# Compaq BASIC for OpenVMS Alpha and VAX Systems

# Reference Manual

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This manual provides reference, syntax, and language element information for Compaq BASIC.

| | |
|---|---|
| **Revision/Update Information:** | This revised manual supersedes the *DEC BASIC and VAX BASIC for OpenVMS Systems Reference Manual.* |
| **Software Version:** | Compaq BASIC Version 1.4 for OpenVMS Alpha Systems<br><br>Compaq BASIC Version 3.8 for OpenVMS VAX Systems |
| **Operating System and Version:** | OpenVMS Alpha Version 7.1 or higher (with IEEE floating-point support); OpenVMS Alpha Version 6.1 or higher (without IEEE floating-point support); or OpenVMS VAX Version 5.5-2 or higher |

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The *Compaq OpenVMS* documentation set is available on CD-ROM.

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# Preface

*Compaq BASIC for OpenVMS Alpha* is the new name for DEC BASIC. *Compaq BASIC for OpenVMS VAX* is the new name for VAX BASIC. Any references to the former names in product documentation or other components should be construed as references to the Compaq BASIC names. Any references to BASIC or to Compaq BASIC apply to both products unless otherwise specified. References to the shortened names Alpha BASIC and VAX BASIC mean Compaq BASIC for OpenVMS Alpha and Compaq BASIC for OpenVMS VAX, respectively.

This manual describes BASIC language elements and syntax.

## Intended Audience

This manual is intended for experienced applications programmers who have a fundamental understanding of the BASIC language. Some familiarity with your operating system is also recommended. This is not a tutorial manual.

## Document Structure

This manual contains the following chapters and appendixes:

- Chapter 1 summarizes BASIC program elements and structure.
- Chapter 2 describes the environment commands (VAX BASIC only).
- Chapter 3 describes the compiler directives.
- Chapter 4 describes the statements and functions.
- Appendix A lists the ASCII codes.
- Appendix B lists the BASIC keywords.
- Appendix C discusses differences between Alpha BASIC and VAX BASIC.

Chapters 2, 3, and 4 provide reference material on each BASIC language element. The language elements are arranged in alphabetical order within these chapters; each language element begins on a separate page. The descriptions include the following sections:

| | |
|---|---|
| **Definition** | A description of what the statement or command does. |
| **Format** | The required syntax for the language element. |
| **Syntax Rules** | Any rules governing the use of parameters, separators, or other syntax items, effect of the statement or command on program execution, and any restrictions governing its use. |
| **Remarks** | Further explanations or restrictions about the statement or command. |
| **Example** | One or more examples of the statement in a partial program. Where appropriate, explanatory text and program output are included. |

## Platform Labels

A **platform** is a combination of operating system and central processing unit (CPU) that provides a distinct environment in which to use a product (in this case, a language). This manual contains information for the following language platforms:

- OpenVMS Alpha
- OpenVMS VAX

Information in this manual applies to both supported platforms, unless it is otherwise noted. Platform-specific information is noted in the manual as follows:

- Alpha BASIC refers to information that is correct for Compaq BASIC for OpenVMS Alpha systems.
- VAX BASIC refers to information that is correct for Compaq BASIC for OpenVMS VAX systems.

## Related Documents

For detailed information about developing, compiling, linking, and running BASIC programs, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

For additional information about OpenVMS products and services, access the following World Wide Web address:

`http://www.compaq.com/`

## Reader's Comments

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## Conventions

In this manual, every use of the name Compaq BASIC or the name BASIC applies to both Compaq BASIC for OpenVMS Alpha and Compaq BASIC for OpenVMS VAX software.

Table 1 shows the conventions used in this manual.

**Table 1 Conventions Used in This Manual**

| Convention | Description |
|---|---|
| $ | A dollar sign ($) represents the OpenVMS DCL system prompt. |

(continued on next page)

**Table 1 (Cont.) Conventions Used in This Manual**

| Convention | Description |
|---|---|
| Return | In examples, a key name enclosed in a box indicates that you press that key on the keyboard. (In text, a key name is not enclosed in a box.)<br>In the HTML version of this document, this convention appears as brackets, rather than a box. |
| Ctrl/*x* | The key combination Ctrl/*x* indicates that you must hold down the key labeled Ctrl while you press another key, for example Ctrl/Y or Ctrl/Z. |
| KP*n* | The phrase KP*n* indicates that you must press the key labeled with the number or character *n* on the numeric keypad, for example, KP3 or KP-. |
| PF1 *x* | A sequence such as PF1 *x* indicates that you must first press and release the key labeled PF1, then press and release another key. |
| *n* | A lowercase italic *n* indicates the generic use of a number. |
| . . . | A horizontal ellipsis in examples indicates one of the following possibilities:<br>• Additional optional arguments in a statement have been omitted.<br>• The preceding item or items can be repeated one or more times.<br>• Additional parameters, values, or other information can be entered. |
| . . . | A vertical ellipsis indicates the omission of items from a code example or command format; the items are omitted because they are not important to the topic being discussed. |
| ( ) | In format descriptions, parentheses indicate that you must enclose the options in parentheses if you choose more than one. |

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**Table 1 (Cont.) Conventions Used in This Manual**

| Convention | Description |
|---|---|
| [ ] | In format descriptions, brackets indicate optional elements; you can select none, one, or all of the elements. |
| { } | In format descriptions, braces indicate that one element in a list is required. You must choose one and only one from the list. |
| **boldface text** | Boldface text is used for the introduction of a new term. |
| *italic text* | Italic text represents parameters, arguments, and information that can vary in system messages (for example, Internal error *number*), as well as book titles and emphasized information. |
| UPPERCASE | Uppercase indicates the name of a command, routine, file, or file protection code, or the abbreviation for a system privilege. |

Table 2 defines mnemonics and other terms used in the syntax diagrams.

**Table 2 Mnemonics and Other Terms Used in Syntax**

| Term | Meaning |
|---|---|
| *angle* | Angle in radians or degrees |
| *array* | Array; syntax rules specify whether the bounds or dimensions can be specified |
| *chnl* | I/O channel associated with a file |
| *chnl-exp* | Numeric expression that specifies a channel number |
| *com* | Specific to a COMMON block |
| *cond* | Conditional expression; indicates that an expression can be either logical or relational |
| *cond-exp* | Conditional expression |
| *const* | Constant value |
| *data-type* | Data type keyword |
| *decimal-var* | Decimal variable |

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**Table 2 (Cont.) Mnemonics and Other Terms Used in Syntax**

| Term | Meaning |
|---|---|
| *decl-item* | Array, record, or variable |
| *def* | Specific to a DEF function |
| *delim* | Delimiter |
| *equiv-name* | File specification, device, or logical name to be assigned a logical name |
| *err-num* | Run-time error number |
| *exp* | Expression |
| *ext-routine* | External function |
| *external-param* | External parameter |
| *file-spec* | File specification |
| *func* | Specific to a FUNCTION subprogram |
| *int* | Integer value |
| *int-const* | Integer constant |
| *int-exp* | Expression that represents an integer value |
| *int-var* | Variable that contains an integer value |
| *label* | Alphanumeric statement label |
| *lex* | Lexical; used to indicate a component of a compiler directive |
| *lex-exp* | Lexical expression |
| *lex-var* | Lexical variable |
| *line* | Statement line; may or may not be numbered |
| *line-num* | Statement line number |
| *lit* | Literal value, in quotation marks |
| *log-exp* | Logical expression |
| *log-name* | 1- to 63-character logical name to be associated with *equiv-name* |
| *macro-id* | User identifier following the rules for BASIC identifiers |
| *map* | Specific to a MAP statement |
| *matrix* | Two-dimensional array |

(continued on next page)

**Table 2 (Cont.) Mnemonics and Other Terms Used in Syntax**

| Term | Meaning |
|---|---|
| *name* | Name or identifier; indicates the declaration of a name or the name of a BASIC structure, such as a SUB subprogram |
| *num* | Numeric value |
| *num-lit* | Numeric literal |
| *param-list* | Parameter list, such as for a SUB subprogram |
| *pass-mech* | Valid BASIC passing mechanism |
| *prog-name* | Program name |
| *real* | Floating-point value |
| *real-exp* | Real expression |
| *real-var* | Real variable |
| *rel-exp* | Relational expression |
| *relationship-type* | Oracle CDD/Repository protocol |
| *replacement-token* | Identifier, keyword, compiler directive, literal constant, or operator |
| *routine* | SUB subprogram or other callable procedure |
| *str* | Character string |
| *str-exp* | Expression that represents a character string |
| *str-lit* | String literal |
| *str-var* | Variable that contains a character string |
| *sub* | Specific to a SUB subprogram |
| *target* | Target point of a branch statement; either a line number or a label |
| *unq-str* | Unique string |
| *unsubs-var* | Unsubscripted variable, as opposed to an array element |
| *var* | Variable |

# 1
# Program Elements and Structure

This chapter discusses BASIC program elements and structure.

**Note**

Compaq BASIC for OpenVMS Alpha systems (hereafter referred to as Alpha BASIC) does not support all features of Compaq BASIC for OpenVMS VAX (hereafter referred to as VAX BASIC). For a discussion of the differences between Alpha BASIC and VAX BASIC, see Appendix C.

The building blocks of a BASIC program are as follows:

- Program lines and their components
- The BASIC character set
- BASIC data types
- Variables and constants
- Expressions
- Program documentation

## 1.1 Components of Program Lines

A BASIC program is a series of program lines that contain instructions for the compiler.

All BASIC program lines can contain the following:

- Line numbers or labels
- Statements
- Compiler directives
- Comment fields

- A line terminator (carriage return)

Only a line terminator is required in a program line. The other elements are optional.

A program line can contain any number of text lines. A text line cannot exceed 255 characters.

### 1.1.1 Line Numbers

Line numbers are not required in programs; you can compile, link, and execute a program with or without line numbers. There are, however, different rules for writing programs with line numbers and for writing programs without line numbers. These differences are described in the following sections.

#### 1.1.1.1 Programs with Line Numbers

In VAX BASIC, if you are entering program lines directly into the VAX BASIC Environment in line mode, then only those statements with line numbers are allowed to start in the first column. Also, any programs entered in line mode must have an initial line number associated with the first program line.

A line number must be a unique integer from 1 through 32767, and must be terminated by a space or tab. Leading spaces, tabs, and zeros in line numbers are ignored. Embedded spaces, tabs, and commas cause BASIC to signal an error.

#### 1.1.1.2 Programs Without Line Numbers

BASIC searches for a line number on the first line of program text when you do the following:

- Load a program into the VAX BASIC Environment with the OLD command.
- Edit a program in the VAX BASIC Environment.
- Compile a program from the DCL command line.

If no line number is found, then the following rules apply:

- No line numbers are allowed in that program module.
- References to the ERL function are not allowed.
- A subroutine will signal the same errors as it would if it were compiled with the /NOLINES qualifier. If an error is resignaled back to the caller, ERL gives the line number of the calling site, rather than the line number of the actual error in the subprogram.
- The REM statement is not allowed.

If your program contains multiple units, the point at which BASIC breaks each program unit is determined by the placement of the statement that terminates each program unit. Any text that follows the program terminator becomes associated with the the following program unit. A program terminator can be END, END PROGRAM, END FUNCTION, END SUB, or END PICTURE[1].

In VAX BASIC, you cannot use the APPEND command in the VAX BASIC Environment, or a plus sign (+) at DCL level, to concatenate programs without line numbers.

Note that when you compile a program from DCL, or when you copy a program into the VAX BASIC Environment with the OLD command, program statements can begin in the first column.

Instead of line numbers, you can use labels to identify and reference program lines.

### 1.1.2 Labels

A label is a 1- to 31-character name that identifies a statement or block of statements. The label name must begin with a letter; the remaining characters, if any, can be any combination of letters, digits, dollar signs ($), underscores (_), or periods (.).

A label name must be separated from the statement it identifies with a colon (:). For example:

```
Yes_routine: PRINT "Your answer is YES."
```

The colon is not part of the label name; it informs BASIC that the label is being defined rather than referenced. Consequently, the colon is not allowed when you use a label to reference a statement. For example:

```
200     GOTO Yes_routine
```

You can reference a label almost anywhere you can reference a line number. However, there are the following exceptions:

- You cannot compare a label with the value returned by the ERL function.
- You cannot reference a label in an IF...THEN...ELSE statement without using the keyword GOTO or GO TO. You can use the implied GOTO form only to reference a line number. In Example 1–1, the GOTO keyword is not required in statement 100 because the reference is to a line number. However, the GOTO keyword is required in statement 200 because the references are to labels.

[1] END PICTURE is for VAX BASIC only.

**Example 1–1 Referencing Label Names in BASIC Programs**

```
100 IF A% = B%
    THEN 1000 ELSE 1050

200 IF A$ = "YES"
    THEN GOTO Yes ELSE GOTO No
```

### 1.1.3 Statements

A BASIC statement generally consists of a statement keyword and optional operators and operands. For example, both of the following statements are valid:

```
LET A% = 534% + (SUM% - DIF%)
PRINT A%
```

BASIC statements can be either executable or nonexecutable:

- Executable statements perform operations (for example, PRINT, GOTO, and READ).
- Nonexecutable statements describe the characteristics and arrangement of data, specify usage information, and serve as comments in the source program (for example, DATA, DECLARE, and REM).

BASIC can accept and process one statement on a line of text, several statements on a line of text, multiple statements on multiple lines of text, and single statements continued over several lines of text.

#### 1.1.3.1 Keywords

Every BASIC statement except LET[1] and empty statements must begin with a keyword. Most keywords are reserved in the BASIC language. The keywords are listed in Appendix B, and the unreserved keywords are footnoted. Keywords are used to do the following:

- Define data and user identifiers
- Perform operations
- Invoke built-in functions

Reserved keywords cannot be used as user identifiers, such as variable names, labels, or names for MAP or COMMON areas. Reserved keywords cannot be used in any context other than as BASIC keywords. The assignment STRING$ = "YES", for example, is invalid because STRING$ is a reserved BASIC keyword and, therefore, cannot be used as a variable. See Appendix B for a list of all the BASIC keywords.

[1] The LET keyword is optional.

A BASIC keyword cannot be split across lines of text. There must be a space, tab, or special character such as a comma between the keyword and any other variable or operator.

Some keywords use two words, and some can be combined with other keywords. Their spacing requirements vary, as shown in Table 1–1.

**Table 1–1 Keyword Space Requirements**

| Optional Space | Required Space | No Space |
|---|---|---|
| GO TO | BY DESC | FNEND |
| GO SUB | BY REF | FNEXIT |
| ON ERROR | BY VALUE | FUNCTIONEND |
| | END DEF | FUNCTIONEXIT |
| | END FUNCTION | NOECHO |
| | END GROUP | NOMARGIN |
| | END IF | SUBEND |
| | END PROGRAM | SUBEXIT |
| | END RECORD | |
| | END SELECT | |
| | END SUB | |
| | EXIT DEF | |
| | EXIT FUNCTION | |
| | EXIT SUB | |
| | INPUT LINE | |
| | MAP DYNAMIC | |
| | MAT INPUT | |
| | MAT LINPUT | |
| | MAT PRINT | |
| | MAT READ | |

### 1.1.3.2 Single-Statement Lines and Continued Statements

A single-statement line consists of one statement on one text line, or one statement continued over two or more text lines. For example:

```
30 PRINT B * C / 12
```

This single-statement line has a line number, the keyword (PRINT), the operators (*, /), and the operands (B, C, 12).

You can have a single statement span several text lines by typing an ampersand (&) and pressing the Return key. Note that only spaces or tabs are valid between the ampersand and the carriage return. For example:

```
OPEN "SAMPLE.DAT" AS FILE 2%,         &
         SEQUENTIAL VARIABLE,         &
         MAP ABC
```

The ampersand continuation character may be used but is not required for continued REM statements. The following example is valid:

```
REM This is a remark
    And this is also a remark
```

You can continue any BASIC statement, but you cannot continue a string literal or BASIC keyword. The following example generates the error message "Unterminated string literal":

```
PRINT "IF-THEN-ELSE- &
       END-IF"
```

This example is valid:

```
PRINT "IF-";         &
      "THEN-";       &
      "ELSE-";       &
      "END-";        &
      "IF"
```

### 1.1.3.3 Multistatement Lines

Multistatement lines contain several statements on one line of text or multiple statements on separate lines of text.

Multiple statements on one line of text must be separated by a backslash ( \ ) character. For example:

```
40 PRINT A \ PRINT V \ PRINT G
```

You can also write a multistatement program line that associates all statements with a single line number by placing each statement on a separate line. BASIC assumes that such an unnumbered line of text is either a new statement or an IF statement clause.

In the following example, each line of text begins with a BASIC statement and each statement is associated with line number 400:

```
400   PRINT A
      PRINT B
      PRINT "FINISHED"
```

BASIC also recognizes IF statement keywords on a new line of text and associates such keywords with the preceding IF statement. For example:

```
100  REM        Determine if the user's response
                was YES or NO.
200  IF (A$ = "YES") OR (A$ = "Y")
     THEN PRINT "You typed YES"
     ELSE PRINT "You typed NO"
     STOP
     END IF
```

You can use any BASIC statement in a multistatement line. Because the compiler ignores all text following a REM keyword until it reaches a new line number, a REM statement must be the last statement on a multistatement line. REM statements are disallowed in programs without line numbers.

### 1.1.4 Compiler Directives

Compiler directives are instructions for the compiler. These instructions cause the compiler to perform certain operations as it compiles the program.

By including compiler directives in a program, you can do the following:

- Place program titles and subtitles in the header that appears on each page of the listing file.
- Place a program version identification string in both the listing file and object module.
- Start or stop the inclusion of listing information for selected parts of a program.
- Start or stop the inclusion of cross reference information for selected parts of a program.
- Include BASIC code from another source file or a text library.
- Conditionally compile parts of a program.
- Terminate compilation.

- Include CDD record definitions in a BASIC program.
- Display messages during the compilation.

Follow these rules when using compiler directives:

- Compiler directives must begin with a percent sign (%).
- Compiler directives must be the only text on the line (except for %IF-%THEN-%ELSE-%END-%IF).
- Compiler directives cannot appear within a quoted string.
- Compiler directives can be preceded by an optional line number.

For more information about compiler directives, see Chapter 2 and the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## 1.2 BASIC Character Set

BASIC uses the full ASCII character set. This includes the following:

- The letters A to Z, both uppercase and lowercase
- The digits 0 to 9
- Special characters

Appendix A lists the full ASCII character set and character values.

The compiler does not distinguish between uppercase and lowercase letters except in string literals or within a DATA statement. The compiler does not process characters in REM statements or comment fields, nor does it process nonprinting characters unless they are part of a string literal.

In string literals, BASIC processes:

- Lowercase letters as lowercase
- Nonprinting characters

The ASCII character NUL (ASCII code 0) and line terminators cannot appear in a string literal. Use the CHR$ function or explicit literal notation to use these characters and terminators.

You can use nonprinting characters in your program, for example, in string constants, but to do so you must use one of the following:

- A predefined constant such as ESC or DEL
- The CHR$ function to specify an ASCII value
- Explicit literal notation

See Section 1.5.4 for more information about explicit literal notation.

## 1.3 BASIC Data Types

Each unit of data in a BASIC program has a specific data type that determines how that unit of data is to be interpreted and manipulated by the compiler. This data type also determines how many storage bits make up the unit of data.

BASIC recognizes the following primary data types:

- Integer
- Floating-point
- Character string
- Packed decimal
- Record file address

Integer data is stored as binary values in a byte, word, longword, or quadword. These values correspond to the BASIC data type keywords BYTE, WORD, LONG, and QUAD; these are all subtypes of the type INTEGER. (VAX BASIC does not support QUAD.)

Floating-point values are stored using a signed exponent and a binary fraction. BASIC allows the floating-point formats F_floating, D_floating, G_floating, H_floating, S_floating, T_floating, and X_floating. These formats correspond to the BASIC data type keywords SINGLE, DOUBLE, GFLOAT, HFLOAT, SFLOAT, TFLOAT, and XFLOAT.[1] These are all subtypes of the type REAL. (See Section 1.3.3.)

Character data consists of strings of bytes containing ASCII code as binary data. The first character in the string is stored in the first byte, the second character is stored in the second byte, and so on. BASIC allows up to 65,535 characters for a STRING data element.

For the DECIMAL(d,s) data type, you can specify the total number of digits (d) in the data type and the number of digits to the right of the decimal point (s). For example, DECIMAL(10,3) specifies decimal data with a total of 10 digits, 3 of which are to the right of the decimal point.

[1] Alpha BASIC does not support the HFLOAT data type. VAX BASIC does not support the SFLOAT, TFLOAT, and XFLOAT data types.

BASIC also recognizes a special RFA data type to provide information about a record's file address. An RFA uniquely specifies a record in a file: you can access RMS files of any organization by a record's file address. By specifying the address of a record, RMS retrieves the record at that address. Accessing records by RFA is more efficient and faster than other forms of random record access. The RFA data type can only be used for the following:

- RFA operations (the GETRFA function and the GET and FIND statements)
- Assignments to other variables of the RFA data type
- Comparisons with other variables of the RFA data type with the equal to (=) and not equal to (<>) relational operators
- Formal and actual parameters
- DEF and function results

You cannot declare a constant of the RFA data type, nor can you use RFA variables for any arithmetic operations.

The RFA data type requires 6 bytes of information. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about Record File Addresses and the RFA data type.

BASIC packed decimal data is stored in a string of bytes. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about the storage of packed decimal data.

Table 1–2 lists BASIC data type keywords and summarizes BASIC data types.

**Table 1–2 BASIC Data Types**

| Data Type Keyword | Size | Range | Precision (Decimal Digits) |
|---|---|---|---|
| **Integer** | | | |
| BYTE | 8 bits | -128 to +127 | 3 |
| WORD | 16 bits | -32768 to +32767 | 5 |
| LONG | 32 bits | -2147483648 to +2147483647 | 10 |

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**Table 1–2 (Cont.) BASIC Data Types**

| Data Type Keyword | Size | Range | Precision (Decimal Digits) |
|---|---|---|---|
| **Integer** | | | |
| QUAD | 64 bits | -9223372036854775808 to +9223372036854775807 | 19 |
| **Real** | | | |
| SINGLE | 32 bits | 0.29E-38 to 1.70E38 | 6 |
| DOUBLE | 64 bits | 0.29E-38 to 1.70E38 | 16 |
| GFLOAT | 64 bits | 0.56E-308 to 0.90E308 | 15 |
| HFLOAT | 128 bits | 0.84E-4932 to 0.59E4932 | 33 |
| SFLOAT | 32 bits | 1.18E-38 to 3.40E38 | 6 |
| TFLOAT | 64 bits | 2.23E-308 to 1.80E308 | 15 |
| XFLOAT | 128 bits | 6.48E-4966 to 1.19E4932 | 33 |
| **Decimal** | | | |
| DECIMAL(d,s) | 0 to 16 bytes | $1 * 10^{-31}$ to $1 * 10^{31}$ | d |
| **String** | | | |
| STRING | One character per byte | Max = 65535 | NA |
| **RFA** | | | |
| RFA | 6 bytes | NA | NA |

In Table 1–2, REAL and INTEGER are generic data type keywords that specify floating-point and integer storage, respectively. If you use the REAL or INTEGER keywords to type data, the actual data type used (SINGLE, DOUBLE, GFLOAT, HFLOAT, SFLOAT, TFLOAT, XFLOAT, BYTE, WORD, LONG, or QUAD) depends on the current default.

You can specify data type defaults by doing the following:

- Use SET and COMPILE commands in the VAX BASIC Environment (VAX only).
- Use the DCL command BASIC at the DCL level.
- Use the OPTION statement within the source program being compiled.

You can also specify whether program values are to be typed implicitly or explicitly. The following sections discuss data type defaults and implicit and explicit data typing.

