color
register from the last COLOR statement executed. To
change this color register, and the color of the
plotted point, use SETCOLOR. Points that can be
plotted on the screen are dependent on the graphics
mode being used. The range of points begins at (Ø,Ø),
and extends to one less than the total number of rows
(X-coordinate) or columns (Y-coordinate).

NOTE: PLOT aexp1,aexp2 is equivalent to:

        POSITION aexp1,aexp2 : PUT #6, COLOR

7.6 POSITION (POS.)

        Format: POSITION aexp1,aexp2

        Example: 100 POSITION 8,12

The POSITION statement is used to place the invisible
graphics window cursor at the specified location on the
screen (usually precedes a PRINT or PUT statement).
This statement can be used in all modes. Note that the
cursor does not actually move until an I/O command
which involves the screen is issued.

7.7 PUT and GET (as applied to graphics)

        Formats: PUT #6,aexp
                  GET #6,avar

        Examples: 10Ø PUT #6,ASC("A")
                  2ØØ GET #6,X

In graphics work, PUT is used to output data to the
screen display. This statement works hand-in-hand with
the POSITION statement. "After a PUT (or GET), the
cursor is moved to the next location on the screen.

Doing a PUT to device #6 causes the one-byte aexp to be
displayed at the cursor position. The byte is either an
ATASCII code byte for a particular character (modes
Ø-2) or the color data (modes 3-8).

GET is used to input the code byte of the character displayed at the cursor position, into the specified arithmetic variable. The values used in PUT and GET correspond to the values in the COLOR statement. (PRINT and INPUT may also be used.)

NOTE: Doing a PRINT after a LOCATE or GET from the screen may cause the data in the pixel which was examined to be modified. To avoid this problem, reposition the cursor and put the data that was read back into the pixel before doing the PRINT.

7.8 SETCOLOR (SE.)

        Format: SETCOLOR aexp1,aexp2,aexp3

        Example: 1ØØ SETCOLOR Ø,1,4

This statement is used to choose the particular hue and luminance to be stored in the specified color register. The parameters of the SETCOLOR statement are defined below:

aexp1 = Color register (Ø-4 depending on graphics mode)
aexp2 = Color hue number (Ø-15 --see the table below)
aexp3 = Color luminance (must be an even number between
        Ø and 14; the higher the number, the brighter
        the display. 14 is almost pure white.)

SETCOLOR aexp2	Color	SETCOLOR aexp2	Color
Ø	Gray	8	Blue
1	Gold	9	Light Blue
2	Orange	1Ø	Turquoise
3	Red-Orange	11	Green-Blue
4	Pink	12	Green
5	Purple	13	Yellow-Green
6	Purple-Blue	14	Orange-Green
7	Blue	15	Light Orange

NOTE: Colors will vary with type and adjustment of TV or monitor used.

The ATARI display hardware contains five color registers, numbered from Ø through 4. The Operating System (OS) has five RAM locations (COLORØ through COLOR4, see Appendix I - Memory Locations) where it keeps track of the current colors. The SETCOLOR statement is used to change the values in these RAM locations. (The OS transfers these values to the hardware registers every television frame.)

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The SETCOLOR statement requires a value from Ø to 4 to
specify a color register. The COLOR statement uses
different numbers because it specifies data which only
indirectly corresponds to a color register. This can be
confusing, so careful study of the various tables in
this section is advised.

SETCOLOR Register	Default Color	Default Luminance	Color
Ø	2	8	Orange
1	12	1Ø	Green
2	9	4	Dark Blue
3	4	6	Pink or Red
4	Ø	Ø	Black

"DEFAULT" occurs if no SETCOLOR statement is used.

The following table shows the COLOR -- SETCOLOR
relationships for all the GRAPHICS modes, and gives
some information on the registers used in a specific
mode:

GRAPHICS Mode	SETCOLOR 'register'	COLOR number	Description and Comments
Ø and all text windows	Ø	COLOR	--
	1	data	--
	2	actually	Character luminance
	3	deter-	Background
	4	mines	Border
1,2, 12,13	Ø	the	Character
	1	char-	Character
	2	acter	Character
	3	to	Character
	4	PLOT	Background, Border
3,5,7, 15	Ø	1	Graphics Point
	1	2	Graphics Point
	2	3	Graphics Point
	3	--	--
	4	Ø	Gr.Pt.,Border,Background
4,6, 14	Ø	1	Graphics Point
	4	Ø	Gr.Pt.,Border,Background
8	1	1	Graphics Point,Luminance
	2	Ø	Graphics Point,Background
	4	--	Border

7.9 XIO (X.) Special Fill Application

        Format: XIO 18,#aexp,aexp1,aexp2,filespec

        Example: 1ØØ XIO 18,#6,Ø,Ø,"S:"

This special application of the XIO statement fills an
area on the screen between plotted points and lines
with a non-zero color value. Dummy variables (Ø) are
used for aexp1 and aexp2.

The following steps illustrate the fill process:

1. PLOT bottom right corner (point 1).
2. DRAWTO upper right corner (point 2). This outlines
    the right edge Of the area to be filled
3. DRAWTO upper left corner (point 3).
4. POSITION cursor at lower left corner (point 4).
5. POKE address 765 with the fill color data (1,2,or 3).

This method is used to fill each horizontal line from
top to bottom of the specified area. The fill starts at
the left and proceeds across the line to the right
until it reaches a pixel which contains non-zero data
(will wraparound if necessary). This means that fill
cannot be used to change an area which has been filled
in with a non-zero value, as the fill will stop.

WARNING: The fill command will go into an infinite loop
if you attempt to put zero (Ø) data on a line which has
no non-zero pixels. <BREAK> or <SYSTEM RESET> can be
used to stop the fill if this happens.

The following program creates a shape and fills it with
a data (color) of 3. Note that the XIO command draws
in the lines of the left and bottom of the figure.

```
1Ø GRAPHICS 5+16
2Ø COLOR 3
3Ø PLOT 7Ø,45
4Ø DRAWTO 5Ø,1Ø
5Ø DRAWTO 3Ø,1Ø
6Ø POSITION 1Ø,45
7Ø POKE 765,3
8Ø XIO 18,#6,Ø,Ø,"S:"
9Ø GOTO 9Ø
```

7.1Ø SOUND (SO.)

          Format: SOUND aexp1,aexp2,aexp3,aexp4

          Example: 1ØØ SOUND 2,2Ø3,1Ø,12

The SOUND statement causes the specified note to begin
playing as soon as the statement is executed. The note
will   continue   playing   until   the   program encounters
another SOUND statement with the same aexp1 or an END
statement.   The   SOUND   parameters   are   described   as
follows:

aexp1   is one of the four voices available on the
            Atari (number Ø - 3).

aexp2   is the frequency (pitch) of the sound, and
            ranges between Ø and 255. The lower aexp2
            is, the higher the frequency.

Aexp3   is   a   measure   of   the   sound's   distortion
            (fuzziness). Valid numbers are Ø - 14, even
            numbers   only. A value of 1Ø creates pure
            tones like a flute, and a 12 produces sounds
            similar to a guitar.

Aexp4   is the volume of the sound. Valid values are
            1 - 15; the lower the number, the lower the
            volume.

Here is a table for various musical notes using a
distortion of 1Ø:

	aexp2	Note(s)		aexp2	Note(s)
HIGH	29	C		91	F
NOTES	31	B		96	E
	33	A# or Bb		1Ø2	D# or Eb
	35	A		1Ø8	D
	37	G# or Ab		114	C# or Db
	4Ø	G	MIDDLE C	121	C
	42	F# or Gb		128	B
	45	F		136	A# or Bb
	47	E		144	A
	5Ø	D# or Eb		153	G# or Ab
	53	D		162	G
	57	C# or Db		173	F# or Gb
	6Ø	C		182	F
	64	B	LOW	193	E
	68	A# or Db	NOTES	2Ø4	D# or Eb
	72	A		217	D
	76	G# or Ab		23Ø	C# or Db
	81	G		243	C
	85	F# or Gb			

The following program plays a C scale using the above values:

```
1Ø READ A
2Ø IF A=256 THEN END
3Ø SOUND Ø,A,1Ø,1Ø
4Ø FOR W=1 TO 4ØØ:NEXT W
5Ø PRINT A
6Ø GOTO 1Ø
7Ø END
8Ø DATA 29,31,35,4Ø,45,47,53,6Ø,64,72,81,91,96,1Ø8,121
9Ø DATA 128,144,162,182,193,217,243,256
```

Note that the DATA statement in line 8Ø ends with a 256, Which is outside of the designated range. The 256 is used as an end-of-data marker.

```
--------------------------------------------------------
Chapter 8:                    PLAYER / MISSILE GRAPHICS
--------------------------------------------------------
```

This chapter describes the BASIC XL commands and
functions used to access the Atari's Player-Missile
Graphics. Player Missile Graphics (hereafter usually
referred to as simply "PMG") represent a portion of the
Atari hardware totally ignored by Atari BASIC and Atari
OS. Even the screen handler (the "S:" device) knows
nothing about PMG.

BASIC XL goes a long way toward remedying these
omissions by adding six PMG commands (statements) and
two PMG functions to the already comprehensive Atari
graphics. In addition, four other statements and two
functions have significant uses in PMG and will be
discussed in this chapter.

For information on the PMG functions, see section 6.5.

8.1 An Overview of P/M Graphics

For a complete technical discussion of PMG, and to
learn of even more PMG "tricks" than are included in
BASIC XL, read the Atari document entitled "Atari
4ØØ/8ØØ Hardware Manual" (Atari part number CØ16555,
Rev. 1 or later).

It was stated above that the "S:" device driver knows
nothing of PMG, and in a sense this is proper: the
hardware mechanisms that implement PMG are, for
virtually all purposes, completely separate and
distinct from the "playfield" graphics supported by
"S:". For example, the size, position, and color of
players on the video screen are completely independent
of the GRAPHICS mode currently selected and any COLOR
or SETCOLOR commands currently active. In Atari (and
now BASIC XL) parlance, a "player" is simply a
contiguous group of memory cells displayed as a
vertical stripe on the screen. Sounds dull? Consider:
each player (there are four) may be "painted" in any of
the 128 colors available on the Atari (see SETCOLOR for
specific colors). Within the vertical stripe, each bit
set to 1 paints the player's color in the corresponding
pixel, while each bit set to Ø paints no color at all!
That is, any Ø bit in a player stripe has no effect on
the underlying playfield display.

Why a vertical stripe? Refer to the figure at the end
of this section for a rough idea of the player concept.
If we define a shape within the bounds of this stripe

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(by changing some of the player's bits to 1's), we may
then move the stripe anywhere horizontally by a simple
register POKE (or via the PMMOVE command in BASIC XL).
We may move the player vertically by simply doing a
circular shift on the contiguous memory block
representing the player (again, the PMMOVE command of
BASIC XL simplifies this process). To simplify:

A player is actually seen as a stripe on the screen 8
pixels wide by 128 (or 256, see below) pixels high.
Within this stripe, you can POKE or MOVE bytes to
establish what is essentially a tall, skinny picture
(though much of the picture may consist of Ø bits, in
which case the background "shows through"). Using
PMMOVE, you may then move this player to any horizontal
or vertical location on the screen. To complicate:

For each of the four players there is a corresponding
"missile" available. Missiles are exactly like players
except that:

> 1) they are only 2 bits wide, and all four
>   missiles share a single block of memory
>
> 2) each 2 bit sub-stripe has an independent
>   horizontal position
>
> 3) a missile always has the same color as
>   its parent player.

Again, by using the BASIC XL commands (MISSILE and
PMMOVE, for example), you the programmer need not be
too aware of the mechanisms of PMG.

Vert. Ø Position

TV Screen

Playfield Area

Hor. Pos. Approx. 14Ø

A Player Shape --
any on (1) bits will
show color selected
by PMCOLOR.

* indicates pixels
(color clocks) of
width.

127   255

1Ø2
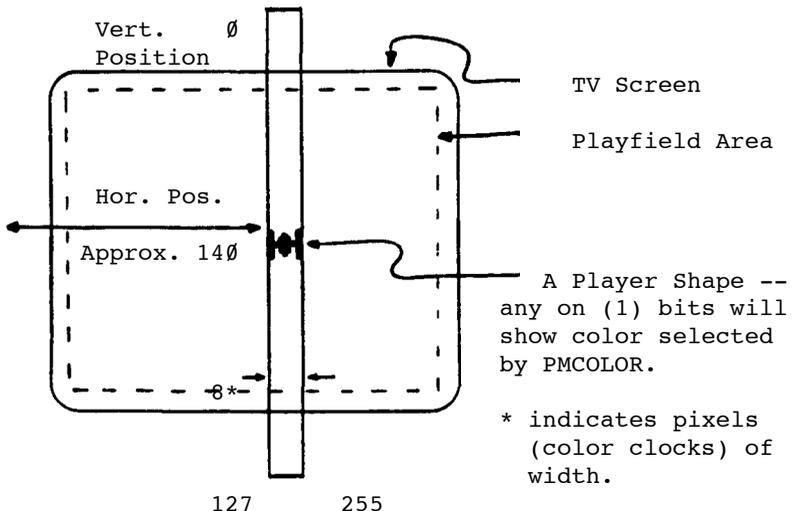
8.2 P/M Graphics Conventions
----

1.   Players are numbered from Ø through 3. Each
      player has a corresponding missile whose number is
      4 greater then that of its parent player, thus
      missiles are numbered 4 through 7. In the BUMP
      function, the "playfields" are numbered from 8
      through 11, corresponding to actual playfields Ø
      through 3. (NOTE: Playfields are actually COLORs
      on the main GRAPHICS screen, and can be PLOTted,
      PRINTed, etc.)

2.   There is some inconsistency in which way is "UP".
      PLOT, DRAWTO, POKE, MOVE, etc. are aware that Ø,Ø
      is the top left of the screen and that vertical
      position numbering increases as you go down the
      screen. PMMOVE and VSTICK, however, do only
      relative screen positioning, and define "+" to be
      UP and "-" to be DOWN. [If this really bothers
      you please let us know!].

3.   "pmnum" is an abbreviation for Player-Missile
      NUMber and must be a number from Ø to 3 (for
      players) or 4 to 7 (for missiles).

8.3 BGET and BPUT with P/M's

As with MOVE (see section 8.11), BGET may be used to
fill a player memory quickly with a player shape. The
difference is that BGET may obtain a player directly
from the disk:

Example: BGET #3,PMADR(Ø),128

Would get a PMG.2 mode player from the file opened in
slot #3.

Example: BGET #4,PMADR(4),256*5

Would fill all the missiles AND players in PMG.1 mode --
with a single statement!

BPUT would probably be most commonly used during program
development to SAVE a player shape (or shapes) to a file
for later retrieval by BGET.

8.4 PMCLR

        Format: PMCLR pmnum

        Example: PMCLR 4

This statement "clears" a player or missile area to all
zero bytes, thus "erasing" the player/missile. PMCLR is
aware of what PMG mode is active and clears only the
appropriate amounts of memory. CAUTION: PMCLR 4
through PMCLR 7 all produce the same action -- ALL
missiles are cleared, not just the one specified. To
clear a single missile, try the following:

        SET 7,Ø : PMMOVE 4;255

8.5 PMCOLOR (PMCO.)

        Format: PMCOLOR pmnum,aexp,aexp

        Example: PMCOLOR 2,13,8

PMCOLORs are identical in usage to those of the
SETCOLOR statement except that a player/missile set has
its color chosen. Note there is no correspondence in
PMG to the COLOR statement of playfield GRAPHICS: none
is necessary since each player has its own color.

The example above would set player 2 and missile 6 to a
medium (luminace 8) green (hue 13).

NOTE: PMG has NO default colors set on power-up or
SYSTEM RESET.

8.6 PMGRAPHICS (PMG.)

        Format: PMGRAPHICS aexp

        Example: PMG. 2

This statement is used to enable or disable the Player/
Missile Graphics system. The aexp should evaluate to Ø,
1, or 2:

        PMG.Ø   Turn off PMG
        PMG.1   Enable PMG, single line resolution
        PMG.2   Enable PMG,'double line resolution

Single and Double line resolution (hereafter referred to
as "PMG Modes") refer to the height which a byte in the
player "stripe" occupies - either one or two television
scan lines. (A scan line height is the pixel height in

GRAPHICS mode 8. GRAPHICS 7 has pixels 2 scan lines
high, similar to PMG.2)

The secondary implication of single line versus double
line resolution is that single line resolution requires
twice as much memory as double line, 256 bytes per
player versus 128 bytes. The following diagram shows
PMG memory usage in BASIC XL, but the user really need
not be aware of the mechanics if the PMADR function is
used.

```
                          RAMSZ ($6A)
           +--------------------------------------+
           |           Current GRAPHICS Mode       |
           +--------------------------------------+
```
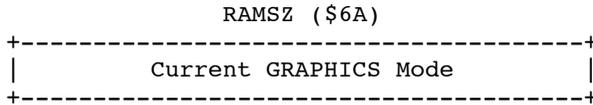
Depending on GRAPHICS mode, there may or may not be
unused memory here.
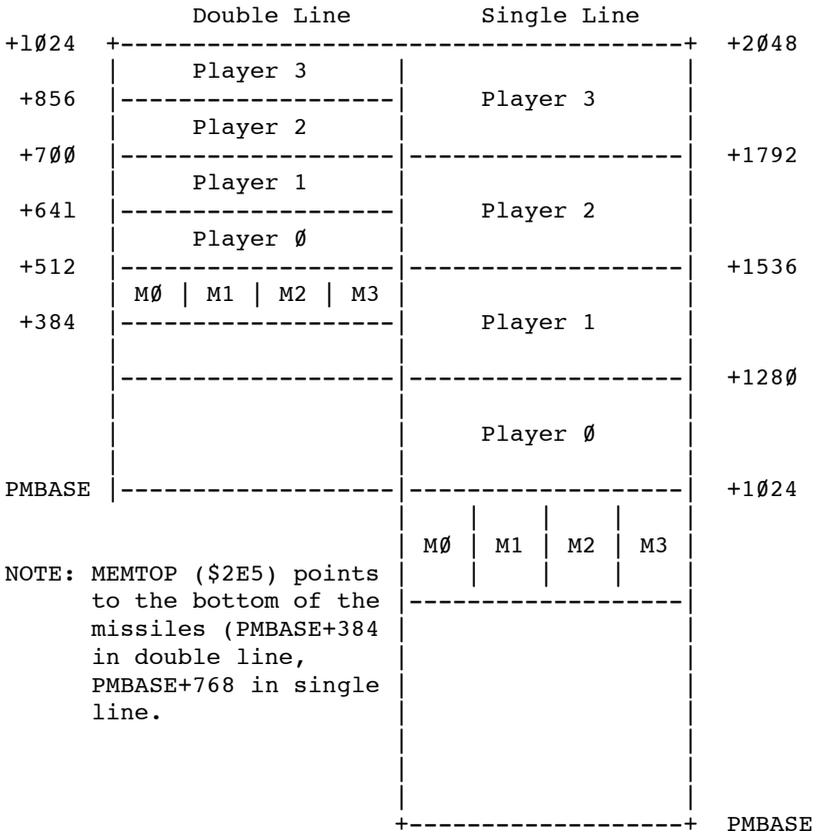
```
                 Double Line        Single Line
  +1024    +--------------------------------------+  +2048
           |        Player 3       |              |
   +856    |------------------|          Player 3 |
           |        Player 2       |              |
   +700    |------------------|------------------|  +1792
           |        Player 1       |              |
   +641    |------------------|          Player 2 |
           |        Player 0       |              |
   +512    |------------------|------------------|  +1536
           | M0 | M1 | M2 | M3 |                  |
   +384    |------------------|          Player 1 |
           |                  |                  |
           |------------------|------------------|  +1280
           |                  |                  |
           |                  |          Player 0 |
           |                  |                  |
PMBASE     |------------------|------------------|  +1024
                              |   |   |   |   |
                              | M0 | M1 | M2 | M3 |
NOTE: MEMTOP ($2E5) points    |   |   |   |   |
      to the bottom of the    |------------------|
      missiles (PMBASE+384    |                  |
      in double line,         |                  |
      PMBASE+768 in single    |                  |
      line.                   |                  |
                              |                  |
                              |                  |
                              |                  |
                              +------------------+  PMBASE
```

8.7 PMMOVE

        Format: PMMOVE pmnum[,aexp][;aexp]

        Examples: PMMOVE Ø,12Ø;1
                  PMMOVE 1,8Ø
                  PMMOVE 4;-3

Once a player or missile has been "defined" (via POKE, MOVE, GET, or MISSILE), the truly unique features of PMG under BASIC XL may be utilized. With PMMOVE, the user may position the player/missile shape anywhere on the screen almost instantly.

BASIC XL allows the user to position each player and missile independently. Because of the hardware implementation, though, there is a difference in how horizontal and vertical positions are specified.

The parameter following the comma in PMMOVE is taken to be the ABSOLUTE position of the left edge of the "stripe" to be displayed. This position ranges from Ø to 255, though the lowest and highest positions in this range are beyond the edges of the display screen. Note the specification of the LEFT edge: changing a player's width (see PMWIDTH) will not change the position of its left edge, but will expand the player to the right.

The parameter following the semi-colon in PMMOVE is a RELATIVE vertical movement specifier. Recall that a "stripe" of player is 128 or 256 bytes of memory. Vertical movement must be accomplished by actual movement of the bytes within the stripe -- either towards higher memory (down the screen) or lower memory (up the screen). BASIC XL allows the user to specify a vertical movement from -255 (down 255 pixels) to +255 (up 255 pixels).

NOTE: The +/- convention on vertical movement conforms to the value returned by VSTICK.

        Example: PMMOVE N;VSTICK(N)

Will move player N up or down (or not move him) in accordance with the joystick position.

NOTE: SET may be used to tell PMMOVE whether an object should "wraparound" (from bottom of screen to top of screen or vice versa) or should disappear as it scrolls too far up or down. SET 7,1 specifies wraparound, and SET 7,Ø disables it.

8.8 PMWIDTH (PMW.)

        Format: PMWIDTH pmnum,aexp

        Example: PMWIDTH 1,2

Just as PMGRAPHICs can select single or double pixel heights, PMWIDTH allows the user to specify the screen width of players and missiles. But where PMGRAPHICs selects resolution mode for all players and missiles, PMWIDTH allows each player AND missile to be separately specified. The aexp used for the width should have values of 1, 2, or 4 -- representing the number of color clocks (equivalent to a pixel width in GRAPHICS mode 7) which each bit in a player definition will occupy.

NOTE: PMG.2 and PMWIDTH 1 combine to allow each hit of a player definition to be equivalent to a GRAPHICS mode 7 pixel -- a not altogether accidental occurrence.

NOTE: Although players may be made wider with PMWIDTH, the resolution then suffers. Wider "players" may be made by placing two or more separate players side-by-side.

8.9 POKE and PEEK with P/M's

One of the most common ways to put player data into a player stripe may well be to use POKE. In conjunction with PMADR, it is easy to write understandable player loading routines.

        Example: 1ØØ FOR LOC=48 TO 52
                 11Ø READ N: POKE LOC+PMADR(Ø),N
                 12Ø NEXT LOC
                 ...
                 9ØØ DATA 255,129,255,129,255

PEEK might be used to find out what data is in a particular player location.

8.1Ø MISSILE (MIS.)

        Format: MISSILE pmnum,aexp,aexp

        Example: MISSILE 4,48,3

The MISSILE statement allows an easy way for a parent player to "shoot" a missile. The first aexp specifies the absolute vertical position of the beginning of the missile (Ø is the top of screen), and the second aexp

specifies the vertical height of the missile.

Example: MISSILE 4,64,3

Would place a missile 3 or 6 scan lines high (depends on PMG. mode) at pixel 64 from the top.

NOTE: MISSILE does NOT simply turn on the bits corresponding to the position specified. Instead, the bits specified are exclusive-or'ed with the current missile memory. This can allow the user to erase existing missiles while creating others.

Examples: MISSILE 5,4Ø,4
          MISSILE 5,4Ø,8

The first statement creates a 4 pixel missile at vertical position 2Ø. The second statement erases the first missile and creates a 4 pixel missile at vertical position 24.

8.11 MOVE with P/M's

MOVE is an efficient way to load a large player and/or move a player vertically by a large amount. This ability to MOVE data either upwards or downwards allows for interesting possibilities.

Also, it would be easy to have several player shapes contained in stripes and then MOVEd into place at will.

Examples: MOVE ADR(A$),PMADR(2),128

          could move an entire double line resolution
          player from A$ to player stripe number 2.

          POKE PMADR(1),255:MOVE PMADR(1),PMADR(1)+1,127

          would fill player 1's stripe with all "on"
          bits, creating a solid stripe on the screen.

8.12 USR with P/M's

Because, of USR's ability to pass parameters to an assembly language routine, PMG functions (written in assembly language) can be easily interfaced to BASIC XL.

Example: A=USR(PMBLINK,PMADR(2),128)

Might call an assembly language program (at address PMBLINK) to BLINK player 2, whose size is 128 bytes.

8.13 Example PMG Programs
----

1. A very simple program with one player and its missile.

```
100 SETCOLOR 2,0,0      : REM note we leave ourselves in GR.0
110 PMGRAPHICS 2        : REM double line resolution
120 LET width=1 : y=48  : REM just initializing
30  PMCLR 0 : PMCLR 4   : REM clear player 0 and missile 0
135 PMCOLOR 0,13,8      : REM a nice green player
140 p=PMADR(0)          : REM gets address of player
150   FOR i=p+y TO p+y+4 : REM a 5 element player to be defined
160   READ val          : REM see below for DATA scheme
170   POKE i,val        : REM actually setting up player shape
180   NEXT I
200   FOR x=1 TO 128    : REM player movement loop
210   PMMOVE 0,x        : REM moves player horizontally
220   SOUND 0,x+x,0,15  : REM just to make some noise
230   NEXT x
240 MISSILE 0,y,1       : REM a one-high missile at top of player
250 MISSILE 0,y+2,1     : REM another, in middle of player
260 MISSILE 0,y+4,1     : REM and again at top of player
300   FOR x=127 TO 255  : REM the missile movement loop
310   PMMOVE 4,x        : REM moves missile 0
320   SOUND 0,255-x,10,15
330     IF (x & 7) = 7  : REM every eighth horizontal position
340     MISSILE 0,y,5   : REM you have to see this to believe it
350     ENDIF           : REM could have had an ELSE, of course
360   NEXT x
370 PMMOVE 0,0          : REM so width doesn't change on screen
400 width=width*2       : REM we will make the player wider
410 IF width > 4 THEN width = 1 : REM until it gets too wide
420 PMWIDTH 0,width     : REM the new width
430 PMCLR 4             : REM no more missile
440 GOTO 200            : REM and do all this again
450 REM
500 REM ********* THE DATA FOR PLAYER SHAPE *********
510 REM
520 DATA 153            : REM $99   *  ** *
530 DATA 189            : REM $BD   * **** *
540 DATA 255            : REM $FF   ********
550 DATA 189            : REM $80   * **** *
560 DATA 153            : REM $99   *  ** *
```

CAUTION: Do NOT put the REMarks on lines 510 thru 550, since DATA must be the last statement on a line.

NOTE: The REM in line 330 is required. All other REMs are optional.

Notice how the data for the player shape is built up... draw a picture on an 8-wide by n-high piece of grid

paper, filling in whole cells. Call a filled in cell a
'1' bit, empty cells are 'Ø'. Convert the 1's and Ø's
to hex notation and thence to decimal.

This program will run noticeably faster if you use
multiple statements per line. It was written as above
for clarity, only.