### 1.3.1 Implicit Data Typing

You can implicitly assign a data type to program values by adding a suffix to the variable name or constant value. If you do not specify any suffix, the variable or constant is assigned the current default data type. The following rules apply for implicit data typing:

- A dollar sign suffix ($) specifies STRING storage.
- A percent sign suffix (%) specifies INTEGER storage.
- No special suffix character specifies storage of the default type, which can be INTEGER, REAL, or DECIMAL.

With implicit data typing, the range and precision for program values are determined by the following corresponding default data sizes or subtypes:

- BYTE, WORD, LONG, or QUAD for INTEGER values
- SINGLE, DOUBLE, GFLOAT, HFLOAT, SFLOAT, TFLOAT, or XFLOAT for REAL values
- The default (d,s) values for DECIMAL values

If you do not specify a value for the default data type, REAL will be assigned.

The BASIC qualifiers for the SET and COMPILE commands are described in Chapter 2. The qualifiers for the DCL command BASIC are listed in the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

### 1.3.2 Explicit Data Typing

Explicit data typing means that you use a declarative statement to specify the data type, range, and precision of your program variables and named constants.

In the following example, the first DECLARE statement associates the string constant value 03060 and the STRING data type with a constant named zip_code. The second DECLARE statement associates the STRING data type with *emp_name*, the DOUBLE data type with *with_tax*, and the SINGLE data type with *int_rate*. No constant values are associated with identifiers in the second DECLARE statement because they are variable names.

```
DECLARE STRING CONSTANT zip_code = "03060"
DECLARE STRING emp_name, DOUBLE with_tax, SINGLE int_rate
```

With explicit data typing, each program variable within a program can have a different data type. You can explicitly assign data types to variables, constants, arrays, parameters, and functions; therefore, integer data does not have to take the compilation default types. Explicit data typing gives you more control over your program.

Using the REAL and INTEGER keywords to explicitly type program values allows you to write programs that are more flexible, because these data type keywords specify that floating-point and integer data take the current defaults for REAL and INTEGER. The data type INTEGER, for example, specifies only that the constant or variable is an integer. The actual subtype (BYTE, WORD, LONG, or QUAD) depends on the default set with the COMPILE or SET command, with the DCL command BASIC, or with the OPTION statement.

### 1.3.3 QUAD and IEEE Floating-Point Data Types

Alpha BASIC adds support for four data types as of Version 1.4. To use these data types, you must have OpenVMS Alpha Version 7.1 or higher. The data types are QUAD, for 64-bit integers, and three IEEE floating-point types: SFLOAT, TFLOAT, and XFLOAT, which correspond to the S_floating, T_floating, and X_floating formats, respectively. VAX BASIC does not support these four data types.

The three formats S_floating, T_floating, and X_floating are for finite values with normal rounding and standard exception handling only. All the floating point formats previously available in Alpha BASIC are still available. QUAD and the IEEE data types are available wherever the other Alpha BASIC formats are available, as detailed in the following sections.

### Qualifiers

The QUAD keyword is added to the allowed values of the /INTEGER_SIZE qualifier, and the SFLOAT, TFLOAT, and XFLOAT keywords are added to the allowed values of the /REAL_SIZE qualifier.

### Statements, Expressions, Functions, and Operators

QUAD, SFLOAT, TFLOAT, and XFLOAT can be used in the following statements wherever a data type is supplied:

| Statement | Elements to Which Data Type Is Applied |
|---|---|
| COMMON | Variables and FILL elements |
| DECLARE | Variables, CONSTANTs, and FUNCTION parameters and value |
| DEF, DEF* | Parameters and value |
| DIMENSION | Variables |
| EXTERNAL | Variables, CONSTANTs, and SUB/FUNCTION parameters and value |
| FUNCTION | Parameters and value |
| MAP | Variables and FILL elements |
| MAP DYNAMIC | Variables |
| MOVE | FILL elements |
| OPTION | Integer and real clauses |
| RECORD/GROUP | Record components |
| REMAP | FILL elements |
| SUB | Parameters |

Expressions with values of these data types can be used in the following statements wherever numeric values are accepted:

CAUSE ERROR, DATA, DET, END, EXIT, FIELD, FIND, FNEND, FNEXIT, FOR, FUNCTIONEND, FUNCTIONEXIT, GET, IF, INPUT, LET, MAT +, MAT -, MAT *, MAT CON, MAT IDN, MAT INPUT, MAT INV, MAT LINPUT, MAT NUL$, MAT PRINT, MAT READ, MAT TRN, MAT ZER, NEXT, ON GOSUB, ON GOTO, OPEN, PRINT, PRINT USING, PUT, READ, RESET, RESTORE, SELECT, SLEEP, UNLESS, UNTIL, UPDATE, WAIT, WHILE

The channel number expression for the following I/O statements and functions is extended to include these data types:

BUFSIZ, CCPOS, CLOSE, DELETE, ECHO, FIELD, FIND, FREE, FSP$, GET, GETRFA, INKEY$, INPUT, INPUT LINE, LINPUT, MAGTAPE, MAR, MARGIN, MAT INPUT, MAT LINPUT, MAT PRINT, NOECHO, NOMARGIN, OPEN, PRINT, PRINT USING, PUT, RCTRLO, RESET, RESTORE, RMSSTATUS, SCRATCH, UNLOCK, UPDATE

In Alpha BASIC, the function INTEGER, besides accepting either a numeric string or any numeric data type expression for the first argument, includes QUAD in the possible data types for the second argument. The function REAL has SFLOAT, TFLOAT, and XFLOAT added to possible data types for its second argument.

All the built-in functions that accept and/or return numerical values allow QUAD and the IEEE data types as appropriate. These include the standard mathematical functions:

ABS, ABS%, ATN, COS, EXP, LOG, LOG10, MAG, MAX, MIN, MOD, SGN, SIN, SQR, TAN

They also include the following miscellaneous functions:

ASCII, CCPOS, CHR$, COMP%, CTRLC, CVT$$ (EDIT$), DATE$, DATE4$, DECIMAL, ECHO, ERT$, FIX, FORMAT$, INKEY$, INSTR, INT, INTEGER, LBOUND, LEFT$, MAGTAPE, MARGIN, MID$, NOECHO, NUM, NUM2, NUM$, NUM1$, PLACE$, POS, PROD$, QUO$, RAD$, RCTRLC, RCTRLO, REAL, RIGHT$, SEG$, SPACE$, STR$, STRING$, SWAP%, TAB, TIME, TIME$, UBOUND, VAL, VAL%

All operators that accept numeric arguments allow the new data types. These include:

unary: +, -
binary: +, -, *, /, ^, <, =, >, =<, =>, <>, = = (fuzzy equals)

### Constants

The explicit literal notation is extended to allow representation of constants of the new data types. See Section 1.5.4.

### Data Type Results in Expressions with Operands of Different Types

See Section 1.6.1.1 and Section 1.6.1.2 for the rules determining the data types of results in expressions with operands of different data types, including the new Alpha BASIC data types.

### Array Subscripts

Array subscripts may be of any numeric data type, but must evaluate to an integer value at run time.

## 1.4 Variables

A variable is a named quantity whose value can change during program execution. Each variable name refers to a location in the program's storage area. Each location can hold only one value at a time. Variables of all data types can have subscripts that indicate their position in an array. You can declare variables implicitly or explicitly.

Depending on the program operations specified, the value of a variable can change from statement to statement. BASIC uses the most recently assigned value when performing calculations. This value remains in effect until a new value is assigned to the variable.

BASIC accepts the following general types of variables:

- Floating-point
- Integer
- String
- RFA
- Packed decimal
- Record

### 1.4.1 Variable Names

The name given to a variable depends on whether the variable is internal or external to the program and whether the variable is implicitly or explicitly declared.

All variable names must conform to the following rules:

- The name can have from 1 to 31 characters.
- The name has no embedded spaces.
- The first character of the name must be an uppercase or lowercase alphabetic character (A to Z).
- The last character of the name can be a dollar sign ($) to indicate a string variable or a percent sign (%) to indicate an integer variable. If the last character is neither a dollar sign nor a percent sign, the name indicates a variable of the default type.

- The remaining characters, if present, can be any combination of uppercase or lowercase letters (A to Z), numbers (0 to 9), dollar signs ($), underscores (_), or periods (.). The use of underscores in variable names helps improve readability and is preferred to the use of periods.

### 1.4.2 Implicitly Declared Variables

BASIC accepts the following implicitly declared variables:

- Integer
- String
- Floating-point (or the default data type)

The name of an implicitly declared variable defines its data type. Integer variables end with a percent sign (%), string variables end with a dollar sign ($), and variables of the default type (usually floating-point) end with any allowable character except a percent sign or dollar sign. All three types of variables must conform to the rules listed in Section 1.4.1 for naming variables. The current data type default (INTEGER, REAL, or DECIMAL) determines the data type of implicitly declared variables that do not end in a percent sign or dollar sign.

A floating-point variable is a named location that stores a floating-point value. The current default size for floating-point numbers (SINGLE, DOUBLE, GFLOAT, HFLOAT, SFLOAT, TFLOAT, or XFLOAT) determines the data type of the floating-point variable. Following are some examples of valid floating_ point variable names:

```
C
M1
F67T_J
L . . . 5
BIG47
Z2.
ID_NUMBER
STORAGE_LOCATION_FOR_XX
STRESS_VALUE
```

If a numeric value of a different data type is assigned to a floating-point variable, BASIC converts the value to a floating-point number.

An integer variable is a named location that stores an integer value. The current default size for integers (BYTE, WORD, LONG, or QUAD) determines the data type of an integer variable. Following are some examples of valid integer variable names:

```
ABCDEFG%
B%
C_8%
D6E7%
RECORD_NUMBER%
THE_VALUE_I_WANT%
```

If the default or explicitly declared data type is INTEGER, the percent suffix (%) is not necessary.

If you assign a floating-point or decimal value to an integer variable, BASIC truncates the fractional portion of the value. It does not round to the nearest integer. For example:

```
B% = -5.7
```

BASIC assigns the value -5 to the integer variable, not -6.

A string variable is a named location that stores strings. Following are some examples of valid string variable names:

```
C1$
L_6$
ABC1$
M$
F34G$
T..$
EMPLOYEE_NAME$
TARGET_RECORD$
STORAGE_SHELF_IDENTIFIER$
```

If the default or explicitly declared data type is STRING, the dollar suffix ($) is not necessary.

Strings have both value and length. BASIC sets all string variables to a default length of zero before program execution begins, with the exception of those variables in a COMMON, MAP, virtual array, or record definition. See the COMMON statement and the MAP statement in Chapter 4 for information about string length in COMMON and MAP areas. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for information about default string length in virtual arrays.

During execution, the length of a character string associated with a string variable can vary from zero (signifying a null or empty string) to 65,535 characters.

### 1.4.3 Explicitly Declared Variables

BASIC lets you explicitly assign a data type to a variable or an array. For example:

```
DECLARE DOUBLE Interest_rate
```

Data type keywords are described in Section 1.3. For more information about explicit declaration of variables, see the COMMON, DECLARE, DIMENSION, DEF, FUNCTION, EXTERNAL, MAP, and SUB statements in Chapter 4.

### 1.4.4 Subscripted Variables and Arrays

A subscripted variable references part of an array. Arrays can be of any valid data type. Subscripted variables and arrays follow the same naming conventions as unsubscripted variables. Subscripts follow the variable name in parentheses and define the variable's position in the array. When you create an array, you specify the maximum size of the array (the bounds) in parentheses following the array name.

In Example 1–2, the DECLARE statement sets the bounds of the array *emp_name* to 1000. Therefore, the maximum value for an *emp_name* subscript is 1000. The bounds of the array define the maximum value for a subscript of that array.

**Example 1–2 Using the DECLARE Statement to Set Array Boundaries**

```
DECLARE STRING emp_name(1000)
FOR I% = 0% TO 1000%
     INPUT "Employee name";emp_name(I%)
NEXT I%
```

Subscripts can be any positive LONG integer value between 0 and 2147483647.

An array is a set of data ordered in one or more dimensions. A one-dimensional array, like *emp_name*(1000), is called a list or vector. A two-dimensional array, like *payroll_data*(5,5), is called a matrix. An array of more than two dimensions, like *big_array*(15,9,2), is called a tensor.

As a default, BASIC arrays are always zero-based. The number of elements in any dimension includes element number zero. For example, the array *emp_name* contains 1001 elements because BASIC allocates element zero. *Payroll_data*(5,5) contains 36 elements because BASIC allocates row and column zero.

Often, however, applications call for arrays that are not zero-based. In BASIC, you can define arrays that are not zero-based by specifying a lower bound, as well as an upper bound, for the subscripts. In this way, you can create an array with arbitrary starting and ending points. For example, you might want to create array *birth_rate* that holds the annual birth rate statistics for the years 1950 to 1985:

```
DECLARE birth_rate(1950 TO 1985)
```

Lower bounds are not allowed with virtual arrays or arrays used in MAT statements. If a multidimensional array is declared with lower bounds specified for some dimensions and not others, zero will be used for those dimensions without lower bounds.

You can use the UBOUND and LBOUND functions to determine the upper and lower bounds of an array. For a description of these functions, see Chapter 4.

For all arrays except virtual arrays, the total number of array elements cannot exceed 2147483647. Note, however, that this is a theoretical value; the actual maximum size of an array that you can declare depends on the configuration of your system.

BASIC arrays can have up to 32 dimensions. You can specify the type of data the array contains with data type keywords. See Table 1–2 for a list of BASIC data types.

An element in a one-dimensional array has a variable name followed by one subscript in parentheses. You may optionally use a space between the array name and the subscript. For example:

```
A(6%)
B (6%)
C$ (6%)
```

A(6%) refers to the seventh item in this list:

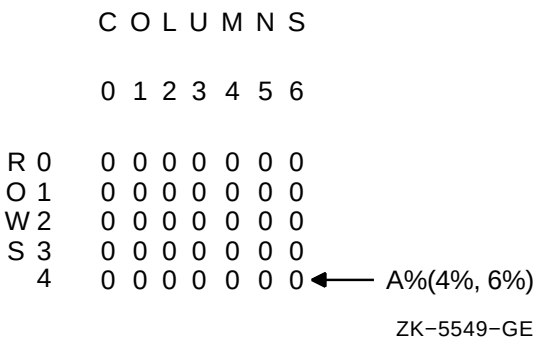
```
A(0%)   A(1%)   A(2%)   A(3%)   A(4%)   A(5%)   A(6%)
```

An element in a two-dimensional array has two subscripts, in parentheses, following the variable name. The first subscript specifies the row number and the second subscript specifies the column number. Use a comma to separate the subscripts. You may optionally put a space between the array name and the subscripts. For example:

```
A (7%,2%)   A%(4%,6%)   A$ (10%,10%)
```

In Figure 1–1, the arrow points to the element specified by the subscripted variable A%(4%,6%).

**Figure 1–1 Representation of the Subscript Variable A%(4%,6%)**




Although a program can contain a variable and an array with the same name, this is poor programming practice. Variable *A* and the array *A*(3%,3%) are separate entities and are stored in completely separate locations, so it is a good idea to give them different names.

Note that a program cannot contain two arrays with the same name but a different number of subscripts. For example, the arrays A(3%) and A(3%,3%) are invalid in the same program.

BASIC arrays can be redimensioned at run time. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about arrays.

### 1.4.5 Initialization of Variables

BASIC generally sets variables to zero or null values at the start of program execution. Variables initialized by BASIC include:

- Numeric variables and in-storage array elements (except those in MAP or COMMON statements).
- String variables (except those in MAP or COMMON statements).
- Variables in subprograms. Subprogram variables are initialized to zero or the null string each time the subprogram is called.

BASIC does not initialize the following:

- Virtual arrays
- Variables in MAP and COMMON areas

- Variables declared as EXTERNAL
- Variables in routines that contain the option INACTIVE=SETUP

## 1.5 Constants

A constant is a numeric or character literal that does not change during program execution. A constant may optionally be named and associated with a data type. BASIC allows the following types of constants:

- Numeric:
  - Floating-point
  - Integer
  - Packed decimal
- String (ASCII characters enclosed in quotation marks)

A constant of any of the above data types can be named with the DECLARE CONSTANT statement. You can then refer to the constant by name in your program. See Section 1.5.3 for information about naming constants.

You can use the OPTION statement to declare a default data type for all constants in your program. This statement allows you to specify a data type for only the constants in your program; you can specify a different data type for variables. You can also use a special numeric literal notation to specify the value and data type of a numeric literal. Numeric literal notation is discussed in Section 1.5.4.

If you do not specify a data type for a numeric constant with the DECLARE CONSTANT statement or with numeric literal notation, the type and size of the constant is determined by the default REAL, INTEGER, or DECIMAL type set with the DCL command BASIC, the BASIC SET or COMPILE command, or the OPTION statement.

To simplify the representation of certain ASCII characters and mathematical values, BASIC also supplies some predefined constants.

The following sections discuss numeric and string constants, named constants, numeric literal notation, and predefined constants.

## 1.5.1 Numeric Constants

A numeric constant is a literal or named constant whose value never changes. In BASIC, a numeric constant can be a floating-point number, an integer, or a packed decimal number. The type and size of a numeric constant is determined by the following:

- The system default values
- The defaults set by the qualifiers for the DCL command BASIC
- The data type qualifiers specified with the COMPILE command
- The defaults set by the SET command
- The data type specified in a DECLARE CONSTANT or OPTION statement
- Numeric literal notation

If you use a declarative statement to name and declare the data type of a numeric constant, the constant is of the type and size specified in the statement. For example:

```
DECLARE BYTE CONSTANT age = 12
```

This example associates the numeric literal 12 and the BYTE data type with the identifier *age*. To specify a data type for an unnamed numeric constant, you must use the numeric literal notation format described in Section 1.5.4.

### 1.5.1.1 Floating-Point Constants

A floating-point constant is a literal or named constant with one or more decimal digits, either positive or negative, with an optional decimal point and an optional exponent (E notation). If the default data type is integer, BASIC will treat the literal as an INTEGER unless it contains a decimal point or the character E. If the default data type is DECIMAL, an E is required or BASIC treats the literal as a packed decimal value.

Table 1–3 contains examples of floating-point literals with REAL, INTEGER, and DECIMAL default data types.

**Table 1–3 Specifying Floating-Point Constants**

| REAL | INTEGER | DECIMAL |
|---|---|---|
| -8.738 | -8.738 | -8.738E |
| 239.21E-6 | 239.21E-6 | 239.21E-6 |
| .79 | .79 | .79E |
| 299 | 299E | 299E |

Very large and very small numbers can be represented in E (exponential) notation. To indicate E notation, a number must be followed by the letter E (or e). It also must be followed by an exponent sign and an exponent. The exponent sign indicates whether the exponent is positive or negative and is optional only if you are specifying a positive exponent. The exponent is an integer constant (the power of 10).

A number can be carried to a maximum of 6 decimal places for SINGLE precision, 16 decimal places for DOUBLE precision, 15 decimal places for GFLOAT precision, 33 places for HFLOAT precision, 6 places for SFLOAT, 15 places for TFLOAT, and 33 places for XFLOAT.

Table 1–4 compares numbers in standard and E notation.

**Table 1–4 Numbers in E Notation**

| Standard Notation | E Notation |
|---|---|
| .0000001 | .1E-06 |
| 1,000,000 | .1E+07 |
| -10,000,000 | –.1E+08 |
| 100,000,000 | .1E+09 |
| 1,000,000,000,000 | .1E+13 |

The range and precision of floating-point constants are determined by the current default data types or the explicit data type used in the DECLARE CONSTANT statement. However, there are limits to the range allowed for numeric data types. See Table 1–2 for a list of BASIC data types and ranges. BASIC signals the fatal error "Floating point error or overflow" (ERR=48) when your program attempts to specify a constant value outside of the allowable range for a floating-point data type.

#### 1.5.1.2 Integer Constants

An integer constant is a literal or named constant, either positive or negative, with no fractional digits and an optional trailing percent sign (%). The percent sign is required for integer literals only if the default type is not INTEGER.

In Table 1–5, the values are all integer constants. The presence of the percent sign varies depending on the default data type.

**Table 1–5 Specifying Integer Constants**

| INTEGER Default Type | REAL or DECIMAL Default Type |
|---|---|
| 81257 | 81257% |
| -3477 | -3477% |
| 79 | 79% |

The range of allowable values for integer constants is determined by either the current default data type or the explicit data type used in the DECLARE CONSTANT statement. Table 1–2 lists BASIC data types and ranges. BASIC signals an error for a number outside the applicable range.

If you want BASIC to treat numeric literals as integer numbers, you must do one of the following:

- Set the default data type to INTEGER.
- Make sure the literal has a percent sign suffix.
- Use explicit literal notation.

**Note**

You cannot use percent signs in integer constants that appear in DATA statements. Doing so causes BASIC to signal "Data format error" (ERR=50).

#### 1.5.1.3 Packed Decimal Constants

A packed decimal constant is a number, either positive or negative, that has a specified number of digits and a specified decimal point position (scale). You specify the number of digits (d) and the position of the decimal point (s) when you declare the constant as a DECIMAL(d,s). If the constant is not declared, the number of digits and the position of the decimal is determined by the representation of the constant.

For example, when the default data type is DECIMAL, 1.234 is a DECIMAL(4,3) constant, regardless of the default decimal size. Likewise, using numeric literal notation, "1.234"P is a DECIMAL(4,3) constant, regardless of the default data type and default DECIMAL size. Numeric literal notation is described in Section 1.5.4.

### 1.5.2 String Constants

String constants are either string literals or named constants. A string literal is a series of characters enclosed in string delimiters. Valid string delimiters are as follows:

- Double quotation marks ("text")
- Single quotation marks ('text')

You can embed double quotation marks within single quotation marks ('this is a "text" string') and vice versa ("this is a 'text' string"). Note, however, that BASIC does not accept incorrectly paired quotation marks and that only the outer quotation marks must be paired. For example, the following character strings are valid:

```
"The record number does not exist."
"I'm here!"
"The terminating 'condition' is equal to 10."
"REPORT 543"
```

However, the following strings are not valid:

```
"Quotation marks that do not match'
"No closing quotation mark
```

Characters in string constants can be letters, numbers, spaces, tabs, 8-bit data characters, or the NUL character (ASCII code 0). If you need a string constant that contains a NUL, you should use CHR$(NUL). See Section 1.5.4 for information about explicit literal notation.

Note that NUL is a predefined integer constant. See Section 1.5.5.

The compiler determines the value of the string constant by scanning all its characters. For example, because of the number of spaces between the delimiters and the characters, these two string constants are not the same:

```
"    END-OF-FILE REACHED    "
"END-OF-FILE REACHED"
```

BASIC stores every character between delimiters exactly as you type it into the source program, including:

- Lowercase letters (a to z)
- Leading, trailing, and embedded spaces
- Tabs
- Special characters

The delimiting quotation marks are not printed when the program is executing. The value of the string constant does not include the delimiting quotation marks. For example:

```
PRINT "END-OF-FILE REACHED"
END
```

**Output**

```
END-OF-FILE REACHED
```

BASIC does, however, print double or single quotation marks when they are enclosed in a second paired set. For example:

```
PRINT 'FAILURE CONDITION: "RECORD LENGTH"'
END
```

**Output**

```
FAILURE CONDITION: "RECORD LENGTH"
```

### 1.5.3 Named Constants

BASIC allows you to name constants. You can assign a name to a constant that is either internal or external to your program and refer to the constant by name throughout the program. This naming feature is useful for the following reasons:

- If a commonly used constant must be changed, you need to make only one change in your program.
- A logically named constant makes your program easier to understand.

You can use named constants anywhere you can use a constant, for example, to specify the number of elements in an array.

You cannot change the value of an explicitly named constant during program execution.

#### 1.5.3.1 Naming Constants Within a Program Unit

You name constants within a program unit with the DECLARE statement, as is shown in Example 1–3.