2. A more complicated program, sparsely commented.

```
110 GRAPHICS 8              : REM not necessary, just prettier
120 PMGRAPHICS 2 : PMCLR Ø , PMCLR 1
130 SETCOLOR 2,Ø,Ø : PMCOLOR Ø,12,8 : PMCOLOR 1,12,8
140 pØ = PMADR(Ø) : p1 = PMADR(1) : REM addr's for 2 players
150 vØ = 6Ø : vold = vØ : REM starting vertical position
160 hØ = 11Ø : REM starting horizontal position
200   FOR loc =vØ-8 TO vØ+7 : REM a 16-high double player
210   READ X
220   POKE pØ+loc,INT(X/$1ØØ)
230   POKE p1+loc,X & $FF
240   NEXT loc
300 REM  ANIMATE IT
310 LET radius=4Ø : DEG : REM 'let' required, RAD is keyword
320   WHILE 1 : REM an infinite loop!!
330   c=int(16*rnd(Ø)) : pmcolor Ø,C,8 : pmcolor 1,C,8
340     FOR angle = Ø TO 355 STEP 5 : REM in degrees, remember
350     vnew = int( vØ + radius * SIN(angle))
360     vchange = vnew - vold : REM change in vertical position
370     hnew = hØ + radius * COS(angle)
380     PMMOVE Ø,hnew;vchange : PMMOVE 1,hnew+8;vchange
: REM move two players together
390     vold = vnew
400     SOUND Ø,hnew,1Ø,12 : SOUND 1,vnew,1Ø,12
410     NEXT angle
420   REM just did a full circle
430   ENDWHILE
440 REM we better NEVER get to here !
500 REM the fancy DATA!           8421842184218421
510 DATA $Ø3CØ                   |       ****      |
520 DATA $ØC3Ø                   |     **    **    |
530 DATA $1ØØ8                   |    *        *   |
540 DATA $2ØØ4                   |   *          *  |
550 DATA $4ØØ2                   |  *            * |
560 DATA $4E72                   |  *  *** ***  *  |
570 DATA $8A51                   | *   * * * *   * |
580 DATA $8E71                   | *   *** ***   * |
590 DATA $8ØØ1                   | *            * |
600 DATA $9ØØ9                   | *  *      *  * |
610 DATA $4812                   |  *  *    *  *  |
620 DATA $47E2                   |  *  ******   * |
630 DATA $2ØØ4                   |   *        *   |
640 DATA $1ØØ8                   |    *      *    |
650 DATA $ØC3Ø                   |     **    **    |
660 DATA $Ø3CØ                   |       ****      |
```

Notice how much easier it is to use the hex data.

The factor slowing this program the most is the SIN and COS being calculated in the movement loop. If these values were pre-calculated and placed in an array this program would move!

```
-------------------------------------------------------
Chapter 9:                        THE BASIC XL TOOLKIT
-------------------------------------------------------
```

IMPORTANT NOTES

BASIC XL Cartridge Versions

The extended BASIC XL statements described in section
9.3 of this manual and the program demonstrating the
use thereof described in section 9.4 will not work on
BASIC XL cartridges with version numbers other than
1.Ø2 or higher. We are sorry about this, but the
extensions "hook into" so many places within the
cartridge that it is simply not practical to provide
multiple versions of the code.

When you turn on your computer and enter the BASIC XL
cartridge, there is a copyright notice which also
specifies the version number of your cartridge. Check
that version number. If it is not version 1.Ø2 or
later, you have two options:

   (1) Try to purchase a version 1.Ø2 or 1.Ø3
       cartridge.

   (2) Update the ROM in your cartridge to the latest
       version 1.Ø3.

Please note that current BASIC XL cartridges with
version numbers 1.Ø2 or later are gold-plated (for
longer and healthier life) and are beveled (for a
better fit).

START PROGRAMMING!

The BASIC XL Programming Environment

9.1 THE BASIC XL RUNTIME PACKAGE

On the labeled side of your BASIC XL ToolKit diskette
is a file called 'BASICXL.COM'. This file contains the
BASIC XL RunTime Program. That program allows you to
run BASIC XL programs without the BASIC XL cartridge.

9.1.1 How Does the RUNTIME Package Work?

The BASIC XL RunTime Program contains those portions of
the BASIC XL cartridge which are used when programs are
running. The program does not, however, contain any
portions of the cartridge which are used to write new
programs or edit existing programs. Thus, a program
running under the BASIC XL RunTime Package can't
perform such statements as LIST, ENTER, DEL, etc.
Obviously, then, the BASIC XL cartridge is still
required to develop programs.

The RunTime Program itself is just an Atari standard
binary file which may be run under any Atari-compatible
DOS, such as DOS XL or Atari DOS. The program may be
run in any of three ways -- as an AUTORUN.SYS file, as
a .COM file under DOS XL, or as an ordinary binary file
using the 'L' option of Atari DOS. When the RunTime
Program begins, it searches the disk in drive 1 (D1:)
for the file AUTORUN.BXL. If that file is found, it is
loaded into memory and run as if the command RUN
'D:AUTORUN.BXL' had been issued in response to the
READY prompt. If the file AUTORUN.BXL is not present on
the disk, RunTime will continually try to find it. You
should eject your diskette, shut off power, and try
again.

9.1.2 How Do You Use the RUNTIME Package?

The easiest way to use the BASIC XL RunTime Package is
to perform the following steps:

1. Initialize a new disk and write DOS.SYS to it. You
   may use virtually any Atari-compatible DOS for this
   purpose. Note that DOSXL.XL (after being renamed to
   DOSXL.SYS) is compatible with RunTime.

2. Copy the file BASICXL.COM from the BASIC XL Toolkit
   disk to a file called AUTORUN.SYS on the newly
   initialized disk.

3. Copy the BASIC XL program you want to run to the new
   disk and name it AUTORUN.BXL.

4. Boot the disk thus created. If you have performed the previous steps correctly, your BASIC XL program will run automatically.

Whenever the disk you created above is booted, your program will run. If you have several programs you want to run with the RunTime Package and you don't want to dedicate several disks just to that purpose, you can simply put (or SAVE) some type of menu program onto the disk as AUTORUN.BXL and use it to select from other programs when the disk is booted. You are welcome to use the program MENU.BXL, described in section 9.2.1, for this purpose.

9.1.3 Statements that can NOT be used with RUNTIME

As we noted above, the BASIC XL RunTime Program does not contain those portions of the code from the BASIC XL cartridge which relate to program development. Any BASIC XL program which you want to use with the RunTime Package cannot use program development statements. If the BASIC XL RunTime Program encounters such a statement in your program, execution will stop with the message "Unimplemented statement in line XX", and you will be asked to hit the START key for a RunTime Restart (see below). The following is a list all BASIC XL statements illegal when using RunTime BASIC XL:

```
        LIST            ENTER
        NEW             DEL
        RENUM           TRACE
        TRACEOFF        LVAR
```

In addition, the following BASIC XL statements have slightly different meanings when using the RunTime Package:

DOS -- After this statement returns control to whatever DOS was booted, you can not return to BASIC XL or your BASIC program.

END -- This statement stops the running program and prompts the user to hit the START Key to do a RunTime Restart.

STOP -- This statement works exactly like END, but also prints the line number at which execution was ended.

9.1.4 Error Handling In RUNTIME BASIC XL

Errors which are TRAPped by the running program are
treated exactly the same way as when using the BASIC XL
cartridge. Errors which are not TRAPped are treated
slightly differently, however. If an error is allowed
to happen when no TRAP is active, an error message is
displayed showing the line number where the error
occurred, and the user is prompted to hit the START Key
to do a RunTime Restart. The user is not allowed to
view or change the program after an error as he could
with the BASIC XL cartridge.

9.1.5 RunTime Restart

At various points above, we noted that under certain
circumstances you may receive a message telling you to
hit START to do a "RunTime Restart" (the message may
indicate that RunTime will "Re-Run" a program). When
this occurs, hitting START will cause RunTime to once
again RUN the program file, AUTORUN.BXL. If your
particular AUTORUN.BXL has chained to another program,
the subsequent program is erased and all work not
already written to file(s) is lost. (Note that RUN
always closes all files, so at least no files are left
dangling open.)

9.1.6 Incompatibilities

The only difference between RunTime BASIC XL and the
BASIC XL cartridge which affects program execution is
memory usage. Since RunTime BASIC XL is not in a
SuperCartridge, it can't "save" memory like cartridge
BASIC XL. For this reason, the BASIC XL RunTime Program
takes up about 11 thousand bytes of code rather than 8
thousand bytes. If your BASIC XL program is extremely
large, it may not run under RunTime BASIC XL.

9.2 BASIC XL Example Programs

Side one of your ToolKit disk contains ten programs
written in standard BASIC XL which will, we hope, give
you a feeling for the capabilities (and limitations) of
the language.

Although the selection of programs is very broad, we
certainly can not guarantee that you will find a
program which answers all your questions about BASIC
XL. In fact, perhaps we should begin by discussing some
of the things which the example programs do not delve
into.

First, we do not worry about the BREAK and RESET Keys. These programs are meant as examples for you, as a programmer or future programmer, to RUN and try. As such, we think YOU should be allowed and encouraged to stop a program at any time, see where it is at and what it is doing, and (our fervent hope) change it so it works better!

Second, we don't try to TRAP all disk errors, etc. The programs here all work properly if given properly formatted disks with the right data/programs (if called for). Again, our philosophy was to allowed you to explore the consequences of disk errors and guard against them in your own way. (And, truthfully, extensive I/O trapping in some of these programs is simply not necessary.)

Third, we do not get into any heavy math. For those of you who are into analytical geometry and its ilk, we apologize. Unfortunately, you are in a distinct minority when compared to those who want to use their machine for simple graphics and/or business applications.

Fourth, the descriptions of the programs (which follow immediately after this introduction) vary considerably in the depth with which they explore the workings of the code. Again, this is on purpose.

The most complicated of the programs (e.g., PICOADVEN-TURE and BLACK BOOK) are so large that even documenting each group of ten lines thoroughly would require a book several times the size of this manual. In these cases, we have tried to explain the principles behind blocks of code. You are encouraged (there's that word again,) to explore each and every line for its implications.

On the other hand, some of the programs are dissected in painstaking detail (e.g., MENU and GTIATEST). In some cases, we have chosen to be thoroughly simple to give beginners a chance to see the full workings of a program. In other cases, the thoroughness is dictated by the complexity of the subject. (Perhaps we are using a poorly documented feature of either BASIC XL or Atari's OS or hardware.) Mainly, though, we describe a program intimately because we want to get YOU in the right "track", thinking of properly structured programs, good error trapping, etc.

So much for the things we do not do in this ToolKit. What do we do? (We thought you'd never ask.)

If you are interested in graphics in general and games in particular, we turn your attention to SNAILS TRAILS, GTIATEST, CIRCLES, and (especially) LEM.

The BASIC XL Programming Environment

Into adventure games? Try PICOADVENTURE as a start on writing your own! (You might want to try playing and solving the game before reading the description.)

Want to learn more about how to talk to your disk drive? Look at CONFIG and DISKIO.

Interested in application programs? Want to learn how to construct random-access and/or keyed-access files? Look at BLACK BOOK.

Finally, MENU and MAKEAUTO are general utility programs. You will undoubtedly use them, but you may not need to understand them. But read about them anyway. The description of MENU, especially, is very detailed and gives some good hints on programming style.

A Commentary on Case -- In the descriptions which follow, we sometimes change a keyword or variable name to all upper case letters, despite the fact that the program listings will (as is usual in BASIC XL) show such names in mixed upper/lower case. This is done on purpose for emphasis only. You need not use upper case unless you have chosen Atari BASIC compatibility (via SET 5,∅).

9.2.1 MENU.BXL

In most ways, this is the simplest program we will present in this section. MENU.BXL is simply a program which presents a menu of available BASIC XL programs and allows you to choose one of them to RUN. If you are an experienced Atari BASIC user, you have probably seen versions of this program floating around in magazines, user-groups, etc., for years. We think, though, that our version has some advantages which are worth discussing.

1Ø7Ø-1Ø8Ø These lines set the tone for not only this program but, where possible, for all programs in this ToolKit. We really didn't need to initialize COUNT to zero, since BASIC XL guarantees that all variables start at Ø.Ø when a program is first RUN. But isn't this better? We both point out that we are using a variable named COUNT and that we know what its starting value should be.

  Further, we could have coded line 1ØØØ as

        1ØØØ Alpha = 64

  but would that have any meaning to you? As clearly shows that ALPHA has a numeric value ATASCII value of the letter A.

11ØØ We chose the dimensions of FILES very carefully. There are 26 elements in the array because we won't allow more than 26 filenames in our menu. (That way we can select any program with a single letter, A to Z.) And each element has 14 characters because that is the maximum possible for a filename of the form "D:filename.ext". If you wish to allow disk drive numbers in your version of this menu, you will need to increase the second dimension here to 15.

113Ø This POKE is documented in many books, including Mapping the Atari, from COMPUTE! books. A non-zero value turns off the cursor. A zero value turns it back on.

124Ø Did you remember that an OPEN in mode 6 is actually an OPEN of the directory? Good. For all intents and purposes, this OPEN will cause subsequent INPUTs to read the same data you see when you give a DIR command. Try it. Type in

        DIR "D:*.BXL"

and see what is displayed. (Yes, yes, the quotes aren't really needed. We Know, thanks.)

125Ø Sometimes, in our zeal to avoid GOTO statements, we have gone to great lengths in these example programs. This is a good instance of such a great length. We read the first file name from the directory here solely because we want the WHILE loop that follows to look neat. Ah, don't knock it. It works.

126Ø We begin the promised WHILE loop. Note how we ensure that we won't get more than 26 names. We check the second character for a space because the only line of the directory where it is not a space is the line noting the number of free sectors (which is not coincidentally, the last line of the directory).

127Ø-131Ø We develop the name which will be held in the string array, File$. First, we count this as a valid name. Then we find out where the first blank is after the first letter of the filename is.

Example: for the file "MENU.BXL", the directory listing is

            * MENU   BXL ØØ8

or similar, where the '*' means, the file is PROTECTed and the 'ØØ8' is arbitrary. Here the FIND function would tell us that the value of BLANK will become 7, the blank after the 'U' of 'MENU'. Line 129Ø is necessary in case the file has 8 letters in its name (the blank found will then be the one between the extension and the number of sectors).

In line 13ØØ, we play a trick that works neat and sweet in BASIC XL (and also in Atari BASIC, but we had to brag a little): As long as you are moving characters "down" in memory (think of that as moving them left in a printed string), you may overlap your string assignment without error! This line, then, strips off the first two characters and all characters from the blank on. Bingo.

Finally, in line 131Ø, we actually put the name into the array. Note the form it takes:
"D:filename.BXL",
"filename" may have from 1 to 8 characters.

1328-1348 This is Just a bit tricky. Since we want our menu to be able to hold 26 names, we can't simply list them straight down our 24 line screen. We must put them two to a line. The expression COUNT&1 (where '&' is BASIC XL's 'bitwise and' operator)

effectively checks whether COUNT is even or odd. If the COUNT is odd, we will put the name at horizontal (X) position 7. If it is even, we will put it at X-position 22.

The vertical position is also obtained through a little magic. To see why it works, try various values for COUNT and observe what Y value results. We will start you off:

```
If COUNT is ... Y will be
        1 ... 3
        2 ... 3
        3 ... 4
       26 ... 15
```

Okay? Then line 1340 is easy. We simply POSITION ourselves at the place we have calculated and print an indicator and the name. But just what is that indicator? Remember, ALPHA is one less than the ATASCII value of the letter 'A'. So if COUNT is 1, PRINTing CHR$(Alpha+Count) will produce the letter 'A' on the screen. Similarly, a COUNT of 2 will produce a 'B', etc. Now you know why we chose the value for ALPHA which we did.

1350-1370 Here we simply get the next line from the directory and go back to the top of the WHILE loop. If it isn't a name (i.e., if it is the free sectors line) or if we already have 26 names, the loop will halt and fall through to the CLOSE of line 1370. We are then done with the directory.

1410 This is the best way to get a single keystroke on an Atari computer. OPEN up the keyboard ("K:") and GET a Key (as in line 1440). Sure, you can do it with PEEKs and POKEs and whatever, but why bother? (Exception: if you don't want to wait for the key, you will have to use at least one PEEK.)

1420 and 1510 This is an "endless" WHILE loop. We could have achieved the same thing by eliminating line 1420 and changing 1510 to read GOTO 1430. But that's terribly ugly! As well as being poor structured programming style.

1430-1470 We ask the user to press a key, get the key from the keyboard, and strip it of extraneous bits. Ummmm..." extraneous bits"?

By doing a bitwise and (&) of KEYPRESSED with $5F (that's 95 decimal or 01011111 binary), we have removed the uppermost bit (bit 7 -- which would indicate inverse video) and also bit 5 (which

distinguishes upper case letters from lower case). So no matter what kind of letter the user pushes, we see an upper case, non-inverse video character.

Now, if it truly was a letter, subtracting ALPHA from it will convert it into the range of 1 to 26. Funny thing how the elements of our string array are numbered from 1 to 26. Do you think that's a coincidence? (If so, we've got some beachfront property in Nevada we'd like you to invest in.)

So, in line 146Ø, we validate that the letter chosen is in the range we have filenames for. (If it isn't, we skip to line 15ØØ, the ENDIF, and go through the WHILE loop again.) Then we show the user what filename he/she chose. Just to keep them happy while...

148Ø-149Ø Line 148Ø illustrates the proper use of a TRAP in a well structured BASIC XL program. You should always TRAP to the last line of a loop or condition. Here, if we get an error in line 149Ø, we want to go back and ask for another menu selection. Voila.(Exception: Sometimes you will want to have a central routine for handling TRAPped errors. That's a good idea, but beware of leaving WHILEs, GOSUBs, etc., sitting on the RunTime stack.)

And, at last, we get to use this program as it was intended. We actually RUN the program requested by the user. Note that since we PRINTed the name in line 147Ø it's hard to make a mistake here. But a diskette failure (bad sector, etc.) could trigger the TRAP when the file doesn't load properly. We emulate the Boy Scouts: Be Prepared.

9.2.2 SNAILS

If you read '3Ø Days to Understanding BASIC XL' (or,
better yet, work your way through it), you will
probably remember Chapter XXIX and a arcade game
program called SNAILS' TRAILS. This game can give you a
real feeling of historical perspective!

By today's standards, SNAILS' TRAILS is a simplistic
game with marginal video appeal. A short five or six
years ago, though, a very similar game called SURROUND
was one of the hot sellers in the Atari 26ØØ VCS
market. And, as recently as the time of the Disney
movie "Tron", the "light cycles" played a variation on
the same game.

Anyway, since this game has been overdone already, why
are we rehashing it on this disk? Truthfully, because
the version in our tutorial was written using only the
statements presented in that book, and we wanted to
show you what just a few added statements could do to a
BASIC XL program. The result is a well structured and
even readable program.

In the description which follows, we will not explore
those parts of the program which are the same as the
version shown in the book. (Note that the line numbers
do not match those in the book. Sorry about that, but
there are enough differences that they couldn't have
been identical, anyway.)

18Ø In the book, we had two variables (SCOREØ and
    SCORE1) to keep track of the players' points. Here,
    we use a two element array. We'll show why below.

26Ø Isn't this easy to understand? You can translate
    this into English as follows: "As long as neither
    player has scored 1Ø points, keep playing!"

29Ø and 34Ø In the original, the COLORs are different.
    We changed them because it makes it easier to flash
    one of the slime trails (line 8ØØ).

49Ø-5ØØ The main movement loop translates to English
    pretty well, also: "While neither player has hit
    anything." Then, since we aren't driving this loop
    with FOR MOVE... anymore, we have to bump the MOVE
    number. The only place MOVE is used, though, is in
    line 69Ø, as the frequency value in a SOUND
    statement. But SOUND won't let us use a value
    greater than 255 for frequency, so after bumping
    MOVE we limit it to an 8-bit value.

    You say you don't understand how bitwise-and (&)
    works after reading the brief description in the

reference manual (section 2.2.1)? We won't go into
a lot of detail here, but let's show what happens
in line 5ØØ as the value of MOVE increases. (In the
binary notations below, we show only 12 bits
instead of the 16 bits which BASIC XL always works
with. The upper four bits are always zero in this
example, though, so they can be ignored.)

```
        MOVE = 3 decimal, binary ØØØØ ØØØØ ØØ11
              bitwise and with ØØØØ 1111 1111
                               --------------
                 binary result ØØØØ ØØØØ ØØ11
                  (decimal value of 3)


      MOVE = 243 decimal, binary ØØØØ ØØØØ ØØ11
              bitwise and with ØØØØ 1111 1111
                               --------------
                 binary result ØØØØ 1111 ØØ11
                  (decimal value of 243)


        MOVE = 2 decimal, binary ØØØØ ØØØØ ØØ1Ø
              bitwise and with ØØØØ 1111 1111
                               --------------
                 binary result ØØØØ ØØØØ ØØ1Ø
                  (decimal value of 2)
```

Do you see what happens? When the value of MOVE
becomes greater than 255, the bitwise-and
effectively subtracts 256 from it. In fact, we
could have coded line 5ØØ thus:

5ØØ Let Move=Move+3:If Move>255 Then Let Move=Move-256

But using the bitwise-and is faster yet, once you
understand bitwise operators, just as easy to
understand.

And, as long as this explanation is too long
already, let us note that we could have achieved
the same effect by using these two lines instead:

```
    5ØØ Let Move=Move+3
    69Ø Sound Ø,Move&255,1Ø,Volume
```

However, the SOUND statement is inside a tight
loop, and placing the bitwise-and in the loop would
slow it down a bit.

6ØØ-65Ø There's nothing really very different from the
book version here except the order of the
statements. We thought this scheme is more
readable. We hope you agree.

124

76Ø Why didn't we just code this line as follows?

```
76Ø If BangØ <> Bang1
```

Because the values of BANGØ and BANG1 could be 1,
2, or 3, depending on who hit what. Using NOT BANGØ
and NOT BANG1 converts all values to a boolean
(zero or one) condition, which is more easily
testable.

If you prefer positive logic, you could change 76Ø
and all following references to BANGØ and BANG1 to
this:

```
76Ø BangØ=Sgn(BangØ) : Bang1=Sgn(Bang1)
761 If BangØ<>Bang1
```

(Recall that SGN() of any positive number is one,
as we want here.)

77Ø See line 76Ø, above. This line looks strange, so
let's translate it into English: "Bump the score of
the player who did not get banged by one." Still
confused? Then substitute the following for line
77Ø:

```
77Ø If Bang1=Ø : Bang(1)=Bang(1)+1
771 Else : Bang(Ø)=Bang(Ø)+1 : Endif
```

But, if you're willing to struggle with the logic a
bit, you will conclude that our original line 77Ø
achieves exactly the same result with less code.

8ØØ Same thing again. Remember, NOT BANGØ is a logical
expression, so it can only take on numeric values
of zero and one. Cute?

89Ø Another case of a logical expression being used to
derive a numeric value. If SCORE(Ø) really is less
than SCORE(1), then WINNER will receive a value of
one. Otherwise, WINNER will be set to zero.

Technical note: Most languages support the notion
of TRUE and FALSE logical expressions.
Unfortunately (?), many restrict their use to
places where a conditional test is being made.
However, BASIC XL, in common with many, many other
(but not all!) dialects of BASIC, allow you to
treat TRUE and FALSE as numeric values. Be careful,
though, in some Microsoft (and other?) BASICs TRUE
is given a value of minus one (-1) for reasons
which are mired in history. (n.b.: BASIC is not the
only language, which allows logical expressions to
produce numeric values. C and some versions of
Fortran allow similar usages.)

91Ø and 93Ø See how neatly we Can use WINNER now that
we know it has a value of either zero or one?

98Ø In English you read this line to say: "As long as
neither joystick trigger is pushed, keep looping."

9.2.3 PICOADV

In addition to being the longest program on the ToolKit disk, PICO-AOVENTURE is also the oldest. It was one of the first major programs we wrote for BASIC A+ (back in 1981-82) and is given here with only minimal modifications, even though it could probably use many of BASIC XL's new statements to advantage. Nevertheless, PICO-ADVENTURE (which name was intended to imply that it is smaller than a Micro-Adventure) is still a reasonably well-written, well-structured program which deserves more than a cursory glance.

For all of its size , PICO (as we shall call it from now on) only uses about half of the memory available when you use BASIC XL with DOS XL. If you feel so inclined, you may retain the structure of the program, replace room descriptions and object actions, and thus produce your own adventure. Nothing could please us more. In fact, we would love to see your results.

One last warning before we start looking at PICO a block at a time: Why don't you RUN and play it before reading this section. In studying the program, you will of necessity see the secrets of the game, which will destroy the pleasure you will get from winning (or losing) gracefully.

Because this program is so large, the best we can do is describe blocks of lines. We will delve into detail only when we feel that reading the program lines within the block won't give you enough understanding of their actions.

Finally, we present this program in execution order (not line number order), because you need an understanding of some of the subroutines before the main line code makes a lot of sense.

1ØØ-119 We use the question mark (?) abbreviation for PRINT a lot in this program. It makes the listing smaller and allows all lines to fit in the bounds of a 12Ø column printer. If you are going to list this program to an 8 inch (nominal 8Ø column printer, the ends of some lines will either wrap or get cut off (depending on how your printer works). If your printer has elite (12 characters per inch) or condensed (usually about 16 characters per inch) print available, we recommend that you set it in one of those modes before listing the program. All program lines will list on one printer line in condensed mode. Almost all will list properly in elite mode. (Note: an easy way to put your printer in one of these modes which works with most printers is to put its control or escape code

sequence right into a REMark line at the beginning of the program.)

We also use some imbedded screen control characters in our quoted strings, something we do not normally do with programs intended to be listed by YOU, our customer and reader. Again, we felt justified using them here (instead of using a CHR$() sequence), because they save so much room. We apologize in advance if they do funny things to your printed listing.

15Ø We put the initialization code up out of the wax as a subroutine so that the program looks better.

8ØØØ-81ØØ Primary initialization. Some variables used as constants, subroutine addresses, or counters are assigned here. Various strings and arrays are dimensioned. Some sizes are arbitrary and/or could be made bigger for a more complex adventure (one that understands more nouns or verbs). Ones that are carefully selected include VS$ and NS$, which are just long enough to hold a prefix character and a three-letter verb or noun. (See lines 12ØØ to 13ØØ and next paragraph.)

811Ø-819Ø We build up the vocabulary lists for the verbs and nouns. Each entry in a list consists of a prefix character (CHR$(155), but any value from 128 to 255 would have worked), a three letter name, and a single byte which holds the verb or noun number associated with this name. Note that the name's number corresponds to the last two digits of the DATA statement from which the name was READ. For example, the first two entries in NOUNS$, the noun vocabulary list, would look like this (where a number in brackets indicates a byte with that value):

```
[155] L I C [1]
[155] M O S [1]
```

Also, as we build the noun vocabulary, we are setting up the WHERE() and SHOW arrays. A noun's entry in SHOW() tells the "visible items" routine whether to show it or not. The entry in WHERE() tells where the item (noun) is located, according to the following table:

If WHERE(noun-number) is ... noun is located
            less than Ø ... gone forever
                      Ø ... with adventurer
                   1-99 ... in that room number
         greater than 99 ... still hidden

8800-8999 The DATA statements which define the verbs (88xx) and nouns (89xx). In theory, then, you could have up to 99 verbs and 99 nouns, each with one or more synonyms. Synonyms are simply listed one after the other on the same DATA line, the last one terminated by an asterisk. Tho first synonym is the one shown by the command line echo, inventory list, and visible items list, so it is spelled out completely. As noted above, nouns also have their initial WHERE and SHOW values listed here. The last entry in each table is terminated by a pound sign (#).

160 Getting a key one at a time from the "K:" device is still the best way. Much easier and more readable than PEEKs and POKEs.

920 This is kind of a cute trick. Rather than print out a special starting location message, etc., we simply tell our movement subroutine (starts at line 7000) that we are in room number 7 and that the user just asked us to go west. We also note that room number 3 is West of the current room. Then we GOSUB to do the movement and (PRESTO!) everything comes up right for somebody who just walked into Room 3! (Much of this will become clearer later...Keep reading.)

1050 Again, we could have coded the subroutine at line 6000 right in-line here (since it is called only once), but this makes the program so much more readable. Besides, wait until you see what that subroutine does.

6000-6199 Special actions processing. In many adventure games, including this one, certain actions must take place at certain times and/or after a particular number of turns have passed since some other event. For example, in PICO, the effect of eating the mushroom wears off after 4 turns. This time period is counted down in the variable CRAZY, and lines 6010 and 6030 reflect this. Three other such variables, CHARM, TORCHFIRE, and HUNGRY are similarly accounted for here. Note that, in lines 6100 to 6103, those counters are never allowed to become less than zero. One of them, HUNGRY, cycles from 29 down to zero, over and over.

1110-1190 This is our get-a-command routine. We only allow a few characters to get through. All others are ignored. Note that the variable OK is used both as a flag and as a counter to the current character within RESPONSE$. If the user hits RETURN (line 1130) we get out of the WHILE loop by simply setting the OK flag to zero. Cute.

In line 114Ø, we only allow back spacing to the
beginning of the command typed in so far. And we
special case inverse video space (KEY=16Ø) for
safety's sake. Finally, when we have masked all
characters to be upper case and non-inverse video,
we make sure that the user typed an alphabetic
character. And, last but not least, we limit the
user's response to 15 letters. That's more than
enough (as we will see).

12ØØ-129Ø We parse the user's response into verb and
noun parts. Or at least we try to. Lines 1215 and
125Ø strip off leading spaces (line 121Ø guaranteed
that RESPONSE$ would contain at least something or
these lines might generate errors). The verb is
presumed to start at the first non-blank character
and continue to the next following blank. (If there
isn't a verb, we go back to line 1ØØØ and get
another response.) The noun is assumed to be
everything after the blank(s) which follow the
verb.

Again, note how the search variables, VS$ and NS$,
were carefully dimensioned to 4 so that they could
hold our separator character and the three
significant letters of a verb or noun. (Do you see
how you could easily increase the number of
significant letters in a PICO vocabulary word?)

Lines 128Ø through 129Ø allow for the special case
of a single letter response indicating a direction
to take. Can you see how easy it would be to add Up
and Down to our list of valid directions?

In any case, we come out of this block with the
variables NOUN and VERB holding numeric values
which represent the action requested by the user.
(See the explanation of lines 8ØØØ-9ØØØ for details
on what the numbers mean.)

13ØØ-133Ø Pretty simple. If we didn't find a valid
verb, say so. Ditto for a noun. Do you see why we
tacked "   is." onto RESPONSE$ in line 121Ø? If
the user tells us to EAT GORP, the variable NOUN$
will be set to "GORP is." Maybe a little too
tricky?

14ØØ-1514 One of the neatest things about PICO is that
it tells you what It thinks you said. We've played
adventures where we typed in "GET SNARE" only to
have it tell you "You got it, but it bit you.
You're dead." How were we supposed to know that SNA
meant "snake" to that game? In PICO, if you type in
"NIB MOS", the game will tell you that it is trying
to "EAT LICHEN". A nice touch, we think.

1520 and 2000-2120 There is a bug in BASIC XL which has
    existed since the earliest versions of Atari BASIC.
    We're afraid to fix it, because there may be
    programs which depend on its action! Anyway, the
    bug is simple: if you GOSUB to a non-existent line,
    the GOSUB is pushed onto the run-time stack before
    the error is discovered. Subsequent RETURNs can
    then end up going back to the wrong place(s). We
    avoid the problem here by GOSUBbing to a known good
    line (2000).

    Then, at line 2100, we play a little bit of magic.
    Do you see what line number we try to go to? If the
    user requested verb number 7 and noun number 2, we
    will try to GOTO·line 17020. Suppose, though, that
    line 17020 doesn't exist (as it doesn't in PICO).
    Then the TRAP 2110 is activated and we GOTO line
    17000 instead.

    Why? Well, as PICO is written, trying to BURN
    MUSHROOM will give us verb 7 and noun 2. Since line
    17020 doesn't exist, we end up at line 17000, where
    OK is set to NO so that the message, "That didn't
    make sense!" will be displayed. Since most items
    won't BURN, this provides a convenient method of
    processing all such non-productive requests the
    same way.

1600-1610 This ELSE clause was started by the IF of
    line 1510. The direction abbreviations (N,E,S,W)
    produce verb numbers of less than zero (-1 through
    -4). Once you understand the routine at line 7000,
    this part becomes easy.

7000-7050 The variables NORTH, EAST, SOUTH, and WEST
    are already set up by the time we get here (we'll
    see how in a moment), so all these lines do is put
    the proper value into GO. And what's a "proper"
    value? Keep reading...

7100-7190 When we get here, GO can have one of four
    meanings:

        If GO is ... we will
        negative ... drown
            zero ... do nothing (direction unavailable)
            1-99 ... go to that room number
            100+ ... do a special action

    The "special action" trick is a neat one, uniquely
    available in BASIC XL and its brethren, because GO
    actually designates the line number of the
    subroutine to GOSUB to perform the action!

7200-7390 And here is where we get the values that end up in GO! After we have moved to another room (HERE=GO in line 7160), or even if we haven't, we RESTORE to the proper room description (line 7200, also uniquely BASIC XL, etc.). We READ in the lines of description (an equal sign on the end of a line indicates more to follow) and then, in line 7300, READ the four directions, NORTH, EAST, SOUTH, and WEST.

Isn't this neat? Look at lines 30160 to 30165. Just by the line numbers, we know that this is the DATA for room number 16 (30000+16*10). The description is 3 lines (each in quotes) long. And the connecting rooms are 15 to the NORTH, 12 to the WEST. But look at the "connections" for SOUTH and EAST, both get a value of 30164. That means that, if the user asks to go SOUTH or EAST from this location, line 7130 will end up doing a GOSUB 30164. So line 30164 is actual executable code (not more DATA) and the poor guy gets zapped by a truck.

Examine some of the other DATA statements in this range. Note how easily we drown adventurers (connecting "room number" of -1) or bar them from proceeding (connection values of zero). It's downright easy to add rooms and conditions to this game!

1800 Believe it or not, this is the "end" of the program. Everything after here is a subroutine. Ain't structured programming neat? Yeah? Then why didn't we use an endless WHILE loop instead of this old-fashioned GOTO? Sigh.

With all the main-line code described, we proceed to some of the subroutines not yet discussed.

7500, 7600, 7700 Three useful little routines, for when the user asks for something not available (7500), uses something he doesn't have (7600), or dies gracefully (7700).

7800 Four entry points provide delays of 1, 2, 3, or 4 seconds, thanks to the clock ticker in location 26.

7900 We display the stuff lying around on the ground. Remember, even if something is located in this room, we don't tell the user unless its SHOW() flag is true. This little nastiness makes PICO harder than it would otherwise would be. You could expand this in your own game(s) as you wished.

Finally, we get to the VERB and VERB/NOUN action routines. Remember, a VERB/NOUN action starts a line 10000+1000*VERB+10*NOUN. With this formula (and with

line numbers 1ØØØØ to 29999 available) you can have 2Ø
different verbs (if they are numbered starting at zero)
and 99 nouns. Changing the multipliers (e.g., make-it
5ØØ*VERB+2Ø*NOUN) could change those ratios and/or make
more lines available for particular actions.

Also recall that a VERB (alone) action starts at
1ØØØØ+1ØØØ*VERB, and VERB/NOUN actions specified end up
at those VERB alone lines.

We do not want to (nor do we feel we need to) devote
the space to a complete description of all the possible
actions. Instead, we will single a few out and leave
the rest to you as an exercise.

13ØØØ-13173 These are the actions taken when the user
asks to LOOK at something. Let's see what happens
when he/she asks to LOOK JUNKPILE.

First of all, if Golem isn't in the right room
(line 1317Ø), how can we look at it? The rest of
the responses depend on the value of JUNKCNT, which
was initialized to 3.

If JUNKCNT is not zero, then we let the user find
something in the pile. What he/she finds depends on
the value of JUNKCNT (line 13172). The item(s) thus
found (item numbers 9, 3, or 8, in that order) are
made visible by giving them a location in the
WHERE() array (line 13173). Recall that all three
of these items received an initial location of 1ØØ
(hidden) in the DATA statements of lines 89ØØ to
8999. Note that changing WHERE() is all that is
needed to cause the visible items print routine
(lines 79ØØ-797Ø) to make it show up.

If JUNKCNT is zero (all three items have been
found), then we are sent off to line 13ØØØ, just as
if we had typed LOOK BOAT (which would cause the
routine at line 1315Ø to be executed, if it
existed).

Line 13ØØØ starts with a cute trick: If the user
typed in just LOOK, the program pretends he/she
really wanted LOOK PLACE. 13ØØ1 is pretty
straightforward if you know how to read it: "If the
Golem isn't carrying the requested object
WHERE(NOUN) isn't zero) and if the object is not in
this room (WHERE(NOUN) is not the same as HERE),
then we can look at it, so ask the dummy HOW we can
do it."

Finally, line 13ØØ2 simply gives a nice bland
message about the object. If the user typed just
LOOK (with no noun), then the message refers to
"this place." Not exciting, but it works.

16000-16169 Almost every adventure you try will have
some sort of secret word or phrase which you must
SAY to unlock the mysteries. In PICO, we hint at
that ability by providing you with a MAGIC LAMP (in
the Junkpile) and putting a message on the
billboard which has a message in quotes, usually a
dead giveaway that the phrase ("A LAD IN BAGHDAD"
in this case) is the sought after magic word(s).

In fact, if you use the command SAY A LAD IN...
before you get the lamp, we even give you a clue
(line 16160) that you need something else before
the magic works.

But all of this is in vain. We borrowed a page from
Sesame street and put the "fix" in: all you get for
all your trouble in this game is a peanut butter
sandwich. (To add insult to injury, it doesn't even
fill you up! Of course , that's because the "I'm
hungry" message is trying to make you eat the
mushroom, another trick cadged from a children's
story.)

That's about it for PICO. (Isn't it enough?) We hope
you will turn it into your game and share it with us
all.

9.2.4 LEM

This program is yet another incarnation of the classic
lunar lander game. The principles of this game haven't
changed, since people first started using computers to
have fun, even if they were using time-sharing on
mainframes and mini-computers back in those prehistoric
days. For example, we have a book (fashioned from clay
tablets, we think) dated 1975 (A.D.!!!) and called
'What to Do After You Hit RETURN or P.C.C.'s First Book
of Computer Games' which includes no less than two
different lunar lander programs. They were played on
H.P. minicomputers with teletypes (you know...at a
maximum of 1Ø characters per second, and no graphics).

So what's different about this program, and why should
we discuss it? Well, it's written entirely in BASIC
(big deal, so were those 1975 gems). And it uses pretty
graphics (that's a little better). And it runs in real
time (whazzat? Impossible!).

To play this game, plug a joystick into socket number 1
(STICK(Ø) in BASIC) and RUN the program from disk. You
can play on two levels, beginner or advanced, but we
recommend you to try it first as beginner, so simply
push the joystick button. You will be presented with a
moonscape, a bar at the left showing your remaining
fuel, a landing pad (which will blink), and an odd-
shaped ship (complete with antennae, legs, etc.) which
you will (try to) control.

To move the ship left or right, simply push the
joystick left or right. Be careful! The effects of such
pushes are cumulative with time. Gentle taps in the
appropriate direction work best.

To fire your retro-rockets, push the joystick button.
If you do nothing further, you will probably crash
(albeit perhaps slowly). That's because there are six
possible settings on the LEM. You increase thrust by
pushing forward on the joystick, decrease by pulling
back. Need we tell you that greater thrust eats fuel
faster? (If you run out of fuel, you run out of thrust.
Need we tell you the results?)

If you manage to land (or- even crash) on the landing
pad, you get points. Too fast a landing results in a
crash. A landing of moderate speed gives you a bouncing
good time. And a near perfect gets you applause and
cheers from the crowd. (Which ignores the fact that
sound doesn't carry in the vacuum on the Moon. Oh,
well, maybe they're back on Earth?) You get 25Ø points
for a great landing, 1ØØ points for a bounce, and
credit for remaining fuel. You also get bonus points
for the actual speed of your landing and the narrowness
of the pad you landed on.

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It's a good game. We've played it many, many times, and
it's still a real challenge to score over 2500 points
in five landings (a standard game) on the Advanced
level. Before perusing the explanation of the workings
which follows, why not try it yourself a few times.

This is a big program, but it is very well self-
documented (with both REMarks and self-explanatory
variable names). As with PICOADV (section 9.2.3) we
will discuss this game in blocks, concentrating on the
non-obvious features.

1000-1290 After waiting for the player to let up on the
          joystick button, we present him/her with a menu and
          some brief instructions. LEVEL is set to zero for a
          beginner and one for an advanced player. Notice how
          we position the arrow, basing it or, the value of
          LEVEL. Also note how, after detecting the fact that
          the joystick has been pushed, we wait for the stick
          to come back to the center before continuing the
          loop. If we didn't do this, the arrows would flick
          back and forth from one level to the other almost
          too fast to see. (Try it yourself. Remove line
          1180, and see what happens.)

1300-1760 Mostly simply initializing various arrays and
          strings. We will show later how these variables are
          used. Note how we choose one or the other set of
          DATA in lines 1700 to 1720, depending on the level
          of the player. You could have more than two levels
          here, if you wished, by adding choices to the
          initial menu and DATA for the acceleration values.

Speaking of which: The first acceleration number is the
          force of gravity. In other words, the positive
          attraction inviting you to crash into the rocky
          surface. The other six numbers are the acceleration
          values produced by the various thrust settings.
          Note that, on advanced level, the lowest thrust
          doesn't even cancel the pull of gravity. You can
          play with these numbers, but the game works pretty
          well with the values shown.

1800-1830 These are some critical constants used
          throughout the game. We need to discuss them just a
          little.

          A POKE of any value to HITCLR clears the collision
          registers (see "Mapping the Atari"). The YSIZE is
          the height of the active playing area (in pixels)
          in GRAPHICS 7+16. If you wanted to play with
          GRAPHICS 15+16 (available only on XL machines), you
          could change this.

          The lander spaceship (LEM) uses player 0. Its flame
          (from the thrust) uses player 1. They are offset a

bit (from the base addresses of their respective
players) to account for differences in their sizes.
If you changed the appearance of the ship, you
could adjust just ADRLANDER and ADRFLAME, and all
would still work.

LANDER and FLAME are established just to save time
in the tight loops later on.

We display the fuel remaining using player 2. The
"+ 32" and "+159" values are empirical--they match
the line to the size of the playfield nicely.

189Ø,375Ø The limits of the once-per-landing loop. Big,
isn't it?

19ØØ-2Ø5Ø Look at all the stuff we have to set up each
time! Most of these variables are self-explanatory
or nearly so. Especially if we tell you that "pos"
means "position" and "vel" means "velocity". FUEL
is actually fuel remaining, while BURN is the
current rate of burn (thrust). BURN is the number
which is adjusted by moving the joystick back and
forth. CURRENTTHRUST matches BURN only if the
button is pushed, otherwise it is zero.

2Ø6Ø-214Ø We set up the fuel-remaining indicator.
Rather than a solid bar, we liked the pattern that
$BDDB produced for a pair of vertically adjacent
lines within the bar. We replicate the pattern via
the MOVE of line 2Ø9Ø. Note how this trick works
and use it in your own programs: If you initialize
the first N bytes of an area of memory, you can
replicate those bytes via

        MOVE area,area+N,(N of replicates/N)

Another trick you might steal is our method of
moving character shapes from ROM to a player (lines
21ØØ to 213Ø). The usual character set starts at
$EØØØ, but we bias it by -$1ØØ because screen byte
values are no identical with ATASCII values. Recall
that each character in ROM occupies 8 bytes, and
you should get an idea how this works. After the
"fuel line" is ready, we move it to the left side
of the playfield screen.

216Ø-251Ø We make the playfield look pretty. After
picking the size and width of the landing pad, we
draw the moonscape in three pieces: From the left
edge to the pad (line 229Ø), the pad itself (231Ø
to 234Ø), and from the pad to the right edge
(236Ø). The subroutine at line 398Ø draws the
jagged mountains. (Note how the mountains are
guaranteed to get no more than 2Ø units high. If

ALT gets up to 2Ø, Ø.96*ALT immediately drops it back to 19. Cute.)

After putting a few distracting stars in the sky, we blink the landing pad (that's one reason it was drawn using a different COLOR than the rest of the moonscape) and then give it the same color as the rest of the mountains.

26ØØ,277Ø This WHILE loop constitutes all the actual movement in the game! Do you see how few lines there are here? That's the primary reason the game can run so fast, thanks to the extensive set up which we have done. And what terminates the movement loop? Look at the five conditions in the WHILE statement: (1) Hitting the landing pad. (2) Hitting the mountains. (3) Going off the left edge of the playing area. (4) Going off the right edge. (5) Going off the top of the area.

261Ø-262Ø We move both the lander and its thrust flame into position. For vertical movement, we actually MOVE data from the strings we set up (from the hex DATA). We do this because it is faster than PMMOVE, which must move 512 bytes in single line resolution (256 bytes out to a buffer and then back in, to avoid overlap problems). For horizontal movement, PMMOVE is just as fast as POKE, so we use it.

263Ø-273Ø After adjusting the BURN rate as requested, we set CURRENTTHRUST to either zero or BURN, depending on whether the button is being pushed. Since fuel is used at a rate equal to Ø.1 times the thrust, we use an intermediate variable (LOSS) to accumulate thrust in units of 1Ø. When the LOSS exceeds 1Ø, we use up a unit of fuel and reflect that fact in the fuel line on the left side (lines 271Ø to 273Ø).

274Ø-276Ø The horizontal velocity is easy: we just accumulate the horizontal stick pushes in one-twentieth of a unit increments. The vertical velocity is also cumulative, but It uses the elements of the THRUST array for its acceleration values. And, you may recall, the values in THRUST() depend on whether you are playing at beginner or advanced level. Finally, after updating the horizontal and vertical positions, we make an appropriate rocket sound.

28ØØ-3Ø6Ø For really great landings, we bring out the crowd. Note the way we assign the bonus points in line 3Ø6Ø.

3Ø7Ø-325Ø For so-so landings, we bounce the ship. The number of bounces depends on how hard the landing

was. Note how we choose the frequency for the plopping sound from the PLOP() array.

3270-3650 A crash landing. We allow pieces of the ship to spew all over the place. Up to 10 pieces are given independent positions--X() and Y()--and velocities--XVEL() and YVEL(). Each follows the laws of physics until it goes off the playing field.

3660-3740 We display the score for this landing as well as the cumulative score so far.

3770-3870 After five landings, we give the grand total. We restart the game (via a simple RUN) when the joystick button is pushed (which is why we waited for the button to be released up there at the beginning).

There it is. A practical real-time game written entirely in BASIC XL. There are a lot of unnecessary frills (e.g., the various types of landings), but they add to the overall effect of the game. Try this on your Apple-owning friends. They'll never believe it was done entirely in BASIC.

9.2.5 GTIATEST

The earliest Atari computers had a graphics chip called
a CTIA. About two years after their introduction,
though, Atari started shipping all 4ØØ and 8ØØ machines
with a newer chip, called a GTIA. (All XL computers use
the GTIA.) The most significant difference between the
two chips is the GTIA's ability to accept commands for
three additional graphics modes, GRAPHICS 9, 1Ø, and 11
in BASIC parlance.

For reasons we at OSS find hard to understand, little
in the way of commercial software has been produced
which uses these three modes. True, compatibility with
older machines is an issue, but the cost of a CTIA to
GTIA upgrade is nominal, at most. And if you must
maintain compatibility, why not provide two versions of
a program? Well, one argument for not doing so was
that, according to Atari literature, there was no way
for a running program to tell which chip was installed.
Would you believe Atari literature?

We thought not. It turns out that a workable method is
a bit involved but more than doable. The subroutine
from line 9ØØØ up in this program demonstrates one way
which we know works.

The principle is as follows: If you are in a text mode
(e.g., GRAPHICS Ø) and you turn on one of the GTIA
enable bits (the upper two bits of GPRIOR), then the
collision detection mechanism does not work between a
player and a character displayed in the modified text
mode. As a sidelight, the characters become unreadable
under these conditions, but this in itself is not
detectable by a program.

We believe this subroutine (and its sample calling
program) are fairly self-explanatory, but we will make
a few comments.

91ØØ As long as we are testing, we might as well PRINT
     something which makes sense.

913Ø-915Ø All of this ensures that we will place a
     black bar (player Ø) right over the word GTIA.

916Ø-921Ø We turn on the GTIA bits, wait for a clock
     tick, clear the collision registers, then wait at
     least two clock ticks.

922Ø If $DØØ4 contains any non-zero bits, it means a
     collision was detected and that the machine under
     test does not have a GTIA.

We hope that some of our users, either of BASIC XL or other languages, will see fit to produce some programs which take advantage of GTIA graphic modes when possible.

9.2.6 CIRCLES

We at OSS cannot take credit for discovering the algorithm used in this program, but we do think that we have made it a little more useful.

The program's workings are certainly self-explanatory up to line 1590. It is the subroutine starting at line 1600, which actually draws the circles, which needs a few comments.

The principle involved is simple in theory: calculate the sine and cosine of angles which get increasingly larger (until they reach 45 degrees), and plot a circle by reflecting these values in all octants. The trouble is, if we use conventional means of generating sine and cosine values, drawing a circle takes so long we might want to take a nap. The trick here is an algorithm, involving the variable DELTA which approximates the sine and cosine values so close as to be indistinguishable when a circle is plotted on an Atari-size screen.

When we enter the subroutine, we assume that XC, YC, and RADIUS are already set up. Then comes the fun.

1670 This begins the real work. The formula for DELTA is magic. Don't question it (unless your math is a whole lot better than average). The values for X and Y are more obvious: We begin at an angle of zero degrees, so the sine is zero and the cosine is one. We will plot the points where lines parallel to the axes intersect the circle.

1680 This allows us to get to 45 degrees, where the sine and cosine values are identical.

1690-1780 We plot the values in all octants. The cute trick we added here was the TRAP statements. Even if the circle is completely outside the bounds of the playfield, we can PLOT it in theory at least! The beauty of this method is that all of those points which fall within the playfield will be plotted, no matter how few or how many they are.

1800-1840 This is the algorithm at work. Again, It's partly magic, but you can sort of see how it works. X is always increased by one, so we never plot the same point twice. Whether or not Y is decreased by one depends on the value of DELTA (which in turn depends on either X or the difference between X and Y) as its sign changes. Those of you with a mathematical streak may enjoy calculating the arc-tangent of X/Y, to see how close this algorithm is.

Once again, this subroutine is one you can use in your own program. Try it, it works.

9.2.7 DISKIO

This is another program which in and of itself is only marginally useful. Its main purpose is to present its primary subroutine (lines 9ØØØ and greater), which you may use in your own programs.

As you may or not be aware, when you ask BASIC to do I/O (Input/Output) to or from most devices attached to your computer (including particularly the disk drive), what actually happens is quite complex. BASIC Interprets your request, into a call to CIO (Central Input Output), which in turn determines what device you are using and vectors to the appropriate driver routine. We assume here that CIO accesses FMS, the File Management System for the disk, usually called DOS (Disk Operating System).

Finally, FMS makes a call to SIO (Serial Input Output), the routine which does the actual physical reading and writing to the device. In the case of the disk drive, this involves the actual transfer of a single sector of 128 bytes (or 256 bytes in non-1Ø5Ø double density).

Most BASIC programmers seldom —- if ever —- have need to read or write a physical disk sector. Writing is dangerous, since disturbing the format of portions of a sector can destroy DOS's ability to manage the disk for you. Reading a sector, though, can be informative, especially if you are trying to either understand DOS or find "lost" information.

However, should you ever feel the need to directly read or write sectors, the subroutine we provide here will do the work for you. Just so you can see how it works, we have included an interactive program which reads selected sectors. (We took our own advice and didn't allow it to write sectors.)

The set-up program, all lines except the subroutine startling at line 9ØØØ, is fairly self-explanatory. It simply asks the needed questions before calling the actual read-a-sector code. It then displays the contents of the sector in an easy to read hex and ATASCII dump format. Only a couple of points are worth making regarding this part.

First, we have arbitrarily used $6ØØ through $6FF as our sector buffer. This is the infamous "page 6" which is so often overused. If you would like to avoid conflicts with other routines using page 6, feel free to locate the buffer anywhere else (e.g., within a DIMensioned string). Second, note the way we print out the dumps. The HEX$() function always returns a four-character string; but, because we want only the last

two (least significant) digits, we assign its value to
a temporary string from whence we can print out only
the last two characters. Also, we avoid problems with
the ATASCII display by prefacing every character with
the ATASCII code for ESCape and ensuring that only
seven bits of the characters value are used in the
display. The former mechanism forces E: (the screen
device here) to display what would otherwise be cursor
control codes, etc. The latter "fix" ensures that
RETURN ($9B) won't be sent to the screen, a desirable
feat since it overrides even the ESCape sequence.

And now, before describing the code in the sector
access routine, we need to examine what SIO expects to
be where when it is called.

9.2.7.1 SIO and the Device Control Block

The entry point to the SIO calling routine is located
at $E459. When SIO is called, it does not care what
values are in the various CPU registers (A,X, and Y),
but it insists that a block of memory known as the
Device Control Block (DCB) be properly set up. There is
only one DCB used in the Atari OS, and it begins at
location $0300 (768 decimal). Its contents are as
follows:

Location	# of bytes	Description
$0300	1	Physical Device ID
$0301	1	Device Unit Number
$0302	1	Device Command Character
$0303	1	Data movement control (on call)
		SIO Returns Status (on exit)
$0304	2	Buffer Address
$0306	2	Timeout value
$0308	2	Buffer Length
$030A	2	Auxiliary Information

Some of those brief descriptions need a little
explanation: The physical device ID is something not
seen in Atari's OS outside of SIO. Atari has assigned
each standard serial peripheral type a unique ID; disk
drives have an ID of $31 ('1', not to be confused with
$01). The device unit number is more familiar as, for
example, the drive number ('n' in 'Dn:').

The device command is again unique to SIO. As we shall
see in the next section of this manual, there are many
possible command characters, though they tend to be
normal ATASCII letters. For example, the command to
read a sector is 'R' while write is 'W', Note that for
versatility disk drives support a second write command,
'P', which means write sector without verify.

The byte at $3Ø3 has two uses. When you call SIO, it must contain $4Ø if you wish to obtain data from a device or $8Ø if you need to send data. A few device control commands need to neither read nor write data, so they use a value of $ØØ here. On return from SIO, the error code value (if any) is placed in this location.

Buffer address and buffer length are similar, if not identical, to their CIO counterparts. They simply tell SIO where the data is and how much of it there is. One unfortunate point: ATARI did not choose to include the data length in the packet sent out over the serial bus. This means that the device and SIO must agree on the length of data being sent. (Example of the consequence: Atari's OS always sends data to a printer in 4Ø byte chunks. Wouldn't it have been simpler if OS could have sent any number of bytes, from 1 to say 255, to the printers?)

Finally, the auxiliary information is sent unmodified to the device along with the command. Each device chooses what the auxiliary info implies, but for disk drives it is always the sector number.

9.2.7.2 The Sector Access Routine

Actually, now that you have seen what SIO requires, this subroutine (lines 9ØØØ up) is almost self-explanatory. Once again, though, a few things need clarifying.