**Example 1–3 Naming Constants Within a Program Unit**

```
DECLARE DOUBLE CONSTANT preferred_rate = .147
DECLARE SINGLE CONSTANT normal_rate = .162
DECLARE DOUBLE CONSTANT risky_rate = .175
   .
   .
   .
new_bal = old_bal * (1 + preferred_rate)^years_payment
```

When interest rates change, only three lines have to be changed rather than every line that contains an interest rate constant.

Constant names must conform to the rules for naming internal, explicitly declared variables listed in Section 1.4.1.

The value associated with a named constant can be a compile-time expression as well as a literal value, as shown in Example 1–4.

**Example 1–4 Associating Values with Named Constants**

```
DECLARE STRING CONSTANT Congrats =            &
         "+--------------------+" + LF + CR + &
         "| Congratulations!   |" + CR + CR + &
         "+--------------------+"
   .
   .
   .
PRINT Congrats
   .
   .
   .
PRINT Congrats
```

Named constants can save you programming time because you do not have to retype the value every time you want to display it.

Valid operators in DECLARE CONSTANT expressions include string concatenations and all valid arithmetic, relational, and logical operators except exponentiation. You cannot use built-in functions in DECLARE CONSTANT expressions.

BASIC allows constants of all data types except RFA to be named constants. Because you cannot declare a constant of the RFA data type, you cannot name a constant of that type.

You can specify only one data type in a DECLARE CONSTANT statement. To declare a constant of a different data type, you must use a second DECLARE CONSTANT statement.

#### 1.5.3.2 Naming Constants External to a Program Unit

To declare constants outside the program unit, use the EXTERNAL statement, as shown in Example 1–5.

**Example 1–5 Declaring Constants Outside the Program Unit**

```
EXTERNAL LONG CONSTANT SS$_NORMAL
EXTERNAL WORD CONSTANT IS_SUCCESS
```

The first line declares the OpenVMS status code SS$_NORMAL to be an external LONG constant. The second line declares IS_SUCCESS, a success code, to be an external WORD constant. Note that BASIC allows only external BYTE, WORD, LONG, QUAD, and SINGLE constants. The OpenVMS Linker supplies the values for the constants specified in EXTERNAL statements.

In BASIC, the named constant might be a system status code or a global constant declared in another OpenVMS layered product.

### 1.5.4 Explicit Literal Notation

You can specify the value and data type of numeric literals by using a special notation called explicit literal notation. The format of this notation is as follows:

[*radix*] *"num-str-lit" [data-type]*

*Radix* specifies an optional base, which can be any of the following:

D Decimal (base 10)

B Binary (base 2)

O Octal (base 8)

| | |
|---|---|
| X | Hexadecimal (base 16) |
| A | ASCII |

The BASIC default radix is decimal. Binary, octal, and hexadecimal notation allow you to set or clear individual bits in the representation of an integer. This feature is useful in forming conditional expressions and in using logical operations. The ASCII radix causes BASIC to translate a single ASCII character to its decimal equivalent. This decimal equivalent is an INTEGER value; you specify whether the INTEGER subtype should be BYTE, WORD, LONG, or QUAD.

*Num-str-lit* is a numeric string literal. It can be the digits 0 and 1 when the radix is binary, the digits 0 to 7 when the radix is octal, the digits 0 to F when the radix is hexadecimal, and the digits 0 to 9 when the radix is decimal. When the radix is ASCII, *num-str-lit* can be any valid ASCII character.

*Data-type* is an optional single letter that corresponds to one of the data type keywords that follow:

| | |
|---|---|
| B | BYTE |
| W | WORD |
| L | LONG |
| Q | QUAD (Alpha BASIC only) |
| F | SINGLE |
| D | DOUBLE |
| G | GFLOAT |
| H | HFLOAT (VAX BASIC only) |
| S | SFLOAT (Alpha BASIC only) |
| T | TFLOAT (Alpha BASIC only) |
| X | XFLOAT (Alpha BASIC only) |
| P | DECIMAL |
| C | CHARACTER |

The following are examples of explicit literals:

| | |
|---|---|
| D"255"L | Specifies a LONG decimal constant with a value of 255 |
| "4000"F | Specifies a SINGLE decimal constant with a value of 4000 |
| A"M"L | Specifies a LONG integer constant with a value of 77 |
| A"m"B | Specifies a BYTE integer constant with a value of 109 |

A quoted numeric string alone, without a radix and a data type, is a string literal, not a numeric literal. For

| | |
|---|---|
| "255" | Is a string literal |
| "255"W | Specifies a WORD decimal constant with a value of 255 |

If you specify a binary, octal, ASCII, or hexadecimal radix, *data-type* must be an integer. If you do not specify a data type, BASIC uses the default integer data type. For example:

| | |
|---|---|
| B"11111111"B | Specifies a BYTE binary constant with a value of -1 |
| B"11111111"W | Specifies a WORD binary constant with a value of 255 |
| B"11111111" | Specifies a binary constant of the default data type (BYTE, WORD, LONG, or QUAD) |
| B"11111111"F | Is illegal because F is not an integer data type |
| X"FF"B | Specifies a BYTE hexadecimal constant with a value of -1 |
| X"FF"W | Specifies a WORD hexadecimal constant with a value of 255 |
| X"FF"D | Is illegal because D is not an integer data type |
| O"377"B | Specifies a BYTE octal constant with a value of -1 |
| O"377"W | Specifies a WORD octal constant with a value of 255 |
| O"377"G | Is illegal because G is not an integer data type |

When you specify a radix other than decimal, overflow checking is performed as if the numeric string were an unsigned integer. However, when this value is assigned to a variable or used in an expression, the compiler treats it as a signed integer.

In the following example, BASIC sets all 8 bits in storage location A. Because A is a BYTE integer, it has only 8 bits of storage. Because the 8-bit two's complement of 1 is 11111111, its value is -1. If the data type is W (WORD), BASIC sets the bits to 0000000011111111, and its value is 255.

```
DECLARE BYTE A
A = B"11111111"B
PRINT A
```

**Output**

```
-1
```

**Note**

In BASIC, D can appear in both the radix position and the data type position. D in the radix position specifies that the numeric string is treated as a decimal number (base 10). D in the data type position specifies that the value is treated as a double-precision, floating-point constant. P in the data type position specifies a packed decimal constant. For example:

| | |
|---|---|
| "255"D | Specifies a double-precision constant with a value of 255 |
| "255.55"P | Specifies a DECIMAL constant with a value of 255.55 |

You can use explicit literal notation to represent a single-character string in terms of its 8-bit ASCII value. For example:

*[radix] num-str-lit* C

The letter C is an abbreviation for CHARACTER. The value of the numeric string must be from 0 to 255. This feature lets you create your own compile-time string constants containing nonprinting characters.

The following example declares a string constant named *control_g* (ASCII decimal value 7). When BASIC executes the PRINT statement, the terminal bell sounds.

```
DECLARE STRING CONSTANT control_g = "7"C
PRINT control_g
```

### 1.5.5 Predefined Constants

Predefined constants are symbolic representations of either ASCII characters or mathematical values. They are also called compile-time constants because their value is known at compilation rather than at run time.

Predefined constants help you to:

- Format program output to improve readability
- Make source code easier to understand

Table 1–6 lists the predefined constants supplied by BASIC, their ASCII values, and their functions.

**Table 1–6 Predefined Constants**

| Constant | Decimal/ ASCII Value | Function |
|---|---|---|
| NUL | 0 | Integer value zero |
| BEL (Bell) | 7 | Sounds the terminal bell |
| BS (Backspace) | 8 | Moves the cursor one position to the left |
| HT (Horizontal Tab) | 9 | Moves the cursor to the next horizontal tab stop |
| LF (Line Feed) | 10 | Moves the cursor to the next line |
| VT (Vertical Tab) | 11 | Moves the cursor to the next vertical tab stop |
| FF (Form Feed) | 12 | Moves the cursor to the start of the next page |
| CR (Carriage Return) | 13 | Moves the cursor to the beginning of the current line |
| SO (Shift Out) | 14 | Shifts out for communications networking, screen formatting, and alternate graphics |
| SI (Shift In) | 15 | Shifts in for communications networking, screen formatting, and alternate graphics |
| ESC (Escape) | 27 | Marks the beginning of an escape sequence |
| SP (Space) | 32 | Inserts one blank space in program output |
| DEL (Delete) | 127 | Deletes the last character entered |
| PI | None | Represents the number PI with the precision of the default floating-point data type |

You can use predefined constants in many ways. The following example shows how to print and underline a word on a hardcopy display:

```
PRINT "NAME:" + BS + BS + BS + BS + BS + "_____"
END
```

**Output**

```
NAME:
```

The following example shows how to print and underline a word on a video display terminal:

```
PRINT ESC + "[4mNAME:" + ESC + "[0m"
END
```

**Output**

```
NAME:
```

Note that in the previous example, *m* must be lowercase.

## 1.6 Expressions

BASIC expressions consist of operands (constants, variables, and functions) separated by arithmetic, string, relational, and logical operators.

The following are types of BASIC expressions:

- Numeric expressions
- String expressions
- Conditional expressions

BASIC evaluates expressions according to operator precedence and uses the results in program execution. Parentheses can be used to group operands and operators, thus controlling the order of evaluation.

The following sections explain the types of expressions you can create and the way BASIC evaluates expressions.

### 1.6.1 Numeric Expressions

Numeric expressions consist of floating-point, integer, or packed decimal operands separated by arithmetic operators and optionally grouped by parentheses. Table 1–7 shows how numeric operators work in numeric expressions.

**Table 1–7 Arithmetic Operators**

| Operator | Example | Use |
|---|---|---|
| + | A + B | Add B to A |
| – | A – B | Subtract B from A |
| * | A * B | Multiply A by B |
| / | A / B | Divide A by B |
| ^ | A^B | Raise A to the power B |
| ** | A**B | Raise A to the power B |

In general, two arithmetic operators cannot occur consecutively in the same expression. Exceptions are the unary plus and unary minus. The following expressions are valid:

```
A * + B
A * - B
A * (-B)
A * + - + - B
```

The following expression is not valid:

```
A - * B
```

An operation on two numeric operands of the same data type yields a result of that type. For example:

| | |
|---|---|
| A% + B% | Yields an integer value of the default type |
| G3 * M5 | Yields a floating-point value if the default type is REAL |

If the result of the operation exceeds the range of the data type, BASIC signals an overflow error message.

The following example causes BASIC to signal the error "Integer error or overflow" because the sum of *A* and *B* (254) exceeds the range of -128 to +127 for BYTE integers. Similar overflow errors occur for REAL and DECIMAL data types whenever the result of a numeric operation is outside the range of the corresponding data type.

```
DECLARE BYTE A, B
A = 127
B = 127
PRINT A + B
END
```

It is possible to assign a value of one data type to a variable of a different data type. When this occurs, the data type of the variable overrides the data type of the assigned value. The following example assigns the value 32 to the integer variable *A%* even though the floating-point value of the expression is 32.13:

```
A% = 5.1 * 6.3
```

#### 1.6.1.1 Floating-Point and Integer Promotion Rules

The following sections describe the floating-point and integer promotion rules for VAX BASIC and Alpha BASIC, unless otherwise noted.

When an expression contains operands with different data types, the data type of the result is determined by BASIC data type promotion rules:

- With one exception, BASIC promotes operands with different data types to the lowest common data type that can hold the largest and most precise possible value of either operand's data type. BASIC then performs the operation using that data type, and yields a result of that data type.
- The exception is that when an operation involves SINGLE and LONG data types, BASIC promotes the LONG data type to SINGLE rather than DOUBLE, performs the operation, and yields a result of the SINGLE data type.

Note that BASIC performs sign extension when converting BYTE, WORD, and LONG integers to a higher INTEGER data type (WORD, LONG, or QUAD). The high order bit (the sign bit) determines how the additional bits are set when the BYTE, WORD, or LONG is converted to WORD, LONG, or QUAD. If the high order bit is zero (positive), all higher-order bits in the converted integer are set to zero. If the high order bit is 1 (negative), all higher-order bits in the converted integer are set to 1.

##### Data Type Results in VAX BASIC Expressions

Table 1–8 lists the data type results possible for VAX BASIC in numeric expressions that combine different data types.

**Table 1–8 Result Data Types in VAX BASIC Expressions**

| | BYTE | WORD | LONG | SINGLE | DOUBLE | GFLOAT | HFLOAT |
|---|---|---|---|---|---|---|---|
| **BYTE** | BYTE | WORD | LONG | SINGLE | DOUBLE | GFLOAT | HFLOAT |
| **WORD** | WORD | WORD | LONG | SINGLE | DOUBLE | GFLOAT | HFLOAT |
| **LONG** | LONG | LONG | LONG | SINGLE | DOUBLE | GFLOAT | HFLOAT |
| **SINGLE** | SINGLE | SINGLE | SINGLE | SINGLE | DOUBLE | GFLOAT | HFLOAT |
| **DOUBLE** | DOUBLE | DOUBLE | DOUBLE | DOUBLE | DOUBLE | HFLOAT | HFLOAT |
| **GFLOAT** | GFLOAT | GFLOAT | GFLOAT | GFLOAT | HFLOAT | GFLOAT | HFLOAT |
| **HFLOAT** | HFLOAT | HFLOAT | HFLOAT | HFLOAT | HFLOAT | HFLOAT | HFLOAT |

For example, if one operand is SINGLE and one operand is DOUBLE, BASIC promotes the SINGLE value to DOUBLE, performs the specified operation, and returns the result as a DOUBLE value. This promotion is necessary because the SINGLE data type has less precision than the DOUBLE value, whereas the DOUBLE data type can represent all possible SINGLE values.

The data types BYTE, WORD, LONG, SINGLE, and DOUBLE form a simple hierarchy: if all operands in an expression are of these data types, the result of the expression is the highest data type used in the expression.

When the operands are DOUBLE and GFLOAT, BASIC promotes both values to HFLOAT, and returns an HFLOAT value. The promotion of DOUBLE and GFLOAT to HFLOAT is necessary because a DOUBLE value is more precise than a GFLOAT value, but cannot contain the largest possible GFLOAT value. Consequently, BASIC promotes these data types to a data type that can hold the largest and most precise value of either operand.

### Data Type Results in Alpha BASIC

Table 1–9 shows the data type of the result of an operation that combines arguments of differing data types. Alpha BASIC first promotes, if necessary, the arguments to the result data type, and then performs the operation.

Alpha BASIC does not support HFLOAT.

**Table 1–9 Result Data Types in Alpha BASIC Expressions**

| | BYTE | WORD | LONG | QUAD | SINGLE | DOUBLE | GFLOAT | SFLOAT | TFLOAT | XFLOAT |
|---|---|---|---|---|---|---|---|---|---|---|
| **BYTE** | BYTE | WORD | LONG | QUAD | SINGLE | DOUBLE | GFLOAT | SFLOAT | TFLOAT | XFLOAT |
| **WORD** | WORD | WORD | LONG | QUAD | SINGLE | DOUBLE | GFLOAT | SFLOAT | TFLOAT | XFLOAT |
| **LONG** | LONG | LONG | LONG | QUAD | SINGLE | DOUBLE | GFLOAT | TFLOAT | TFLOAT | XFLOAT |
| **QUAD** | QUAD | QUAD | QUAD | QUAD | GFLOAT | GFLOAT | GFLOAT | TFLOAT | TFLOAT | XFLOAT |
| **SINGLE** | SINGLE | SINGLE | SINGLE | GFLOAT | SINGLE | DOUBLE | GFLOAT | TFLOAT | TFLOAT | XFLOAT |
| **DOUBLE** | DOUBLE | DOUBLE | DOUBLE | GFLOAT | DOUBLE | DOUBLE | GFLOAT | TFLOAT | TFLOAT | XFLOAT |
| **GFLOAT** | GFLOAT | GFLOAT | GFLOAT | GFLOAT | GFLOAT | GFLOAT | GFLOAT | GFLOAT | TFLOAT | XFLOAT |
| **SFLOAT** | SFLOAT | SFLOAT | TFLOAT | TFLOAT | TFLOAT | TFLOAT | GFLOAT | SFLOAT | TFLOAT | XFLOAT |
| **TFLOAT** | TFLOAT | TFLOAT | TFLOAT | TFLOAT | TFLOAT | TFLOAT | TFLOAT | TFLOAT | TFLOAT | XFLOAT |
| **XFLOAT** | XFLOAT | XFLOAT | XFLOAT | XFLOAT | XFLOAT | XFLOAT | XFLOAT | XFLOAT | XFLOAT | XFLOAT |

#### 1.6.1.2 DECIMAL Promotion Rules

BASIC allows the DECIMAL(d,s) data type. The number of digits (d) and the scale or position of the decimal point (s) in the result of DECIMAL operations depends on the data type of the other operand. If one operand is DECIMAL and the other is DECIMAL or INTEGER, the d and s values of the result are determined as follows:

- If both operands are typed DECIMAL, and if both operands have the same digit (d) and scale (s) values, no conversions occur and the result of the operation has exactly the same d and s values as the operands. Note, however, that overflow can occur if the result exceeds the range specified by the d value.
- If both operands are DECIMAL but have different digit and scale values, BASIC uses the larger number of specified digits for the result.

  In the following example, variable *A* allows three digits to the left of the decimal point and two digits to the right. Variable *B* allows one digit to the left of the decimal point and three digits to the right.

```
DECLARE DECIMAL(5,2) A
DECLARE DECIMAL(4,3) B
```

  The result allows three digits to the left of the decimal point and three digits to the right.

- If one operand is DECIMAL and one is INTEGER, the INTEGER value is converted to a DECIMAL(d,s) data type as follows:
  - BYTE is converted to DECIMAL(3,0).
  - WORD is converted to DECIMAL(5,0).
  - LONG is converted to DECIMAL(10,0).
  - QUAD is converted to DECIMAL(19,0).

  BASIC then determines the d and s values of the result by evaluating the d and s values of the operands as described above.

Note that only INTEGER data types are converted to the DECIMAL data type. If one operand is DECIMAL and one is floating-point, the DECIMAL value is converted to a floating-point value. The total number of digits in (d) in the DECIMAL value determines its new data type, as shown in Table 1–10 for VAX BASIC and Table 1–11 for Alpha BASIC.

**Table 1–10 VAX BASIC Result Data Types for DECIMAL Data**

| Number of DECIMAL Digits | Floating-Point Operands | | | |
|---|---|---|---|---|
| in Operand | SINGLE | DOUBLE | GFLOAT | HFLOAT |
| 1-6 | SINGLE | DOUBLE | GFLOAT | HFLOAT |
| 7-15 | DOUBLE | DOUBLE | GFLOAT | HFLOAT |
| 16 | DOUBLE | DOUBLE | HFLOAT | HFLOAT |
| 17-31 | HFLOAT | HFLOAT | HFLOAT | HFLOAT |

For example, if the value of d is from 7 to 15, the operand is converted to:

- DOUBLE if the floating-point operand is SINGLE or DOUBLE
- GFLOAT if the floating-point operand is GFLOAT
- HFLOAT if the floating-point operand is HFLOAT

Thus, a DECIMAL(8,5) operand is converted to DOUBLE if the other operand is SINGLE or DOUBLE, to GFLOAT if the other operand is GFLOAT, and to HFLOAT if the other operand is HFLOAT. Note also that exponentiation of a DECIMAL data type returns a REAL value.

For Alpha BASIC, if one argument is DECIMAL data type and one is a floating point data type, the DECIMAL data type argument is first converted to a floating point data type as follows in Table 1–11.

**Table 1–11 Alpha BASIC Result Data Types for DECIMAL Data**

| Number of DECIMAL Digits in Operand | Floating-Point Operands | | | | | |
|---|---|---|---|---|---|---|
| | SINGLE | DOUBLE | GFLOAT | SFLOAT | TFLOAT | XFLOAT |
| 1-6 | SINGLE | DOUBLE | GFLOAT | SFLOAT | TFLOAT | XFLOAT |
| 7-15 | DOUBLE | DOUBLE | GFLOAT | TFLOAT | TFLOAT | XFLOAT |
| 16 | DOUBLE | DOUBLE | GFLOAT | XFLOAT | XFLOAT | XFLOAT |
| 17-31 | GFLOAT | GFLOAT | GFLOAT | XFLOAT | XFLOAT | XFLOAT |

GFLOAT maintains up to 15 digits of precision. Mixing DECIMAL items containing 16 or more bits with GFLOAT items may cause a loss of precision.

Operations performed on DOUBLE operands are performed in GFLOAT. When the operation is complete, the GFLOAT result is converted to DOUBLE. Therefore, it is possible to lose three binary digits of precision in arithmetic operations using DOUBLE.

### 1.6.2 String Expressions

String expressions are string entities separated by a plus sign (+). When used in a string expression, the plus sign concatenates strings. For example:

```
INPUT "Type two words to be combined";A$, B$
C$ = A$ + B$
PRINT C$
END
```

**Output**

```
Type two words to be combined? long
? word
longword
```

## 1.6.3 Conditional Expressions

Conditional expressions can be either relational or logical expressions. Numeric relational expressions compare numeric operands to determine whether the expression is true or false. String relational expressions compare string operands to determine which string expression occurs first in the ASCII collating sequence.

Logical expressions contain integer operands and logical operators. BASIC determines whether the specified logical expression is true or false by testing the numeric result of the expression. Note that in conditional expressions, as in any numeric expression, when BYTE, WORD, and LONG operands are compared to WORD, LONG, and QUAD, the specified operation is performed in the higher data type, and the result returned is also of the higher data type. When one of the operands is a negative value, this conversion will produce accurate but perhaps confusing results, because BASIC performs a sign extension when converting BYTE and WORD integers to a higher integer data type. See Section 1.6.1.1 for information about integer conversion rules.

### 1.6.3.1 Numeric Relational Expressions

Operators in numeric relational expressions compare the values of two operands and return either -1 if the relation is true (as shown in Example 1), or zero if the relation is false (as shown in Example 2). The data type of the result is the default integer type.

**Example 1**

```
A = 10
B = 15
X% = (A <> B)
IF X% = -1%
THEN PRINT 'Relationship is true'
ELSE PRINT 'Relationship is false'

END IF
```

**Output**

```
Relationship is true
```

**Example 2**

```
A = 10
B = 15
X% = A = B
IF X% = -1%
THEN PRINT 'Relationship is true'
ELSE
     PRINT 'Relationship is false'

END IF
```

**Output**

```
Relationship is false
```

Table 1–12 shows how relational operators work in numeric relational expressions.

**Table 1–12 Numeric Relational Operators**

| Operator | Example | Meaning |
|---|---|---|
| = | A = B | A is equal to B. |
| < | A < B | A is less than B. |
| > | A > B | A is greater than B. |
| <= or =< | A <= B | A is less than or equal to B. |
| >= or => | A >= B | A is greater than or equal to B. |
| <> or >< | A <> B | A is not equal to B. |
| = = | A = = B | A and B will PRINT the same if they are equal to six significant digits. However, if one value prints in explicit notation and the other value prints in E format notation, the relation will always be false. |

### 1.6.3.2 String Relational Expressions

Operators in string relational expressions determine how BASIC compares strings. BASIC determines the value of each character in the string by converting it to its ASCII value. ASCII values are listed in Appendix A. BASIC compares the strings character by character, left to right, until it finds a difference in ASCII value.

In the following example, BASIC compares *A$* and *B$* character by character. The strings are identical up to the third character. Because the ASCII value of *Z* (90) is greater than the ASCII value of *C* (67), *A$* is less than *B$*. BASIC evaluates the expression *A$* < *B$* as true (-1) and prints "ABC comes before ABZ".

```
A$ = 'ABC'
B$ = 'ABZ'
IF A$ < B$
THEN PRINT 'ABC comes before ABZ'
ELSE IF A$ == B$
     THEN PRINT 'The strings are identical'
     ELSE IF A$ > B$
          THEN PRINT 'ABC comes after ABZ'
          ELSE PRINT 'Strings are equal but not identical'
          END IF
     END IF
END IF
END
```

If two strings of differing lengths are identical up to the last character in the shorter string, BASIC pads the shorter string with spaces (ASCII value 32) to generate strings of equal length, unless the operator is the double equal sign (==). If the operator is the double equal sign, BASIC does not pad the shorter string.

In the following example, BASIC compares "ABCDE" to "ABC " to determine which string comes first in the collating sequence. "ABC " appears before "ABCDE" because the ASCII value for space (32) is lower than the ASCII value of *D* (68). Then BASIC compares "ABC " with "ABC" using the double equal sign and determines that the strings do not match exactly without padding. The third comparison uses the single equal sign. BASIC pads "ABC" with spaces and determines that the two strings match with padding.

```
A$ = 'ABCDE'
B$ = 'ABC'
PRINT 'B$ comes before A$' IF B$ < A$
PRINT 'A$ comes before B$' IF A$ < B$
C$ = 'ABC '
IF B$ == C$
      THEN PRINT 'B$ exactly matches C$'
      ELSE PRINT 'B$ does not exactly match C$'
END IF
IF B$ = C$
      THEN PRINT 'B$ matches C$ with padding'
      ELSE PRINT 'B$ does not match C$'
END IF
```

**Output**

```
B$ comes before A$
B$ does not exactly match C$
B$ matches C$ with padding
```

Table 1–13 shows how relational operators work in string relational expressions.

**Table 1–13 String Relational Operators**

| Operator | Example | Meaning |
|---|---|---|
| = | A$ = B$ | Strings A$ and B$ are equal after the shorter string has been padded with spaces to equal the length of the longer string. |
| < | A$ < B$ | String A$ occurs before string B$ in ASCII sequence. |
| > | A$ > B$ | String A$ occurs after string B$ in ASCII sequence. |
| <= or =< | A$ <= B$ | String A$ is equal to or precedes string B$ in ASCII sequence. |
| >= or => | A$ >= B$ | String A$ is equal to or follows string B$ in ASCII sequence. |
| <> or >< | A$ <> B$ | String A$ is not equal to string B$. |
| == | A$ == B$ | Strings A$ and B$ are identical in composition and length, without padding. |

#### 1.6.3.3 Logical Expressions

A logical expression can have one of the following formats:

- A unary logical operator and one integer operand
- Two integer operands separated by a binary logical operator
- One integer operand

Logical expressions are valid only when the operands are integers. If the expression contains two integer operands of differing data types, the resulting integer has the same data type as the higher integer operand. For example, the result of an expression that contains a BYTE integer and a WORD integer would be a WORD integer. Table 1–14 lists the logical operators.

**Table 1–14 Logical Operators**

| Operator | Example | Meaning |
|---|---|---|
| NOT | NOT A% | The bit-by-bit complement of A%. If A% is true (-1), NOT A% is false (0). |
| AND | A% AND B% | The logical product of A% and B%. A% AND B% is true only if both A% and B% are true. |
| OR | A% OR B% | The logical sum of A% and B%. A% OR B% is false only if both A% and B% are false; otherwise, A% OR B% is true. |
| XOR | A% XOR B% | The logical exclusive OR of A% and B%. A% XOR B% is true if either A% or B% is true but not if both are true. |
| EQV | A% EQV B% | The logical equivalence of A% and B%. A% EQV B% is true if A% and B% are both true or both false; otherwise the value is false. |
| IMP | A% IMP B% | The logical implication of A% and B%. A% IMP B% is false only if A% is true and B% is false; otherwise, the value is true. |

The truth tables in Figure 1–2 summarize the results of these logical operations. Zero is false; -1 is true.

The operators XOR and EQV are logical complements.

BASIC determines whether the condition is true or false by testing the result of the logical expression to see whether any bits are set. If no bits are set, the value of the expression is zero and it is evaluated as false; if any bits are set, the value of the expression is nonzero, and the expression is evaluated as true. However, logical operators can return unanticipated results unless -1 is specified for true values and zero for false.

In the following example, the values of *A%* and *B%* both test as true because they are nonzero values. However, the logical AND of these two variables returns an unanticipated result of false.

```
A% = 2%
B% = 4%
IF A% THEN PRINT 'A% IS TRUE'
IF B% THEN PRINT 'B% IS TRUE'
IF A% AND B% THEN PRINT 'A% AND B% IS TRUE'
            ELSE PRINT 'A% AND B% IS FALSE'
END
```

**Figure 1–2 Truth Tables**

| A% | NOT A% |
|---|---|
| 0 | −1 |
| −1 | 0 |

| A% | B% | A% OR B% |
|---|---|---|
| 0 | 0 | 0 |
| 0 | −1 | −1 |
| −1 | 0 | −1 |
| −1 | −1 | −1 |

| A% | B% | A% AND B% |
|---|---|---|
| 0 | 0 | 0 |
| 0 | −1 | 0 |
| −1 | 0 | 0 |
| −1 | −1 | −1 |

| A% | B% | A% EQV B% |
|---|---|---|
| 0 | 0 | −1 |
| 0 | −1 | 0 |
| −1 | 0 | 0 |
| −1 | −1 | −1 |

| A% | B% | A% XOR B% |
|---|---|---|
| 0 | 0 | 0 |
| 0 | −1 | −1 |
| −1 | 0 | −1 |
| −1 | −1 | 0 |

| A% | B% | A% IMP B% |
|---|---|---|
| 0 | 0 | −1 |
| 0 | −1 | −1 |
| −1 | 0 | 0 |
| −1 | −1 | −1 |

ZK−5548−GE

**Output**

```
A% IS TRUE
B% IS TRUE
A% AND B% IS FALSE
```

The program returns this seemingly contradictory result because logical operators work on the individual bits of the operands. The 8-bit binary representation of 2% is as follows:

```
0  0  0  0  0  0  1  0
```

The 8-bit binary representation of 4% is as follows:

```
0  0  0  0  0  1  0  0
```

Each value tests as true because it is nonzero. However, the AND operation on these two values sets a bit in the result only if the corresponding bit is set in both operands. Therefore, the result of the AND operation on 4% and 2% is as follows:

```
0  0  0  0  0  0  0  0
```

No bits are set in the result, so the value tests as false (zero).

If the value of *B%* is changed to 6%, the resulting value tests as true (nonzero) because both 6% and 2% have the second bit set. Therefore, BASIC sets the second bit in the result and the value tests as nonzero and true.

The 8-bit binary representation of -1 is as follows:

```
1  1  1  1  1  1  1  1
```

The result of -1% AND -1% is -1% because BASIC sets bits in the result for each corresponding bit that is set in the operands. The result tests as true because it is a nonzero value, as shown in the following example:

```
A% = -1%
B% = -1%
IF A% THEN PRINT 'A% IS TRUE'
IF B% THEN PRINT 'B% IS TRUE'
IF A% AND B% THEN PRINT 'A% AND B% IS TRUE'
            ELSE PRINT 'A% AND B% IS FALSE'
END
```

**Output**

```
A% IS TRUE
B% IS TRUE
A% AND B% IS TRUE
```

Your program may also return unanticipated results if you use the NOT operator with a nonzero operand that is not -1.

In the following example, BASIC evaluates both *A%* and *B%* as true because they are nonzero. *NOT A%* is evaluated as false (zero) because the binary complement of -1 is zero. *NOT B%* is evaluated as true because the binary complement of 2 has bits set and is therefore a nonzero value.

```
A%=-1%
B%=2
IF A% THEN PRINT 'A% IS TRUE'
      ELSE PRINT 'A% IS FALSE'
IF B% THEN PRINT 'B% IS TRUE'
      ELSE PRINT 'B% IS FALSE'
IF NOT A% THEN PRINT 'NOT A% IS TRUE'
          ELSE PRINT 'NOT A% IS FALSE'
IF NOT B% THEN PRINT 'NOT B% IS TRUE'
          ELSE PRINT 'NOT B% IS FALSE'
END
```

**Output**

```
A% IS TRUE
B% IS TRUE
NOT A% IS FALSE
NOT B% IS TRUE
```

### 1.6.4 Evaluating Expressions

BASIC evaluates expressions according to operator precedence. Each arithmetic, relational, and string operator in an expression has a position in the hierarchy of operators. The operator's position informs BASIC of the order in which to perform the operation. Parentheses can change the order of precedence.

Table 1–15 lists all operators as BASIC evaluates them. Note the following:

- Operators with equal precedence are evaluated logically from left to right.
- BASIC evaluates expressions enclosed in parentheses first, even when the operator in parentheses has a lower precedence than that outside the parentheses.

**Table 1–15 Numeric Operator Precedence**

| Operator | Precedence |
|---|---|
| ** or ^ | 1 |
| – (unary minus) or + (unary plus) | 2 |
| * or / | 3 |
| + or – | 4 |
| + (concatenation) | 5 |
| all relational operators | 6 |
| NOT | 7 |
| AND | 8 |
| OR, XOR | 9 |
| IMP | 10 |
| EQV | 11 |

For example, BASIC evaluates the following expression in five steps:

```
A = 15^2 + 12^2 - (35 * 8)
```

| | | |
|---|---|---|
| 1. | (35 * 8) = 280 | Multiplication |
| 2. | 15^2 = 225 | Exponentiation (leftmost expression) |
| 3. | 12^2 = 144 | Exponentiation |
| 4. | 225 + 144 = 369 | Addition |
| 5. | 369 – 280 = 89 | Subtraction |

There is one exception to this order of precedence: when an operator that does not require operands on either side of it (such as NOT) immediately follows an operator that does require operands on both sides (such as the addition operator (+)), BASIC evaluates the second operator first. For example:

```
A% + NOT B% + C%
```

This expression is evaluated as follows:

```
(A% + (NOT B%)) + C%
```

BASIC evaluates the expression NOT B before it evaluates the expression A + NOT B. When the NOT expression does not follow the addition (+) expression, the normal order of precedence is followed. For example:

```
NOT A% + B% + C%
```

This expression is evaluated as:

```
NOT ((A% + B%) + C %)
```

BASIC evaluates the two expressions (A% + B%) and ((A% + B%) + C%) because the + operator has a higher precedence than the NOT operator.

BASIC evaluates nested parenthetical expressions from the inside out.

In the following example, BASIC evaluates the parenthetical expression *A* quite differently from expression *B*. For expression *A*, BASIC evaluates the innermost parenthetical expression (25 + 5) first, then the second inner expression (30 / 5), then (6 * 7), and finally (42 + 3). For expression *B*, BASIC evaluates (5 / 5) first, then (1 * 7), then (25 + 7 + 3) to obtain a different value.

```
A = ((((25 + 5) / 5) * 7) + 3)
PRINT A
B = 25 + 5 / 5 * 7 + 3
PRINT B
```

**Output**

```
45
35
```

# 1.7 Program Documentation

Documentation within a program clarifies and explains source program structure. These explanations, or comments, can be combined with code to create a more readable program without affecting program execution. Comments can appear in two forms:

- Comment fields (including empty statements)
- REM statements

## 1.7.1 Comment Fields

A comment field begins with an exclamation point (!) and ends with a carriage return. You supply text after the exclamation point to document your program. You can specify comment fields while creating BASIC programs at DCL level as well as in the VAX BASIC Environment. In both cases, BASIC does not execute text in a comment field. Example 1–6 shows how to specify a comment field.

**Example 1–6 Specifying a Comment Field**

```
! FOR loop to initialize list Q
FOR I = 1 TO 10
    Q(I) = 0 ! This is a comment
NEXT I
! List now initialized
```

BASIC executes only the FOR...NEXT loop. The comment fields, preceded by exclamation points, are not executed.

Example 1–7 shows how you can use comment fields to help make your program more readable and allow you to format your program into readily visible logical blocks. Example 1–7 also shows how comment fields can be used as target lines for GOTO and GOSUB statements.

**Example 1–7 Using Comment Fields to Format a Program**

```
!
! Square root program
!
INPUT 'Enter a number';A
PRINT 'SQR of ';A;'is ';SQR(A)
!
! More square roots?
!
INPUT 'Type "Y" to continue, press RETURN to quit';ANS$
GOTO 10 IF ANS$ = "Y"
!
END
```

You can also use an exclamation point to terminate a comment field, but this practice is not recommended. You should make sure that there are no exclamation points in the comment field itself; otherwise, BASIC treats the text remaining on the line as source code.

**Note**

Comment fields in DATA statements are invalid; the compiler treats the comments as additional data.

### 1.7.2 REM Statements

A REM statement begins with the REM keyword and ends when BASIC encounters a new line number. The text you supply between the REM keyword and the next line number documents your program. Like comment fields, REM statements do not affect program execution. BASIC ignores all characters between the keyword REM and the next line number. Therefore, the REM statement can be continued without the ampersand continuation character and should be the only statement on the line or the last of several statements in a multistatement line. Example 1–8 shows the use of the REM statement.

**Example 1–8 Using REM Statements in BASIC Programs**

```
  5   REM This is an example
      A=5
      B=10
      REM A equals 5
          B equals 10
 10   PRINT A, B
```

**Output**

```
0       0
```

Note that because line 5 began with a REM statement, all the statements in line 5 were ignored.

The REM statement is nonexecutable. When you transfer control to a REM statement, BASIC executes the next executable statement that lexically follows the referenced statement.

**Note**

Because BASIC treats all text between the REM statement and the next line number as commentary, REM should be used very carefully in programs that follow the implied continuation rules. REM statements are disallowed in programs without line numbers.

In the following example, the conditional GOTO statement in line 20 transfers program control to line 10. BASIC ignores the REM comment on line 10 and continues program execution at line 20.

```
10  REM ** Square root program
20  INPUT 'Enter a number';A
    PRINT 'SQR of ';A;'is ';SQR(A)
    INPUT 'Type "Y" to continue, press RETURN to quit';ANS$
    GOTO 10 IF ANS$ = "Y"
40  END
```

# 2

# VAX BASIC Environment Commands

**Note**

The information in this chapter is specific to Compaq BASIC for OpenVMS VAX systems (referred to as VAX BASIC). The Environment commands are not supported by Compaq BASIC for OpenVMS Alpha systems (Alpha BASIC). For more information about the differences between Alpha BASIC and VAX BASIC, see Appendix C.

**Environment commands** are commands that you use in the VAX BASIC Environment. With Environment commands you can display, edit, and merge VAX BASIC programs, set compiler defaults, move VAX BASIC source programs to and from storage, and execute programs.

This chapter alphabetically lists all of the compiler commands that can be used within the VAX BASIC Environment. For information about immediate mode and calculator mode statements, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

# ! Your-comment

You can enter comments while in the VAX BASIC Environment by typing an exclamation point (!) and the comment.

## Format

! *Your-comment*

## Syntax Rules

1. The exclamation point must be the first character on the line.
2. You cannot continue a comment over more than one line.

## Remarks

None

## Examples

**Example 1**

```
Ready
! Comments here ...
```

**! Your-comment**

**Example 2**

```
$ TYPE BUILD_SPECIAL.COM

$ SET VERIFY
$ BASIC
!+
! Set the compilation options by uncommenting
! the appropriate ones.
!-
! SET LIST
SET WORD
SET DEBUG
!+
! Get the source module.
!-
OLD SPECIAL
!+
! Compile it.
!-
COMPILE
!+
! All done.
!-
EXIT
```

# $ System-command

You can execute a DCL command while in the VAX BASIC Environment by typing a dollar sign ($) before the command. VAX BASIC passes the command to the operating system for execution. The context of the VAX BASIC Environment and the program currently in memory do not change.

## Format

$ *system-command*

## Syntax Rules

VAX BASIC passes *system-command* directly to the OpenVMS operating system without checking for validity.

## Remarks

1. The terminal displays any error messages or output that the command generates.
2. Control returns to the VAX BASIC Environment after the command executes. The context (source file status, loaded modules, and so on) of the VAX BASIC Environment and the program currently in memory do not change unless the command causes the operating system to end VAX BASIC or log you out.
3. The command you specify executes within the context of a subprocess. Consequently, commands such as the DCL command SET, execute only within the subprocess and do not affect the process running VAX BASIC.

## Example

```
Ready
$ SHOW PROTECTION
  SYSTEM=RWED, OWNER=RWED, GROUP=RWED, WORLD=RE
Ready
```

# APPEND

The APPEND command merges an existing VAX BASIC source program with the program currently in memory.

## Format

APPEND *[file-spec]*

## Syntax Rules

*File-spec* is the name of the VAX BASIC program you want to merge with the program currently in memory. The default file type is .BAS.

## Remarks

1. You cannot specify the APPEND command on programs that do not contain line numbers.
2. If you type APPEND without specifying a file name, VAX BASIC prompts with the following:

   ```
   Append file name--
   ```

   You should respond with a file name. If you respond by pressing Return and no file name, VAX BASIC searches for a file named NONAME.BAS. If the VAX BASIC compiler cannot find NONAME.BAS, VAX BASIC signals the error "Can't find file or account" (ERR=5).
3. You can append the contents of *file-spec* to a source program that is either called into memory with the OLD command or created in the VAX BASIC Environment. If there is no program in memory, VAX BASIC appends the file to an empty program with the default file name NONAME.
4. If *file-spec* contains a VAX BASIC line with the same line number as a line of the program in memory, the line in the appended file replaces the line of the program in memory. Otherwise, VAX BASIC inserts appended lines into the program in memory in sequential, ascending line number order.
5. The APPEND command does not change the name of the program in memory.

6. If you have not saved the appended version of the program, VAX BASIC signals the warning "Unsaved change has been made, Ctrl/Z or EXIT to exit" the first time you try to leave the VAX BASIC Environment.

## Example

```
Ready
New FIRST_TRY.BAS
Ready
10  PRINT "First program"
APPEND NEW_PROG.BAS
Ready
LIST
10  PRINT "First Program"
20  PRINT "This section has been appended"
   .
   .
   .
```

# ASSIGN

The ASSIGN command equates a logical name to a complete file specification, a device, or another logical name within the context of the VAX BASIC Environment.

## Format

ASSIGN *equiv-name*[**:**] *log-name*[**:**]

## Syntax Rules

1. *Equiv-name* specifies the file specification, device, or logical name to be assigned a logical name. If you specify a physical device name, you must terminate it with a colon (:).
2. *Log-name* is the 1- to 63-character logical name to be associated with *equiv-name*. You can specify a logical name for any portion of a file specification. If the logical name translates to a device name, and will be used in place of a device name in a file specification, you must terminate it with a colon (:).
3. If *log-name* has more than 63 characters, VAX BASIC signals the error "Invalid logical name."

## Remarks

1. When the logical name assignment supersedes another logical name previously assigned, VAX BASIC displays the message "Previous logical name assignment replaced."
2. Logical names assigned with the ASSIGN command are placed in the process logical name table and remain there until you exit the VAX BASIC Environment.

## Example

```
ASSIGN [HENRY.BAS] PRO:
```

# COMPILE

The COMPILE command converts a VAX BASIC source program to an object module and writes the object file to disk.

## Format

COMPILE [ *file-spec* ] [ */qualifier* ]...

| Command Qualifiers | Defaults |
|---|---|
| /[NO]ANSI_STANDARD | /NOANSI_STANDARD |
| /[NO]AUDIT [ sep text-entry ] | /NOAUDIT |
| /[NO]BOUNDS_CHECK | /BOUNDS_CHECK |
| /BYTE | /LONG |
| /[NO]CROSS_REF [ sep [NO]KEYWORDS ] | /NOCROSS_REF |
| /[NO]DEBUG | /NODEBUG |
| /DECIMAL_SIZE sep (d,s) | /DECIMAL_SIZE=(15,2) |
| /DOUBLE | /SINGLE |
| /[NO]FLAG [ sep ( flag-clause,... ) ] | /NOFLAG |
| /GFLOAT | /SINGLE |
| /HFLOAT | /SINGLE |
| /[NO]LINES | /LINES |
| /[NO]LIST | /NOLIST |
| /LONG | /LONG |
| /[NO]MACHINE_CODE | /NOMACHINE |
| /[NO]OBJECT | /OBJECT |
| /[NO]OVERFLOW [ sep (data-type,...) ] | /OVERFLOW=(INTEGER,DECIMAL) |
| /[NO]ROUND | /NOROUND |
| /[NO]SETUP | /SETUP |
| /[NO]SHOW [ sep ( show-item,... ) ] | /SHOW |
| /SINGLE | /SINGLE |
| /[NO]SYNTAX_CHECK | /NOSYNTAX_CHECK |
| /[NO]TRACEBACK | /TRACEBACK |
| /TYPE_DEFAULT sep default-clause | /TYPE_DEFAULT=REAL |
| /VARIANT sep int-const | /VARIANT=0 |
| /[NO]WARNINGS [ sep warn-clause ] | /WARNINGS |
| /WORD | /LONG |

## Syntax Rules

1. *File-spec* specifies a name for the output file or files. If you do not provide a *file-spec*, the VAX BASIC compiler uses the name of the program currently

in memory for the file name, a default file type of .OBJ for the object file, and a default file type of .LIS for the listing file, if a listing file is requested.

2. *File-spec* can precede or follow any qualifier.
3. *Qualifier* specifies a qualifier keyword that sets a VAX BASIC default.
4. You can abbreviate all positive qualifiers to the first three letters of the qualifier keyword. You can abbreviate a negative qualifier to NO and the first three letters of the qualifier keyword.
5. In cases of ambiguous or erroneous qualifiers, VAX BASIC signals "Unknown qualifier," and the program does not compile. When qualifiers conflict, VAX BASIC compiles the program using the last specified conflicting qualifier. For example, the following command line causes VAX BASIC to compile the program currently in memory but does not cause VAX BASIC to create an .OBJ file:

   ```
   COMPILE/OBJ/NOOBJ
   ```

6. There must be a program in memory, or the COMPILE command does not execute; VAX BASIC does not signal an error or warning.

## Remarks

The following qualifiers cannot be used within the VAX BASIC Environment with the COMPILE command:

/ANALYSIS_DATA
/CHECK
/DEPENDENCY_DATA
/DESIGN
/DIAGNOSTICS
/INTEGER_SIZE
/OLD_VERSION=CDD_ARRAY
/OPTIMIZE
/REAL_SIZE
/SCALE

If an object file for the program already exists in your directory, VAX BASIC creates a new version of the .OBJ file.

You should not specify both a file name and file type. For example, if you enter the following command line, VAX BASIC creates two versions of NEWOBJ.FIL:

```
COMPILE NEWOBJ.FIL/LIS/OBJ
```

The first version, NEWOBJ.FIL;1, is the listing file; the second version, NEWOBJ.FIL;2, is the object file. If you specify only a file name, VAX BASIC uses the .OBJ and .LIS file type defaults when creating these files. Use the COMPILE/NOOBJECT command to check your program for errors without producing an object file.

When you exit from the VAX BASIC Environment, all options set with qualifiers return to the system default values. Use the SHOW command to display your system defaults before setting any qualifiers.

## Command Qualifiers

### /[NO]ANSI_STANDARD

The /ANSI_STANDARD qualifier causes VAX BASIC to compile programs according to the ANSI Minimal BASIC standard and to flag syntax that does not conform to the standard. The /NOANSI_STANDARD qualifier causes VAX BASIC not to compile the program according to the ANSI Minimal BASIC standard. The default is /NOANSI_STANDARD.

**/[NO]AUDIT [ { : } { str-lit } ]**
**{ = } { file-spec }**

The /AUDIT qualifier causes VAX BASIC to include a history list entry in the Commond Data Dictionary (CDD) data base when a CDD definition is extracted. *Str-lit* is a quoted string. *File-spec* is a text file. The history entry includes the following:

- The contents of *str-lit*, or up to the first 64 lines in the file specified by *file-spec*
- The name of the program module, process, user name, and user UIC that accessed the CDD
- The time and date of the access
- A note that access was made by the VAX BASIC compiler
- A note that access was an extraction

If you specify /NOAUDIT, VAX BASIC does not include a history list entry. The default is /NOAUDIT.