923Ø No real reason for this, except that the resultant listing looks so much neater.

924Ø We use ASC("1") to emphasize the fact that Atari, for some reason, used printable characters for most of the SIO control information. (As a guess, we would say that they did this to make debugging using a serial data analyzer easier.)

927Ø-932Ø We only allow the values we said we would. Everything else is fatal. Not fancy, but safe.

933Ø A little sneaky, but we have already verified that CMD equals either 1 or 2, so only a legal value is possible here.

935Ø The timeout value is arbitrarily large.

936Ø-941Ø Again, we allow only legal density values. Note that 1Ø5Ø density-and-a-half is considered Single density by this routine.

9420-9470 Validating the sector number. If you are
     using a 1050 in density-and-a-half mode, you
     obviously need change the 720 value to 1040,
     instead.

9480-9490 This is such a neat trick! Because BASIC XL
     allows us to specify that the count of parameters
     will not be pushed on the stack, we can call
     machine language routines which do not expect
     values in registers without any need for an
     intermediate routine! So simple it's almost hard to
     believe.

9500 As advertised.

9510 Just in case the caller is using a routine where
     he wants the count of parameters pushed!

9.2.7.3 Technical Sidelight

There are two sectors on a standard Atari DOS disk
(version 2.0s and its derivatives, including OS/A+ and
DOS XL versions 2) which you may read or write at will,
since they are "invisible" to DOS: sector 3 and sector
720.

Sector 720's availability has been documented before:
DOS "manages"·sector numbers 0 to 719, but the disk
drive understands only sectors 1 to 720. DOS has been
"fixed" to think that sector 0 is always in use, but
sector 720 remains outside its Ken. Sector 3 is a
quirk: it is the last sector of the traditional 3-
sector boot process. But, for some reason lost in
programming legend, it turns out that none of the disk
boot code used by DOS is present in sector 3: sectors 1
and 2 contain all the boot that is needed!

A word of warning, though: if you erase, write, modify,
or rename the DOS.SYS file, sector 3 will automatically
be rewritten by DOS (it thinks it needs to reestablish
the boot code). So, if you choose to use sector 3 for
your own purposes, be sure to do so on a disk which
either never receives a DOS.SYS file or which has one
which you feel is reasonably permanent.

9.2.8 CONFIG

This program was written in response to all of our
users who wanted to know how to read and/or change the
configuration information which all true double density
drives utilize. The configuration scheme, often called
the config block, was developed by Percom Data
Corporation, the producers of the first commercially
available double density disk drive for Atari
computers. Since that time, all other manufacturers
except Atari have followed the Percom lead. Strangely
enough, the Percom scheme was in turn developed from
the ill-fated Atari 815, a double density drive which
never saw retailers' shelves.

In any case, the degree of double density compatibility
between drives of rival manufacturers in the Atari
market is nothing short of amazing. In those instances
where one drive cannot read a diskette written by
another make of drive, the problem is almost always
related to the rotational speed of the motor turning
the disk. Adjusting that speed can often work wonders
with a diskette which otherwise produces only ERROR144.

Of course, when Atari finally came out with their own
"double density" drive, naturally they had to invent a
new standard. (It wouldn't do to accept one begun by a
rival--that would be an insult to Atari's dignity.) As
a result we now have three important diskette
configurations in the Atari world, which are summarized
in the chart below.

Our Name	Style	Sectors per Track	Bytes per Sector	Kbytes
Single Density	81Ø	18	128	9Ø
1Ø5Ø Density	1Ø5Ø	26	128	13Ø
Double Density	Percom	18	256	18Ø

All drives use 4Ø tracks per diskette. In addition to
those shown, various manufacturers have also made
drives with 8Ø tracks, two heads (i.e., 4Ø tracks per
side of the disk), double-headed with 8Ø tracks per
side, and even 8" disks with other strange and wondrous
configurations. Since only OS/A+ version 4 (of all OSS
DOS's) supports other than ordinary single and double
density drives, we will not go into detail about these
drives here.

As of this writing, the following drives are known to
be capable of understanding Percom-standard double
density mode:

    Indus   TRAK
    Astra   Rana

The BASIC XL Programming Environment

    SWP   NCT Turbo
    and, of course, Percom

In addition, Amdek conforms to the software standard
even though their diskettes are 3.5" (instead of the
usual 5.25"). If you hook a 5.25" drive up to an Amdek
controller (e.g., as a second or third drive on the
controller), then its diskettes will be hardware
compatible as well.

Now that we have all that out of the way, maybe we
ought to find out just what the "Percom standard" is.

9.2.8.1 The Percom Standard

For a drive to qualify for that title, we at OSS feel
that it must be capable of all the following:

1. Read and write standard Atari 81Ø single density
   diskettes.

2. Read and write double density diskettes with 4Ø
   tracks, 18 sectors per track, 256 bytes per sector.
   Peculiarity: because of the way Atari's OS wants to
   boot, the first three sectors of a double density
   disk will hold only 128 bytes of data (excess is
   ignored) and transfer only those 128 bytes on all
   SIO reads and writes to sectors 1 through 3.

3. Be able to transfer an internal configuration block
   to the host computer on request.

4. Be able to accept changes in that same configuration
   block sufficient to at least allow the drive to be
   changed back and forth between single and double
   density.

5. Have that configuration block be read/written by SIO
   commands 'N' and 'O' (respectively) and consist of
   12 bytes conforming to the following table:

Byte #	# of Bytes	Description
Ø	1	Number of Tracks
1	1	Step Rate
2	2	# of Sectors per Track
4	1	# of Sides per Track
5	1	Density (Ø=Single, 4=Double)
6	2	# of Bytes per Sector
8	1	Drive Selected?
9	1	Serial Rate Value
1Ø	2	Miscellaneous (reserved)

Once again, a little explanation of some of those items is necessary: First of all, note that all double byte values are not in standard 6502 low/high order. The reason is historical: Percom uses a 680x CPU chip in their disk controller, and all 680x chips do double byte work in reverse of the 6502 manner.

'Step Rate' is not a meaningful number from one manufacturer to another. Step rate 1 might mean 6 milliseconds per track to one manufacturer and 20 milliseconds each to another.

"Number of sides" is a misnomer: it is actually the number of sides minus one. Thus most drives will show a zero here. Note that, in theory, this number could have any value. For example, a hard disk drive might show 4 here (five heads).

The only agreed upon values for "Density" are 0 ("FM" recording mode) and 4 ("MFM") recording mode. Other values are possible for strange circumstances.

Some drives can actually be turned "off-line" by an appropriate value in "Drive selected." There seems little value in this, since they can only be brought back into the system by turning them off and back on again.

The "Serial Rate Value" has not found any compatible acceptance. As originally conceived by Percom, it would inform the drive what baud rate the computer would use for high speed data transfer. So far, those manufacturers offering higher speed transfers have not used this byte in any meaningful way.

Finally, the "Miscellaneous"· value is not—to the best of our knowledge--being used by anyone for any purpose.

Now that you know what a Config Block looks like, how can you tell, from software running in the Atari computer, whether a particular disk drive is set up for a particular density of diskette? Equally important, how can you change a drive's set up? If you want the answers to these questions, read on.

9.2.8.2 Reading and Writing the Config Block

As noted in section 9.2.7, SIO is a means of transferring control and/or data between an Atari computer and a peripheral device via the standard serial bus. Although the most common operations on the bus involve reading (command 'R') and writing (commands 'W' or 'P'), other commands are certainly possible. In fact, all devices are required to support a status ('S') command, if for no other reason than so that the

computer can tell whether they exist on a given bus or
not.

When Percom invented their double density disk drive,
they invented their Config Block and, quite naturally,
a pair of commands to pass such a block between the
computer and the drive.

The command to read a Config Block from the drive into
the computer memory is 'N' (think of it as iNto the
computer). The command to write a Config Block to a
drive is 'O' (think of it as Out of the computer).
Aside from the need to use these command characters,
the only differences between making an SIO call to
read/write a sector and making one to read/write a
Config Block are (1) the length of the data, which is
always 12 bytes (instead of the 128 or 256 for a
sector) and (2) the auxiliary bytes (used for sector
number) have no effect.

For example, then, to read a configuration block from
drive 1 into a buffer at location $6ØØ (page 6) you
would need to set up the following values in the DCB at
the locations shown:

```
    $3ØØ   $31    Unit ID
    $3Ø1   $Ø1    Drive 1
    $3Ø2   $4E    'N', read Config Block
    $3Ø3   $4Ø    see section 9.2.7
    $3Ø4   $ØØ
           $Ø6    $6ØØ, LSB first, buffer address
    $3Ø6   $ØF
           $ØØ    15, an arbitrary timeout value
    S3Ø8   $ØC
           $ØØ    12, length of the Config Block
```

And that's it! A JSR (or USR) to location $E459 will
read that block right into memory. If, of course, the
drive is capable of reading/writing Config Blocks.
Atari drives, for example, will return an error 138
(NAK), because they do not understand the command. A
command given to a drive not on the serial bus will
result in a time-out error.

1ØØØ-12ØØ Mostly just simple constants. Note that we
    will read the configuration table into the string,
    Config tables, rather than using valuable page six
    memory. Also note in line 12ØØ the way we produce
    screen control characters which will list on any
    printer.

124Ø This allows us to call system routines via USR()
    directly. See section 9.2.7.

1270-1290 We will discuss these DATA statements later. For now, note that each line has 12 values (funny how that matches the size of a Config Block). Negative values indicate bytes we won't change.

1330, 1920 Look at the size of this endless loop. We think that, in a well structured program, a loop really shouldn't get any bigger.

1340 Two ways to use screen controls in BASIC XL, thanks to the fact that you can PUT to channel zero.

1430 This is one way to ensure that all the configuration games we are playing here will take effect. When you change a drive's configuration, DOS needs to know about it. Usually, one does this by calling a routine named DOSINI, which will return to you after reestablishing DOS's internal drive configuration table. If you don't need the routine to return to you, simply force a system reset by a jump (of any kind) to $E474. This is exactly equivalent to hitting the RESET key.

1490-1500 See, we can use our SIO calling routine to do more than just read/write Config Blocks. In this case, we simply do a drive status call.

1600-1730 The status was okay, so read the Config Block. Hmm? Can't do it? Why did you buy an Atari drive?

1750-1890 Here is where we display and then (optionally) change the Config Block in a form readable by humans. Note how little of the code is actually here; it is almost all in subroutines.

1940-2220 Once again, we have a keyboard access routine which avoids the vagaries of the INPUT statement (see PICO.BXL for a fully commented example of this same thing). In this case, we want only numbers in the proper range. It's easy if you step through it.

2230-2590 Remember what we said about a handful of subroutines which do the real work? Here's one of them. If you followed our discussion of the meaning of each byte of the configuration table (above) you shouldn't have any trouble following this code. That's primarily thanks to the fact that all the pertinent values have already been placed in variables with meaningful names by...

2600-2750 A very important subroutine. This takes the bytes of the Config Block and converts them as appropriate. Note how we can not use the DPEEK() function, thanks to the fact that the double byte

values are "backwards"·compared to standard 6502 practice.

2760-2910 The opposite of the previous routine. Take the values in the variables and stuff them into the bytes of the Config Block. Again, note that we can not use DPOKE.

2920-3120 We really shouldn't need to explain this routine, since it is virtually identical to its counterpart in DISKIO, described in section 9.2.7.

3130-3380 Here's where we allow you to play games, if you wish. We give you a menu. If you choose one of the standard configurations (Single, 1050, or Double Density), then the appropriate RESTORE allows us to read the standard configuration information from our DATA statements. Once again we note that some bytes are never changed: Step Rate, Acia, and the Miscellany locations.

3390-3900 Anything goes. You can tell the disk drive's controller that it's connected to a drive with 130 tracks, 204 bytes per sector, 12 heads, or whatever. Some controllers will believe you and try to do as you ask. We sincerely hope that you have a blank or trash diskette in the drive when you give such commands. Other drives will only accept a limited number of configurations, ignoring much of the information you send them. For example, Indus drives allow only the three standard densities.

Note how we re-read the Config Block after writing. This is to ensure that we haven't lost control of the drive. (With same drives, you can de-select them, and they will cease responding to anything.)

That's about it. If you are confused, try playing with the program with a copy of a listing in front of you. It should become a bit clearer.

9.2.9 PHONE

PHONE.BXL is a fairly large but well organized program
which is a simple but very efficient phone number list
organizer. It will maintain a list of first and last
names and phone numbers, keeping the list "sorted" by
last name. Thanks to the "sort" scheme adopted, it
finds a phone number in less than a second, no matter
how many names there are in the list, when given a last
name to work with.

Its other advantage is that it is easily changed and
expanded to provide, for example, a mailing list pro-
gram. Or perhaps a list of books in your library. The
possibilities are limited mostly by your willingness to
tackle its code and bend it to your purposes.

Again, this program has been provided in response to
numerous requests for a complete explanation of how to
do random access file I/O under DOS 2. We hope that
this program and its description will satisfy most of
these requests. Before exploring the program, though,
there are several technical considerations which you
may enjoy considering. If you get lost in all the
technical stuff, skip down to the program description
and come back and try to understand the rest later. (It
is worth understanding.)

9.2.9.1 Sequential and Other Files

Perhaps the biggest flaw in Atari DOS 2.0s (and all its
derivatives, including OS/A+ and DOS XL version 2.x) is
in the structure of the files it creates. Atari DOS 2
files are classified as "linked sequential" types. That
means, each sector in the file points to (links to) the
next sector.

Sequential files have a few advantages: (1) File
managers which handle sequential files are generally
simpler and smaller than those for other file types.
(2) If a disk is partially "clobbered," you can often
still recover much of its data when linked sequential
files are used. This is true even if the disk's
directory is damaged,a generally fatal condition in
other file systems. (3) File manager disk space
overhead is reasonably low.

Unfortunately, there are also several major
disadvantages: (1) To erase a linked sequential file,
the file manager must read through each sector of the
file, a very time-consuming process. As disk and file
sizes get larger, this become a major factor in disk
I/O time. (2) To locate a particular record in a linked
sequential file, you generally have no choice but to

start at the beginning of the file and read until you come to it. (3) Similarly, to append to a linked sequential file, you may have to read the entire file.

Now, truthfully, file manager types don't matter if you are using a DOS to do nothing but save programs, letters, and other things where you always load all the information into memory before working on it. You're actual1y using the disk as a slightly smart tape drive in these circumstances. Where file structure be comes important is when you need to randomly use bits and pieces of a hunk of data (a file) too big to fit in memory.

The best of all worlds would be a DOS smart enough that you could say something like this: "Give me the address of John Doe." Generally, the computer world considers convenience like this beyond the scope of DOS, relegating it to the world of Data Base Managers and their ilk.

The next step down is usually being able to say, "Give me the 433rd record in that file." With most file organization schemes, this is a trivial task if the records are all the same length (and about as hard as the first request if they are not).

9.2.9.2 How to Use NOTE and POINT to Advantage

But what about those linked sequential files we are stuck with? To get to the 433rd record, we have to read through the first 432! And we would be stuck here were it not for the fact that Atari DOS does provide one added feature: it allows you to find out just where on the disk you are as you read or write a file. The magic statement is NOTE. As you may remember from your BASIC XL reference manual, its format is:

     NOTE # filenumber,avar1,avar2

where the first avar gets the sector number of the current position within the file and the second avar gets the byte number within that sector.

Then, if you once read a file and find out (via NOTE) where its 433rd record begins, you can later ask DOS to change its file position marker to that same location (via POINT, which has the same format as NOTE). Voila, you are then able to read or re-write the record.

How, you may wonder, is this different from those DOS systems which allow you direct access to any byte (and thus record) in a file? Don't they allow you to POINT to any disk location, also? Not really. Atari DOS allows only what we call Absolute access. That means

that the numbers you use with POINT describe a physical location on the diskette. Other DOS types allow you to POINT to a location which is relative to the beginning of the file. (Example: To point to the 22nd record when each record has 2Ø bytes, you would simply POINT to relative byte number 44Ø, if records are numbered starting at zero.)

With Atari DOS, knowing that record number 22 starts at sector 3Ø1, byte 115, doesn't tell you anything about where record number 23 starts (unless record 22 is shorter than 1Ø bytes), because sectors are not always allocated to a file in order. (Instead, as a file is built it is always given the next unused sector.) To make matters worse, when a file is appended to, sectors with fewer than 125 bytes (253 bytes in double density) may be left in it.

The only real solution, then, is to build a table of pointers, one per record. This technique has been described often before (among other places, in Atari's DOS 2.Øs Reference Manual). In most such discussions, what is built is a numeric array (or arrays) of pointers to records by number. A segment of a typical program is shown:

```
95Ø NOTE #3,Sector,Byte
96Ø Sector(Recordnumber)=Sector
97Ø Byte(Recordnumber)=Byte
```

This is a lot of overhead: 12 bytes per record.

Let us sidetrack for a moment. Consider this: when you use NOTE, you are given a sector number and a byte number. But the maximum sector number is 72Ø and the maximum byte number is 253 (double density), so we can store the sector number in as little as two bytes (remember, a double byte location can hold values from Ø to 65535) and the byte number in a single byte. Total: three bytes. Again, a program fragment to implement this scheme is shown here:

```
93Ø NOTE #3,Sector,Byte
94Ø Temp=Recordnumber*3+1
95Ø Shi=Int(Sector/256) : Slow=Sector&255
96Ø Pointer$(Temp,Temp+2)=Chr$(Slow),Chr$(Shi),Chr$(Byte)
```

Look at the savings when compared to the numeric arrays! But an additional advantage of using a string to hold our pointers is that it can hold any other string as well. Why not a record's 'name'?

If you are using 1ØØ byte records, a file with 5ØØ records needs only 15ØØ bytes worth of pointers, which can easily be held in memory. Even if you add "record

names" (as PHONE.BXL does), the memory requirement for
a set of pointers is quite small compared to the amount
of disk space we can access with them.

And, while you could re-build the pointers each time
you RUN a program, isn't it just as easy to keep them
in another file on the disk? Yes! And all of this is
made so much easier thanks to same statements in BASIC
XL. There is, however, a necessary caveat: Recall that
the sector and byte numbers given you by NOTE are
absolute. If you copy the data file to another disk,
your set of pointers is no longer valid. You thus have
two choices: rebuild the pointers after copying the
data file or duplicate the entire disk instead (which
preserves everything on the disk).

9.2.9.3 The Concept Behind PHONE.BXL. alias BlackBook
---------------------------   -----------------

It's kind of funny that, because other COS systems
support random access files implicitly, you seldom see
programs such as this published for them. And what's so
special about this program? In it we give you a
complete set of routines for performing what is known
as an "Indexed" or "Keyed Sequential Access Method".
Remember how we said it would be neat to be able to
access John Doe's account information using just his
name? Remember how we said this was in the domain of
Data Base systems? Guess what. PHONE.BXL (or, as we
prefer, "BlackBook") is actually a mini-Data Base. All
in all, we have turned a DOS limitation into a helpful
situation.

(Sidelight: Actually, there is no reason you couldn't
use all the techniques of this program under any DOS.
In fact, most random access would make some of the
steps in our process -- such as "prebuilding" all data
files — unnecessary.)

BlackBook always works with its files in pairs: a data
file and an index file. The structures of the files are
shown below:

9.2.9.4 BlackBook Data Files

Each record consists of three fields. Each field is a
string of up to 24 characters which is written to the
file via BASIC XL's RPUT statement. Since RPUT uses
five bytes of overhead per string (as a safety measure
-- see your reference manual), the total number of
bytes per record is 87 (24+5 is 29; 3 times 29 is 87).
If you were to look at a record byte by byte, it would
look like this:

Record Structure in BlackBook Data File

Record:
```
    Field 1:
        Byte  1      String Field indicator
        Bytes 2-3    Dimension of String Field
        Bytes 4-5    Length of String Field
        Bytes 6-29   Field data, as a string
    Field 2:
        Byte  3Ø     String Field indicator
        Bytes 31-32  Dimension of String Field
        Bytes 33-34  Length of String Field
        Bytes 35-58  Field data, as a string
    Field 3:
        Byte  59     String Field indicator
        Bytes 6Ø-61  Dimension of String Field
        Bytes 62-63  Length of String Field
        Bytes 64-87  Field data, as a string
```

9.2.9.5 BlackBook Index Files

Aside from the actual key (index) entries, there are
two pieces of information needed when maintaining a
keyed file as BlackBook does: (1) We must know how many
records the file is capable of holding. This number --
called MAXREC -- is established when the empty file is
pre-built. (2) Out of those MAXREC records, how many
are currently in use? NUMREC tells us.

In BlackBook, MAXREC and NUMREC are placed first in the
index file via RPUT. They are directly followed by all
the bytes of the index string. Since MAXREC describes
the size of this string, we chose to write/read it with
BPUT. (There is another advantage to using here, as we
shall see later.) The byte-by-byte form of an index is
thus as follows:

```
    Byte  1      Numeric field indicator
    Bytes 2-7    MAXREC, a number
    Byte  8      Numeric field indicator
    Bytes 9-14   NUMREC, a number
    Bytes 15-?   The index string
```

Sidelight: the reasons we set up the files for MAXREC
records, instead of just adding space to the file as we
need it, are twofold and related: (1) You can only use
POINT on a file which has been OPENed in update mode.
(2) You can't append to a file when you are in update
mode.

9.2.9.6 The Index String

The proper structure to the index string is the secret
to not only the success but also the speed of this
program. Rather than trying to explain it as we
describe the workings of the program, we will present
it in some detail here.

The string actually consists of MAXREC "elements", just
as if it were an array. In BlackBook, we have chosen to
use the first four characters of each person's last
name as our key value. This is arbitrary and could,
without a lot of trouble, be changed. (In fact its size
is dependent on the value of the Indexsize variable.)

In addition to the 4 character key, there are 4 bytes
of overhead. Three of them we know about: two bytes for
the sector number, one byte for the byte number. The
last byte is used as a key separator and always has a
value of 255 ($FF). At this point, you may be wondering
why we went to the trouble of using a long string (with
its complicated subfield addressing) in favor of a
string array (where we could get the entire key
pertinent to a record with a simple record number). One
main reason: BASIC XL's FIND() function works only on a
single string (not an array), and we wanted to use it
for speed.

But using FIND() has its own problem. Suppose that,
just by coincidence, the sector and byte number
characters (which is what they have become, once they
are in the string) happen to have values which make
them look like characters in a key name we are
searching for with FIND(), causing the function to
return a false match. We avoid the problem through the
mechanism of the $FF byte field separators: When we
search for a key name with FIND(), the search string is
preceded by a byte of $FF. A match is thus guaranteed
to start on a key separator boundary. (We go further
for safety: we separate the sector number into high and
low bytes by dividing by 128, instead of the more
conventional 256. This means that the sector number and
byte number characters can never have a value of 255
either. Overkill? Perhaps, but why not when it costs us
nothing.)

Got all that? If not, don't worry about it. If the
description of the program still doesn't make it clear,
it doesn't matter. If you follow our lead, the scheme
will always work.

9.2.9.7 Program Description: PHONE.BXL, BlackBook

If you list this program to a printer (and we sincerely
hope you do before trying to follow this description),
you will find that it will take over 8 pages of paper.
Obviously, there is no way we can give you a line-by-
line description of such a program. Instead, we can
only point out the functions of various subroutines,
etc. Of necessity, some of the detail about program
function, etc., given in other descriptions will be
missing here. We hope and expect that your programming
skills will have been sharpened enough by now to allow
you to work through the details.

As with some of our other programs, we will describe
this program from the "top down". That is, we will
present it in roughly execution order rather than
listing order.

1000-1330 The usual constants, both strings and
    numbers. Note how we have given "names" to commonly
    used small numbers such as zero and one. This saves
    memory space, not time.

1340-1430 If you adapt BlackBook to your own purposes,
    you can add data fields here and/or change the
    sizes of the ones given. If you do so, be sure to
    adjust Recsize, the number of bytes in each record.
    If you choose to change the length of the portion
    of a field used as the key, change Indexsize at
    your own risk. In theory, everything in the program
    keys off this variable, but we have never tested
    the theory.

1540-1550 One advantage of using BGET with the index
    string is that we do not need to make the DIMension
    of Index$ match the size in the file, as we would
    if we used RGET. This makes building a file
    somewhat easier also, as we shall see.

1570-1710 We have given all major subroutines names in
    this program. This makes renumbering and
    reorganizing a bit more difficult, but pays off in
    much more readable code.

1720-1950 Did we mention that BlackBook will even dial
    your phone for you? Here, we're just setting up an
    array of values for later use with SOUND.

2000-2290 This monstrous program is all driven from
    these few lines. All we do is present a menu and
    accept only one of five choices. If you are using
    BlackBook, you have to create a file before you can
    do anything else, so we will now track what happens
    when you ask for that main menu option.

The BASIC XL Programming Environment

15000-15280 This major routine figures out how big a
    file you have, allows you to specify any size up to
    that maximum, makes you choose a name for the file,
    and creates an empty data file corresponding index.
    Such a lot of work for so little code! It's done
    with mirrors, otherwise called subroutines.

6900-7060 The Calcsize routine. It figures out how big
    a data file is possible using a trick or two we
    hadn't seen before. First, it creates a trash file
    containing 200 bytes. It does this so that it can
    read the sector count for this file in the
    directory: 200 bytes is guaranteed to require one
    sector in double density, two sectors in single
    density. Then, when it finds out how many free
    sectors there are, it knows how many free bytes
    there are on the disk. From this count of free
    bytes it estimates the maximum number of records by
    dividing by the number of bytes used by each
    record, which is in turn the sum of the record size
    and the index size. Finally, we never allow
    ourselves more records than we have room to point
    to in the index string.

5000-5260 Our Getline routine is used to avoid the
    INPUT statement. We avoid INPUT because we don't
    want the user moving the cursor all over the
    screen, erasing the screen, etc. Either the ESCape
    key or the RETURN key terminate a line here (mainly
    because they have the same value if you ignore the
    upper bit). The only editing key we allow is Back
    Space, and then only to the beginning of the field.
    We even provide for the use of a flag which changes
    lower case into upper case, used by the
    Getfilenames routine to avoid lower case in file
    names. Finally, we will only get as many characters
    as the caller asks for (the contents of Maxline on
    entry).

5400-5480 Getfilenames is only a little bit smart. The
    user should not type the file name extension, and
    typing the drive specifier is optional (D1: is
    provided automatically if the specifier is
    omitted). Two names are returned, alike except for
    the extensions, DBF and DBX (Data Base File and
    indeX).

7500-7680 Most of the work in Create is done by this
    routine, Makeindex. Since this is a very important
    routine, we will examine it in some detail.
    Exception: As this routine works, it keeps the user
    informed of where it is. The code for this is
    fairly obvious and will not be discussed.

    We first set up the data fields with some filler
    byte ($FF, in fact). After performing a NOTE (line
    7570) to find out where the beginning of the

current record is, we write the filler data to the
data file (line 761∅). As we did that, we built a
key string. Note its structure (line 759∅): first
byte is always $FF (255), followed by four bytes
which match the first four characters in the last
name of the person being indexed, followed by the
NOTEd information. We lengthen the index string
(line 76∅∅) by simply tacking the key we built onto
the end of it.

We perform all those steps for each record in the
file (the FOR loop). When all data records have
been written out, we write out the new index file
(lines 764∅-766∅). Note the presence of the check
in line 763∅: if the length of the index string
doesn't correspond to the number of blank records
which were set up, something went disastrously
wrong. When writing your own code, checks like this
are a good idea (but see our final comments also).

After creating a blank BlackBook file, you would
presumably want to put some data in it. In this
program, one main routine is used for operations on the
data in the file: the Edit operations start at line
1∅∅∅∅.