### /[NO]BOUNDS_CHECK

The /BOUNDS_CHECK qualifier causes VAX BASIC to perform range checks on array subscripts. With bounds checking enabled, VAX BASIC checks that all subscript references are within the array boundaries set when the array was declared. If the subscript bounds are not within the bounds initially declared for the array, VAX BASIC signals an error message. If you specify /NOBOUNDS_CHECK, VAX BASIC does not check that all subscript references are within the array bounds set. The default is /BOUNDS_CHECK.

**/BYTE**

The /BYTE qualifier causes VAX BASIC to allocate 8 bits of storage as the default for all integer data not explicitly typed in the program. Untyped integer values are treated as BYTE values and must be in the BYTE range or VAX BASIC signals the error "Integer error or overflow." Table 1–2 lists VAX BASIC data types and ranges. By default, the VAX BASIC compiler allocates 32 bits of storage.

**/[NO]CROSS_REFERENCE [ { : = } [NO]KEYWORDS ]**

If you use the /CROSS_REFERENCE qualifier with the /LIST qualifier when you compile your program, the VAX BASIC compiler includes cross-reference information in the program listing file. If you specify /CROSS_REFERENCE=KEYWORDS, VAX BASIC also cross-references VAX BASIC keywords used in the program. If you specify /NOCROSS_REFERENCE, VAX BASIC does not include a cross reference section in the compiler listing. The default is /NOCROSS_REFERENCE.

**/[NO]DEBUG**

The /DEBUG qualifier appends to the object file information about symbolic references and line numbers. This information is used by the OpenVMS Debugger when you debug your program. When you specify the /DEBUG qualifier on the COMPILE command, you cause the debugger to be invoked automatically when the program is run at DCL level (unless you specify RUN/NODEBUG). If you specify COMPILE/NODEBUG, information about program symbols and line numbers is not included in the object file. The default is /NODEBUG.

See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about using the OpenVMS Debugger.

**/DECIMAL_SIZE** { **:** / **=** } **(d,s)**

The /DECIMAL_SIZE qualifier allows you to specify the default size and precision for all DECIMAL data not explicitly assigned size and precision in the program. You specify the total number of digits (d) and the number of digits to the right of the decimal point (s). VAX BASIC signals the error "Decimal error or overflow" (ERR=181) when DECIMAL values are outside the range specified with this qualifier. See Table 1–2 for more information about the storage and range of packed decimal data. The default is /DECIMAL_SIZE=(15,2).

**/DOUBLE**

The /DOUBLE qualifier causes VAX BASIC to allocate 64 bits of storage in D_floating format as the default size for all floating-point data not explicitly typed in the program. Untyped floating-point values are treated as DOUBLE values and must be in the DOUBLE range or VAX BASIC signals the error "Floating-point error or overflow." Table 1–2 lists VAX BASIC data types and ranges. The default is /SINGLE.

**/[NO]FLAG [** { **:** / **=** } **(** { **[NO]AXPCOMPATIBILITY** / **[NO]BP2COMPATIBILITY** / **[NO]DECLINING** } **,...) ]**

The /FLAG qualifier causes VAX BASIC to provide compile-time information about program elements that are not compatible with Alpha BASIC or BASIC-PLUS-2 or that Compaq designates as not recommended for new program development. For more information about the differences between Alpha BASIC and VAX BASIC, see Appendix C.

If you specify the DECLINING clause, VAX BASIC flags the following source code as declining:

- CVT$$ (use EDIT$)
- CVT$%, CVT$F, CVT%$, CVTF$, AND SWAP% (use multiple MAP statements)
- DEF* functions (use DEF functions)
- FIELD statements (use MAP DYNAMIC and REMAP)
- GOTO line-num% (do not use the integer suffix with a line number)

The default is /NOFLAG.

### /GFLOAT

The /GFLOAT qualifier causes VAX BASIC to allocate 64 bits of storage in G_floating format as the default size for all floating-point data not explicitly typed in the program. Untyped floating-point values are treated as G_floating values and must be in the G_floating range or VAX BASIC signals "Floating-point error or overflow." Table 1–2 lists VAX BASIC data types and ranges. The default is /SINGLE.

### /HFLOAT

The /HFLOAT qualifier causes VAX BASIC to allocate 128 bits of storage in H_floating format as the default size for all floating-point data not explicitly typed in the program. Untyped floating-point values are treated as H_floating values and must be in the H_floating range or VAX BASIC signals "Floating-point error or overflow." Table 1–2 lists VAX BASIC data types and ranges. The default is /SINGLE.

### /[NO]LINES

The /LINES qualifier includes line number information in object modules. If you specify /NOLINES, VAX BASIC does not include line number information in object modules.

In VAX BASIC, if you specify /NOLINES in a program containing a RESUME statement or the run-time ERL function, VAX BASIC issues a warning that the /NOLINES qualifier has been overridden. Alpha BASIC does not issue a warning message but turns on /LINES.

In Alpha BASIC, the default is /NOLINES.

In VAX BASIC, the default is /LINES.

### /[NO]LIST

The /LIST qualifier causes VAX BASIC to produce a compiler listing file. This compiler listing contains a memory allocation map. By default, the name of the listing file is the same as the name of the first program module specified, and has a default file type of .LIS. If you specify /NOLIST, VAX BASIC does not generate a compiler listing. The default is /NOLIST.

## COMPILE

### /LONG

The /LONG qualifier causes VAX BASIC to allocate 32 bits of storage as the default size for all integer data not explicitly typed in the program. Untyped integer values are treated as LONG values and must be in the LONG range or VAX BASIC signals the error "Integer error or overflow." Table 1–2 lists VAX BASIC data types and ranges. The default is /LONG.

### /[NO]MACHINE_CODE

When you specify the /MACHINE_CODE qualifier with the /LIST qualifier in the COMPILE command, VAX BASIC includes the machine code generated by the compilation in the program listing file. If you specify /NOMACHINE_CODE, VAX BASIC does not include a machine code section in the listing file. The default is /NOMACHINE_CODE.

### /[NO]OBJECT

The /OBJECT qualifier generates an object module with the same file name as the program and a default file type of .OBJ. The /NOOBJECT qualifier allows you to check your program for errors without creating an object file. The default is /OBJECT.

### /[NO]OVERFLOW [ { : / = } ( { INTEGER / DECIMAL },...) ]

The /OVERFLOW qualifier causes VAX BASIC to report arithmetic overflow for operations on integer or packed decimal data, or both. If you specify /NOOVERFLOW, VAX BASIC does not report arithmetic overflows. The default is /OVERFLOW=(INTEGER,DECIMAL).

### /[NO]ROUND

The /ROUND qualifier causes VAX BASIC to round rather than truncate DECIMAL values. If you specify /NOROUND, VAX BASIC truncates DECIMAL values. The default is /NOROUND.

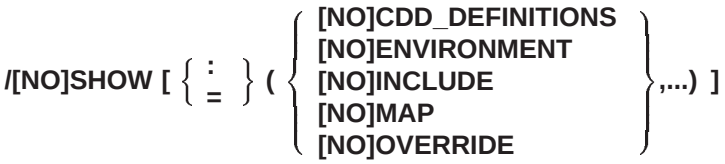
/ROUND also causes the INTEGER function to round its argument instead of truncating it.

### /[NO]SETUP

The /SETUP qualifier causes VAX BASIC to make calls to the Run-Time Library to set up the stack for VAX BASIC variables, set up dynamic string and array descriptors, initialize variables, and enable VAX BASIC error handling. If you specify the /NOSETUP qualifier, the compiler will attempt to optimize your program by omitting these calls. If your program contains any of the following elements, VAX BASIC provides an informational diagnostic and does not optimize your program:

- CHANGE statements
- DEF or DEF* statements
- Dynamic string variables
- Executable DIM statements
- EXTERNAL string functions
- MAT statements
- MOVE statements for an entire array
- ON ERROR statements
- READ statements
- REMAP statements
- RESUME statements
- WHEN blocks
- All graphics statements
- String concatenation
- Built-in string functions
- Virtual array declarations

Note that program modules compiled with the /NOSETUP qualifier cannot perform I/O and have no error-handling capabilities. If an error occurs in such a module, the error is resignaled to the calling program. The default is /SETUP.




The /SHOW qualifier (when used with the /LIST qualifier) tells VAX BASIC what to include in the compiler listing file. You can specify the following /SHOW qualifier items:

- CDD_DEFINITIONS causes VAX BASIC to include a section of translated CDD definitions.
- ENVIRONMENT causes VAX BASIC to list compilation qualifiers in effect.
- INCLUDE causes VAX BASIC to include a section on the contents of any %INCLUDE files.
- MAP causes VAX BASIC to include a storage allocation map section.
- OVERRIDE cancels the effect of all %NOLIST directives in the source program.

For example, if you specify the following command, VAX BASIC includes a storage allocation map section in the compiler listing:

```
COMPILE/LIST/SHOW=MAP
```

If you specify a /SHOW qualifier but do not specify any /SHOW items, VAX BASIC includes *all* the aforementioned sections in the listing. If you specify /NOSHOW, VAX BASIC does not add any additional sections to the compiler listing. The default is /SHOW.

### /SINGLE

The /SINGLE qualifier causes VAX BASIC to allocate 32 bits of storage in F_floating format as the default size for all floating-point data not explicitly typed in the program. Untyped floating-point values are treated as SINGLE values and must be in the SINGLE range or VAX BASIC signals the error "Floating-point error or overflow." Table 1–2 lists VAX BASIC data types and ranges. The default is /SINGLE.

### /[NO]SYNTAX_CHECK

The /SYNTAX_CHECK qualifier causes VAX BASIC to perform syntax checking after each program line is typed. If you specify /NOSYNTAX_CHECK, VAX BASIC does not perform syntax checking after each program line is typed. The default is /NOSYNTAX_CHECK.

### /[NO]TRACEBACK

The /TRACEBACK qualifier causes VAX BASIC to include traceback information in the object file that allows reporting of the sequence of calls that transferred control to the statement where an error occurred. The /NOTRACEBACK qualifier tells VAX BASIC not to include traceback information in the object file. The default is /TRACEBACK.

**/TYPE_DEFAULT** { **:** / **=** } { **REAL** / **INTEGER** / **DECIMAL** / **EXPLICIT** }

The /TYPE_DEFAULT qualifier sets the default data type (REAL, INTEGER, or DECIMAL) for all data not explicitly typed in your program or specifies that all data must be explicitly typed (EXPLICIT). The following list describes the /TYPE_DEFAULT variables:

- REAL specifies that all data not explicitly typed is floating-point data of the default size (SINGLE, DOUBLE, GFLOAT, or HFLOAT).
- INTEGER specifies that all data not explicitly typed is integer data of the default size (BYTE, WORD, LONG, or QUAD).
- DECIMAL specifies that all data not explicitly typed is packed decimal data of the default size.
- EXPLICIT specifies that all data in a program must be explicitly typed. Implicitly declared variables cause VAX BASIC to signal an error.

The default is TYPE_DEFAULT=REAL.

**/VARIANT** { **:** / **=** } **int-const**

The /VARIANT qualifier establishes *int-const* as a value to be used in compiler directives. The variant value can be referenced in a lexical expression with the lexical function, %VARIANT. *Int-const* always has a data type of LONG. The default is /VARIANT=0.

**/[NO]WARNINGS [** { **:** / **=** } { **[NO]WARNINGS** / **[NO]INFORMATIONALS** } **]**

The /WARNINGS qualifier causes VAX BASIC to display warning or informational messages, or both. If you specify /WARNINGS but do not specify a warning clause, VAX BASIC displays both warnings and informational messages. If you specify /NOWARNINGS, VAX BASIC does not display warning and informational messages. The default is /WARNINGS.

#### /WORD

The /WORD qualifier causes VAX BASIC to allocate 16 bits of storage as the default for all integer data not explicitly typed in the program. Untyped integer values are treated as WORD values and must be in the range -32768 to 32767 or VAX BASIC signals the error "Integer error or overflow." Table 1–2 lists VAX BASIC data types and ranges. The default is /LONG. In the following example, VAX BASIC compiles the program LETSGO and creates a new version of the object file as well as a listing file. In addition, VAX BASIC allocates 64 bits of storage in D_FLOAT format as the default for all floating point data not explicitly typed in the program.

## Example

```
COMPILE LETSGO/DOUBLE/LIST
```

# CONTINUE

The CONTINUE command continues program execution after VAX BASIC executes a STOP statement or encounters a Ctrl/C.

## Format

CONTINUE

## Syntax Rules

None

## Remarks

1. After a STOP statement or a Ctrl/C, you can enter immediate mode commands and resume program execution with the CONTINUE command.
2. After a STOP statement or a Ctrl/C, you cannot resume program execution if you have made source code changes or additions.

## Example

```
%BAS-I-STO, Stop
-BAS-I-FROLINMOD, from line 25 in module ABC
Ready
CONTINUE
```

# DELETE

The DELETE command removes a specified line or range of lines from the program currently in memory.

## Format

DELETE line-num [ – line-num ,line-num... ]...

## Syntax Rules

None

## Remarks

1. You cannot specify the DELETE command on programs that do not contain line numbers.
2. The separator characters (comma or hyphen) allow you to delete individual lines or a block of lines under the following conditions:
   - If you separate line numbers with commas, VAX BASIC deletes each specified line number.
   - If you separate line numbers with a hyphen, VAX BASIC deletes the inclusive range of lines. The lower line number must be specified first. If it is not specified first, the DELETE command has no effect.
3. You can combine individual line numbers and line ranges in a single DELETE command. Note, however, that a line number range must be followed by a comma and not another hyphen, or VAX BASIC signals an error.
4. VAX BASIC signals an error if there are no lines in the specified range or if you specify an illegal line number.

## Examples

**Example 1**
```
DELETE 50
```

**Example 2**
```
DELETE 70-80, 110, 124
```

**Example 3**
```
DELETE 50,60,90-110
```

# EDIT

The EDIT command allows you to edit individual program lines in the VAX BASIC Environment while invoking an editor. Entering EDIT with no arguments invokes a text editor and reads the current program into the editor's buffer.

## Format

EDIT [ line-num search-clause [ replace-clause ] ]

search-clause: *delim unq-str1 delim*

replace-clause: *[ unq-str2 ] [ delim [ int-const1 ] [ ,int-const2 ] ]*

## Syntax Rules

1. *Line-num* specifies the line to be edited.
2. *Search-clause* specifies the text you want to remove or replace. *Unq-str1* is the search string you want to remove or replace.
3. *Replace-clause* specifies the replacement text and the occurrence of the search string you want to replace.
   - *Unq-str2* is the replacement string.
   - *Int-const1* specifies the occurrence of *unq-str1* you want to replace. If you do not specify an occurrence, VAX BASIC replaces the first occurrence of *unq-str1*.
   - *Int-const2* specifies the line number of a block of program code where you want VAX BASIC to begin the search.
4. *Delim* can be any printing character not used in *unq-str1* or *unq-str2*. The examples for this command use the slash (/) as a delimiter.

## Remarks

1. The *delim* characters in *search-clause* must match, or VAX BASIC signals an error.
2. If the delimiter you use to signal the end of *replace-clause* does not match the delimiter used in *search-clause*, VAX BASIC does not signal an error and treats the end delimiter as part of *unq-str2*.
3. VAX BASIC replaces or removes text in a program line as follows:
   - If *unq-str1* is found, VAX BASIC replaces it with *unq-str2*.
   - If *unq-str1* is not found, VAX BASIC signals "No change made".
   - If *unq-str1* is null, VAX BASIC signals "No change made".
   - If *unq-str2* is null, VAX BASIC deletes *unq-str1*.
   - VAX BASIC matches and replaces strings exactly as you type them. If *unq-str1* is uppercase, VAX BASIC searches for an uppercase string. If it is lowercase, VAX BASIC searches for a lowercase string.
4. VAX BASIC displays the edited line with changes after the EDIT command successfully executes.
5. If you specify a line number with no text parameters, VAX BASIC displays the line.
6. The EDIT command followed by pressing Return causes VAX BASIC to save your current source file in BASEDITMP.BAS and automatically invokes EDT as the default text editor.
7. At DCL level, you can override the default text editor. To do this, assign the logical name BASIC$EDIT to another editor such as TPU or the Compaq Language Sensitive Editor for OpenVMS (LSE) before entering the VAX BASIC Environment. In the following example, BASIC$EDIT is defined to be TPU$EDIT. The EDIT command followed by pressing Return then invokes TPU as the default text editor.

   ```
   $ DEFINE BASIC$EDIT TPU$EDIT
   ```

8. If you define BASIC$EDIT to be an editor other than EDT, TPU, or LSE, VAX BASIC spawns a subprocess to invoke the editor assigned to BASIC$EDIT.

9. When you finish editing your program and exit from the editor, the edited program is the program currently in memory, and the context of the VAX BASIC Environment is unchanged. Note that VAX BASIC deletes all versions of BASEDITMP.BAS when you return to VAX BASIC from the editor.

## Example

```
Ready
LIST 100
100 NEW_STRING$ = LEFT$(STRING$,12)
EDIT 100 /LEFT$/RIGHT$/3,2
LIST 100
100 NEW_STRING$ = RIGHT$(STRING$,12)
```

# EXIT

The EXIT command or Ctrl/Z clears the memory and returns control to the operating system.

## Format

EXIT

## Syntax Rules

None

## Remarks

If you enter EXIT after creating a new program or editing an old program without first entering SAVE or REPLACE, VAX BASIC signals "Unsaved change has been made, Ctrl/Z or EXIT to exit." The message warns you that the new or revised program will be lost if you do not Save or Replace it. If you enter EXIT again, VAX BASIC exits from the VAX BASIC Environment whether you have saved your changes or not.

## Example

```
EXIT
%BASIC-W-CHANGES, unsaved change has been made, Ctrl/Z or EXIT to exit
Ready
SAVE
EXIT
$
Ready
```

# HELP

The HELP command displays online documentation for VAX BASIC commands, keywords, statements, functions, and conventions.

## Format

HELP [ *unq-str* ] ...

## Syntax Rules

1. *Unq-str* is a VAX BASIC topic, keyword, command, statement, function, or convention.
2. The first *unq-str* must be one of the topics described in the HELP file. If it is not, VAX BASIC displays a list of topics for you to choose from.
3. You can specify a subtopic after the topic. Separate one *unq-str* from another with a space.
4. You can use the asterisk (*) wildcard character in *unq-str*. VAX BASIC then matches any portion of the specified topic.

## Remarks

1. If you type HELP with no parameters, VAX BASIC displays a list of statements, functions, compiler directives, compiler commands and language topics.
2. If the *unq-str* you specify is not a unique topic or subtopic, VAX BASIC displays information about all topics or subtopics beginning with *unq-str*.
3. An asterisk (*) indicates that you want to display information that matches any portion of the topic you specify. For example, if you type HELP GO*, VAX BASIC displays information about the GOSUB statement and the GOTO statement.
4. When information about a particular topic or subtopic is not available, BASIC signals the message "Sorry, no documentation on *unq-str*" and provides a list of alternative HELP topics to choose from.

## Example

```
Ready
Help GO*
GOSUB
  The GOSUB statement transfers control to a specified line number or
  label and stores the location of the GOSUB statement for eventual
  return from the subroutine.
  Example
  200 GOSUB 1100
  Additional information available:
  Syntax
GOTO
  The GOTO statement transfers control to a specified line number or
  label.
  Example
  20 GOTO 200
  Additional information available:
  Syntax
Topic?
```

# IDENTIFY

The IDENTIFY command displays an identification header on the controlling terminal. The header contains the name and version number of VAX BASIC.

## Format

IDENTIFY

## Syntax Rules

None

## Remarks

The message displayed by the IDENTIFY command includes the name of the VAX BASIC compiler and the version number. In the example, *n* represents the version and point release number.

## Example

```
IDENTIFY
VAX BASIC Vn.n
```

# INQUIRE

The INQUIRE command is a synonym for the HELP command. See the HELP command for more information.

# LIST and LISTNH

The LIST command displays the program lines of the program currently in memory. Line numbers are sequenced in ascending order. The LISTNH command displays program lines without the program header.

## Format

LIST[NH] [ line-num [ – line-num ,line-num... ] ]...

## Syntax Rules

A *line-num* followed by a hyphen (-) and the Return key displays the specified line and all remaining lines in the program.

## Remarks

1. The LIST command displays program lines, along with a header containing the program name, the current time, and the date. To suppress the program header, enter LISTNH.
2. LIST without parameters displays the entire program.
3. The separator characters (comma or hyphen) allow you to display individual lines or a block of lines.
   - If you separate line numbers with commas, VAX BASIC displays each specified line number.
   - If you separate line numbers with hyphens, VAX BASIC displays the inclusive range of lines. The lower line number must come first. If it does not, LIST has no effect.
4. You can combine individual line numbers and line ranges in a single LIST command. Note, however, that a line number range must be followed by a comma and not another hyphen, or VAX BASIC signals an error.
5. A hyphen between the list command and *line-num* causes VAX BASIC to signal an error.

6. VAX BASIC displays the source program lines in the order you specify in the command line. VAX BASIC displays line 100 before line 10 if you enter LIST 100,10.

## Example

```
LIST 200-300
```

**Output**

```
200 %IF %VARIANT = 2 %THEN %ABORT
300 %END %IF
```

# LOAD

The LOAD command makes a previously created object module or modules available for execution with the RUN command.

## Format

LOAD file-spec [ + file-spec ] ...

## Syntax Rules

*File-spec* must be a VAX BASIC object module or VAX BASIC signals an error. The default file type is .OBJ. If you specify only the file name, VAX BASIC searches for an .OBJ file in the current default directory.

## Remarks

1. Each device and directory specification applies to all following file specifications until you specify a new directory or device.
2. The LOAD command accepts multiple device, directory, and file specifications.
3. VAX BASIC does not process the loaded object files until you issue the RUN command. Consequently, errors in the loaded modules may not be detected until you execute them.
4. VAX BASIC signals an error in the following cases:
   - If the file is not found
   - If the file specification is not valid
   - If the file is not a VAX BASIC object module
   - If run-time memory is exceeded

   Errors do not change the program currently in memory.
5. The LOAD command clears all previously loaded object modules from memory.
6. Typing the LOAD command does not change the program currently in memory.

## Example

```
LOAD PROGA + PROGB + PROGC
```

# LOCK

The LOCK command changes default values for COMPILE command qualifiers and is a synonym for the SET command. See the SET command for more information.

# NEW

The NEW command clears VAX BASIC memory and allows you to assign a name to a new program.

## Format

NEW [ *prog-name* ]

## Syntax Rules

*Prog-name* is the name of the program you want to create. VAX BASIC allows program names to contain a maximum of 39 characters. You can use any combination of alphanumeric characters in your program name, as well as the dollar sign ($), hyphen (-), and underscore (_) characters.

## Remarks

1. VAX BASIC signals an error if *prog-name* exceeds 39 characters.
2. VAX BASIC signals "error in program name" if you specify a file type.
3. If you do not specify a *prog-name*, VAX BASIC prompts with:

   ```
   New file name--
   ```

4. The default name is NONAME. If you do not provide a *prog-name* in response to the prompt, VAX BASIC assigns the file name NONAME to your program.
5. When you enter the NEW command, the program currently in memory is cleared. Program modules loaded with the LOAD command remain unchanged.

## Example

```
NEW PROG1
```

# OLD

The OLD command brings a previously created VAX BASIC program into memory.

## Format

OLD [ *file-spec* ]

## Syntax Rules

1. If you do not name a *file-spec*, VAX BASIC prompts for one. If you do not enter a *file-spec* in response to the prompt, BASIC searches for a file named NONAME.BAS in the current default directory.
2. The default file type is .BAS.

## Remarks

1. If the VAX BASIC compiler cannot find the file you specify, BASIC signals the error "File not found."
2. When the specified file is found, it is placed in memory and any program currently in memory is erased. If VAX BASIC does not find the specified file, the program currently in memory does not change.