1∅∅∅∅-1∅31∅ Once again, a major routine devolves to a
small loop with many subroutine calls. And once
again its primary purpose is to present you with a
menu of selections and make you choose one. In the
case of Edit, it first asks you a question and does
a little set up.

72∅∅-732∅ Even though BlackBook files on only the first
drive are listed for you, the Showfiles routine
will accept a choice of a pair of files from any
on-line drive.

74∅∅-746∅ Getindexinfo is a simple routine: it opens
the index file, reads the count of available and
in-use records, and gets the index string in place.

57∅∅-585∅ By never using zero as a real record number,
we make Showrec's Job easy: If it sees us trying to
display record number zero, it displays blanks
instead. Note that the record number referred to is
actually an 8 byte key entry in the index string,
which may bear no relationship to the record's
position within the data file. If you modify
BlackBook to add fields, this routine must change
to fit; but the POSITION and PRINT statements are
easy to modify. To get the data to be displayed,
this routine in turn calls...

6300-6340 Getbykey simply gets the various fields of
   the data record after requesting a POINT to the
   right spot in the file. Again, you could add data
   fields in each record quite easily in this routine,
   simply by extending the RGET statement.

6000-6070 Even deeper in the GOSUB information about
   sector and proper spot in the data file.

10240-10290 Finally, back in the Edit menu, we
   demonstrate a neat way of making menu choices using
   the FIND() function. The nice part about it is that
   an invalid choice provides an Option value of zero.
   Valid choices are vectored to the appropriate
   routine. For the sub-commands of Edit, we chose to
   use line numbers, primarily so we could renumber
   this section of the program more easily. Let's look
   at some of those choices in a logical order.

11110-11290 Again, on the assumption that we are
   setting up a new BlackBook file, we start by adding
   records. Since the Edit menu routine at lines 6600
   through 6770 simply sets up a set of blank fields
   to be filled in, we won't describe it further here.
   The Getline routine does yeoman duty again,
   ensuring that we get nice neat data, confined to
   the proper areas of the screen.

   Before bumping the count of records (as well as the
   current record number), we call two routines which
   do the bulk of our work. Observe how, in line
   11250, we built up KEY$. By now, you know that an
   index string entry consists of a separator byte,
   four bytes of the record's name, and three bytes of
   NOTE info. But look where that NOTE info comes from
   here: from the last possible index entry in the
   index string! As you follow the next subroutine,
   you will see why.

7800-7930 This is potentially the slowest part of
   BlackBook when you are adding to a large file.
   Using a FOR loop, we search through the index
   string looking for a record whose name is equal to
   or greater than the one in KEY$. Because we never
   try to insert into a full index, we are guaranteed
   to find one such name: blank records were given a
   name of all $FF characters!

   When we find the proper position to insert our new
   entry, we must make room. We leave it to you to
   work out how beautifully the MOVE of line 7900
   works (though we will remind you that a negative
   length forces an insertion-type move). The special
   case shown is only used if we are putting the last
   possible name in and it happens, to fall at the end
   of the list.

Do you see what we have done? If this was the first real name being inserted into all the dummy names in the index string, its 8 bytes find their way to the beginning of the string. But look what data record we will use: the last possible one. So what? That's why we are using an indexed file, right?

6360-6400 Speaking of which, we new need to Putbykey to get the data record on the disk. As with GetbyKey, we let the PointbyKey routine set up the POINT for us and then we simply RPUT the data fields to the disk. It would be easy to add more data fields here, to correspond to GetbyKey.

Back in the Edit menu: Once you have added some records, you may want to go forward or backward in the file looking at what you have done. Or maybe you want to find a particular name.

10330-10450 As long as we're still within the bounds of valid data, we let the user go to the Next or Last (previous) name (alphabetically) in the file. Simple, isn't it? Thanks to the fact that the index string is already sorted in alphabetical order. (Well, that's really ATASCII order, but for names the difference is moot, unless some use upper case and some use lower case.) Notice that these routines do not need to display any data, since the main Edit menu loop does that for them.

10470-10590 This is why we went to all the trouble to set up that monstrous index string! See how we build our search name in line 10540, with a leading $FF byte. Then all the work is done for us in line 10550: we simply FIND the first match! Very fast, very efficient. Again, by calculating REC as a function of the position we found the name in the index string, we can let the Edit menu loop display the data for us.

And the only other things this program allows you to do with your data is dial a phone number or erase a name from the list.

10600-10950 This only works on touch-tone phone systems, but it does work. If you hold your phone's microphone up to your computer's speaker it is actually possible to let the computer dial for you. Some other things to note: A 'P' in a phone number indicates a short pause (some long distance companies need such pauses during dialing). You may easily adjust the duration of the pause by changing line 10780. A 'W' causes the dialer to wait until you give it the go-ahead. Once again, our friend the FIND() function passes through only those values we actually want to handle.

The tone generator uses the special 16-bit resolution mode of the Atari sound generators to produce frequencies which are more accurate in pitch than those available with the SOUND statement. The subject is too complex for further explanation here. Many graphic and sound books for the Atari explore this fairly fully.

10960-11090 In most ways, the Erase a Record routine is simply the reverse of the ADD routine. We first remove the record pointer from the index string by simply squeezing up the string (lines 11020 and 11030). But, because we don't want to lose the NOTE information in that pointer, we fill it in with the standard dummy name (all $FF characters) and tack it onto the end of the index string (line 11050). We mark the record as deleted in the data file by zapping just the last character of its PHONE$ string (11060 and 11070). Naturally, the number of records is now one less than it was before.

Aside from the various edit options, the Edit menu provides an exit choice and a hidden choice (note the presence of the underline character in line 10240).

11300-11370 To exit from the Edit menu, we simply close the data file and write out a new version of the index file. The next time we get to the Edit menu, reading the index file will put us right back where we left off.

9900-9940 In the process of developing this program, we had several occasions to doubt our sanity. Loops would straighten out. GOTOs wouldn't. Data would be lost. And the index string would get mangled unmercifully. To help view what was going on, we would often write small routines to display certain pieces of data. For example, we built in this debug routine, which simply displays the current contents of the index string in a reasonably readable manner. It then waits for a key press before going back to the Edit menu.

Now, truthfully, there is no need for this routine in the final version of the program. The indexing bugs seem to be gone, data moves smoothly, and loops keep on looping. But we thought it might be educational for you to see how we approach the debug process: carefully and with a lot of extra displays.

Well, after we've created a BlackBook file and added several records, we may notice that the file is getting full. Time to expand the file and make room for more phone numbers, right? Right.

20000-20270 Actually, this increase file size routine
is almost identical with the Create a BlackBook
file routine. The major difference is that we use
the information about file space left on the disk
(and the user's response to our query) to append a
chunk of file to our existing. The Makeindex
routine, discussed above, does all the work. Now
you may notice why Startrec and Maxrec and Rec were
all set up before the call to Makeindex in ADD. By
doing so, we need only use other appropriate values
to properly call the same routine here in Increase.

The only other possibility provided for here is the
case of the clobbered index file. There are four ways
the index file could become invalid: (1) Power to the
computer goes off before the file is Closed or the disk
is some how damaged. (2) The program crashes with an
error. (3) You erase some records you didn't mean to.
(4) You COPY the data file to another disk so that the
NOTE pointers are no longer valid.

No matter what the cause, the Fix/Recreate Index
routine will cure all ills. In the case of deleted
records, it gives you a chance to recover them (so long
as you didn't ADD a name after doing the accidental
ERASE).

25000-25110 Again, we show the user what BlackBook
files are on the disk and allow him/her to choose
one. We prepare the screen for·some messages and
fill the index string with $FF characters.

25130, 25540 Don't you wish BASIC XL had a function
which would detect the end of a file? Well, it
doesn't, but the PEEK() which controls this loop
functions as one just fine.

25140-25180 We simply figure out where we are at in the
data base file, get the record from disk (line
25160 would have to change if you add more fields
to each record), and create a valid key, consisting
of the separator byte, the record name, and the
NOTE info.

25190-25310 Remember how we zapped the last byte of the
PHONE$ string when we erased a record? Here's where
that pays off. If such a record is detected, FIX
gives you a chance to "undelete" it.

25320-25410 If the user wants to undelete the record,
we change that magic character in PHONE$ to a
space. If not, we change all the fields (and the
record's name in the index string) to filler bytes.
In any case, we write out the modified record.
Lines 25390 and 25400 are necessary to avoid a

false end-of-file indicator (produced because of a
bug in DOS) when writing the last record.

25430-25510 This part's almost easy: If the record
found is a filler (blank) record, we simply add its
pointer info to the end of the index string. If the
found record is a real·one, we have to put its name
in the proper place in the index string. Look at
that! A call to our old friend, InsertKey, just
exactly as if we were adding a new record.

25520-25530 Since we have to count the number of
records in the file anyway, why not give the user
some thing to watch as we work.

25550-25600 Funny how this code resembles that at the
end of the Edit Menu exit and the end of the
Makeindex routine. Maybe we need another subroutine
just to write out the completed index file.

There will be a quiz tomorrow.

Whew! Did you get through all that? If so, then you are
ready to convert BlackBook to your own needs.

Several fairly simple improvements would increase the
usability and safety of the program dramatically. We
leave them as exercises for you:

1. There's not a single TRAP in this entire hodgepodge.
   May we suggest TRAPping at least the most dangerous
   sections, such as where we create file, etc.

2. The Edit Menu is missing one obvious and important
   choice: Change (edit) an existing record. No good
   reason for the omission other than the fact that it
   seemed unnecessary in a demo program.

3. Cut the program up into pieces, chaining between
   them via RUN, so that the index string can be
   bigger.

4. Use a larger key. Change the file to a mailing list
   file (add field info in all the places we noted) and
   use the zip code plus first two letters of last name
   as the record name for the index string.

5. Use this basic program for something we didn't think
   of. Tell us about your efforts.

9.2.1Ø MAKEAUTO

We have received many requests for this program. Its
purpose is quite simple: it creates an AUTORLN.SYS file
for use with BASIC XL. More importantly, it allows you
to specify one or more commands or statements which
BASIC XL will execute on power-up.

We will not explain this program on a line-by-line
basis, because the bulk of the program is so simple. It
simply allows you to type in one line after another
until you either enter a blank line (RETURN only) or
you run out of room (you are allowed up to 159
characters, including RETURNs). It then writes out a
new AUTORUN.SYS file by (1) reading the machine
language program, including the run address, from some
hex data statements and then (2) writing out your
commands in a format acceptable to DOS's binary file
loader.

Perhaps the only other thing worth mentioning is the
fact that your commands are written out backwards (the
FOR loop of lines 77Ø to 79Ø) to make the job of the
machine language program easier. When AUTORUN.SYS is
loaded by DOS, your backward commands will start at
location $Ø6Ø1, preceded by a byte containing their
total length less one (line 75Ø). Again, this is all to
make the machine language program smaller and simpler.

Normally, we use AUTORUN.SYS to just cause BASIC XL to
RUN our menu program. In other words, we respond to
this program's prompt with

      RUN "D:MENU.BXL"

However, you may choose any commands you wish. For
example, suppose you had a very large program you
wished to run on power up, but you want the user to
know that the loading delay was normal. There are two
solutions to that: (1) Have AUTORUN.SYS run a small
program which simply prints a "please wait" message and
then chains to the larger program, (2) Let AUTORUN.SYS
do all the work, by answering its prompts like this:

      GRAPHICS 16:POSITION 4,11
      PRINT#6;"please wait"
      RUN "D:MYPROG.BXL"

Why not? About the only statements you can't use via
AUTORUN.SYS are those which might affect page six
(e.g., POKEs) or the device handler table (at $Ø31A).
Try it out yourself.

The BASIC XL Programming Environment

9.3 BASIC XL Extended Statements

9.3.1 How to Install the Extended Statements

Because BASIC is usually an interpreted language, it is
no more flexible than the keywords with which it is
endowed. When we at OSS designed BASIC XL, we wanted a
true interpretive BASIC with a reasonable amount of
power and speed. However, we also wanted a degree of
flexibility unmatched in most versions of the language.
Hence the ability to add statements to the language was
included, even though no such "extended" statements
existed. Until now!

This release of The BASIC XL ToolKit includes six new
extended statements for you to use in your own
programs. The statements added fall into two groups:
(1) procedure calls and (2) string array sorting.
Before describing the new statements (in sections 9.3.3
and 9.3.4, respectively), we need to discuss how these
extended statements are added to BASIC XL.

If you request a directory of the reverse ("flip") side
of your BASIC XL ToolKit disk (via BASIC XL's DIR
command), you will find the file

        EXTEND.COM

and it is this file which contains the code which
implements the extended statements.

There are several ways to begin using the extended
statements. The easiest way is to simply duplicate that
flip side of your ToolKit disk and boot the resultant
copy. (Again, please don't use your original disk for
anything other than making duplicates. Thank you.)

The reason booting that flip side works is that, in
addition to EXTEND.COM, we have provided you with an
AUTORUN.SYS program which incorporates both the
extensions (identical code to that in EXTEND.COM) and a
BASIC XL command invoker identical to that provided by
MAKEAUTO.BXL (see section 9.2.1Ø). In the version on
your disk, we have given this MAKEAUTO equivalent only
one command:

        RUN D:EXTEND.BXE

In turn, EXTEND.BXE is a very, very short program. We
list it here in its entirety:

        1Ø Graphics 18 : Position 2,12
        2Ø Print #6; "...please wait..."

168

```
3Ø Move $57Ø,$C4,4
4Ø Run "D:MENU.BXL"
```

The only important line here is line 3Ø, the MOVE
statement. NOTE CAREFULLY: even after the extended
statements have been loaded into memory, they must be
made available to BASIC XL. This is accomplished by
placing pointers to their execution and syntax tables
in $C4-$C5 and $C6-$C7. This has to be done after BASIC
XL issues the Ready prompt, because BASIC XL always
clears these locations to zero upon a coldstart (e.g.,
at power-on). Note the other implication of this: if,
later, you convince BASIC XL to undergo a coldstart
(either by exiting to DOS and performing a LOAD of some
kind or, as some programs do, by POKEing the warmstart
flag off), you must once again perform this MOVE or the
extended statements will not be available to you.
(Actually, if you exit to DOS and LOAD or run some
program, the chances are good that you should then LOAD
EXTEND.COM again, since most disk-based programs will
overwrite the memory used by the extensions.)

Another way to implement the extensions was just hinted
at: you may, from virtually any DOS, simply LOAD
EXTEND.COM and then enter the BASIC XL cartridge. If
you are using a menu-driven DOS, choose the appropriate
menu options to do the LOAD and enter the cartridge. If
you are working with OS/A+ or DOS XL, you may simply
type

```
EXTEND
CARTRIDGE
```

in response to the D1: prompts (and, in turn, these
commands could be part of a STARTUP.EXC file -- see
your DOS XL manual). If you enter BASIC XL in either of
these ways, you will be presented with the Ready
prompt. In order to use the extended statements, you
will have to use a MOVE $57Ø,$C4,4 command as was given
above.

The final way to implement the extensions which we will
explore here is a variation on the first one. Simply
replace the program EXTEND.BXE with your own program of
the same name. If you keep the MOVE statement in your
program, and if it is executed before you use any
extended statements, this will work just great.
Probably the easiest way to customize EXTEND.BXE to
your own purposes would be to simply change the name of
the program to RUN in line 4Ø.

Remember: the DOS given you on this disk has neither
menu nor command processor. It is only capable of
booting a disk with an AUTORUN.SYS file present. You
may, however, COPY all or some of the files on this

disk to another one which has your preferred version of
DOS already on it.

Without further ado, then, let us proceed toward the
descriptions of the extended statements.

9.3.2 Abbreviations Used In Formal Statement Definitions

The following are the abbreviations used in the formal
format definitions of the following sections (an
abbreviation marked with an asterisk is new; others are
consistent with the BASIC XL Reference Manual):

avar   **a**rithmetic **var**iable, neither a string nor an
          array.

          Examples: TOTAL   I   J   XØ

svar   **s**tring **var**iable, either a string array or
          simple string, distinguished from an avar by a
          trailing dollar sign.

          Examples: NAMES$ SA$

          Note that one, two, or three subscripts are
          often used between the parentheses following
          an svar. For the special case of an svar used
          to satisfy the requirement for a pvar or cvar
          (see be low), no paren theses may be used.

savar   **s**tring **a**rray **var**iable, same format, etc., as
          svar but must be a properly dimensioned array.

mvar   **m**atrix **var**iable, numeric array, distinguished
          from an avar by a trailing left parenthesis.

          Examples: VALUES()   SCORES()

          Note that one or two subscripts normally
          appear between the parentheses following an
          mvar. For the special case of an mvar used to
          satisfy the requirement for a pvar or cvar
          (see below), nothing may appear between the
          parentheses.

aexp   **a**rithmetic **exp**ression, any valid combination
          of numeric value, operators, etc.

          Examples: 33   7+VALUE   SCORE(3*J)

* rparm   **r**eceiving **par**ameter, either an avar or an
           exclamation point followed by an svar or mvar.

           Examples: TOTAL   !NAMES$!VALUES()

* cparm   **c**alling **par**ameter, either an aexp or an
           exclamation point followed by an svar or mvar.

           Examples: 29*SIN(3Ø)   !TEMP$!AMAX()

slit   **s**tring **lit**eral, a string of characters
           enclosed in quotation marks.

           Examples: "TOTALIZE"   "Test-->>"

* pname   **p**rocedure **name**, used to identify a procedure,
           always consists of only an slit.

* cname   **c**alling **name**, used to name a procedure to be
           CALLed, may be either a slit or svar. If a
           svar is used, it may not be a string array and
           may not use any subscripts.

Remember: words in a format definition which are given
in all capital letters (e.g., USING) must be entered
exactly as shown. Items in square brackets are
optional. Items with ellipses following may be repeated
as desired. Example: rparm [,rparm,...] implies that
you may use one or more receiving parameters.

9.3.3 Procedure Blocks and Related Statements

Before describing the individual statements, we present
an overview of PROCEDUREs in BASIC XL.

If you have programmed at all in any dialect of BASIC,
you have used the GOSUB statement and its companion,
RETURN. For example, you might see a program which
looks something like that which follows. (This program
is for demonstration purposes only, but it is a fairly
amusing little thing to spring on an unsuspecting
friend.)

```
2Ø Value=1ØØ
3Ø Min=1Ø : Max=9Ø : Gosub 1ØØ
4Ø Result1=Num
5Ø Min=1Ø*Value : Max=9Ø*Value : Gosub 1ØØ
6Ø Result2=Num
7Ø If Result2 > Value*Result1 Then 9Ø
8Ø Print "You appear to be conservative in nature." : End
9Ø Print "You seem ready to take risks." : End
1ØØ Rem THE SUBROUTINE
```

```
110 Print: Print "Please give me a number between "; Min
120 Print" and "j Max ;
130 Input ", inclusive > ",Num
140 If Num>=Min And Num<=Max Then Return
150 Print "Can't you read? That number is"
160 Print" out of the range I gave you."
170 Goto 100
```

And, in a small program like this one, that usage of GOSUB may be just fine. As programs get larger, though, lines such as GOSUB 3250 become less and less meaningful. Atari BASIC (and thus BASIC XL) allows you to do something like this:

```
10 Let Getinrange=100
20 Value=100
30 Min=10 : Max=90 : Gosub Getinrange
   (etc.>
```

Do you see what we did? By giving a name to the subroutine, we can make our code more readable. A disadvantage to this method is that BASIC XL (in common with Atari BASIC) allows only 128 unique variable names. Using a variable like this to name a subroutine diminishes the pool of available names. This, then, is the first advantage of BASIC XL's new procedures: because we use a literal (quoted) string to name them, we need waste no variables! For example:

```
20 Temp=100
30 Call "Get In Range" Using 10,90 To Result:
50 Call "Get In Range" Using 10*Temp,90*Temp To Result2
70   If Result2 < Temp*Result1 : Type$="conservative"
80   Else: Type$="a risk taker"
90   Endif
95 Print "You Seem to be "; Type$; " by nature." End
100 Procedure "Get In Range" Using Min,Max
110 Local Temp: Temp=1E90
120   While Temp<Min Or Temp>Max
130     If Temp<>1E90 : Print
140     Print "Can't you read? That number is"
150     Print "   out of the range I gave you."
160     Endif
170   Print : Print "Please give me a number between "; Min
180   Print "  and "; Max ;
190   Input " , inclusive > ",Temp
200   Endwhile
210 Exit Temp
```

Confused? Not too surprising. Let's take a look at the new lines a step at a time. First, in line 30, note the CALL to the PROCEDURE named "Get In Range" (which starts at line 100). Note how clear that CALL is, since

we can use any characters we like in the string. That's pretty easy, right?

But what about that USING which appears in both the CALL and PROCEDURE statements? In line 3Ø, we are "Using" values of 1Ø and 9Ø. But in line 1ØØ, we are "Using" the variables Min and Max. Isn't that neat? We didn't have to do the assignments to the variables before we called the subroutine: CALL does the work for us! It automatically moves the values (1Ø and 9Ø) into the corresponding variables (Min and Max). This is called "passing parameters" to a PROCEDURE.

It gets better. Notice the EXIT statement of line 21Ø. It specifies a value (the contents of Temp) which is to be placed in to the variable Result1 that follows the TO in the CALL statement. That's reasonable, right? If you Can "pass" parameter values, you should be able to "return" parameter values.

But doesn't using the variable Temp in the procedure subroutine wreak havoc on its later use in the main program (e.g., in line 6Ø)? Ah, but there's line 11Ø, with ts deceptively simple-looking LOCAL statement. Between the use of LOCAL Temp and the EXIT statement, the old value of Temp is saved for you. When EXIT is executed, all LOCAL variables are automatically restored to their previous values. Wow! And Whew!
The example we just worked through used all of the new PROCEDURE-oriented extended statements:

    PROCEDURE
    CALL
    LOCAL
    EXIT

By no means, though, did we use all of the capabilities of these 5tatements. In addition to the formal definitions which will follow, we will present further examples both in the text and in programs on the disk.

We have presented these statements before the formal definitions because they are all closely related, and we felt that having a small but effective demonstration of their use would make it easier to understand the definitions.

9.3.3.1 PROCEDURE (PROC.)

Format: PROCEDURE pname [USING rparm [.rparm...]]

Examples:

```
1000 Procedure "Calculate Pay" Using Hours,Rate,Taxtable()
 387 Procedure "Print Msg" Using !Msg$
4040 Procedure "Quit"
```

The PROCEDURE statement is the nucleus around which the
other statements in its group are built. It is used to
define the beginning of a subroutine which is intended
to be executed via a CALL statement.

A PROCEDURE must be given a name, which may be any set
of ATASCII characters enclosed in quotation marks, the
number   of   characters   being   subject   only   to   the
limitation   that   the   entire   line   must   be   of   legal
length. Note in the examples above how spaces have been
used   in   the   PROCEDURE   names   to   add   clarity   to   the
program. As a matter of good programming style, you
should make the names as self-explanatory as possible,
shortening them only if you begin to run out of memory.

When a CALL statement is executed, it places an entry
on the Run-Time Stack (the same stack used by GOSUB,
FOR, WHILE, and their partners). This entry serves to
identify the fact that a PROCEDURE statement has been
encountered,   and   its   subroutine   (which   we   will   here
call the "procedure block") is now in control. When the
PROCEDURE   statement   itself   is   executed,   then,   it
ignores its own name and does nothing further to the
Run-Time   Stack.   Unless,   that   is,   the   user   has
specified that one or more parameters are being passed
via the USING keyword.
If USING is coded, it must be followed by one or more
variable names. If the variable names refer to string
variables,   string   arrays,   or   numeric   arrays,   the   name
must be preceded by an exclamation point (!). No matter
which   kind(s)   of   variable(s)   is/are   used,   when
PROCEDURE   is   executed,   their   current   "values"   are
pushed onto the Run-Time Stack. Then, after the values
have been pushed, the new values as specified in the
CALL   which   invoked   this   procedure   block,   are   copied
into these same variables.

When working with simple numeric variables, this is a
fairly straight-forward process. Take the following set
of statements as an example:

```
10 Junk=20
20 CALL "Test" USING 12*17
30 Print Junk
40 End
```

```
      ...
7Ø PROCEDURE "Test" Using Junk
8Ø Print Junk+Junk
9Ø Exit
```

In this example, when the PROCEDURE named "Test"·at
line 7Ø is invoked and the statement is executed, the
current value of the variable Junk (2Ø, as assigned in
line 1Ø) is pushed on the Run-Time Stack. Then the
value of the expression (12*17, or 2Ø4) is copied into
Junk. Any subsequent references to Junk will find that
it contains this new value. For example, the Print of
line 8Ø will display the value 4Ø8.

The effect of pushing the prior value of Junk is
simple: when the EXIT statement (line 9Ø) is executed,
it will discover the value that was pushed on the stack
and restore Junk to its prior condition. Thus the Print
of line 3Ø will display the value 2Ø. (The EXIT
statement is discussed in more detail in section
9.3.3.4.)

The purpose of all this pushing may be less clear.
First, by "reusing" the variable name Junk in our
procedure block, we are conserving our precious names
(remember, we are allowed only 128 different names in a
program). Since the value of the variable is restored
on EXIT from the block, we need not worry about
changing it within the block. Second, and perhaps more
difficult to grasp from this simplistic example, we are
able to pass values "into" the procedure block without
having to be aware of what names are used within it.
The example which introduced this chapter shows this
feature to some advantage and also serves to
demonstrate how the resultant code can be both smaller
and more readable.

For strings and arrays used as PROCEDURE parameters,
the methodology is the same, but the results are more
complex. The difficulty lies in understanding just what
is the "value" of a string or array. In Atari BASIC and
BASIC XL, the value of any variable is the content of
its entry in the Variable Value Table. This table
reserves eight (8) bytes per variable and consists of a
flag byte, the variable's number (Ø through 127), and
six bytes of "information".

In the case of simple numeric variables, the
information is the numeric value of the variable,
expressed in an internal floating point form. (You may
consult the Atari Technical Manuals or COMPUTE!'s Atari
BASIC Source Book for much more detail on the structure
of these and other tables.)

For string and array variables, the flag byte indicates
that the "information" describes the location and

characteristics of the contents of the variable. For example, a simple string variable needs information about its address (within string/array space), its dimension, and its current length. The string itself (the "contents" of the variable from an external point of view) is located at the given address. Arrays (both string and numeric) need an address and two dimensions instead; but, again, the actual "contents" are found at the given address.

Thus, when we push the "value" of a string or array variable on the Run-Time Stack, we are pushing this information about where the actual contents are located in memory. Similarly, when we copy a value passed by the CALL statement into one of these variables, we are not copying the actual string or array. Instead, we are copying the address, dimension, etc., as appropriate. Consider this sequence:

```
1Ø Fun$="Swimming is fun." : X$ = "Right?"
2Ø CALL "What Fun" USING !Fun$
3Ø Print Fun$, X$
4Ø End
   ...
6Ø PROCEDURE "What Fun"·USING !X$
7Ø Print Fun$, X$
8Ø X$(1,5)="Laugh"
9Ø EXIT
```

Hopefully. you will actually try this little program. If so, you will find that line 7Ø shows that, as we have described above, the "value" of Fun$ has been copied into X$. Line 7Ø will display:

```
Swimming is fun. Swimming is fun.
```

The real surprise comes when line 3Ø is executed (following the successful EXIT in line 9Ø). The resultant display is:

```
Laughing is fun.    Right?
```

Do you see why? If the value of Fun$ is copied to X$, then the address of the contents of Fun$ is now in X$'s address entry with its value in the variable table. Thus, any change we make in the string pointed to by X$ affects the memory at that address and thus affects the contents of Fun$. Complicated, yes?