## Example

```
OLD CHECK
Ready
```

# RENAME

The RENAME command allows you to assign a new name to the program currently in memory. VAX BASIC does not write the renamed program to a file until you save the program with the REPLACE or SAVE command.

## Format

RENAME [ *prog-name* ]

## Syntax Rules

1. *Prog-name* specifies the new program name. VAX BASIC allows program names to contain a maximum of 39 characters. You can use any combination of alphanumeric characters in your program name, as well as the dollar sign ($), hyphen (-), and underscore (_) characters.
2. If you specify a file type, VAX BASIC signals the error "Error in program name."

## Remarks

1. The program you want to rename must be in memory. If you enter RENAME with no program in memory, VAX BASIC renames the default program, NONAME, to the specified *prog-name*.
2. If you do not specify a *prog-name*, VAX BASIC renames the program currently in memory NONAME.
3. You must enter SAVE or REPLACE to write the renamed program to a file. If you do not enter SAVE or REPLACE, VAX BASIC does not save the renamed program.
4. The RENAME command does not affect the original saved version of the program.

## Example

```
OLD TEST
Ready

RENAME NEWTEST
Ready

LIST
NEWTEST   06-OCT-1999 13:50
PRINT "This program is a simple test"
   .
   .
   .

Ready

SAVE
%BASIC-I-FILEWRITE, NEWTEST written to file:
                    USER$$DISK:[SMITH.COMS]NEWTEST.BAS;5
Ready
```

In this example, the OLD command calls the program named TEST into memory. The RENAME command renames TEST to NEWTEST and the SAVE command writes NEWTEST.BAS to a file. The original file, TEST.BAS, is not changed and is not deleted from your account.

# REPLACE

The REPLACE command writes the current program back to the file specified by the last OLD command.

## Format

REPLACE

## Syntax Rules

None

## Remarks

1. If you do not have write access to the directory containing the original file, VAX BASIC signals an error message.
2. VAX BASIC creates and saves a new version of the file, incrementing the version number by 1 unless you supplied a specific version number with the OLD command.
3. A REPLACE command following a NEW command or a SCRATCH command causes VAX BASIC to write the program in memory to the current default directory.
4. A REPLACE command following a RENAME command writes the file to the directory specified in the OLD command with the file name specified in the RENAME command.

## Example

```
 $ DIR USER$$DISK:[BASICUSER]TEST.BAS
 Directory USER$$DISK:[BASICUSER]
 TEST.BAS;1
 Total of 1 file.
 $  BASIC
VAX BASIC Vn.n
Ready
```

```
OLD USER$$DISK:[BASICUSER]TEST.BAS;
.
.
.
Ready
REPLACE
%BASIC-I-FILEWRITE, TEST written to file:
 USER$$DISK:[BASICUSER]TEST.BAS;2

Ready

EXIT

$ DIR USER$$DISK:[BASICUSER]TEST.BAS

Directory USER$$DISK:[BASICUSER]

TEST.BAS;1  TEST.BAS;2

Total of 2 files.
$
```

# RESEQUENCE

In a program with line numbers, the RESEQUENCE command allows you to resequence the line numbers of the program currently in memory. VAX BASIC also changes all references to the old line numbers so they reference the new line numbers.

## Format

RESEQUENCE [ *line-num1* [ - *line-num2* ] [ *line-num3* ] ] [ STEP *int-const* ]

## Syntax Rules

1. *Line-num1* is the line number in the program currently in memory where resequencing begins. The default for *line-num1* is the first line of the program module.
2. *Line-num2* is the optional end of the range of line numbers to be resequenced. If you specify a range, VAX BASIC begins resequencing with *line-num1* and resequences through *line-num2*. If you do not specify *line-num2*, VAX BASIC resequences the specified line. If you do not specify either *line-num1* or *line-num2*, VAX BASIC resequences the entire program.
3. *Line-num3* specifies the new first line number; the default number for the new first line is 100. You can specify *line-num3* only when resequencing a range of lines.

   If *line-num3* causes existing lines to be deleted or surrounded, VAX BASIC signals an error.
4. *Int-const* specifies the numbering increment for the resequencing operation. The default for *int-const* is 10.

## Remarks

1. You cannot specify the RESEQUENCE command on programs that do not contain line numbers.

2. VAX BASIC signals an error when you try to resequence a program that contains a %IF directive. VAX BASIC also signals an error when you try to resequence a program that has a %INCLUDE directive if the file to be included contains a reference to a line number.
3. Before the RESEQUENCE command executes, VAX BASIC verifies the syntax of the program. If the program is not syntactically valid, the RESEQUENCE command does not execute.
4. VAX BASIC sorts the renumbered program in ascending order when the RESEQUENCE command executes.
5. If the renumbering creates a line number greater than the maximum line number of 32767, VAX BASIC signals an error.
6. VAX BASIC signals an error if resequencing causes a change in the order in which program statements are to execute and does not resequence the program.
7. VAX BASIC signals the error "Undefined line number" in the case of undefined line numbers and does not resequence the program.
8. VAX BASIC corrects all line numbers for statements that transfer control.
9. VAX BASIC does not modify the program currently in memory when the RESEQUENCE command generates an error.
10. In general, the RESEQUENCE command is not recommended for programs containing error handlers that test the value of ERL. However, the RESEQUENCE command correctly modifies the program if the tests that reference ERL are of the following form:

    ERL *relational-operator int-lit*

    The RESEQUENCE command does not correctly renumber programs if the test compares ERL with an expression or a variable, or if ERL follows the relational operator. The following line number references, for example, would not be correctly renumbered:

```
IF ERL = 1000 + A% THEN ...
IF 1000 > ERL THEN ...
```

## Example

```
10 INPUT "Enter a numeric value";A%
20 IF A% = 0 THEN GOTO 50
30 PRINT "Your number was  ";A%
40 GOTO 10
50 PRINT "Goodbye"
60 END
```

**Output**

```
100 INPUT "Enter a numeric value";A%
105 IF A% = 0 THEN GOTO 120
110 PRINT "Your number was  ";A%
115 GOTO 100
120 PRINT "Goodbye"
125 END
```

In this example, the command RESEQUENCE 10-60 STEP 5 causes VAX BASIC to resequence lines 10 to 60, incrementing each new line number by 5.

# RUN and RUNNH

The RUN command allows you to execute a program from the VAX BASIC Environment without first invoking the OpenVMS Linker to construct an executable image. In addition, the RUN command allows you to access user specified and system shareable image libraries for undefined symbols. The RUNNH command is identical to RUN, except that it does not display the program header, current date, and time.

## Format

RUN[NH] [ *file-spec* ]

## Syntax Rules

None

## Remarks

1. Executing a Program
   - If you specify only the file name, VAX BASIC searches for a file with a .BAS file type in the current default directory.
   - If you do not supply a *file-spec*, VAX BASIC executes the program currently in memory.
   - VAX BASIC signals the warning message "No main program" if you do not supply a *file-spec* and do not have a program currently in memory.
   - When you specify a *file-spec* with the RUN command, VAX BASIC brings the program into memory and then executes it. You do not have to bring a program into memory with the OLD command in order to run it. The RUN command executes just as if the program had been brought into memory with the OLD command.
   - If your program calls a subprogram, the subprogram must be compiled and placed in memory with the LOAD command. If your program tries to call a subprogram that has not been compiled and loaded, VAX BASIC signals an error.
   - The RUN command does not create an object module file or a list file.

- When VAX BASIC encounters a STOP statement in the program, the program stops executing and control passes to the VAX BASIC Environment immediate mode.
- Any VAX BASIC statement that does not require the creation of new storage can be entered in immediate mode to debug the program. You cannot create new variables in immediate mode.
- Enter the CONTINUE command to resume program execution.
- The RUN command uses whatever qualifiers have been set, with the exception of those that have no effect on a program running in the VAX BASIC Environment. These qualifiers are as follows:

  NOCROSS
  NODEBUG
  NOLIST
  NOMACHINE
  NOOBJECT

  These qualifiers are always in effect when you run a program in the Environment.

2. Accessing Shareable Images

   - To automatically access shareable image libraries, you must make an assignment to the logical name BASIC$LIB*n*. For example:

     ```
     $ ASSIGN DBA0:[BABCOCK]TESTLIB.OLB BASIC$LIB0
     ```

   - After you enter a command line, VAX BASIC will automatically access your library to resolve undefined program symbols.
   - If you have more than one library for the OpenVMS Linker to search, you must assign the first one as BASIC$LIB0, the second one as BASIC$LIB1, the third as BASIC$LIB2, and so on.
   - If you do not number libraries consecutively, the OpenVMS Linker does not search past the first missing logical name.
   - As long as routines are contained in shareable images in libraries, they are not required to be written in VAX BASIC to be accessed with the RUN command.
   - VAX BASIC provides no default file specification for user-supplied shareable image libraries; the current default device and the directory are used.

- The RUN command does not support data sharing with shareable images, for example, by way of a MAP statement. The program must execute outside the VAX BASIC Environment to share data.
- After all possible shareable image libraries have been accessed, VAX BASIC will subsequently search the default library SYS$LIBRARY:.OLB with the logical name IMAGELIB to resolve any additional undefined program symbols.

## Example

```
RUN PROG1
PROG1   06-OCT-1999 13:52
 1
 3
 6
 10
Ready
RUNNH PROG1
 1
 3
 6
 10
Ready
```

# SAVE

The SAVE command writes the VAX BASIC source program currently in memory to a file on the default or specified device.

## Format

SAVE [ *file-spec* ]

## Syntax Rules

None

## Remarks

1. If you do not supply a *file-spec*, VAX BASIC saves the file with the name of the program currently in memory and the .BAS default file type.
2. If you specify only the file name, VAX BASIC saves the program with the default file type in the current default directory.
3. When you enter the SAVE command, VAX BASIC writes a new version of the program.
4. VAX BASIC stores the sorted program in ascending line number order.
5. You can store the program on a specified device. For example:

   ```
   SAVE DUA1:NEWTEST.PRO
   ```

   VAX BASIC saves the file NEWTEST.PRO on disk DUA1:.

## Example

```
SAVE PROG_SAMP.BAS
%BASIC-I-FILEWRITE, PROG_SAMP written to file:
                    USER$$DISK[BASICUSER]PROG_SAMP.BAS;2
```

# SCALE

The SCALE command allows you to control accumulated round-off errors by multiplying numeric values by 10 raised to the scale factor before storing them.

## Format

SCALE *int-const*

## Syntax Rules

*Int-const* specifies the power of 10 you want to use as the scaling factor. *Int-const* must be an integer from 0 to 6 or VAX BASIC signals the error "Illegal argument for command."

## Remarks

1. SCALE with no argument causes VAX BASIC to signal the error "Illegal argument for command."
2. SCALE affects only values of the data type DOUBLE.
3. VAX BASIC multiplies values using the scale factor you specify. For example, the value 2.488888 is rounded as shown in Table 2–1. Because the constant value 2.488888 is stored as a SINGLE precision number, it is rounded to 2.48889. When scaling is used, the value is multiplied by the scale factor and then converted to an integer. For example, the value 2.48 in Table 2–1 is converted to the integer 248. This number is stored internally as 248.0 in SINGLE precision format.

**Table 2–1 Multiplying a Numeric Value with the SCALE Command**

| Scale | Value Produced for 2.488888 |
|---|---|
| 0 | 2.48889 |
| 1 | 2.4 |
| 2 | 2.48 |
| 3 | 2.488 |
| 4 | 2.4888 |
| 5 | 2.48888 |
| 6 | 2.48889 |

## Example

```
SCALE 2
```

# SCRATCH

The SCRATCH command clears any program currently in memory, removes any object files loaded with the LOAD command, and resets the program name to NONAME.

## Format

```
SCRATCH
```

## Syntax Rules

None

## Remarks

None

## Example

```
SCRATCH
```

# SEQUENCE

The SEQUENCE command causes VAX BASIC to automatically generate line numbers for your program text. VAX BASIC supplies line numbers for your text until you end the procedure or reach the maximum line number of 32767.

## Format

SEQUENCE [ *line-num* ] [ , *int-const* ]

## Syntax Rules

1. *Line-num* specifies the line number where sequencing begins.
2. *Int-const* specifies the line number increment for your program. If you do not specify an increment, VAX BASIC defaults to the *int-const* specified in the last SEQUENCE command; if there is no previous SEQUENCE command, the default is 10.

## Remarks

1. You cannot specify the SEQUENCE command on programs that do not contain line numbers.
2. If you do not specify a *line-num*, the VAX BASIC default is the last line inserted by a SEQUENCE command; if there is no previous SEQUENCE command, the default is line number 100.
3. If you specify a *line-num* that already contains a statement, or if the sequencing operation generates a line number that already contains a statement, VAX BASIC signals "Attempt to sequence over existing statement," and returns to normal input mode.
4. Enter your program text in response to the line number prompt; pressing Return ends each line and causes VAX BASIC to generate a new line number.
5. If you press Ctrl/Z in response to the line number prompt, VAX BASIC terminates the sequencing operation and prompts for another command.

6. When the maximum line number of 32767 is reached, VAX BASIC terminates the sequencing process and returns to normal input mode.
7. VAX BASIC does not check syntax during the sequencing process.

## Example

```
SEQUENCE 100,10
100 INPUT "Enter a numeric value";A%
110  IF A% = 20
```

In this example, the command SEQUENCE 100,10 causes VAX BASIC to automatically generate line numbers into the program text, beginning with the line number 100 and incrementing each line by 10.

# SET

The SET command allows you to specify VAX BASIC defaults for all VAX BASIC qualifiers. Qualifiers control the compilation process and the run-time environment. The defaults you set remain in effect for all subsequent operations until they are reset or until you exit from the compiler.

## Format

SET [ */qualifier* ]...

## Syntax Rules

1. */Qualifier* specifies a qualifier keyword that sets a BASIC default. See the COMPILE command for a list of all BASIC qualifiers and their defaults.
2. VAX BASIC signals the error "Unknown qualifier" if you do not separate multiple qualifiers with commas (,) or slashes (/), or if you mix commas and slashes on the same command line. The same error is signaled if you separate qualifiers with a slash but do not prefix the first qualifier with a slash.

## Remarks

If you do not specify any qualifiers, VAX BASIC resets all defaults to the defaults specified with the DCL command BASIC.

## Examples

**Example 1**

```
SET /DOUBLE/BYTE/LIST
```

**Example 2**

```
SET DOUBLE,BYTE,LIST
```

In these examples, the SET command causes VAX BASIC to allocate 64 bits of storage for all floating-point data, and to allocate 8 bits of storage for all integer data. A source listing file is also created.

# SHOW

The SHOW command displays the current defaults for the VAX BASIC compiler on your terminal.

## Format

SHOW

## Syntax Rules

None

## Remarks

None

## Example

```
SHOW
VAX BASIC n.n     Current Environment Status    dd-mmm-yyyy hh:mm:ss.cc
DEFAULT DATA TYPE INFORMATION:           LISTING FILE INFORMATION INCLUDES:
    Data type : REAL                        NO List
    Real size : SINGLE                      NO Cross reference
    Integer size : LONG                        CDD Definitions
    Decimal size : (15,2)                      Environment
    Scale factor : 0                        NO Override of %NOLIST
    NO Round decimal numbers                NO Machine code
                                               Map
COMPILATION QUALIFIERS IN EFFECT:              INCLUDE files
       Object file
       Overflow check integers          FLAGGERS:
       Overflow check decimal numbers      NO Declining features
       Bounds checking                     NO BASIC PLUS 2 subset
    NO Syntax checking                     NO Alpha AXP subset
       Line
       Variant : 0                      DEBUG INFORMATION:
       Warnings                               Traceback records
       Informationals                      NO Debug symbol records
       Setup
       Object Libraries : NONE
Ready
```

# UNSAVE

The UNSAVE command deletes a specified file from storage.

## Format

UNSAVE [ *file-spec* ]

## Syntax Rules

None

## Remarks

1. If you do not supply a *file-spec*, VAX BASIC deletes a file that has the file name of the program currently in memory and a file type of .BAS.
2. If you do not supply a *file-spec* and do not have a program in memory, VAX BASIC searches for the default file NONAME.BAS.
3. If you do not specify a complete file name with a file type, VAX BASIC deletes the file with the specified name and the .BAS file type from the default device and directory. Other file types with the same file name are not deleted.

## Example

```
UNSAVE DB2:CHECK.DAT
```

# 3

# Compiler Directives

**Compiler directives** are instructions that cause BASIC to perform certain operations as it translates the source program. This chapter describes all of the compiler directives supported by BASIC. The directives are listed and discussed alphabetically.

# %ABORT

The %ABORT directive terminates program compilation and displays a fatal error message that you can supply.

## Format

%ABORT [ *str-lit* ]

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %ABORT directive.
2. BASIC stops the compilation and terminates the listing file as soon as it encounters a %ABORT directive. An optional *str-lit* is displayed on the terminal screen and in the compilation listing, if a listing has been requested.

## Example

```
%IF %VARIANT = 2 %THEN
    %ABORT "Cannot compile with variant 2"
%END %IF
```

# %CROSS

The %CROSS directive causes BASIC to begin or resume accumulating cross-reference information for the listing file.

## Format

```
%CROSS
```

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %CROSS directive.
2. The %CROSS directive has no effect unless you request both a listing file and a cross-reference. For more information about listing file format, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual.*
3. When a cross-reference is requested, the BASIC compiler starts or resumes accumulating cross-reference information immediately after encountering the %CROSS directive.

## Example

```
%CROSS
```

# %DECLARED

The %DECLARED directive is a built-in lexical function that allows you to determine whether a lexical variable has been defined with the %LET directive. If the lexical variable named in the %DECLARED function is defined in a previous %LET directive, the %DECLARED function returns the value -1. If the lexical variable is not defined in a previous %LET directive, the %DECLARED function returns the value 0.

## Format

%DECLARED (*lex-var*)

## Syntax Rules

1. The %DECLARED function can appear only in a lexical expression.
2. *Lex-var* is the name of a lexical variable. Lexical variables are always LONG integers.
3. *Lex-var* must be enclosed in parentheses.

## Remarks

None

## Example

```
! +
! Use the following code in %INCLUDE files
! which reference constants that may be already ! -
%IF %DECLARED (%TRUE_FALSE_DEFINED) = 0
%THEN
    DECLARE LONG CONSTANT True = -1, False = 0
    %LET %TRUE_FALSE_%END %IF
```

# %DEFINE

The %DEFINE directive lets you define a user-defined identifier as another identifier or keyword.

## Format

%DEFINE *macro-id replacement-token*

## Syntax Rules

1. *Macro-id* is a user identifier that follows the rules for BASIC identifiers. It must not be a keyword or a compiler directive.
2. *Replacement-token* may be an identifier, a keyword, a compiler directive, a literal constant, or an operator.
3. The "&" line continuation character may be used after the macro-id to continue the %DEFINE directive on the next line.
4. The "\" statement separator cannot be used with the %DEFINE directive.
5. "!" comments and line numbers used with the %DEFINE directive behave in the same manner as they do with other compiler directives.

## Remarks

1. The replacement-token is substituted for every subsequent occurrence of the macro identifier in the program text.
2. Macro-identifiers in REM or "!" comments, string literals, or DATA statements are not replaced.
3. A macro-id cannot be used as a line number.
4. A macro definition is in effect from the %DEFINE directive that defines it until either a corresponding %UNDEFINE directive or the end of the source module is encountered. This applies to any included code that occurs after the definition.
5. A previously defined macro identifier may be redefined by using the %DEFINE directive.

6. A previously defined macro may be canceled by using the %UNDEFINE directive.
7. Macros may not be nested. For example, if the replacement-token is an identifier that is defined by itself or some other %DEFINE directive, it is not replaced.
8. Macro-identifiers are not known to the Debugger.
9. The %DEFINE directive can be used within conditionally compiled code.

## Example

```
%DEFINE widget LONG
DECLARE widget X
X = 3.75
PRINT "X squared :"; X*X
```

**Output**

```
X squared : 9
```

# %IDENT

The %IDENT directive lets you identify the version of a program module. The identification text is placed in the object module and printed in the listing header.

## Format

%IDENT *str-lit*

## Syntax Rules

*Str-lit* is the identification text. *Str-lit* can consist of up to 31 ASCII characters. If it has more than 31 characters, BASIC truncates the extra characters and signals a warning message.

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %IDENT directive.
2. The BASIC compiler inserts the identification text in the first 31 character positions of the second line on each listing page. BASIC also includes the identification text in the object module, if the compilation produces one, and in the map file created by the OpenVMS Linker.
3. The %IDENT directive should appear at the beginning of your program if you want the identification text to appear on the first page of your listing. If the %IDENT directive appears after the first program statement, the text will appear on the next page of the listing file.
4. You can use the %IDENT directive only once in a module. If you specify more than one %IDENT directive in a module, BASIC signals a warning and uses the identification text specified in the first directive.
5. No default identification text is provided.

## Example

```
%IDENT "Version 10"
   .
   .
   .
```

**Output**

```
TIME$MAIN
Version 10
     1         10      %IDENT "Version 10"
   .
   .
   .
```

# %IF-%THEN-%ELSE-%END %IF

The %IF-%THEN-%ELSE-%END %IF directive lets you conditionally include source code or execute another compiler directive.

## Format

%IF *lex-exp* %THEN code [ %ELSE code ] %END %IF

## Syntax Rules

1. *Lex-exp* is always a LONG integer.
2. *Lex-exp* can be any of the following:
   - A lexical constant named in a %LET directive.
   - An integer literal, with or without the percent sign suffix.
   - A lexical built-in function.
   - Any combination of the above, separated by valid lexical operators. Lexical operators include logical operators, relational operators, and the arithmetic operators for addition (+), subtraction (-), multiplication (*), and division (/).
3. *Code* is BASIC program code. It can be any BASIC statement or another compiler directive, including another %IF directive. You can nest %IF directives to eight levels.

## Remarks

1. The %IF directive can appear anywhere in a program where a space is allowed, except within a quoted string. This means that you can use the %IF directive to make a whole statement, part of a statement, or a block of statements conditional.
2. %THEN, %ELSE, and %END %IF do not have to be on the same physical line as %IF.

3. If *lex-exp* is true, BASIC processes the %THEN clause. If *lex-exp* is false, BASIC processes the %ELSE clause. If there is no %ELSE clause, BASIC processes the %END %IF clause. The BASIC compiler includes statements in the %THEN or %ELSE clause in the source program and executes directives in order of occurrence.
4. You must include the %END %IF clause. Otherwise, BASIC assumes the remainder of the program is part of the last %THEN or %ELSE clause and signals the error "MISENDIF, missing END IF directive" when compilation ends.

## Example

```
%IF (%VARIANT = 2)
%THEN DECLARE SINGLE hourly_pay(100)
%ELSE %IF (%VARIANT = 1)
      %THEN DECLARE DOUBLE salary_pay(100)
      %ELSE %ABORT "Can't compile with specified variant"
      %END %IF
%END %IF
     .
     .
     .
PRINT %IF (%VARIANT = 2)
      %THEN 'Hourly Wage Chart'
            GOTO Hourly_routine
      %ELSE 'Salaried Wage Chart'
            GOTO Salary_routine
      %END %IF
```

# %INCLUDE

The %INCLUDE directive lets you include BASIC source text from another program file in the current program compilation. BASIC also lets you access Oracle CDD/Repository record definitions from the Common Data Dictionary (CDD) and access commonly used routines from text libraries.

## Format

### Including a File

%INCLUDE *str-lit*

### Including a CDD Definition

%INCLUDE %FROM %CDD *str-lit*

### Including a File from a Text Library

%INCLUDE str-lit %FROM %LIBRARY [*str-lif*]

## Syntax Rules

1. Including a File

   *Str-lit* must be a valid file specification for the file to be included.