A similar action takes place when a string array or numeric array is passed as a parameter: changes in the contents of the PROCEDURE's parameter affect the contents of the CALLer's parameter.

Technical Note: In computer lingo, simple numeric variables are passed to a procedure block via a "call by value". Arrays and strings, on the other hand, are passed via a "call by reference". The exclamation point required by the syntax of the extended statements can be used as a reminder that these are calls by reference, something not hitherto seen in BASIC XL. (Actually, the exclamation point is necessary so that the expression evaluator can make the distinction between an expression — which could, for example, start with a string or array reference — and one of these special calls by reference.)

9.3.3.1.1 Secondary Considerations
----

(1) You may, if you wish, pass too many numeric parameters to a PROCEDURE. BASIC XL makes no check for matching number of parameters. It does, however, insist on a type match. Thus this sequence will cause a "USING Type Mismatch" error:

```
4Ø1Ø CALL "Gorp" USING 33
     ...
72B9 PROCEDURE "Gorp" Using !A$
```

If the CALL passes too many parameters, the excess are ignored. If it passes too few, a numeric value of zero (Ø.Ø) is assigned to all remaining PROCEDURE parameters. This, in turn, can cause a type mismatch, since only numeric variables may receive a numeric value.

Exception to the last paragraph: If the CALL passes no parameters, BASIC XL does nothing at all to the parameter passing area. This is on purpose, since passing parameters takes time . Thus, even a PROCEDURE expecting only numeric parameter(s) may report a mismatch error, since it attempts to obtain those parameters from the miscellaneous data left in the parameter area. Generally, we recommend passing the correct number of parameters unless you have a specific purpose which can use the "default" feature to a real advantage.

(2) You must be careful when changing the value of a simple string passed as a parameter. Recall that the length of a CALLing string variable is found in its variable value table entry, and that the entry is copied intact to the PROCEDURE's string variable. If you then change the length of the string within the procedure block, it will indeed change the PROCEDURE variable's entry. However, when you EXIT, the entry is not automatically copied back to the CALLer's variable! This can produce some bizarre results.

To demonstrate: modify line 8Ø of the last example program to read

```
8Ø X$="Laugh" : Print X$
```

Not surprisingly, the new Print in line 8Ø shows us that the contents of X$ are simply "Laugh". However, look at the display resulting from line 3Ø:

```
Laughing is fun.    Right?
```

Do you see the problem we warned of? Changing X$ in line 8Ø changed the memory at the address which Fun$ also used for its contents, but it did not change the length of Fun$. Presumably, this could be a feature under the right circumstances, but there are stranger consequences possible. For example, try changing line 8Ø to read

```
8Ø X$="XXX"
```

Now line 3Ø's Print will display

```
XXXmming is fun.    Right?
```

which is almost surely not we wanted.

One solution to this situation is simply to avoid changing a passed string within a procedure block. This may not be satisfactory, though, so we have provided another mechanism which you can use to circumvent the problem: Change lines 2Ø and 9Ø in the original program to read

```
2Ø CALL "What Fun" USING !Fun$ TO !Fun$
9Ø EXIT !X$
```

EXIT will be discussed in more detail in section 9.3.3.4, but suffice to say that this sequence guarantees that the complete new value of X$ is copied back to Fun$. On this same topic, you may be relieved to know that the difficulty with length does not exist with arrays, either of strings or numeric values.

(3) One way to get in real trouble with either strings or arrays is to pass back (via EXIT) one which was not passed in as a CALLing parameter. Examine the following program excerpt:

```
1ØØ CALL "Oops" To !A$
11Ø CALL "Oops" To !B$
12Ø Print AS,B$ : End
    …
3ØØ PROCEDURE "Oops"
31Ø Input "Type something: ",Line$
32Ø EXIT !Line$
```

If you enter and RUN this program, giving a different response each time you are prompted, you will be surprised at the results of the PRINT of line 12Ø: A$ and B$ will be identical (up to the length of the shorter), taking on the value of your second INPUT. If you recall our discussion of what actually gets passed when a string or array is involved, this seemingly bizarre result can be explained.

When you pass LINE$ back to the CALLer, you are actually transferring the contents of LINE$'s variable value table entry to first A$ and then to B$. But that table entry consists (among other things) of LINES's address. Thus you end up with all three variables pointing to the same piece of memory!

Once again, the proper solution is to pass a string both in via USING and back out via EXIT. For arrays (of either strings or numbers), you need only pass the value in, since anything the PROCEDURE does to a parameter array is properly reflected in the CALLer's original value(s).

The only way you can get in trouble with arrays is if you pass an undimensioned array to a procedure block which then dimensions it. Unless you pass back the "value" via EXIT (similar to the fix for strings just given above), the space dimensioned within the block is simply lost, since no variable will any longer be referring to it via the address portion of its entry in the variable value table.

When in doubt, then, pass strings and arrays both ways. It can't hurt. It may help.

(4) Finally, another caution. A PROCEDURE must be the first statement on a line. CALL can not find a PROCEDURE if is not at the beginning of a line. Strange and wondrous and woefully unpredictable things can happen if you violate this rule.

Similarly, you should never allow a program to "fall through" to a PROCEDURE. Always make sure that the program immediately preceding each PROCEDURE finishes with a GOTO, STOP, END, RETURN, or EXIT statement. We recommend grouping all procedure blocks at one spot in your program and ensuring that they are preceded by an END statement.

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9.3.3.2 CALL

Format: CALL cname [USING cvar[,cuar...]] [TO pvar[,pvar...]]

Examples: 1Ø CALL "Test"
           72Ø CALL "Totals" USING !Values() TO Sum
           8ØØ CALL "Get Num' TO Number
           1ØØ CALL Proc$ USING 7,!A$ TO Result

The CALL statement has been discussed and demonstrated
in both the introduction to this chapter and in the
explanation   of   the   PROCEDURE   statement   (section
9.3.3.1). In this section, then, we will not dwell on
such   things   as   the   mechanics   of   parameter   passing.
Rather   we   will   discuss   the   subtleties   of   the   CALL
statement itself.

First, unlike a PROCEDURE statement, the name specified
by a CALL may be contained within a string variable
instead of being a string literal (see the last of the
above example lines). However, you have no other choice
of   format   than   that   shown.   You   may   use   neither   a
substring nor an element of a string array as a CALLed
name. (This stricture was necessary for consistency, in
order to allow the syntax to be as close as possible to
that of PROCEDURE. The alternative was using a comma
instead   of   the   word   USING.)   This   is   not   an   onerous
restriction,   though,   as   the   great   bulk   of   all   calls
will probably be made with litera1 strings.

For those rare occasions where you wish to choose one
of several PROCEDUREs based on the value of some index,
may   we   suggest   a   program   format   similar   to   the
following:

     3Ø Input "Give me an index > ",Index
     4Ø Name$=Proc$(Index;) : CALL Name$

Remember,   also,   that   the   name   which   you   CALL   with
(whether literal or variable) must match exactly that
given in a PROCEDURE statement. All characters are
considered in the match (including leading or trailing
spaces), with upper case, lower case, and inverse video
all distinct.

Second,   we   remind   you   of   the   possible   problem
associated with using a string variable as a CALLing
parameter (if its length is modified in the procedure
block, the length change is not visible to the CALLer
—- see section 9.3.3.2). Generally, it is good form to
always code a simple string variable as both a calling
and returning parameter, thus:

     999 CALL "Invert String" USING !Gorp$ TO !Gorp$

Similarly, any array which may not be dimensioned at the time of the CALL should receive the same treatment. Recall our earlier cautions, also: DIMensioned arrays need not be passed back to the CALLing routine, but they must be passed in as parameters.

9.3.3.2.1 Secondary Considerations

The number of levels you may nest CALLs is limited only by the amount of FREe memory left in your system which may be used by the Run-Time Stack. Like GOSUBs and WHILEs, each CALL uses four (4) bytes of Run-Time Stack space. Each parameter passed (either expression value or string/array reference) occupies 12 bytes. A demonstration of the implications of these facts may be found in the example programs in section 9.4 (see especially the FACTORIAL program).

CALLs are slow when compared to GOSUB line-number in BASIC XL's FAST mode. However, when compared to normal GOSUBs in slow mode, they may actually be just a bit faster if they do not pass parameters. Parameter passing can, indeed, slow things down remarkably. But, when you compare it to the method of doing several assignments before a GOSUB followed by one or more afterward, it may actually save time in some situations.

Within a CALLed procedure block, you must never attempt to POP the parameter variables. You can cause a sytem crash if you POP a variable with the wrong value. Only if a procedure block has neither parameters nor LOCAL variables may you safely POP the CALL itself. We recommend that you do not use POP anywhere in a procedure block unless absolutely necessary.

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9.3.3.3 LOCAL

      Format: LOCAL avar [,avar...]

      Examples: 73Ø LOCAL Temp1
                137Ø LOCAL Sum,N,Count,Misc

The LOCAL statements has been provided to allow you
more   flexibility   in   your   programming.   While   the
parameter   received   by   a   PROCEDURE   are   automatically
made   local   to   that   procedure   block,   there   are   many
times   when   you   need   a   simple   variable   to   hold   a
temporary value, such as the result of a calculation, a
flag, etc. LOCAL gives you such temporary variables.

LOCAL works in a very simple fashion. When a LOCAL
statement is excuted, all simple arithmetic variable
names (no strings or arrays allowed) following it are
"pushed" onto BASIC XL's run-time stack (the same stack
which receives GOSUBs, FORs, CALLs, etc.). Then, when a
subsequent   EXIT   is   encountered,   all   such   LOCAL
variables   are   pulled   back   off   the   stack   and   put   in
their original places. The effect of this is simple yet
powerful: within the bounds of LOCAL and EXIT, you may
change   the   value   of   any   of   these   variables   to   your
heart's   content   without   worrying   about   whether   some
other routine in your program is using a variable with
the same name.

A simple example will help:

      1Ø Test=1234567 : Print 1Ø,Test
      2Ø Gosub 4Ø : Print 2Ø,Test
      3Ø End
      4Ø Local Test : Print 4Ø,Test
      5Ø Test=Ø.54321 : Print 5Ø,Test
      6Ø Exit

Note   that   PRINT   statements   purposely   display   the
current line number as well as the value of Test. This
is   simply   to   make   tracing   the   flow   of   the   program
easier. Does it surprise you to find that the output of
the above program will look something like this?

      1Ø   1234567
      4Ø   1234567
      5Ø   Ø.54321
      2Ø   1234567

Let's examine that program a little closer. First, line
1Ø   is   simple   enough.   We   just   assign   a   value   to   the
variable and verify that it has been accepted. In line
2Ø, we first GOSUB to a routine and then again display
the   contents   of   our   variable.   Note   that   in   the
program's running this PRINT of Test is the last thing
executed (other than END).

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Line 4Ø, then, begins the interesting part of this program. We declare that Test is a LOCAL variables and, once again, display its value. Line 5Ø is a repeat of line 1Ø except that we assign a different value to our variable. Note that the PRINT verifies our change. Finally, in line 6Ø, we use another new statement, EXIT, to restore our variable to its original value, as shown by the PRINT in line 2Ø.

Once again, the point of all this was that our subroutine (lines 4Ø through 6Ø) could do what it liked with the now-LOCAL variable without affecting its value in the rest of the program.

9.3.3.3.1 Secondary Considerations

Some things are made obvious in the above program which (1) LOCAL does not have to be used in conjunction with (2) The value of a variable which is made LOCAL does because of the push onto the Run-Time stack. We will points in order.

The fact that LOCAL may be used with GOSUB-typ" subroutines is not an accident. EXIT was specially constructed to examine what invoked its subroutine and handle the returning condition appropriately (either GOSUB or CALL only, though). This small fact alone may allow you to change many programs to use LOCAL without the need to modify all GOSUBs·to CALLs.

Also, there are occasions where it could be advanta-geous to use GOSUB instead of CALL. In particular, GOSUB to an absolute line number is significantly quicker when your program is·in FAST mode than any other type of subroutine access. (A mild warning, though: LOCAL does occupy precious processing time, so you may do best to use truly unique variable names in a routine which must be super fast.)

Our second point, the fact that variables do not change value when they are made LOCAL can actually be used to advantage in a few cases. Try the following small example program:

```
1Ø Input "An integer greater than 1, please >> ",N
2Ø Sum=Ø : Gosub 5Ø
3Ø Print "The sum of integers from 1 to ";N;" is ";Sum
4Ø End
5Ø Local N
6Ø Sum = Sum+N
7Ø If N=1 Then Exit
8Ø N=N-1 : Gosub 5Ø
9Ø Exit
```

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To follow what happens here, assume that we choose a
value of 3 for our integer. The first time lines 5Ø
through 7Ø are executed, then, Sum will take on the
value of 3 and, since N is not 1, we continue on to
line 8Ø. There N is given a value of 2 (one less than
its current value), and we again call the subroutine at
line 5Ø.

The second time through, the same things happen: Sum
acquires a value of 5 and we do not yet do the Exit of
line 7Ø. In line 8Ø, N's value changes to 1 and line 5Ø
is called once again.

This third time performing the same lines sees lines 5Ø
and 6Ø performing as before, with Sum getting a new
value of 6. In line 7Ø, though, since N now has a value
of 1 we do take the Exit. We return to the Gosub of
line 8Ø, fall through to line 9Ø, return to line 8Ø
again, fall through to line 9Ø again, and (at last!)
return to the original Gosub of line 2Ø.

9.3.3.4 EXIT

      Format: EXIT [cparm [,cparm...]]

      Examples: 39Ø EXIT 1Ø*Maxvalue
                799 EXIT Flag,!Names$
                2499Ø EXIT !Inverse() ,Rows,Columns
                835 EXIT

If you have been reading this instruction manual in
front to back order, you have encountered several
examples of the use of EXIT by now. If you have not, we
refer you to sections 9.3.3, 9.3.3.2, and 9.3.3.3 for
some illustrative examples.

Just as Return is a partner to Gosub, so is Exit a
partner to Call. Every Procedure which you invoke via
Call must end with an Exit statement.

Exit performs three functions, in the following order :
(1) If there are any parameters after the Exit keyword,
they are placed into BASIC XL's parameter-passing area,
for use by the TO-keyword's processing (which is, in
turn, part of the work which Call does). (2) If there
are any variables on the run-time stack (either as a
result of using a local statement or needing to save
the parameter variables of a Procedure), Exit must
restore them to their proper places in the variable
value table. (3) Exit checks to see whether the current
subroutine was invoked via Call or Gosub. If via the
latter, Exit simulates the action of a Return
statement; otherwise, it performs the special
processing needed to allow TO to access its parameters
(if any).

9.3.3.4.1 Secondary Considerations

In common with the other stack pulling statements
(Return, Endwhile, Next), if Exit discovers a For on
the Run-Time stack which doesn't "belong" there, it
ignores it (e.g., it "throws it away") and tries the
next entry on the stack. For example, the following
program will not cause an error:

```
10 Gosub 50
20 End
50 Rem === Subroutine ===
60 For I=1 To 5
70 Exit
```

Even though the For loop started in line 60 has not
finished (and is thus still sitting on the stack), Exit
has no trouble finding that its subroutine was called
via the Gosub of line 10.

On the other hand, this program will cause a 'nesting'
error because While can only be terminated by Endwhile!

```
10 Gosub 50
20 End
50 Rem === Subroutine ===
60 While 1 : Rem (a never ending loop)
70 Exit
```

Another thing to be careful of is that no error will
result if an Exit statement tries to pass parameter
values back to a Gosub. Instead, they are simply
ignored. (The reason for this, again, is that the
cartridge BASIC XL is not prepared for such things, so
it does not check for them.)

Similarly, if you pass back too many parameters to a
Call, the excess ones will be ignored. This design
allows a single Procedure to serve more than one
function, returning more values to some Callers than to
others. Remember, though, that all parameters expected
by the TO portion of a Call statement must be matched
by type by the parameters of Exit (e.g., a string
variable to a string variable, a numeric expression to
a numeric variable). The matching needed is the same as
that needed by parameters passed to a Procedure via a
Call. See section 9.3.3.1 for more details.

Since you can never properly Pop variables, you may not
use Pop in a subroutine which uses either local
variables or Procedure parameter variables. Thanks to
the fact that Exit may return a parameter value, we
find little need to use Pop in these circumstances
anyway. A better method is illustrated here:

```
1Ø While
15 Call "Demo 1"
2Ø Endwhile
   ...
5Ø Procedure "Demo 1"
55 N=Random(8) : Call "Demo 2" Using N To Flag,Inverse
6Ø If Flag Then Exit
65 Print "The inverse of ";N;" is ";Inverse
7Ø Exit
   ...
85 Procedure "Demo 2" Using Value
9Ø Trap 95 : Exit Ø,1/Value
95 Exit 1
```

The trick in this program is embodied in lines 9Ø to
95. In line 9Ø, we first set up a Trap to line 95, in
case an error occurs. But where can an error occur?
Certainly not in the evaluation of the zero following
the Exit. But what about when we evaluate 1/Value? If
Value is zero, this expression will cause overflow, an
error condition. If the error occurs, the Trap will
send us off to line 95, where we simply return the flag
value of one, indicating failure.

Line 6Ø is where we check the value of the returned
flag. If it is non-zero, we immediately Exit rather
than displaying the results. Do you see why this is
cleaner than using a Pop statement? Aside from the fact
that the flow of the program becomes much more
readable, we could add man y local variables at any
point in this program without adversely affecting its
functioning.

This concludes our presentation of the BASIC XL ToolKit
extended statements which relate to Procedure blocks.
See also section 9.4 for discussions of the example
programs provided on your ToolKit disk.

9.3.4 Sorting String Arrays

Apart from the PROCEDURE blocks described in section 3.3, the only extended BASIC XL statements included with this ToolKit are those which allow you to easily sort a string array. There are two such statements, SORTUP and SORTDOWN, which are described formally in sections 9.3.4.1 and 9.3.4.2 (respectively). However, since both sorting statements have many foibles in common, we thought it best to begin with some comments and hints about their use.

First and foremost, note that SORTUP and SORT DOWN can only be used to sort string arrays. In their simplest form, they are extremely easy to use. For example, consider the following short program:


```
1Ø Dim Array$(5,2Ø)
2Ø For I=1 To 5 : Input Array$(I;) : Next I
3Ø Sortup Array$
4Ø For I=1 To 5 : Print Array$(I;) : Next I
5Ø Run
```

This program simply allows you to INPUT five strings, sorts them, and then shows the sorted order. At this time, we would like to suggest that you boot a copy of side 2 of your master ToolKit diskette. Then type in this program and try it out. (Keep it around. We will use it more later.) Give several sets of common and uncommon words as answers. Note how neatly it sorts the words into ascending order.

Or does it? Try entering some words in upper case and some in lower case. What happens? Does it surprise you to find that "ZOO" comes "apple"? Actually, the reason for this behavior is readily understood once you realize that SORTUP works on characters using ATASCII ordering (ATari version of ASCII, the American Standards Code for Information Interchange —- how's that for a mouthful). For a list of ATASCII codes as they relate to your computer's keyboard, see Appendix D of the BASIC XL Reference Manual.

Even if we restrict ourselves to the "printable" characters in the ATASCII set (usually the numbers, upper and lower case letters, and standard typewriter-style symbols —- codes numbered 32 through 124 in the manual), we find no real help. Numbers come before upper case letters which come before lower case letters, but symbols are intermixed in no real useful fashion.

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Because the effects of this hodgepodge ordering may not
be desirable in a sorted list, you may wish to limit a
SORTUP or SORTDOWN to work with only part of each
element of a string array. For example, if you have an
array where each string within it contains both a
person's name and their phone number, you may wish to
perform a sort based solely on names. Further, to
ensure that the sorted order is consistent, you may
wish to ensure that the names being sorted are stored
as upper case letters only.

Fortunately, the design of SORTUP and SORTDOWN is good
enough that sorting based on "fields" (portions of each
element in the string array) is extremely easy. And,
while BASIC XL does not provide a built-in method of
obtaining upper-case-and-non-inverse-video-only strings,
it isn't very hard to build a routine which will do the
real work for you. For example, the following PROCEDURE
converts all characters in its parameter string (not a
string array) to non-inverse video and converts lower
case letters to upper case:

```
8ØØ Procedure "To Upper" Using String$
81Ø Local I,Temp
82Ø For I=1 To Len(String$)
83Ø   Temp=Asc(String$(I)) & $7F
84Ø   If Temp>$6Ø And Temp<$7B Then Temp=Temp & $5F
85Ø   String$(I,I)=Chr$(Temp)
86Ø Next I
87Ø Exit
```

For now, don't enter that subroutine.

Instead, let's investigate the concept of " fields", as
mentioned above. Just change line 3Ø in that little
program we typed in earlier so that a LIST gives you
the following:

```
1Ø Dim Array$(5,2Ø)
2Ø For I=1 To 5 : Input Array$(I;) : Next I
3Ø SORTUP Array$ USING j 3,5
4Ø For I=1 To 5 : Print Array$(I;) : Next I
5Ø Run
```

Once again, enter some strings in response to INPUT's
prompt. This time, though, pay special attention to the
third through fifth characters of each string. Notice
any thing funny about the sorted order? That's right,
it is based solely on the characters in those posi-
tions. If you have worked with BASIC XL string arrays
at all yet, the notation in line 3Ø may be both famil-
iar and confusing. Perhaps changing line 4Ø as follows
will allow us to clarify the meaning of line 3Ø:

```
4Ø For I=1 To 5 : Print Array$(I;3,5),Array$(I;) Next I
```

This little example should serve to remind you that you
may reference characters within an element of a string
array just as easily as you may reference them in an
ordinary string. The "magic" character is the semi-
colon. It separates the array element number from the
desired· character positions. (And, as the second usage
of ArrayS in that same line shows, the semi-colon is
always necessary when referring to an element of a
string array.)

Now, since the SORTUP of line 3Ø refers to the entire
array, String$, there is no need for the following
parentheses (and, indeed, they are not allowed).
Instead, the keyword USING tells BASIC XL that we will
be working with only part of the array and/or its
elements. In particular, the semi-colon following USING
again serves as a reminder that the numeric expressions
following it refer to character positions within an
element (or, more properly when using SORTUP or
SORTDOWN, within all elements) of a string array.

By the way, as a simple variation on what we have done
so far, you might change line 39 to read:

```
    3Ø SORTDOWN Array$ USING ; 3,5
```

Again, try it out. Not too surprised by the results?
Good. The only difference between SORTUP and SORTDOWN
is where the "top" of the sort (the "largest" string)
appears.

There is one last capability of the sorting statements
which we will discuss before moving on to other helpful
hints. The program we have been working with seems all
fine and good if we wan t to enter exactly five
elements into the array. Suppose, though, that we did
not know how many elements we would be working with.
Fear not, BASIC XL's extended statements shall provide.
Time for another example:

```
    1Ø Dim String$(2Ø,2Ø)
    2Ø For I=1 To 2Ø : Input String$(I;)
    25 If Len(String$(I;)) Then Next I
    3Ø Sortup String$ Using 1,I-1
    4Ø For J=1 To I-1 : Print String$(J;) : Next J
    5Ø Run
```

The first change you will notice is in lines 2Ø and 25.
Instead of blindly continuing to ask for INPUT until 2Ø
items have been entered, the program only goes back for
another if the length of the current item is non-zero.
That means that you may stop entering items at any time

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by hitting the RETURN key alone in response to any
INPUT prompt.

And look at SORTUP in line 3Ø. Can you guess what Using
1,I-1 is for? That's right, only the first I-1 elements
of the array will be sorted! And if, for some reason,
you wanted to never sort the first element of the
array, you could have coded

```
3Ø Sortup String$ Using 2,I-1
```

(Why would you ever do that? Well, maybe you keep
special information about a file in the first "record"
of the file, thus having the actual data start at the
second "record".) In fact, you are not limited as to
which elements may be sorted other than having to
follow two rules: (1) The maximum element number to be
sorted must be greater than or equal to the minimum
element number. (2) Each number must be within the
bound of the array, as dimensioned.

Naturally, we have to give you the last of the possible
variations on SORTUP (and, similarly, on SORTDOWN). We
won't explain this. Just type it in and try it:

```
3Ø Sortup String$ Using 1,I-1 ; 2,4
```

Now for some hints.

We already noted that it is probably a good idea to
restrict the contents of a normal alphabetic field to
upper-case, non-inverse characters only. Suppose,
though, that you really want to sort some numbers. What
can you do? A program such as the following will not
work:

```
1Ø Dim String$(5,2Ø)
2Ø For I=1 To 5 : Input N : String$(I;)=Str$(N) : Next I
3Ø Sortup String$
4Ø For I=1 To 5 : Print String$(I;) : Next I
5Ø Run
```

Why not? Well, try some numbers in response to the
INPUT prompts and see what happens. May we suggest
values of 1, 11, 111, 2, and 22 for your test. When we
tried those numbers, BASIC XL told us that the order
was

```
          1
          11
          111
          2
          22
```

If you think about the ATASCII values of those characters (and they are characters, since they are in a string) for a bit, you will realize that those are the proper results. The problem, then, is to make numbers appear in a string in a fashion such that the sort statements can handle them.

We could present a complete solution here, but we leave that for a program on the ToolKit disk (called SORTNUM.BXL. We will, however, consider at least the case of sorting positive integers, which may cover all the cases you will ever need.

```
1Ø Dim String$(5,1Ø)
2Ø For I=1 To 5 : Input N : String$(I;)="ØØØØØØØØØØ"
25 String$(I;11-Len(Str$(N))) = Str$(N) : Next I
3Ø Sortup String$
4Ø For I=1 To 5: Print String$(I;) : Next I
5Ø Run
```

We have altered line 2Ø and added line 25. The trick here is not too terribly obscure: We first fill the pertinent element of the string array with place-holding zeroes. Then we position our integer at the proper location within that field of zeroes. Since all numbers (as represented in ATASCII) are now the same length, it is only the significant digits which affect the sort process. Try it and see.
Note that there is no protection in this program to keep you from entering a number which is not a positive integer. Purists might add line 22:

22 If N<>Int(N) Or N<Ø Or N>=1E1Ø Then Print "Bad number":Stop

And, if you prefer a neater looking numeric print-out, you can change line 4Ø to:

4Ø For I=1 To 5 : Print Val(String$(I;)) : Next I

We at OSS can see many uses for SORTUP and SORTDOWN. Again, we invite you to peruse the sorting demo programs on the ToolKit disk. Perhaps you can find a use for some of the techniques in your own programs.

9.3.4.1 SORTUP

Format: SORTUP savar [USING [aexp TO aexp] [;aexp,aexp]]

Examples: SORTUP Stringarray$
          SORTUP Array$ USING Min TO Max
          SORTUP X$; 1,4
          SORTUP X$ Using 5 To 1Ø ; 4,8

This statement will sort selected elements of a
specified string array in ascending order, based on the
contents of a selected portion (a "field") of each
element of the array. Unless otherwise specified by the
user, the field of each element which forms the basis
for the sort shall consist of the entirety of each
element. Unless otherwise specified by the user, all
elements of the array will be selected to be sorted.

The user may choose the beginning element of the range
of elements to be sorted by coding the keyword USING
followed by an arithmetic expression. If a beginning
element is so specified, an ending element must also be
given by an arithmetic expression following the keyword
TO.

The user may choose the beginning position of the field
in each element which forms the basis of the sort by
coding a semi-colon followed by an arithmetic
expression. If a beginning position is so specified, an
ending position must also be given by an arithmetic
expression following a comma. If a range of elements
was not selected by the user (see preceding paragraph),
the keyword USING must precede the semi-colon.

Secondary considerations: (1) The sort is done in
ascending ATASCII order. (2) If the length of an
element is less than the ending position of the field
being used as the basis of the sort, the field shall be
shortened accordingly. This condition applies
regardless of whether the field is specified implicitly
or explicitly. (Note that if two compared fields are
equal except that one is longer than the other, the
longer one is greater than the shorter one. This is
intuitively correct as well as being consistent with
string comparisons made with other BASIC XL statements
and operations.)

9.3.4.2 SORTDOWN

Format: SORTDOWN savar [USING[aexp TO aexp] [;aexp,aexp]]

Examples: SORTDOWN Stringarray$
          SORTDOWN Array$ USING Min TO Max
          SORTDOWN X$; 1,4
          SORTDOWN X$ Using 5 To 1Ø ; 4,8

This statement will sort selected elements of a
specified string array in descending order, based on
the contents of a selected portion (a "field") of each
element of the array. Unless otherwise specified by the
user, the field of each element which forms the basis
for the sort shall consist of the entirety of each
element. Unless otherwise specified by the user, all
elements of the array will be selected to be sorted.

The user may choose the beginning element of the range
of elements to be sorted by coding the keyword USING
followed by an arithmetic expression. If a beginning
element is so specified, an ending element must also be
given by an arithmetic expression following the Keyword
TO.

The user may choose the beginning position of the field
in each element which forms the basis of the sort by
coding a semi-colon followed by an arithmetic
expression. If a beginning position is so specified, an
ending position must also be given by an arithmetic
expression following a comma. If a range of elements
was not selected by the user (see preceding paragraph),
the keyword USING must precede the semi-colon.

Secondary considerations: (1) The sort is done in
descending ATASCII order. (2) If the length of an
element is less than the ending position of the field
being used as the basis of the sort, the field shall be
shortened accordingly. This condition applies
regardless of whether the field is specified implicitly
or explicitly. (Note that if two compared fields are
equal except that one is longer than the other, the
longer one is greater than the shorter one. This is
intuitively correct as well as being consistent with
string comparisons made with other BASIC XL statements
and operations.)

9.4 Example BASIC XL Programs with Extended Statements

This section gives examples of programs written using
the extended statements presented in section 9.3. Three
of the programs here (those in sections 9.4.1, 9.4.2,
and 9.4.3) are "brand new", presenting aspects of the
extended statements which are very difficult to
duplicate in BASIC XL (or any BASIC) without the unique
capabilities of the extended statements. Of necessity,
then, their descriptions are somewhat detailed.

The other three programs are retreads of three of our
old friends from section 2. We present them again here
to show you how you can turn a hard-to-read program
riddled with GOSUBs into a well structured exercise.
For these programs, only the significant differences
from their originals are noted. You are invited to
peruse the descriptions in section 9.2 for details on
other parts of these programs.

9.4.1 FACTOR.BXE

For such a short program, this will be a rather long
explanation. The program given here is actually one of
the classic ones used to show how recursion works: We
calculate the factorial of a number by repetitive calls
to a procedure.

Now, actually, this is a fairly inefficient way to
calculate a factorial. Perhaps the simplest way is the
following little program:

```
1Ø Input "Give me a positive integer> ",N
2Ø P=1
3Ø For I=1 To N: P=P*I: Next I
4Ø Print N; "! is "; P
```

So if all you want is the factorial of a number, use
the above routine and forget about the demo on the
disk. But if you want to understand how recursion
works, read on.

If you will examine a listing of FACTOR.BXE, you will
find the first part, lines 1ØØ through 22Ø, rather
ordinary and mundane. The possible sole exception is
the CALL to the Factorial procedure, where we pass in a
number and expect a result.

But now look at the Factorial procedure itself. If you
recall our discussion of procedure parameters and local
variables in section 9.3.3, you probably aren't too
surprised to find the name used in the main routine
reused here in the procedure. Recall also that the

effect of using an arithmetic variable either as a parameter (i.e., Number in this example) or as a local variable (i.e., Result) is that, upon Exit from the Procedure, its original value is restored. Now, there isn't really any reason to use these same variable names again in this program other than as a teaching mechanism, but its a fairly effective mechanism.

Well, once we get past the Procedure and local declarations, there isn't much left to the routine, so let's examine it in close detail.

Since the main code ensured that we would, indeed, use a positive integer for Number, we know that we have a number which will produce a valid factorial. Now, the factorial of 1 is 1, so line 28Ø makes sense: If the parameter is 1, then Exit with an answer of 1. Simple. Clean. Neat.

Just as an exercise, let's assume that we want the factorial of 3. Okay, Number is not 1, so we get to line 29Ø. How about that? We turn around and Call ourselves again, but this time our calling parameter has a value of 2 (...Using Number-1...). Let's keep going.

We're back at line 28Ø. But Number now has a value of 2, so we don't take the Exit here. Instead, we once again Call ourselves. Ready to keep going?

Back at line 28Ø, Number now has a value of 1. Aha! Finally, we get to Exit with a value of 1. But wait a minute? Certainly 3! is not 1, is it? Not to worry. Remember, the last time we called the procedure, we did so from line 29Ø, when Number had a value of 2. Okay, so we return back to that same line 29Ø, and Result gets a value of 1. Then we continue on to line 3ØØ, where we Exit with what?

Well, we just said Result is 1, and since Number had a value of 2 when line 29Ø made the call, that value has been restored by now (as we noted above). So Number*Result is 2*1, and we Exit with a value of 2.

But where do we Exit back to? Well, we got rid of the last of the calls on that last Exit, so this time we end up back at line 29Ø from the time we called with Number equal to 3, and Result gets a value of 2. By the same logic, we continue to line 3ØØ and Exit with 3*2.

This time, though, we have dispensed with all the calls except the original one, in line 19Ø, so that Result gets the Exit value of 3*2, or 6. Voila! 3! is truly 6, as we wanted.

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There was nothing magic about our choice of 3 for our
example. The principle holds no matter what the value
we use: Keep calling the procedure with successively
smaller values until the value reaches 1. Then start
Exiting back up the Call chain, multiplying as we go.
Terribly inefficient, but a beautiful example of
classical recursion at work.

So, do you see the advantage of truly local values, not
only for parameters but for other explicitly declared
variables? No? You think this was an artificially
created example? Well, just wait ... we have some more
realistic examples coming up.

Technical Sidelight: By the way, try to discover the
largest integer whose factorial can be represented
within your Atari's numeric range (it's less than 1ØØ).
Then try finding out what 1ØØ! is. Bang! You got
numeric overflow when the multiplies created a result
larger than Atari floating point can represent. But for
real fun, try finding out what 5ØØØ! is. Do you
understand why you got that error? Does it help if we
remind you that each local or parameter variable uses
12 bytes of memory? And that each Call itself uses 4
bytes? Hmmm ... how much memory does your machine have?
(To get rid of all that junk on the stack, just use the
CLR command from the Ready prompt level.)

9.4.2 SORTDIR.BXE

This isn't really a very exciting program. All it does
is read in a disk directory and then allow you to
choose which one of three ways you would like to see it
sorted. Its primary purpose is to show how you may sort
on different "fields" within the single "record" each
element of a a string array can represent.

1ØØ-24Ø Just the usual necessary set up. Note the names
        given to the console keys; obviously not a
        necessary step, but one which makes a prettier
        program. The FILES() array is dimensioned large
        enough to hold the largest directory a standard DOS
        2 disk will allow. If your DOS allows more files,
        or if the entries in the directory are longer, feel
        free to change the DIMensions.

26Ø, 6ØØ By now, you are used to seeing endless WHILE
        loops in our programs. The beginning of this loop
        may be in the wrong place for you. As is, it reads
        the directory in off the disk each time a new sort
        is done. This is so that you can change diskettes
        if you wish. It might have been better to at least
        give you a chance to tell the program that you have
        changed disks. Sounds like a good programming
        exercise for you to us.

270-340 This is an easy way to read in the directory. The LINES variable is not really needed –– you can INPUT directly into a string array element if you wish –– but it avoids having the "FREE SECTORS" line end up in the array. Just a small nicety.

Notice how we depend on the space in the second character position for each directory line except the "xxx FREE SECTORS" of the final line.

350-390 Self-explanatory. Actually, we could have special cased a directory with a single file (why bother to sort it?), but it isn't necessary.

400-480 After presenting the menu, a beep (PUT #0,253) reminds you to push a button. After you do, we clear the screen.

490-560 This is what we really wanted to demonstrate. Depending on which button you pushed, we SORTUP based on a particular field. The SORTUP statements of lines 500, 520, and 540 are identical except for the numbers following the semi-colon. Inspect a single line of the directory listing. Do you see how the numbers are the character positions within the line? Easy, isn't it.

Notice, also, that we do not sort the entire array. Rather, we only sort the part which holds valid directory entries. Also very easy, right?

588-648 Just a way to display the directory in two columns. The sorted listing reads down the first column and then down the second. It would have been easier to simply alternate, but this is easier to scan visually.

Again, feel free to modify this program to your liking.

9.4.3 SORTNUM.BXE

In the presentation of the sort statements in section 9.3.3, we discussed a way to sort integers by converting them into a consistent form in a string. This program presents a different and more general way to sort the floating point numbers which BASIC XL (and Atari BASIC) uses.

Performing this sort depends upon knowing the internal format of floating point numbers used by BASIC. The form is fairly simple: A single byte of sign and exponent followed by 10 BCD digits, two to a byte. The sign of the number is given by the uppermost bit of that first byte. The exponent is a power of 100 in what

is known as "excess-64" form. (That means that the true power of 100 has 64 added to it so that all exponents appear as positive numbers. To form the true exponent, then, subtract 64 from the byte after getting rid of the sign bit.)

If you study this format, you will discover a fortuitous occurrence: If you treat the six bytes of a positive number as if they were a string, positive numbers will automatically be sorted correctly by SORT UP and SORTDOWN. Truthfully, this is not a coincidence. Internal to BASIC, such consistency is used for comparisons (e.g., as when you code something like IF A>B THEN ...).

On the other hand, because negative numbers have that upper bit set, they will all sort as larger than any positive number! Oops, to say the least. Not only that, if you ignore the sign bit, the negative numbers look exactly like positive numbers, so they will be sorted in reverse order. And, finally, what about zero. Which consists of six bytes of $00? Well, it is now time to examine the program listing to see how we turned adversity to advantage.

150-160 The only reason for the DUMMY$ string is to provide an address for that single element numeric array. Recall that in BASIC XL (and Atari BASIC), string and array variables always use memory in the order they are DIMensioned. Thus the address of VALUE has to be one greater than the address of DUMMY$.

180 This array is actually going to hold our array of floating point numbers. In fact, notice that it is the same size as an array of 20 numbers. Of course we have to use a string array because SORTUP And SORTDOWN can only handle string arrays. That's only a minor inconvenience, as we shall see.

280, 360 We're going to generate, manipulate, and display 20 random numbers.

290 This is just to give each element of the array a LENgth of six. Otherwise, the sort process won't know how many bytes in each array element need sorting.

300 We generate random numbers in an arbitrary range, but one which is easy to view.

310-320 See how we move the six bytes of the floating pointer number into the element of the string array? Didn't know you could do that in BASIC?

33Ø All we do here is flip the state of the sign bit: if the number was positive, it is now negative; and vice versa. Note the effect of this: What were negative numbers will now sort as smaller than what what were positive numbers. Just think of that bit as representing a plus sign now, instead of a minus sign.

34Ø We count all the numbers which were negative. Don't worry why. We'll show you.

35Ø We Just display the numbers in an easy to view form. Mixed up bunch of digits, aren't they?

37Ø-38Ø, 41Ø-42Ø The only reason for these lines is so that you can see how fast the array is sorted. Pretty impressive, even if it is only 26 numbers. Feel free to try it with more.

39Ø Okay. This is obvious. Everything is now sorted very prettily. Except that playing games with that sign bit didn't fix the fact that the negative numbers will be sorted backwards.

4ØØ The magic. Because we kept track of the count of negative numbers, and because the SORTUP of line 39Ø put all the negative numbers before the positive ones in the array, this works! We simply re-sort the negative numbers in backward order via SORTDOWN. You'll simply have to RUN this program to believe it.

44Ø-49Ø This loop just displays the now sorted array. Note how we now have to flip the sign bit back to its original state before moving it back to VALUE(Ø) for printing. Not very hard, right? (Actually, we didn't have to flip the bit. We could have moved the number as is and then printed -VALUE(Ø) for the same effect. But the way shown is more orderly.)

That's it. The best part of this method is that you could easily incorporate the six byte 'field' of the floating point number into a longer "record" so that you could sort the array several ways, as we did in the last section.

9.4.4 GTIATEST.BXE

This is the first of our "conversions' from a standard
BASIC XL version to one using extended statements. In
the mainline code, line 1040 has been changed to a
CALL. The subroutine starting at line 9000 has been
turned into a PROCEDURE, and the variables used in it
have been made LOCAL (line 9080).

Now, truthfully, there was little incentive to change
this routine into a Procedure. What have we saved? The
variables are local, so they can get used for other
purposes elsewhere in the program. And since we Exit
with the test value, the caller doesn't have to aware
of name we use in the subroutine. Big deal.

No, the real reason we changed this program was once
again instructional. We just wanted to show how easy it
really is to use Procedures and write readable code.
There's more to come.

9.4.5 DISKIO.BXE

Another fairly simple conversion from the original
standard BASIC XL program . This time, though, there is
little more justification for using Procedures.

Just look at lines 9560, 9600, 9620, and 9660. What
could be clearer? Just think: You could have an entire
library of Procedures sitting around on disks. And you
could keep a listing of just the entry (Procedure) and
Exit lines. You almost wouldn't need any other
documentation, would you?

Watch how easy it is to use these routines if the code
from 9000 up is included in your code:

```
  10 Dim High$(128) : High$="00000000000"
   20 Call "Read Sector" Using 1,720,Adr(High$),1 To
Test
  30 Print "High score is ";Val(High$)
  40 Input "New high score ? ",High
  50 High$=Str$(High),Chr$($9B)
  60 Call "Write Sector" Using 1,720,Adr(High$),1 To Test
  70 Stop
```


If you included something like that in your code, you
could save the high score from a game in the usually
invisible sector 720. Cute?

Trickies in that code: We give High$ that initial value
so that it will have a valid LENgth (like BGET, direct

sector access doesn't change the length of a string). Similarly, we put a RETURN character into the string (line 5Ø) so that a later sector read and VAL() will find something to terminate the number.

Finally, we leave you with the thought that a sector holds 128 bytes. If you used a string array such as

    DIM High$(11,1Ø)

and then, in the Call used ADR(High$(1;))-2 (minus 2 so that we get the length bytes for the first element of the array), we could keep track of up to 1Ø high scores with, perhaps, 3 initials and up to 7 digits of score each. (Why not 11 scores, when we dimensioned the array to have 11 elements? Well, the actual size of that array in bytes is 11*(1Ø+2) or 132 bytes, where the +2 accounts for the length bytes in each element. But the sector can only hold 128 bytes, so we would be missing 4 bytes from the last element.)

9.4.6 PHONE.BXE

This last program "conversion" is our "Little Black Book" program from section 9.2.9. It was a monster as a standard program. It remains a monster using extended statements. But, perhaps, it is a more manageable monster now.

Actually, we changed the character of the program very little. And we even tried to keep all subroutines at or near the same line numbers. What we tried to do was change every GOSUB to a CALL. Now, we will admit that some of the routines didn't really need to be made into Procedures, but once again it is at worst an educational exercise.

We invite you to peruse especially the Procedures in lines 5ØØØ through 9999. What you might find most interesting is looking for the variables which we left global, those we did not pass as parameters. The most notable of these are strings used as field names (e.g., Last$) and file names (DBX$, DBF$). The hassle of making these into parameters every place they are used was fueled with the likelihood that in any application of this system you would most likely use only one data base file at a time. Result: they are left global.

On the other hand, look at the "Get Line" routine, lines 5ØØØ to 526Ø. Here was a great opportunity to pass a string both in and out, thus allowing us to put the edited line directly into the user's string variable space, no muss, no fuss. This same Procedure benefits by being able to easily call it with the

maximum number of characters you want to get as well as
a flag determining the fate of lower case letters.

And look at all the routines which use the variables
Temp1 and Temp2, which they inevitably make into LOCAL
variables. How nice it is to not have to worry about
possible conflicts in temporary variable usage anymore.

Similarly, "Make Index" starting at line 7500 shows off
its usage of parameters passed to it. Look at the Call
to it in line 20240. How nice to not be forced into
making variable names match!

Aside from all of that, you might look at the code in
lines 1570 through 1710. Notice how we build up two
string arrays with the names of our Procedures
carefully ensconced as elements therein. Then look at
line 2260 and lines 10250 and 10260. Do you see how we
can use a menu option to nicely choose even the correct
Procedure to call?

The most important aspect of all this, though, may be
that now the routines have been somewhat freed of the
tyranny of line numbers and variable names. Feel free
to copy them and use them in your own programs. Who
knows? You may be a budding data base programmer who
just hasn't had the right tools. Until now.

```
--------------------------------------------------
Appendix A:                      ERROR DESCRIPTIONS
--------------------------------------------------
```

ERROR
NUMBER DESCRIPTION

   1   While SET Ø,1 was specified, the user hit the
         BREAK key. This TRAPpable error gives the BASIC
         XL programmer total system control.

   2   All available memory has been used. No more
         statements can be entered and no more variables
         (arithmetic, string or array) can be defined.

   3   An expression or variable evaluates to an
         incorrect value. Example:

             An expression that can be converted to a two
             byte integer in the range Ø to 65535 (hex
             $FFFF) is called for and the given expression
             is either too large or negative.

                     A = PEEK(-1)
                     DIM B(7ØØØØ)

             Both these statements will produce a value
             error.

         Example:

             An expression that can be converted to a one
             byte integer in the range ~ to 255 hex(FF) is
             called for and the given expression is too
             large.

                     POKE 5ØØØ,75Ø

             This statement produces a value error.

         Example:

             A=SQR(-4)   Produces a value error.

   4   No more variables can be defined. The maximum
         number of variables is 128.

ERROR
NUMBER   DESCRIPTION

5   A character beyond the DIMensioned or current
      length of a string has been accessed. Example:

                1000 DIM A$(3)
                2000 A$(5) = "A"

      This will produce a string length error at line
      2000 when the program is RUN.

6   A READ statement is executed but we are already
      at the end of the last DATA statement.

7   A line number larger than 32767 was entered.

8   The INPUT or READ statement did not receive the
      type of data it expected. Example:

                1000 READ A
                2000 PRINT A
                3000 END
                4000 DATA 12AB

      Running this program will produce this error.

9   A previously DIMensioned string or array is
      DIMensioned again. Example:

                1000 DIM A(10)
                2000 DIM A(10)

      This program produces a DIM error.

10   An expression is too complex for BASIC XL to
      handle.   The   solution   is   to   break   the
      calculation   into   two   or   more   BASIC   XL
      statements.

11   The floating point routines have produced a
      number that is either too large or too small.

12   The line number required for a GOTO or GOSUB
      does not exist. The GOTO may be implied as in:

                1000 IF A=B THEN 500

      The GOTO / GOSUB may also be part of an ON
      statement.

ERROR
NUMBER   DESCRIPTION

13   A NEXT was encountered but there is no
     information about a FOR with the same variable.
     Example:

                   1ØØØ DIM A(1Ø)
                   2ØØØ REM FILL THE ARRAY
                   3ØØØ FOR I = Ø TO 1Ø
                   4ØØØ A(I) = I
                   5ØØØ NEXT I
                   6ØØØ REM PRINT THE ARRAY
                   7ØØØ FOR K = Ø TO 1Ø
                   8ØØØ PRINT A(K)
                   9ØØØ NEXT K
                   1ØØØØ END

     Running this program will cause the following
     output:

     Ø
     ERROR- 13 AT LINE 9ØØØ

     NOTE: Improper use of POP could cause this
     error.

14   The line just entered is longer than Basic can
     handle. The solution is to break the line into
     multiple lines by putting fewer statements on a
     line, or by evaluating the expression in
     multiple statements.

15   The line containing a GOSUB or FOR was deleted
     after it was executed but before the RETURN or
     NEXT was executed.

     This can happen if, while running a program, a
     STOP is executed after the GOSUB or FOR, then
     the line containing the GOSUB or FOR is
     deleted, then the user types CONT and the
     program tries to execute the RETURN or NEXT.
     Example:

                   1ØØØ GOSUB 2ØØØ
                   11ØØ PRINT "RETURNED FROM SUB"
                   12ØØ END
                   2ØØØ PRINT "GOT TO SUB"
                   21ØØ STOP
                   22ØØ RETURN

     If this program is run the print out is:

     GOT TO SUB
     STOPPED   AT LINE 21ØØ

ERROR
NUMBER   DESCRIPTION

            Now if the user deletes line 1000 and then
            types CONT we get

            ERROR- 15 AT LINE 2200

    16   A   RETURN   was   encountered   but   we   have   no
            information about a GOSUB. Example:

                        1000 PRINT "THIS IS A TEST"
                        2000 RETURN

            If this program is run the print out is:

            THIS IS A TEST

            ERROR- 16 AT LINE 2000

            NOTE: Improper use of POP could also cause this
            error.

    17   If when entering a program line a syntax error
            occurs, the line is saved with an indication
            that it is in error. If the program is run
            without this line being corrected, execution of
            the line will cause this error.

            NOTE: The saving of a line that contains a
            syntax error can be useful when LISTing and
            ENTERing programs.

    18   If when executing the VAL function, the string
            argument does not start with a number, this
            message number is generated. Example:

                        A = VAL("ABC") produces this error.

    19   The program that the user is trying to LOAD is
            larger than available memory.

            This could happen if the user had used LOMEM to
            change the address at which Basic tables start,
            or if he is LOADing on a machine with less
            memory than the one on which the program was
            SAVEd.

    20   If the device / file number given in an I/O
            statement is greater than 7 or less than 0,
            then this error is issued.

            Example: GET #8,A

ERROR
NUMBER   DESCRIPTION

21   This error results if the user tries to LOAD a
      file that was not created by SAVE.

22   This error occurs if the length of the entire
      format string in a PRINT USING statement is
      greater than 255. It also occurs if the length
      of the sub-format for one specific variable is
      greater than or equal to 6Ø.

23   The value of a variable in a PRINT USING
      statement is greater than or equal to 1E+5Ø.

24   In a PRINT USING statement, the format
      indicates that a variable is a numeric when in
      fact the variable is a string. Or the format
      indicates the variable is a string when it is
      actually a numeric. Example:

              PRINT USING "###",A$
              PRINT USING "%%%",A

              Will produce this error.

25   The string being retrieved by RGET from a
      device (i.e., the one written by RPUT) has a
      different DIMension length than the string
      variable to which it is to be assigned.

26   The record being retrieved by RGET (i.e., the
      one written by RPUT) is a numeric, but the
      variable to which it is to be assigned is a
      string. Or the record is a string, but the
      variable is a numeric.

27   An INPUT statement was executed and the user
      entered CTRL-C <RETURN>.

28   The end of a control structure such as ENDIF or
      ENDWHILE was encountered but the run-time stack
      did not have the corresponding beginning
      structure on the Top of Stack. Example:

              1Ø WHILE 1 : REM loop forever
              2Ø GOSUB 1ØØ
              1ØØ ENDWHILE

      ENDWHILE finds the GOSUB on Top of Stack and
      issues the error.

ERROR
NUMBER   DESCRIPTION

29   An illegal player/missile number. Players must
     be numbered from Ø-3 and missiles from 4-7.

3Ø   The user attempted to use a PMG statement other
     than PMGRAPHICS before executing PMGRAPHICS 1
     or PMGRAPHICS 2.

32   End of ENTER. This is the error resulting from
     a program segment such as:

     SET 9,1 : TRAP line# : ENTER filename

     when the ENTER terminates normally.

34   The second aexp in a RENUM or NUM command
     evaluated to zero, and an increment of Ø is
     invalid.

35   When RENUMbering, the maximum line (32767) was
     exceeded.

4Ø   You attempted to use a string variable as a
     string array variable, or visa versa. Example:

     DIM A$(3,29)
     A$="THIS CAUSES AN ERROR"

     would create this error.

```
      ----------------------------------------------------
      Appendix B:                         SYSTEM MEMORY LOCATIONS
      ----------------------------------------------------


             HEXADECIMAL
      LABEL   LOCATION      COMMENTS and DESCRIPTION
      -----   --------      -----------------------

      APPMHI    DE          Highest location used by BASIC XL
                            (LSB, MSB)

      RTCLOK  12,13,14      Screen Frame Counter (1/6Ø sec.)
                            (LSB, NSB, MSB)

      SOUNDR    41          Noisy I/O Flag (Ø=quiet)

      ATRACT    4D          Attract Mode Flag (128=Attract Mode)

      LMRGIN,  52,53        Left, Right Margin (Defaults 2, 39)
      RMRGIN

      RAMTOP    6A          Actual top of memory (page number)

      LOMEM    8Ø,81        BASIC XL low memory pointer

      MEMTOP   9Ø,91        BASIC XL high memory pointer (usually
                            same as APPMHI)

      FRØ      D4,D5        Value returned to BASIC XL from a USR
                            function (LSB, MSB)

      MEMTOP  2E5,2E6       OS top of available memory (LSB, MSB)

      MEMLO   2E7,2E8       OS low memory pointer (LSB, MSB)

      CRSINH   2FØ          Cursor Inhibit (Ø=cursor on)

      CHACT    2F3          Character Mode Register (4=vertical
                            reflect; 2=normal; 1=blank)

      CHBAS    2F4          Character Set Base Register

      ATACHR   2FB          Last ATASCII Character

      CH       2FC          Last keyboard key pressed (keyboard
                            matrix code)

      FILDAT   2FD          Fill data for graphics Fill (XIO)

      DSPFLG   2FE          Display Flag (1=display control
                            character)
```

```
        HEXADECIMAL
LABEL   LOCATION      COMMENTS and DESCRIPTION
-----   -----------   -----------------------


CONSOL  DØ1F          Console Keys (bit 2=OPTION;
                      bit 1=SELECT; bit Ø=START)

SKCTL   D2ØF          Serial Port Control Register (bit 2=Ø
                      if last key still pressed)
```

```
      $00  +----------------------------+
           |         OS Variables       |
      $80  +----------------------------+
           |    BASIC XL System RAM     |
      $CB  +----------------------------+
           |    Free BASIC XL RAM       |
      $D2  +----------------------------+
           |   ATARI Floating Point     |
           |        Registers           |
     $100  +----------------------------+
           |      Hardware Stack        |
     $200  +----------------------------+
           |        OS Variables        |
           |          IOCBs             |
     $3C0  +----------------------------+
           |      Printer Buffer        |
     $3E8  +----------------------------+
           |          OS RAM            |
     $3FD  +----------------------------+
           |      Cassette Buffer       |
     $480  +----------------------------+
           |    BASIC XL Stack and      |
           |  Miscellaneous Variables   |
     $57E  +----------------------------+
           |    ACTION! Hash Tables     |
     $680  +----------------------------+
           |         Free RAM           |
     $700  +----------------------------+
           |          DOS RAM           |
   (MEMLO) +----------------------------+
           | BASIC XL program, buffers, |
           |  tables, run-time stack.   |
  (APPMHI) +----------------------------+
           |         Free RAM           |
   MEMTOP  +----------------------------+
           |       Screen Memory        |
           | also optional P/M Memory   |
    $A000  +----------------------------+
           |    BASIC XL Cartridge      |
    $C000  +----------------------------+
           |      OS, ROMs, etc.        |
    $D000  +----------------------------+
           |     Hardware Registers     |
    $D800  +----------------------------+
           |  OS and Floating Pt. ROM   |
    $FFFF  +----------------------------+
```

```
--------------------------------------------------------
Appendix D:                          ATASCII CHARACTER SET
--------------------------------------------------------
```

ATASCII stands for "ATARI ASCII". Letters and numbers
have the same values as those in ASCII, others are
different.