2. Including a CDD Definition

   *Str-lit* specifies a CDD path name enclosed in quotation marks. The path name can be in either DMU or CDO format. This directive lets you extract a RECORD definition from the dictionary.

3. Including a File from a Text Library

   - *Str-lit* specifies a particular module to be included.
   - The optional *str-lit* identifies a specific text library in which the included module resides. If the library name is not specified, BASIC uses the logical name BASIC$LIBRARY with a default file specification of BASIC.TLB. If BASIC$LIBRARY is undefined, BASIC uses SYS$LIBRARY:BASIC$STARLET.TLB.

## Remarks

1. Any statement that appears after an END statement inside an included file causes BASIC to signal an error.
2. Only a line number or a comment field can appear on the same physical line as the %INCLUDE directive.
3. The BASIC compiler includes the specified source file in the program compilation at the point of the %INCLUDE directive and prints the included code in the program listing file if the compilation produces one.
4. The included file cannot contain line numbers. If it does, BASIC signals the error "Line number may not appear in %INCLUDE file."
5. All statements in the accessed file are associated with the line number of the program line that contains the %INCLUDE directive. This means that a %INCLUDE directive cannot appear before the first line number in a source program if you are using line numbers.
6. A file accessed by %INCLUDE can itself contain a %INCLUDE directive.
7. All %IF directives in an included file must have a matching %END %IF directive in the file.
8. You can control whether or not included text appears in the compilation listing with the /[NO]SHOW=INCLUDE qualifier. When you specify /SHOW=INCLUDE, the compilation listing file identifies any text obtained from an included file by placing a mnemonic in the first character position of the line on which the text appears. The "n" specifies that the text was either accessed from a source file or from a text library. The "I" tells you that the text was accessed with the %INCLUDE directive and *n* is a number that tells you the nesting level of the included text. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about listing mnemonics.
9. Including a File

   If you do not specify a complete file specification, BASIC uses the default device and directory and the file type .BAS.
10. Including a CDD Definition

    - There are two types of CDD path names: *full* and *relative*. A full path name begins with CDD$TOP and specifies the complete path to the record definition. A relative path name begins with any string other than CDD$TOP and is appended to the current CDD$DEFAULT.

- In Oracle CDD/Repository, the path names described previously are known as DMU path names, as distinct from CDO path names. You can specify either a *full* DMU path name, a *full* CDO path name, or a *relative* path name. A full path name consists of a dictionary origin followed by a dictionary path. A full DMU path name has CDD$TOP as its origin. A full CDO path name has an *anchor* as its origin. See Oracle CDD/Repository documentation for detailed information about path names.
- If the record definition being accessed is in a CDO-format dictionary, you can create a dependency relationship in the dictionary between a dictionary representation of your program and the record definitions that you include in the program. The dictionary representation of the program is called a compiled module entity.
- If you specify the /DEPENDENCY_DATA qualifier to the compiler and your CDD$DEFAULT points to a CDO-format dictionary, a compiled module entity is created for each compilation unit at compile time in CDD$DEFAULT. No compiled module entity is created if both conditions are not true.
- If a compiled module entity exists for the program, an %INCLUDE %FROM %CDD directive specifying a record description in a CDO-format dictionary creates a relationship between the compiled module entity and the CDO-format record definition.
- If the record description specified in the path name exists, it is copied to the program, whether a compiled module entity can be created or not.
- When you use the %INCLUDE directive to extract a record definition from the CDD, BASIC translates the CDD definition to the syntax of the BASIC RECORD statement.
- You can use the /SHOW=CDD_DEFINITIONS qualifier to specify that translated CDD definitions (in RECORD statement syntax) are included in the compilation listing file. BASIC places a "C" in column 1 when the translated RECORD statement appears in the listing file.
- When you specify /SHOW=NOCDD_DEFINITIONS, BASIC does not include the CDD definition in the listing file. However, BASIC still includes the names, data types, and offsets of the CDD record components in the program listing's allocation map.
- See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* and the Oracle CDD/Repository documentation for more information about dictionary data definitions.

11. Including a File from a Text Library

    - The BASIC compiler searches through the specified text library for the module named and compiles the module upon encountering the %INCLUDE directive.
    - BASIC allows only 16 text libraries to be opened at one time; therefore, you cannot have %INCLUDE directives from a text library nested more than 16 levels deep. If you exceed this maximum, BASIC signals an error message.
    - If you do not specify a directory name and file type, BASIC uses the default device and directory and the file type .TLB.
    - BASIC provides the text library BASIC$STARLET. BASIC$STARLET contains condition codes and other symbols defined in the system object and shareable image libraries. Using the definitions from BASIC$STARLET allows you to reference condition codes and other system-defined symbols as local, rather than global symbols. To create your own text libraries using the OpenVMS Librarian utility, see the *OpenVMS Command Definition, Librarian, and Message Manual*.

## Examples

### Example 1

```
!Including a File
%INCLUDE "YESNO"
```

### Example 2

```
!Including a CDD Definition
%INCLUDE %FROM %CDD "CDD$TOP.EMPLOYEE"
```

### Example 3

```
!Including a CDD Definition with a CDO-format path name
%INCLUDE %FROM %CDD "MYNODE::MY$DISK:[MY_DIR]PERSONNEL.EMPLOYEE"
!The anchor is MYNODE::MY$DISK:[MY_DIR]
```

### Example 4

```
!Including a File from a Text Library
%INCLUDE "EOF_CHECK" %FROM %LIBRARY "SYS$LIBRARY:BASIC_LIB.TLB"
```

# %LET

The %LET directive declares and provides values for lexical variables. You can use lexical variables only in conditional expressions in the %IF-%THEN-%ELSE directive and in lexical expressions in subsequent %LET directives.

## Format

%LET %*lex-var* = *lex-exp*

## Syntax Rules

1. *Lex-var* is the name of a lexical variable. Lexical variables are always LONG integers.
2. *Lex-var* must be preceded by a percent sign (%) and cannot end with a dollar sign ($) or percent sign.
3. *Lex-exp* can be any of the following:
   - A lexical variable named in a previous %LET directive.
   - An integer literal, with or without the percent sign suffix.
   - A lexical built-in function.
   - Any combination of the above, separated by valid lexical operators. Lexical operators can be logical operators, relational operators, and the arithmetic operators for addition (+), subtraction (-), multiplication (*), and division (/).

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %LET directive.
2. You cannot change the value of *lex-var* within a program unit once it has been named in a %LET directive. For more information about coding conventions, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## Example

```
%LET %DEBUG_ON = 1%
```

# %LIST

The %LIST directive causes the BASIC compiler to start or resume accumulating compilation information for the program listing file.

## Format

```
%LIST
```

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %LIST directive.
2. The %LIST directive has no effect unless you requested a listing file. For more information about listing file format, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.
3. As soon as it encounters the %LIST directive, the BASIC compiler starts or resumes accumulating information for the program listing file. Thus, the directive itself appears as the next line in the listing file.

## Example

```
%LIST
```

# %NOCROSS

The %NOCROSS directive causes the BASIC compiler to stop accumulating cross-reference information for the program listing file.

## Format

```
%NOCROSS
```

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %NOCROSS directive.
2. The BASIC compiler stops accumulating cross-reference information for the program listing file immediately after encountering the %NOCROSS directive.
3. The %NOCROSS directive has no effect unless you request a listing file and cross-reference information.
4. It is recommended that you do not embed a %NOCROSS directive within a statement. Embedding a %NOCROSS directive within a statement makes the accumulation of cross-reference information unpredictable. For more information about listing file format, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual.*

## Example

```
%NOCROSS
```

# %NOLIST

The %NOLIST directive causes the BASIC compiler to stop accumulating compilation information for the program listing file.

## Format

```
%NOLIST
```

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %NOLIST directive.
2. As soon as it encounters the %NOLIST directive, the BASIC compiler stops accumulating information for the program listing file. Thus, the directive itself does not appear in the listing file.
3. The %NOLIST directive has no effect unless you requested a listing file.
4. In BASIC, you can override all %NOLIST directives in a program with the /SHOW=OVERRIDE qualifier. For more information about listing file format, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## Example

```
%NOLIST
```

# %PAGE

The %PAGE directive causes BASIC to begin a new page in the program listing file.

## Format

```
%PAGE
```

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %PAGE directive.
2. The %PAGE directive has no effect unless you request a listing file.

## Example

```
%PAGE
```

# %PRINT

The %PRINT directive lets you insert a message into your source code that the BASIC compiler prints during compilation.

## Format

%PRINT *str-lit*

## Syntax Rules

None

## Remarks

1. Only a line number or a comment field can appear on the same physical line as the %PRINT directive.
2. BASIC will print the message specified as soon as it encounters a %PRINT directive. *Str-lit* is displayed on the terminal screen and in the compilation listing.

## Example

```
%IF %DEBUG = 1% %THEN
%PRINT "This is a debug compilation"
```

**Output**

```
%BASIC-S-USERPRINT, This is a debug compilation
```

# %REPORT

The %REPORT directive lets you record a dependency relationship between the compiled module entity for your program and the data definitions in Oracle CDD/Repository dictionaries. The data definitions are not copied into the program.

## Format

%REPORT %DEPENDENCY *str-lit* [ *relationship-type* ]

## Syntax Rules

1. *Str-lit* specifies a path name in a CDO-format dictionary. It can be either a DMU-format path name or a CDO-format path name, enclosed in quotation marks. This specifies a dictionary entity, such as a form definition or an Rdb/VMS database, that the program references.
2. *Relationship-type* specifies a valid Oracle CDD/Repository protocol; it must be enclosed in quotation marks if specified. The default *relationship-type* is CDD$COMPILED_DEPENDS_ON.

## Remarks

1. For this directive to be meaningful, you must specify the /DEPENDENCY_DATA qualifier at compile time. If /DEPENDENCY is not specified, the compiler will simply check the syntax and otherwise ignore the %REPORT directive.
2. Your current CDD$DEFAULT and *str-lit* must refer to CDO-format dictionaries (not necessarily the same one).
3. If you specify the /DEPENDENCY_DATA qualifier to the compiler, and if CDD$DEFAULT points to a CDO-format dictionary, a compiled module entity is created in CDD$DEFAULT for each compilation unit. No compiled module entity is created if both conditions are not true.
4. The %REPORT %DEPENDENCY directive creates a dependency relationship in the dictionary between the compiled module entity for the program and the CDO-format dictionary entity to which it refers.

## Example

```
!Establish access to the form PINK_SLIP in a dictionary
!on a specified node, and report the program's dependency
!relationship with the form.
%REPORT %DEPENDENCY "MYNODE::MY$DISK:[MYDIR]PERSONNEL.FORMS.PINK_SLIP"
!Relationship is CDD$COMPILED_DEPENDS_ON, the default.
```

# %SBTTL

The %SBTTL directive lets you specify a subtitle for the program listing file.

## Format

%SBTTL *str-lit*

## Syntax Rules

*Str-lit* can contain up to 45 characters in VAX BASIC and 31 characters in Alpha BASIC.

## Remarks

1. BASIC truncates extra characters from *str-lit* and does not signal a warning or error. In Alpha BASIC, *str-lit* is truncated at 31 characters. In VAX BASIC, *str-lit* is truncated at 45 characters.
2. Only a line number or a comment field can appear on the same physical line as the %SBTTL directive.
3. The specified subtitle appears underneath the title on the second line of all pages of source code in the listing file until the BASIC compiler encounters another %SBTTL or %TITLE directive. BASIC clears the subtitle field before the allocation map section of the listing is generated. This way, you only get a subtitle on the listing pages that contain source code.
4. Because BASIC associates a subtitle with a title, a new %TITLE directive sets the current subtitle to the null string. In this case, no subtitle appears in the listing until BASIC encounters another %SBTTL directive.
5. If you want a subtitle to appear on the first page of your listing, the %SBTTL directive should appear at the beginning of your program, immediately after the %TITLE directive. Otherwise, the subtitle will start to appear only on the second page of the listing.
6. If you want the subtitle to appear on the page of the listing that contains the %SBTTL directive, the %SBTTL directive should immediately follow a %PAGE directive or a %TITLE directive that follows a %PAGE directive.
7. The %SBTTL directive has no effect unless you request a listing file.

## Example

```
100     %TITLE "Learning to Program in BASIC"
        %SBTTL "Using FOR-NEXT Loops"
        REM     THIS PROGRAM IS A SIMPLE TEST
200     DATA    1, 2, 3, 4
   .
   .
   .
        NEXT I%
300     END
```

**Output**

```
TEST$MAIN                       Learning to Program in BASIC
                                Using FOR-NEXT Loops

     1          100     %TITLE "Learning to Program in BASIC"
     2                  %SBTTL "Using FOR-NEXT Loops"
     3                  REM THIS PROGRAM IS A SIMPLE TEST
     4          200     DATA  1, 2, 3, 4
   .
   .
   .
    10                  NEXT I%
    11          300     END
```

# %TITLE

The %TITLE directive lets you specify a title for the program listing file.

## Format

%TITLE *str-lit*

## Syntax Rules

*Str-lit* can contain up to 45 characters in VAX BASIC and up to 31 characters in Alpha BASIC.

## Remarks

1. BASIC truncates extra characters from *str-lit* and does not signal a warning or error. In Alpha BASIC, *str-lit* is truncated at 31 characters. In VAX BASIC, *str-lit* is truncated at 45 characters.
2. Only a line number or a comment field can appear on the same physical line as the %TITLE directive.
3. The specified title appears on the first line of every page of the listing file until BASIC encounters another %TITLE directive in the program.
4. The %TITLE directive should appear on the first line of your program, before the first statement, if you want the specified title to appear on the first page of your listing.
5. If you want the specified title to appear on the page that contains the %TITLE directive, the %TITLE directive should immediately follow a %PAGE directive.
6. Because BASIC associates a subtitle with a title, a new %TITLE directive sets the current subtitle to the null string.
7. The %TITLE directive has no effect unless you request a listing file.

## Example

```
100     %TITLE "Learning to Program in BASIC"
        REM THIS PROGRAM IS A SIMPLE TEST
200     DATA 1, 2, 3, 4
   .
   .
   .
        NEXT I%
300     END
```

**Output**

```
TEST$MAIN                     Learning to Program in BASIC

     1         100     %TITLE "Learning to Program in BASIC"
     2                 %SBTTL "Using FOR-NEXT Loops"
     3                 REM THIS PROGRAM IS A SIMPLE TEST
     4         200     DATA 1, 2, 3, 4
   .
   .
   .
    10                 NEXT I%
    11         300     END
```

# %UNDEFINE

The %UNDEFINE directive causes BASIC to undefine an identifier that was previously defined with the %DEFINE directive.

## Format

%UNDEFINE *macro-id*

## Syntax Rules

*Macro-id* is a user identifier that follows the rules for a BASIC identifier.

## Remarks

1. The %UNDEFINE directive cancels a previous definition of *macro-id* by a %DEFINE.
2. The %UNDEFINE directive may appear with included code and will cancel the definition of an identifier that was previously defined.

## Example

```
G = 6%
PRINT "G ="; G
%DEFINE G "anything"
PRINT "G = "; G
%UNDEFINE G
PRINT "G ="; G
```

**Output**

```
G = 6
G = anything
G = 6
```

# %VARIANT

The %VARIANT directive is a built-in lexical function that allows you to conditionally control program compilation. %VARIANT returns an integer value when you reference it in a lexical expression. You set the variant value with the /VARIANT qualifier when you compile the program or with the SET VARIANT command. If the /VARIANT qualifier or the SET VARIANT command is not used, the value of %VARIANT is 0.

## Format

%VARIANT

## Syntax Rules

None

## Remarks

1. The %VARIANT function can appear only in a lexical expression.
2. The %VARIANT function returns the integer value specified either with the COMPILE /VARIANT command, the SET /VARIANT command, or the DCL command BASIC. The returned integer always has a data type of LONG.

## Example

```
%LET %VMS = 0
%LET %RSX = 1
%LET %RSTS = 2

%IF %VARIANT = %VMS
    %THEN
        .
        .
        .
%ELSE %IF %VARIANT = %RSX OR %VARIANT = %RSTS
    %THEN
        .
        .
        .
```

```
        %ELSE %ABORT "Illegal compilation variant"
        %END %IF
    %END %IF
```

# 4

# Statements and Functions

This chapter provides reference material on all of the BASIC statements and functions. The shortened forms Alpha BASIC and VAX BASIC refer to Compaq BASIC for OpenVMS Alpha and Compaq BASIC for OpenVMS VAX, respectively.

The statements and functions are listed in alphabetical order and each description contains the following format:

| | |
|---|---|
| **Definition** | A description of what the statement does. |
| **Format** | The required syntax for the statement. |
| **Syntax Rules** | Any rules governing the use of parameters, separators, or other syntax items. |
| **Remarks** | Explanatory remarks concerning the effect of the statement on program execution and any restrictions governing its use. |
| **Example** | One or more examples of the statement in a BASIC program. Where appropriate, sample output is also shown. |

# ABS

The ABS function returns a floating-point number that equals the absolute value of a specified floating-point expression.

## Format

*real-var* = ABS (*real-exp*)

## Syntax Rules

None

## Remarks

1. The argument of the ABS function must be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.
2. The returned floating-point value is always greater than or equal to zero. The absolute value of 0 is zero. The absolute value of a positive number equals that number. The absolute value of a negative number equals that number multiplied by -1.

## Example

```
G = 5.1273
A = ABS(-100 * G)
B = -39
PRINT ABS(B), A
```

**Output**

```
 39             512.73
```

# ABS%

The ABS% function returns an integer that equals the absolute value of a specified integer expression.

## Format

*int-var* = ABS% (*int-exp*)

## Syntax Rules

None

## Remarks

1. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer.
2. The returned value is always greater than or equal to zero. The absolute value of 0 is zero. The absolute value of a positive number equals that number. The absolute value of a negative number equals that number multiplied by -1.

## Example

```
G% = 5.1273
A = ABS%(-100% * G%)
B = -39
PRINT ABS%(B), A
```

**Output**

```
 39           500
```

# ASCII

The ASCII function returns the ASCII value in decimal of a string's first character.

## Format

*int-var* = { ASC / ASCII } (*str-exp*)

## Syntax Rules

None

## Remarks

1. The ASCII value of a null string is zero.
2. The ASCII function returns an integer value of the default size from 0 to 255.

## Example

```
DECLARE STRING time_out
time_out = "Friday"
PRINT ASCII(time_out)
```

**Output**

```
 70
```

# ATN

The ATN function returns the arctangent (that is, angular value) of a specified tangent in radians or degrees.

## Format

*real-var* = ATN (*real-exp*)

## Syntax Rules

None

## Remarks

1. The returned angle is expressed in radians or degrees, depending on which angle clause you choose with the OPTION statement.
2. ATN returns a value from –PI/2 to PI/2 when you request the result in radians via the OPTION statement. It returns a value from -90 to 90 when you request the result in degrees.
3. The argument of the ATN function must be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.

## Example

```
OPTION ANGLE = RADIANS
DECLARE SINGLE angle_rad, angle_deg, T
INPUT "Tangent value";T
angle_rad = ATN(T)
PRINT "The smallest angle with that tangent is" ;angle_rad; "radians"
angle_deg = angle_rad/(PI/180)
PRINT "and"; angle_deg; "degrees"
```

### Output

```
Tangent value? 2
The smallest angle with that tangent is 1.10715 radians
and 63.435 degrees
```

# BUFSIZ

The BUFSIZ function returns the record buffer size, in bytes, of a specified channel.

## Format

*int-var* = BUFSIZ (*chnl-exp*)

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number.
2. The value assigned to *int-var* is a LONG integer.

## Remarks

1. If the specified channel is closed, BUFSIZ returns a value of zero.
2. BUFSIZ of channel #0 always returns the value 132.

## Example

```
DECLARE LONG buffer_size
buffer_size = BUFSIZ(0)
PRINT "Buffer size equals";buffer_size
```

**Output**

```
Buffer size equals 132
```

# CALL

The CALL statement transfers control to a subprogram, external function, or other callable routine. You can pass arguments to the routine and can optionally specify passing mechanisms. When the called routine finishes executing, control returns to the calling program.

## Format

CALL *routine* [ *pass-mech*] [ ( actual-param ,...) ]

routine: { *sub-name* | *any-callable-routine* }

pass-mech: { BY VALUE | BY REF | BY DESC }

actual-param: { *exp* | *array ( [,]...)* } *[pass-mech]*

## Syntax Rules

1. *Routine* is the name of a SUB subprogram or any other callable procedure, such as a system service or an RTL routine you want to call. It cannot be a variable name. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about using system services, RTL routines, and other procedures.
2. You should use parameter-passing mechanisms only when calling non BASIC routines or when a subprogram expects to receive a string or entire array by reference.

   For more information about parameter-passing mechanisms, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.
3. When *pass-mech* appears before the parameter list, it applies to all arguments passed to the called routine. You can override this passing mechanism by specifying a *pass-mech* for individual arguments in the *actual-param* list.

4. *Actual-param* lists the arguments to be passed to the called routine.
5. You can pass expressions or entire arrays. Optional commas in parentheses after the array name specify the dimensions of the array. The number of commas is equal to the number of dimensions -1. Thus, no comma specifies a one-dimensional array, one comma specifies a two-dimensional array, two commas specify a three-dimensional array, and so on.
6. You cannot pass entire virtual arrays.
7. The name of the routine can be from 1 to 31 characters and must conform to the following rules:
   - The first character of an unquoted name must be an alphabetic character (A to Z). The remaining characters, if present, can be any combination of letters, digits (0 to 9), dollar signs ($), periods (.), or underscores (_).
   - A quoted name can consist of any combination of printable ASCII characters.
8. BASIC allows you to pass up to 255 parameters.

## Remarks

1. You can specify a null argument as an *actual-param* for non BASIC routines by omitting the argument and the *pass-mech*, but not the commas or parentheses. This forces BASIC to pass a null argument and allows you to access system routines from BASIC.
2. Arguments in the *actual-param* list must agree in data type and number with the formal parameters specified in the subprogram.
3. An argument is modifiable when changes to it are evident in the calling program. Changing a modifiable parameter in a subprogram means the parameter is changed for the calling program as well. Variables and entire arrays passed by descriptor or by reference are modifiable.
4. An argument is nonmodifiable when changes to it are not evident in the calling program. Changing a nonmodifiable argument in a subprogram does not affect the value of that argument in the calling program. Arguments passed by value, constants, and expressions are nonmodifiable. Passing an argument as an expression (by placing it in parentheses) changes it from a modifiable to a nonmodifiable argument. Virtual array elements passed as parameters are nonmodifiable.

5. BASIC will automatically convert numeric actual parameters to match the declared data type. If the actual parameter is a variable, BASIC signals the informational message "Mode for parameter <*n*> of routine <*name*> changed to match declaration" and passes the argument by local copy. This prevents the called routine from modifying the contents of the variable.
6. For expressions and virtual array elements passed by reference, BASIC makes a local copy of the value, and passes the address of this local copy. For dynamic string arrays, BASIC passes a descriptor of the array of string descriptors. The compiler passes the address of the argument's actual value for all other arguments passed by reference.
7. In VAX BASIC, only BYTE, WORD, LONG, and SINGLE values can be passed by value. BYTE and WORD values passed by value are converted to LONG values.
8. In Alpha BASIC, you can pass BYTE, WORD, LONG, QUAD, DOUBLE, GFLOAT, SINGLE, SFLOAT, and TFLOAT values by value.
9. If you attempt to call an external function, BASIC treats the function as if it were invoked normally and validates all parameters. Note that you cannot call a STRING, HFLOAT, or RFA function. See the EXTERNAL statement for more information about how to invoke functions.

## Example

```
EXTERNAL SUB LIB$PUT_OUTPUT (string)
DECLARE STRING msg_str
msg_str = "Successful call to LIB$PUT_OUTPUT!"
CALL LIB$PUT_OUTPUT (msg_str)
```

**Output**

```
Successful call to LIB$PUT_OUTPUT!
```

# CAUSE ERROR

The CAUSE ERROR statement allows you to artificially generate a BASIC run-time error and transfer program control to a BASIC error handler.