Dec	Hex	CHARACTER		Dec	Hex	CHARACTER		DEC	HEX	CHARACTER
Ø	$ØØ	♥	á	32	$2Ø	■		64	$4Ø	@
1	$Ø1	├	ù	33	$21	!		65	$41	A
2	$Ø2	▌	ñ	34	$22	"		66	$42	B
3	$Ø3	┘	É	35	$23	#		67	$43	C
4	$Ø4	┤	ç	36	$24	$		68	$44	D
5	$Ø5	┐	ô	37	$25	%		69	$45	E
6	$Ø6	╱	ò	38	$26	&		7Ø	$46	F
7	$Ø7	╲	ì	39	$27	'		71	$47	G
8	$Ø8	◢	£	4Ø	$28	(		72	$48	H
9	$Ø9	▪	ï	41	$29	)		73	$49	I
1Ø	$ØA	◣	ü	42	$2A	✶		74	$4A	J
11	$ØB	▪	ä	43	$2B	+		75	$4B	K
12	$ØC	▪	ö	44	$2C	,		76	$4C	L
13	$ØD	▬	ú	45	$2D	−		77	$4D	M
14	$ØE	▬	ó	46	$2E	.		78	$4E	N
15	$ØF	▪	ö	47	$2F	╱		79	$4F	O
16	$1Ø	♣	ü	48	$3Ø	Ø		8Ø	$5Ø	P
17	$11	┌	â	49	$31	1		81	$51	Q
18	$12	─	û	5Ø	$32	2		82	$52	R
19	$13	┼	î	51	$33	3		83	$53	S
2Ø	$14	●	é	52	$34	4		84	$54	T
21	$15	▬	è	53	$35	5		85	$55	U
22	$16	│	ñ	54	$36	6		86	$56	V
23	$17	┬	ê	55	$37	7		87	$57	W
24	$18	┴	å	56	$38	8		88	$58	X
25	$19	▌	à	57	$39	9		89	$59	Y
26	$1A	└	Å	58	$3A	:		9Ø	$5A	Z
27	$1B		Ę	59	$3B	;		91	$5B	[
28	$1C	↑		6Ø	$3C	<		92	$5C	╲
29	$1D	↓		61	$3D	=		93	$5D	]
3Ø	$1E	←		62	$3E	>		94	$5E	^
31	$1F	→		63	$3F	?		95	$5F	_

Note: Columns with two symbols for one dec/hex value
show standard ATASCII to the left, and to the right the
symbol from the international character set available
with XL/XE computers.

Dec	Hex	CHARACTER		Dec	Hex	CHARACTER		DEC	HEX	CHARACTER
96	$60	◆	i	128	$80			160	$A0	
97	$61	a		129	$81			161	$A1	
98	$62	b		130	$82			162	$A2	
99	$63	c		131	$83			163	$A3	
100	$64	d		132	$84			164	$A4	
101	$65	e		133	$85			165	$A5	
102	$66	f		134	$86			166	$A6	
103	$67	g		135	$87			167	$A7	
104	$68	h		136	$88			168	$A8	
105	$69	i		137	$89			169	$A9	
106	$6A	j		138	$8A			170	$AA	
107	$6B	k		139	$8B			171	$AB	
108	$6C	l		140	$8C			172	$AC	
109	$6D	m		141	$8D			173	$AD	
110	$6E	n		142	$8E			174	$AE	
111	$6F	o		143	$8F			175	$AF	
112	$70	p		144	$90			176	$B0	
113	$71	q		145	$91			177	$B1	
114	$72	r		146	$92			178	$B2	
115	$73	s		147	$93			179	$B3	
116	$74	t		148	$94			180	$B4	
117	$75	u		149	$95			181	$B5	
118	$76	v		150	$96			182	$B6	
119	$77	w		151	$97			183	$B7	
120	$78	x		152	$98			184	$B8	
121	$79	y		153	$99			185	$B9	
122	$7A	z		154	$9A			186	$BA	
123	$7B	♠		155	$9B			187	$BB	
124	$7C	┃		156	$9C			188	$BC	
125	$7D	↖		157	$9D			189	$BD	
126	$7E	◄		158	$9E			190	$BE	
127	$7F	►		159	$9F			191	$BF	

Notes: Add 32 to upper case code to get lower case code
for same letter.

Characters from 128 to 255 are reverse colors of
1 to 127.

Dec	Hex	CHARACTER	Dec	Hex	CHARACTER
192	$CØ		224	$EØ	
193	$C1		225	$E1	
194	$C2		226	$E2	
195	$C3		227	$E3	
196	$C4		228	$E4	
197	$C5		229	$E5	
198	$C6		230	$E6	
199	$C7		231	$E7	
200	$C8		232	$E8	
201	$C9		233	$E9	
202	$CA		234	$EA	
203	$CB		235	$EB	
204	$CC		236	$EC	
205	$CD		237	$ED	
206	$CE		238	$EE	
207	$CF		239	$EF	
208	$DØ		240	$FØ	
209	$D1		241	$F1	
210	$D2		242	$F2	
211	$D3		243	$F3	
212	$D4		244	$F4	
213	$D5		245	$F5	
214	$D6		246	$F6	
215	$D7		247	$F7	
216	$D8		248	$F8	
217	$D9		249	$F9	
218	$DA		250	$FA	
219	$DB		251	$FB	
220	$DC		252	$FC	
221	$DD		253	$FD	
222	$DE		254	$FE	
223	$DF		255	$FF	

Note: To get ATASCII code, tell computer (direct mode) to PRINT ASC ("__"). Fill blank with letter, character, or number of code. Must use the quotes!

```
--------------------------------------------------------
Appendix E:            SYNTAX SUMMARY AND KEYWORD INDEX
--------------------------------------------------------


All keywords, grouped by statements and then functions,
are listed below in alphabetical order. A page number
reference is given to enable the user to quickly find
more information about each keyword.

EXPLANATION OF TERMS
--------------------


exp      - expression
aexp     - arithmetic exp
sexp     - string exp
var      — variable
avar     - arithmetic var
svar     - string var
mvar     - matrix var (or element)
fn       - file number
<stmts>  - one or more statements
filename - svar or string literal (quotes are optional
              except with LIST)
line     - line number (can be aexp)
pm       - Player/Missile number (aexp)
[xxx]    - xxx is optional
[xxx...] - xxx is optional, and may be repeated
addr     - address aexp, must be Ø - 65535

NOTE:Keywords  denoted  by  an  asterisk  (*)  are  not
      available in Atari BASIC.


STATEMENTS
----------


page     syntax
----     ------
49       *BGET #fn,addr,len
5Ø       *BPUT #fn,addr,len
21       BYE
5Ø       CLOAD
51       CLOSE #fn
21       CLR
91       COLOR aexp
22       CONT
23       *CP
51       CSAVE
51       DATA <ATASCII data>
72       DEG
22       *DEL line[,line]
12       *DIM svar(aexp [,aexp])
```

```
        The BASIC XL Programming Environment

        page     syntax
        ----     ------
        1Ø       DIM mvar(aexp [,aexp])
        52       *DIR [filename]
        23       DOS
        82       *DPOKE addr,aexp
        92       DRAWTO aexp,aexp
        4Ø       *ELSE {see IF}
        34       END
        4Ø       *ENDIF {see IF}
        46       *ENDWHILE
        52       ENTER filename
        53       *ERASE filename
        23       *FAST
        35       FOR avar=aexp TO aexp [STEP aexp]
        53       GET #fn,avar
        36       GOSUB line
        37       GOTO line
        87       GRAPHICS aexp
        39       IF aexp THEN <stmts>
        39       IF aexp THEN line
        4Ø       *IF aexp : <stmts>
                     ELSE : <stmts>
                     ENDIF
        54       *INPUT "...",var [,var...]
        53       INPUT [#fn,] var [,var...]
        41       *[LET] svar=sexp [,sexp...]
        41       [LET] avar=aexp
        41       [LET] mvar=aexp
        24       LIST [filename]
        24       LIST [filename,] line [,line]
        55       LOAD filename
        92       LOCATE aexp,aexp,avar
        24       *LOMEM addr
        55       LPRINT [exp [;exp...] [,exp...] ]
        25       *LVAR [filename]
        1Ø5      *MISSILE pm,aexp,aexp
        43       *MOVE fromaddr,toaddr,lenaexp
        25       NEW
        35       NEXT avar
        55       NOTE #fn,avar,avar
        25       *NUM [line] [,aexp]
        43       ON aexp GOTO line [,line...]
        43       ON aexp GOSUB line [,line...]
        56       OPEN #fn,mode,avar,filename
        93       PLOT aexp,aexp
        1Ø2      *PMCLR pm
        1Ø2      *PMCOLOR pm,aexp,aexp
        1Ø2      *PMGRAPHICS aexp
        1Ø4      *PMMOVE pm[,aexp] [;aexp]


        218
```

```
page    syntax
----    ------
1Ø5     *PMWIDTH pm,aexp
57      POINT #fn,avar,avar
83      POKE addr,aexp
44      POP
93      POSITION aexp,aexp
57      PRINT [#fn]
57      PRINT exp [ [;exp...] [,exp...] ] [;]
57      PRINT #fn [ [;exp...] [,exp...] ] [;]
58      *PRINT [#fn,] USING sexp, [exp [,exp...] ]
67      *PROTECT filename
63      PUT #fn,aexp
72      RAD
7Ø      RANDOM
63      READ var [,var...]
26      REM <any remark>
64      *RENAME filenames
27      *RENUM [start][,increment]
45      RESTORE [line]
36      RETURN
64      *RGET #fn, svar [,svar...]
64      *RGET #fn, avar [,avar...]
65      *RPUT #fn,exp [,exp...]
27      RUN [filename]
66      SAVE filename
28      *SET aexp,aexp
94      SETCOLOR aexp,aexp,aexp
97      SOUND aexp,aexp,aexp,aexp
66      STATUS #fn,avar
35      STEP {see FOR}
31      STOP
67      *TAB [#fn], avar
39      THEN {see IF}
35      TO {see FOR}
31      *TRACE
31      *TRACEOFF
45      TRAP line
67      *UNPROTECT filename
46      *WHILE aexp
67      XIO aexp,#fn,aexp,aexp,filename
57      ? {same as PRINT}
```

```
       The BASIC XL Programming Environment

       FUNCTIONS
       ---------

       page    syntax
       ----    ------
       69      ABS(aexp)
       81      ADR(svar)
       73      ASC(sexp)
       72      ATN(aexp)
       8Ø      *BUMP (pmnum,aexp)
       73      CHR$(aexp)
       69      CLOG(aexp)
       72      COS(aexp)
       81      *DPEEK(addr)
       82      *ERR(aexp)
       7Ø      EXP(aexp)
       74      *FIND(sexp,sexp,aexp)
       82      FRE(Ø)
       78      *HSTICK(aexp)
       7Ø      INT(aexp)
       75      LEN(sexp)
       7Ø      LOG (aexp)
       78      PADDLE (aexp)
       78      *PEN(aexp)
       81      *PMADR(pm)
       78      PTRIG(aexp)
       83      PEEK(addr)
       71      RND(Ø)
       71      SGN(aexp)
       72      SIN(aexp)
       71      SQR(aexp)
       79      STICK(aexp)
       79      STRIG(aexp)
       76      STR$(aexp)
       84      *SYS(aexp)
       84      *TAB(aexp)
       84      USR(addr [,aexp...])
       76      VAL(sexp)
       79      *VSTICK(aexp)
```

Appendix F: COMPATIBILITY WITH ATARI BASIC

Generally, BASIC XL is totally compatible with Atari
BASIC. Virtually all programs written in Atari BASIC
and SAVEd or CSAVEd thereunder will LOAD or CLOAD
properly with BASIC XL and run without changes.
However, in a few very subtle ways, there are minor
differences between Atari BASIC and BASIC XL. This
appendix presents a list of known differences, but OSS
cannot guarantee that it is an exhaustive list.

1. VARIABLE NAMES

When programs are SAVEd or CSAVEd under Atari BASIC and
then LOADed or CLOADed under BASIC XL, there will never
be a conflict in variable name usage. However, when a
program is LISTed from Atari BASIC and then ENTERed
into BASIC XL, or when a program listing published in a
magazine or book is typed into BASIC XL, it is possible
that BASIC XL will not accept lines of code which are
valid in Atari BASIC.

The reason, of course, is that BASIC XL has a much
richer range of keywords for statements and functions
than does Atari BASIC, and in neither language can a
variable name begin with a statement name unless it is
preceded with a LET keyword. To illustrate the problem,
let us examine the following valid Atari BASIC line:

          NUMBER = 7

Because NUM is a valid BASIC XL statement name, it will
now be seen by our syntax parsers as this:

          NUM BER=7

That is, it is seen as a NUM command with a starting
line number of (BER=7). Since you probably don't have a
variable named BER in your program, BER will not equal
7, so the statement becomes the equivalent of simply

          NUM Ø

which is certainly not what was intended.

In most cases, variable name conflicts such as this
will result in a syntax error. In this particular case
(and a few others), the result appears valid to BASIC
XL so no syntax error results. How can you detect such
problems easily? The easiest way is to examine the
LISTed form of the program. Since BASIC XL always lists
a space after every keyword, and since all keywords and
variables are listed in lower case except for the first

letter, it is often easy to spot discrepancies of this form.

In any case, the intent of the original Atari BASIC program can always be accomplished by simply placing the LET keyword in front of the offending variable, thusly:

```
LET NUMBER=7
```

In the case of array variables, the situation is both simpler and more complex. Only those variables which have EXACTLY the same name as a new BASIC XL function (such as BUMP or RANDOM) will be in conflict, so the number of offending names is much smaller. However, the only fix that can be made in these cases is to change the name of the variable, usually by simply adding a single character (e.g., change BUMP to BUMPS).

2. Upper and Lower Case, Inverse Video

Again, these problems will never occur with programs SAVEd in Atari BASIC and LOADed under BASIC XL. In order to make keyboard entry more flexible and more consistent, BASIC XL allows you, the programmer, to type your programs in with upper case letters, lower case letters, or even inverse video characters. BASIC XL accomplishes this by simply changing all such characters to their conventional normal video, upper case counterparts, excepting ONLY those characters enclosed in quote marks.

The only times that this makes any difference at all are (1) when the user types in a string and does not terminate it with a quote mark and (2) in DATA and REM statements where the user really desired the lower case or inverse characters. In either case, enclosing the desired characters in matching quotes will solve the problem (recall that BASIC XL supports quoted strings in DATA statements).

However, BASIC XL also provides a means of completely emulating Atari BASIC in this regard, should you wish. Simply use the command

```
SET 5,Ø
```

and all characters will remain unconverted. This is also handy when ENTERing programs LISTed from Atari BASIC.

This same SET has a secondary effect: when non-converting, upper case only entry is selected, then all LISTings will be in upper case only. This allows the BASIC XL user to LIST programs which will be compatible

with Atari BASIC's ENTER capability (providing, of course, that no advanced statements or functions were used in the code).

3. Programs Which RUN Too Fast

Of course, the fact that your programs will run faster is probably one of the primary reasons that you bought BASIC XL. And, generally, the speed-up provided is only beneficial.

A few programs, though, will depend on timing loops, etc., to run properly. There is no real "cure" for this ·problem". Hopefully, you will be able to play the faster games and/or read the faster messages.

A related problem has to do with the fact that BASIC XL always automatically executes a FAST command whenever it encounters a statement of the form

          RUN filename

(that is, ONLY when a filename is given in conjunction with RUN).

Many programs which run only somewhat faster with normal BASIC XL will run much, much faster when the FAST command is given. You may really find yourself with a game which is simply too fast to play.

There are two solutions. The first is simply to LOAD the program first and then issue a separate RUN command. If, however, you have an auto-booting disk or a program which chains to another program via RUN, this is not a practical solution. The second solution, then, is to simply hold down the SELECT button when the RUN is executed (which may imply holding the button for a while when an auto-booting disk is started). BASIC XL allows this usage of SELECT as a means of telling it to slow down.

4. Memory Locations

BASIC XL attempts to conform to all memory location usage published in any or all of the following books:

Atari BASIC Reference Manual,
     by Atari, Inc.

Operating System Source Listing for Atari 400/800,
     by Atari, Inc.
         (except that locations SIN, COS, ATAN, and SQR
         are incorrect, even for Atari BASIC)

The BASIC XL Programming Environment

De Re Atari,
      by Chris Crawford, et al

Mapping the Atari,
      from COMPUTE! Books

Master Memory Map,
      by Educational Software, Inc.

A few programs written by extremely knowledgeable
individuals have, in the past, made use of one or more
of the following unpublished facts about Atari BASIC:

(1) Atari BASIC uses certain memory locations only at
certain times. (2) Certain zero page memory locations
have special meanings to Atari BASIC. (3) Certain
subroutines, internal to Atari BASIC, are located at
certain addresses.

Obviously, it was impossible to add the features and
speed to BASIC XL which we did without adding code and
making more use of the memory reserved for BASIC.
Although we attempted to keep the changes to an
absolute minimum, we cannot possibly be responsible for
maintaining compatibility with programs which use such
undocumented and unpublished information.

May we remind you of the memory locations and map which
we presented in Appendices B and C. We invite
comparison of these with Appendices D and I in the
Atari BASIC Reference Manual. All usage is compatible.

Finally, for those who are experienced programmers, we
present here a list of all zero page locations which
ARE used in the same way by both Atari BASIC and BASIC
XL. Only addresses are given. Refer to a memory map
book or The Atari BASIC Sourcebook (published by
COMPUTE! Books) for descriptions of the locations'
uses.

              $8Ø to $92 $94 to $B3
              $B6 to $B8 $BA to $BB
              $C2 to $C3 $C8 to $C9
              $D2 to $FF

CAUTION: Some of these locations may be used by BASIC
XL for additional purposes, beyond (but compatible
with) the usages of Atari BASIC. These additional
purposes may imply use of the locations at times when
they were unused by Atari BASIC or even use of certain
bits left unmodified by Atari BASIC. It is suggested
that the user should not modify these locations, though
he might profitably use the information they contain.
Additionally, OSS reserves the right to change usage of

these locations if necessary for future corrections or improvements, though you may safely assume that those locations mentioned in "Mapping the Atari" will remain unchanged.

5. AUTOMATIC STRING DIMENSION

BASIC XL automatically dimensions strings to 4Ø characters. Again, this should have no effect on currently running Atari BASIC programs. If desired, you can use

        SET 11,9

to ensure total compatibility.

6. INDENTED LISTINGS

When BASIC XL lists a program, it automatically adds indentation for FOR...NEXT loops (and other control structures). This could only be a problem with long lines LISTed to disk and then re-ENTERed into BASIC. Again, you may use

        SET 12,9

to ensure compatibility and remove the indenting.

```
-------------------------------------------------------
Appendix G:                              BENCHMARKS
-------------------------------------------------------
```

These are the benchmark tests known from Compute!
(issue 57, February 1985, pp. 139-142), adapted to
BASIC XL.

INSIGHT: Atari by Bill Wilkinson
```
-----------------------------
```
I am much gratified by the response to my decision to
work harder on answering readers' questions. I have
received several very interesting letters with both
good comments and good questions. Since it is always
fun to defend Atari BASIC against the outside world,
let me start with a subject near and dear to my heart.

Benchmarks
```
----------
```
Several readers have asked me why Atari BASIC compares
so unfavorably to other computers on certain
benchmarks. The two most commonly mentioned are the
BYTE magazine benchmarks (September, 1981 BYTE
Magazine, pp. 18Ø-198) and the Creative Computing
benchmark invented by David Ahl (November, 1983
Creative Computing Magazine, pp. 259-26Ø). Stan Smith,
of Los Angeles, asked some very pointed questions,
which I will try to answer here.

The BYTE benchmark is reproduced below in Atari BASIC.
It is the often-mentioned "Sieve of Erastothenes," a
program which produces (and counts) prime numbers. Its
primary advantage as a benchmark is that it can be
implemented in virtually any language (although only
with much difficulty when using Logo and its ilk). It
relies only on addition and logical choices, with very
little number crunching.

```
    1Ø DIM N$(8192)
    2Ø N$="Ø":N$(8192)="Ø":N$(2,8192)=N$
    3Ø FOR I=1 TO 8192:IF N$(I,I)="1" THEN 6Ø
    4Ø PRIME=I+I+I:CNT=CNT+1:K=I
    5Ø K=K+PRIME:IF K<8193 THEN N$(K,K)="1":GOTO 5Ø
    6Ø NEXT I
    7Ø PRINT CNT : REM BETTER PRINT 1899!!!
```

An aside: If you have seen the BYTE original and are
puzzled by my changes, be aware of three things: (1) I
had to use a string because there is not enough room
for an array of 8192 elements. (2) The math was
modified very slightly to accommodate the fact that
string indices start at one, instead of zero. (3)
Multiple statements per line simplify the original
somewhat.

The BASIC XL Programming Environment

Anyway, why is Atari BASIC so slow (317 seconds versus, for example, the IBM PC at 194 seconds)? Primarily for three reasons. First, note all the numbers in this listing, which must be treated as integers. Line numbers and indices are always kept and calculated as floating-point numbers, but all must be converted to integers before being used. (You simply can't GOTO line 137.38, can you?) And, sigh, the routine in the Atari Operating System ROMs which converts numbers to integers is incredibly slow (in fact, it is the only floating-point routine we modified when we produced BASIC A+ and BASIC XL).

Second, Atari BASIC performs FOR-NEXT loops by remembering the line number of the FOR statement. Then, when NEXT is encountered, BASIC must search for the FOR line, just as if a GOTO had been used. (Other BASICS remember the actual memory address of the FOR statement. Faster, but less flexible. Atari BASIC allows you to STOP in the middle of a loop, change the program, and continue, something no other home computer BASIC allows. (This - among many other things - is in direct opposition to Consumer Reports' claim that Atari BASIC is hard for beginners.)

Third, if you type in and use this listing as shown, you are paying almost a 5Ø percent penalty in speed, thanks to Atari's screen DMA and Vertical Blank Interrupts taking up a significant portion of the processing time. The simple addition of the following two lines will improve the time for this little test to 211 seconds:

```
5  POKE 54286,Ø : POKE 54272,Ø
65 POKE 54286,64
```

All of a sudden, Atari BASIC isn't even near the bottom of the list. And, yet, there is more we can do to improve the machine's performance. As many have suggested, you can install the Newell Fastchip, a replacement for the floating point routines built into your computer (available from many dealers, produced by Newell Industries of Plano, Texas).

Or you can change to another BASIC. Obviously, there is Atari's Microsoft BASIC. It produces results very close to those of Applesoft; but it, too, can be improved by turning off screen DMA, etc. And there is OSS's own BASIC XL. Using a combination of clever programming and a Fastchip, the BASIC XL program below will count up all those prime numbers in 58.5 seconds, about three times as fast as Microsoft BASIC on an IBM PC can do it. 'Nuff said. (Except a P.S.: The Set 3 in line 1Ø requests zero-time FOR loops, something not available in many BASICs, which alone accounts for about 2Ø seconds worth of improvement. See section 3.15 for details.)

```
10 FAST: POKE 54286,0: POKE 542
   72,0: SET 3,1: DIM N$(8192):
   N=ADR(N$)
30 FOR I=0 TO 8191
50 IF NOT PEEK(N+I) THEN PRIME=
   I+I+3:CNT=CNT+1:FOR K=I+PR
   IME TO 8191 STEP PRIME: POKE
   N+K,1: NEXT K
60 NEXT I
70 POKE 54286,64: POKE 559,34:
   PRINT CNT
```

Measures Of Accuracy

The Ahl benchmark is listed below. It purports to measure both accuracy and number-crunching ability. It does neither very well. Still, we have to ask why Atari BASIC is near dead last in its rankings, requiring 6 minutes and 45 seconds to complete the test.

```
10 FOR N=1 TO 100: A=N
20 FOR I=1 TO 10: A=SQR(A): R=R
   +RND(0): NEXT I
30 FOR I=1 TO 10: A=A^2: R=R+RN
   D(0): NEXT I
40 S=S+A: NEXT N
50 PRINT "ACCURACY="; ABS(1010-
   S/5), "RANDOM="; ABS(1000-R)
```

The culprit here (in terms of time-wasting) is line 30, with its A=A^2. Atari BASIC, in common with most small computer BASICS, calculates powers according to a formula:

$$x^y = exp(y * log(x))$$

where log() is the natural logarithm function and exp() is the exponent-of-e function.

If you don't understand that, don't worry about it. The point is that the calculation of such a simple thing as a number to the second power involves the calculation of a logarithm and an exponentiation. And why is that so bad? Simply because the floating-point routines in the Atari OS ROMs are too slow. Again, the solution is to install the Newell Fastchip and/or turn off DMA and VBI (as outlined above).

I am indebted to Clyde Spencer, one of the founders of the Bay Area Atari Users Group (one of the oldest), for supplying me with a most surprising figure. Spencer reports that, using the Fastchip and with DMA turned off, he obtained a timing of 1 minute 38 seconds, a

very respectable (albeit not record-shattering) performance. I still wouldn't use my Atari for advanced scientific applications, but it is more than adequate for most purposes.

There is a problem with the "accuracy" figures in this test, however. First, because Ahl's accuracy number is the result of 1ØØØ simple sums, it is clearly possible that a particular machine may exhibit wildly variant results for various numbers and still show a good figure in his test. (To illustrate, assume that the SQR() function randomly tosses in an error of plus or minus one. If it tossed in an equal number of errors, they would balance to zero. Yet choosing to make the loop just one unit shorter [FOR N=1 TO 999] might give a completely different result. To be fair, this is a very unlikely result with modern math algorithms; but, still, one never knows.) A minor change to his program would improve the testing qualities considerably:

```
4Ø S=S+ABS(A-N):NEXT N
```

Do you see the difference? This method produces the sum of the errors, and doesn't fall prey to offsetting errors.

The Random Number Trap

There is no hope for the accuracy of this random number tester, though. I will quote Clyde Spencer on this matter: "If the numbers are truly random and not normally distributed, any difference between Ø and 1ØØØ is possible. All you can say is that you would have a high probability of ... being near zero for a perfect random number generator." The benchmark test falls into the infamous BASIC repeating-random-sequence trap.

In most BASICS, when you command a program to run, the pseudo-random generator is always reseeded with the same number. So each and every time you will get the same results, with Ahl's test. And, depending on what seed is chosen, you may get truly phenomenal results (because you happened to hit a hot spot in the generator's sequence). Now, though, try starting the generator off with a different (and randomly chosen) seed each time. What happens? The test's randomness figure wanders all over the place.

Once again, to quote Spencer...... in eight tests I obtained numbers ranging from 1.6 to 24.2, with the mean being 7.Ø2 ......

Finally, I would like to point out that Ahl's test penalizes small machine BASIC interpreters in yet another way: When you have 32K bytes to spend on a BASIC, one thing you do is insure that numbers to a

power are performed by successive multiplications, if possible. Thus Cromemco 32K Structured BASIC (for example) performs A^2 with just one multiply. In other words, it converts A^2 to A*A. If you manually substitute that same form in Ahl's program, the times for almost all of the smaller and less expensive machines will improve dramatically. (Surprisingly, though, the accuracy figures may not change. After all, the original version may have had offsetting errors.) Of course, if you need to use non-integer powers in your programs, this comment doesn't apply, and the benchmark's results are a bit more meaningful for you.

Well, what does all this long-winded discussion boil down to? Two simple points: (1) Always presume that a benchmark program is worth slightly less than the paper it is printed on. (2) If you want to do number crunching on your Atari computer (against my best advice), go out and buy the Newell Fastchip. (And it won't hurt to try some other languages.)

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