## Format

CAUSE ERROR *err-num*

## Syntax Rules

*Err-num* should be a valid BASIC run-time error number.

## Remarks

All error numbers are listed in the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*. Any error outside the valid range of BASIC Run-Time Library errors results in the following error message: "NOTBASIC, Not a BASIC error" (ERR=194).

## Example

```
WHEN ERROR IN
   .
   .
   .
CAUSE ERROR 11%
   .
   .
   .
USE
    SELECT ERR
        CASE = 11
             PRINT "End of file"
             CONTINUE
        CASE ELSE
             EXIT HANDLER
    END SELECT
END WHEN
```

# CCPOS

The CCPOS function returns the current character or cursor position of the output record on a specified channel.

## Format

*int-var* = CCPOS (*chnl-exp*)

## Syntax Rules

*Chnl-exp* must specify an open file or terminal.

## Remarks

1. If *chnl-exp* is zero, CCPOS returns the current character position of the controlling terminal.
2. The *int-var* returned by the CCPOS function is of the default integer size.
3. The CCPOS function counts only characters. If you use cursor addressing sequences such as escape sequences, the value returned will not be the cursor position.
4. The first character position on a line is zero.

## Example

```
DECLARE LONG curs_pos
PRINT "Hello";
curs_pos = CCPOS (0)
PRINT curs_pos
```

**Output**

```
Hello 5
```

# CHAIN

The CHAIN statement transfers control from the current program to another executable image. CHAIN closes all files, then requests that the new program begin execution. Control does not return to the original program when the new image finishes executing.

**Note**

The CHAIN statement is not recommended for new program development. It is recommended that you use subprograms and external functions for program segmentation.

## Format

CHAIN *str-exp*

## Syntax Rules

*Str-exp* represents the file specification of the program to which control is passed.

## Remarks

1. *Str-exp* must refer to an executable image or BASIC signals an error.
2. If you do not specify a file type, BASIC searches for an .EXE file type.
3. You cannot chain to a program on another node.
4. Execution starts at the beginning of the specified program.
5. Before chaining takes place, all active output buffers are written, all open files are closed, and all storage is released.

6. Because a CHAIN statement passes control from the executing image, the values of any program variables are lost. This means that you can pass parameters to a chained program only by using files or a system-specific feature such as LIB$GET_COMMON and LIB$PUT_COMMON.

## Example

```
DECLARE STRING time_out
time_out = "Friday"
PRINT ASCII(time_out)
CHAIN "CCPOS"
```

**Output**

```
 70
The current cursor position is 0
```

In this example, the executing image ASCII.EXE passes control to the chained program, CCPOS.EXE. The value that results from ASCII.EXE is 70. The second line of output reflects the value that results from CCPOS.EXE.

# CHANGE

The CHANGE statement either converts a string of characters to their ASCII integer values or converts a list of numbers to a string of ASCII characters.

## Format

### String Variable to Array

CHANGE *str-exp* **TO** *num-array-name*

### Array to String Variable

CHANGE *num-array-name* **TO** *str-var*

## Syntax Rules

1. *Str-exp* is a string expression.
2. *Num-array-name* should be a one-dimensional array. If you specify a two-dimensional array, BASIC converts only the first row of that array. BASIC does not support conversion to or from arrays of more than two dimensions.
3. *str-var* is a string variable.

## Remarks

1. BASIC does not support RECORD elements as a destination string or as a source or destination array for the CHANGE statement.
2. String Variable to Array
   - This format converts each character in the string to its ASCII value.
   - BASIC assigns the value of the string's length to element zero (0) of the array.
   - BASIC assigns the ASCII value of the first character in the string to element one, (1) or (0,1), of the array, the ASCII value of the second character to element two, (2) or (0,2), and so on.
   - If the string is longer than the bounds of the array, BASIC does not translate the excess characters, and signals the error "Subscript out of range" (ERR=55). The first element of array still contains the length of the string.

3. Array to String Variable

   - This format converts the elements of the array to a string of characters.
   - The length of the string is determined by the value in element zero, (0) or (0,0), of the array. If the value of element zero is greater than the array bounds, BASIC signals the error "Subscript out of range" (ERR=55).
   - BASIC changes element one, (1) or (0,1), of array to its ASCII character equivalent, element two, (2) or (0,2), to its ASCII equivalent, and so on. The length of the returned string is determined by the value in element zero of the array. For example, if the array is dimensioned as (10), but the zero element (0) contains the value 5, BASIC changes only elements (1), (2), (3), (4), and (5) to string characters.
   - BASIC truncates floating-point values to integers before converting them to characters.
   - Values in array elements are treated as modulo 256.

## Example

```
DECLARE STRING ABCD, A
DIM INTEGER array_changes(6)
ABCD = "ABCD"
CHANGE ABCD TO array_changes
FOR I% = 0 TO 4
PRINT array_changes(I%)
NEXT I%
CHANGE array_changes TO A
PRINT A
```

**Output**

```
 4
 65
 66
 67
 68
ABCD
```

# CHR$

The CHR$ function returns a 1-character string that corresponds to the ASCII value you specify.

## Format

*str-var* = CHR$ (*int-exp*)

## Syntax Rules

None

## Remarks

1. CHR$ returns the character whose ASCII value equals *int-exp*. If *int-exp* is greater than 255, BASIC treats it as modulo 256. For example, CHR$(325) is the same as CHR$(69).
2. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE INTEGER num_exp
INPUT "Enter the ASCII value you wish to be converted";num_exp
PRINT "The equivalent character is ";CHR$(num_exp)
```

**Output**

```
Enter the ASCII value you wish to be converted? 89
The equivalent character is Y
```

# CLOSE

The CLOSE statement ends I/O processing to a device or file on the specified channel.

## Format

CLOSE [#]*chnl-exp*,...

## Syntax Rules

*Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It can be preceded by an optional number sign (#).

## Remarks

1. BASIC writes the contents of any active output buffers to the file or device before it closes that file or device.
2. Channel #0 (the controlling terminal) cannot be closed. An attempt to do so has no effect.
3. If you close a magnetic tape file that is open for output, BASIC writes an end-of-file on the magnetic tape.
4. If you try to close a channel that is not currently open, BASIC does not signal an error and the CLOSE statement has no effect.

## Example

```
OPEN "COURSE_REC.DAT" FOR INPUT AS #2
INPUT #2, course_nam, course_num, course_desc, course_instr
   .
   .
   .
CLOSE #2
```

In this example, COURSE_REC.DAT is opened for input. After you have retrieved all of the required information, the file is closed.

# COMMON

The COMMON statement defines a named, shared storage area called a COMMON block or program section (PSECT). BASIC program modules can access the values stored in the COMMON block by specifying a COMMON block with the same name.

## Format

{ COM / COMMON } [ ( *com-name* ) ] {[*data-type* ] *com-item*},...

com-item: { *num-unsubs-var* / *num-array-name ([int-const1* **TO***] int-const2 ,... )* / *str-unsubs-var [= int-const]* / *str-array-name ([int-const1* **TO***] int-const2,... ) [ = int-const ]* / *record-var* / ***FILL*** *[(int-const)]* / ***FILL%*** *[(int-const)]* / ***FILL$*** *[(int-const)][ = int-const ]* }

## Syntax Rules

1. A COMMON block can have the same name as a program variable.
2. A COMMON block and a map in the same program module cannot have the same name.
3. All COMMON elements must be separated with commas.
4. *Com-name* is optional. If you specify a *com-name*, it must be in parentheses. If you do not specify a *com-name*, the default is $BLANK.
5. *Com-name* can be from 1 through 31 characters. The first character of the name must be an alphabetic character (A to Z). The remaining characters, if present, can be any combination of letters, digits (0 to 9), dollar signs ($), periods (.), or underscores (_).
6. *Data-type* can be any BASIC data type keyword or a data type defined in the RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.

7. When you specify a data type, all following *com-items*, including FILL items, are of that data type until you specify a new data type.
8. If you do not specify any data type, *com-items* take the current default data type and size.
9. *Com-item* declares the name and format of the data to be stored.
   - *Num-unsubs-var* and *num-array-name* specify a numeric variable or a numeric array.
   - *Record-var* specifies a record instance.
   - *Str-unsubs-var* and *str-array-name* specify a fixed-length string variable or array. You can specify the number of bytes to be reserved for the variable with the *=int-const* clause. The default string length is 16.
   - When you specify either a numeric or a string array, BASIC allows you to declare both lower and upper bounds. The upper bound is required; the lower bound is optional.
     - *Int-const1* specifies the lower bounds of the array.
     - *Int-const2* specifies the upper bounds of the array and, when accompanied by *int-const1*, must be preceded by the keyword TO.
     - *Int-const1* must be less than or equal to *int-const2*.
     - If you do not specify *int-const1*, BASIC uses zero as the default lower bound.
     - *Int-const1* and *int-const2* can be either negative or positive values.
   - The FILL, FILL%, and FILL$ keywords allow you to reserve parts of the record buffer within or between data elements and to define the format of the storage. *Int-const* specifies the number of FILL items to be reserved. The *=int-const* clause allows you to specify the number of bytes to be reserved for string FILL items. Table 4–1 describes FILL item format and storage allocation.

**Note**

In the applicable formats of FILL, *(int-const)* represents a repeat count, not an array subscript. FILL *(n)* represents *n* elements, not *n* + 1.

**Table 4–1 FILL Item Formats and Storage Allocations**

| FILL Format | Storage Allocation |
|---|---|
| FILL | Allocates storage for one element of the default data type unless preceded by a *data-type*. The number of bytes allocated depends on the default or the specified data type. |
| FILL(int-const) | Allocates storage for the number of the default data type elements specified by *int-const* unless preceded by a *data type*. The number of bytes allocated for each element depends on the default floating-point data size or the specified *data type*. |
| FILL% | Allocates storage for one integer element. The number of bytes allocated depends on the default integer size. |
| FILL%(int-const) | Allocates storage for the number of integer elements specified by *int-const*. The number of bytes allocated for each element depends on the default integer size. |
| FILL$ | Allocates 16 bytes of storage for a string element. |
| FILL$(int-const) | Allocates 16 bytes of storage for the number of string elements specified by *int-const*. |
| FILL$=int-const | Allocates the number of bytes of storage specified by *int-const* for a string element. |
| FILL$(int-const1)=int-const2 | Allocates the number of bytes of storage specified by *int-const2* for the number of string elements specified by *int-const1*. |

## Remarks

1. Variables in a COMMON area are not initialized by BASIC.
2. A COMMON area and a MAP area with the same name, in different program modules, specify the same storage area.
3. BASIC does not execute COMMON statements. The COMMON statement allocates and defines the data storage area at compilation time.
4. When you link your program, the size of the COMMON area is the size of the largest COMMON area with that name. BASIC concatenates COMMON statements with the same *com-name* within a single program module into a single PSECT. The total space allocated is the sum of the space allocated in the concatenated COMMON statements.

   If you specify the same *com-name* in several program modules, the size of the PSECT will be determined by the program module that has the greatest amount of space allocated in the concatenated COMMON statements.
5. The COMMON statement must lexically precede any reference to variables declared in it.
6. A COMMON area can be accessed by more than one program module, as long as you define the *com-name* in each module that references the COMMON area.
7. Variable names in a COMMON statement in one program module need not match those in another program module.
8. Variables and arrays declared in a COMMON statement cannot be declared elsewhere in the program by any other declarative statements.
9. The data type specified for *com-items* or the default data type and size determines the amount of storage reserved in a COMMON block. For example:
   - BYTE integers reserve 1 byte.
   - WORD integers reserve 2 bytes.
   - LONG integers reserve 4 bytes.
   - QUAD integers reserve 8 bytes.
   - SINGLE floating-point numbers reserve 4 bytes.
   - DOUBLE floating-point numbers reserve 8 bytes.

- GFLOAT floating-point numbers reserve 8 bytes.
- HFLOAT floating-point numbers reserve 16 bytes.
- SFLOAT floating-point numbers reserve 4 bytes.
- TFLOAT floating-point numbers reserve 8 bytes.
- XFLOAT floating-point numbers reserve 16 bytes.
- DECIMAL(d,s) packed decimal numbers reserve ( d+1 )/2 bytes.
- STRING reserves 16 bytes (the default) or the number of bytes you specify with =*int-const*.

## Example

```
COMMON (sales_rec) DECIMAL net_sales (1965 TO 1975),          &
                   STRING row = 2,                            &
                          report_name = 24,                   &
                   DOUBLE FILL,                               &
                   LONG part_bins
```

# COMP%

The COMP% function compares two numeric strings and returns -1, 0, or 1, depending on the results of the comparison.

## Format

*int-var* = COMP% (*str-exp1*, *str-exp2*)

## Syntax Rules

*Str-exp1* and *str-exp2* are numeric strings with an optional minus sign (-), ASCII digits, and an optional decimal point (.).

## Remarks

1. If *str-exp1* is greater than *str-exp2*, COMP% returns 1.
2. If the string expressions are equal, COMP% returns 0.
3. If *str-exp1* is less than *str-exp2*, COMP% returns -1.
4. The value returned by the COMP% function is an integer of the default size.
5. The COMP% function does not support E-format notation.

## Example

```
DECLARE STRING num_string, old_num_string, &
        INTEGER result
num_string = "-24.5"
old_num_string = "33"
result = COMP%(num_string, old_num_string)
PRINT "The value is ";result
```

**Output**

```
The value is -1
```

# CONTINUE

The CONTINUE statement causes BASIC to clear an error condition and resume execution at the statement following the statement that caused the error or at the specified target.

## Format

CONTINUE [ *target* ]

## Syntax Rules

If you specify a target, it must be a label or line number that appears either inside the associated protected region, inside a WHEN block protected region that surrounds the current protected region, or in an unprotected region of code.

## Remarks

1. CONTINUE with no target causes BASIC to transfer control to the statement immediately following the statement that caused the error. The next remark is an exception to this rule.
2. If an error occurs on a FOR, NEXT, WHILE, UNTIL, SELECT or CASE statement, control is transferred to the statement immediately following the corresponding NEXT or END SELECT statement, as in the following code:

```
10  WHEN ERROR IN
        A=10
        B=1
20      FOR I=A TO B STEP 2
30          GET #1
40          C=1
        NEXT I
50      C=0
    USE
   .
   .
   .
        CONTINUE
    END WHEN
```

If an error occurs on line 20, the CONTINUE statement transfers control to line 50. If an error occurs on line 30, program control resumes at line 40.

3. The CONTINUE statement must be lexically inside of a handler.
4. If you specify a CONTINUE statement within a detached handler, you cannot specify a target.

## Example

```
WHEN ERROR USE err_handler
   .
   .
   .
END WHEN
   .
   .
   .
HANDLER err_handler
     SELECT ERR
         CASE = 50
              PRINT "Insufficient data"
              CONTINUE
         CASE ELSE
         EXIT HANDLER
     END SELECT
END HANDLER
```

# COS

The COS function returns the cosine of an angle in radians or degrees.

## Format

*real-var* = COS (*real-exp*)

## Syntax Rules

None

## Remarks

1. The returned value is from -1 to 1. The parameter value is expressed in either radians or degrees depending on which angle clause you choose with the OPTION statement.
2. BASIC expects the argument of the COS function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.

## Example

```
DECLARE SINGLE cos_value
cos_value = 26
PRINT COS(cos_value)
```

**Output**

```
 .646919
```

# CTRLC

The CTRLC function enables Ctrl/C trapping. When Ctrl/C trapping is enabled, a Ctrl/C typed at the terminal causes control to be transferred to the error handler currently in effect.

## Format

*int-var* = CTRLC

## Syntax Rules

None

## Remarks

1. When BASIC encounters a Ctrl/C, control passes to the error handler currently in effect. If there is no error handler in a program, the program aborts.
2. In a series of linked subprograms, setting Ctrl/C for one subprogram enables Ctrl/C trapping for all subprograms.
3. When you trap a Ctrl/C with an error handler, your program may be in an inconsistent state; therefore, you should handle the Ctrl/C error and exit the program as quickly as possible.
4. Ctrl/C trapping is asynchronous; that is, BASIC suspends execution and signals "Programmable ^C trap" (ERR=28) as soon as it detects a Ctrl/C. Consequently, a statement can be interrupted while it is executing. A statement so interrupted may be only partially executed and variables may be left in an undefined state.
5. BASIC can trap more than one Ctrl/C error in a program as long as the error does not occur while the error handler is executing. If a second Ctrl/C is detected while the error handler is processing the first Ctrl/C, the program aborts.
6. The CTRLC function always returns a value of zero.
7. The function RCTRLC disables Ctrl/C trapping. See the description of the RCTRLC function for further details.

## Example

```
WHEN ERROR USE repair_work
Y% = CTRLC
   .
   .
   .
END WHEN
HANDLER repair_work
IF (ERR=28) THEN PRINT "Interrupted by CTRLC!"
   .
   .
   .
END HANDLER
```

# CVT$$

The CVT$$ function is a synonym for the EDIT$ function. See the EDIT$ function for more information.

**Note**

It is recommended that you use the EDIT$ function rather than the CVT$$ function for new program development.

## Format

*str-var* = CVT$$ (*str-exp*, *int-exp*)

# CVT*xx*

The CVT$% function maps the first two characters of a string into a 16-bit integer. The CVT%$ function translates a 16-bit integer into a 2-character string. The CVT$F function maps a 4- or 8-character string into a floating-point variable. The CVTF$ function translates a floating-point number into a 4- or 8-byte character string. The number of characters translated depends on whether the floating-point variable is single- or double-precision.

**Note**

CVT functions are supported only for compatibility with BASIC-PLUS. It is recommended that you use the BASIC dynamic mapping feature or multiple MAP statements for new program development.

## Format

*int-var* = CVT$% (*str-var*)

*real-var* = CVT$F (*str-var*)

*str-var* = CVT%$ (*int-var*)

*str-var* = CVTF$ (*real-var*)

## Syntax Rules

CVT functions reverse the order of the bytes when moving them to or from a string. Therefore, you can mix MAP and MOVE statements, but you cannot use FIELD and CVT functions on a file if you also plan to use MAP or MOVE statements.

## Remarks

1. **CVT$%**
   - If the CVT$% *str-var* has fewer than two characters, BASIC pads the string with nulls.
   - If the default data type is LONG, only 2 bytes of data are extracted from *str-var*; the high-order byte is sign-extended into a longword.
   - The value returned by the CVT$% function is an integer of the default size.
2. **CVT%$**
   - Only 2 bytes of data are inserted into *str-var*.
   - If you specify a floating-point variable for *int-var*, BASIC truncates it to an integer of the default size. If the default size is BYTE and the value of *int-var* exceeds 127, BASIC signals an error.
3. **CVT$F**
   - CVT$F maps four characters when the program is compiled with /SINGLE and eight characters when the program is compiled with /DOUBLE.
   - If *str-var* has fewer than four or eight characters, BASIC pads the string with nulls.
   - The *real-var* returned by the CVT$F function is the default floating-point size. If the default size is not SINGLE or DOUBLE, BASIC signals the error "Floating CVT valid only for SINGLE or DOUBLE."
4. **CVTF$**
   - The CVTF$ function maps single-precision numbers to a 4-character string and double-precision numbers to an 8-character string.
   - BASIC expects the argument of the CVTF$ function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size. If the default floating-point size is not SINGLE or DOUBLE, BASIC signals the error "Floating CVT valid only for SINGLE or DOUBLE."

## Examples

### Example 1

```
DECLARE STRING test_string, another_string
DECLARE LONG first_number, next_number
test_string = "AT"
PRINT CVT$%(test_string)
another_string = "at"
PRINT CVT$%(another_string)
first_number = 16724
PRINT CVT%$(first_number)
next_number = 24948
PRINT CVT%$(next_number)
END
```

**Output**

```
 16724
 24948
AT
at
```

### Example 2

```
DECLARE STRING test_string, another_string
DECLARE SINGLE first_num, second_num
test_string = "DESK"
first_num = CVT$F(test_string)
PRINT first_num
another_string = "desk"
second_num = CVT$F(another_string)
PRINT second_num
PRINT CVTF$(first_num)
PRINT CVTF$(second_num)
END

$ BASIC/SINGLE CVTF
$ LINK CVTF
$ RUN CVTF
```

**Output**

```
 .218256E+12
 .466242E+31
DESK
desk
```

# DATA

The DATA statement creates a data block for the READ statement.

## Format

DATA [ *num-lit* | *str-lit* | *unq-str* ] ,...

## Syntax Rules

1. *Num-lit* specifies a numeric literal.
2. *Str-lit* is a character string that starts and ends with double or single quotation marks. The quotation marks must match.
3. *Unq-str* is a character sequence that does not start or end with double quotation marks and does not contain a comma.
4. Commas separate data elements. If a comma is part of a data item, the entire item must be enclosed in quotation marks.

## Remarks

1. Because BASIC treats comment fields in DATA statements as part of the DATA sequence, you should not include comments.
2. A DATA statement must be the last or the only statement on a physical line.
3. DATA statements must end with a line terminator.
4. When a DATA statement is continued with an ampersand (&), BASIC interprets all characters between the keyword DATA and the ampersand as part of the data. Any code that appears on a noncontinued line is considered a new statement.
5. You cannot use the percent sign suffix for integer constants that appear in DATA statements. An attempt to do so causes BASIC to signal the error, "Data format error" (ERR=50).
6. DATA statements are local to a program module.

7. BASIC does not execute DATA statements. Instead, control is passed to the next executable statement.
8. A program can have more than one DATA statement. BASIC assembles data from all DATA statements in a single program unit into a lexically ordered single data block.
9. BASIC ignores leading and trailing blanks and tabs unless they are in a string literal.
10. Commas are the only valid data delimiters. You must use a quoted string literal if a comma is to be part of a string.
11. BASIC ignores DATA statements without an accompanying READ statement.
12. BASIC signals the error "Data format error" if the DATA item does not match the data type of the variable specified in the READ statement or if a data element that is to be read into an integer variable ends with a percent sign (%). If a string data element ends with a dollar sign ($), BASIC treats the dollar sign as part of the string.

## Example

```
10 DECLARE INTEGER A,B,C
   READ A,B,C
   DATA 1,2,3
   PRINT A + B + C
```

**Output**

```
 6
```

# DATE$

The DATE$ function returns a string containing a day, month, and year in the form *dd-mmm-yy*.

## Format

*str-var* = DATE$ (*int-exp*)

## Syntax Rules

1. *Int-exp* can have up to 6 digits in the form *yyyddd*, where the characters *yyy* specify the number of years since 1970 and the characters *ddd* specify the day of that year. The day of year must be a value between 1 and the number of days in the specified year.
2. You must fill all three of the *d* positions with digits or zeros before you can fill the *y* positions. For example:
   - DATE$(121) returns the date 01–May–70, day 121 of the year 1970.
   - DATE$(1201) returns the date 20–Jul–71, day 201 of the year 1971.
   - DATE$(12001) returns the date 01–Jan–82, day one of the year 1982.
   - DATE$(10202) returns the date 20–Jul–80, day 202 of the year 1980.

## Remarks

1. If *int-exp* equals zero, DATE$ returns the current date.
2. The *str-var* returned by the DATE$ function consists of nine characters and expresses the day, month, and year in the form *dd-mmm-yy*.
3. If you specify an invalid date, such as day 385, results are unpredictable.
4. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE STRING todays_date
todays_date = DATE$(0)
PRINT todays_date
```

**Output**

```
09-Oct-99
```

The DATE4$ function is strongly recommended as replacement for the DATE$ function to avoid problems in the year 2000 and beyond. It functions the same as the DATE$ function except that the year portion of the result string contains two more digits indicating the century. For example:

```
PRINT 32150, DATE$ (32150), DATE4$ (32150)
```

This produces the following output:

```
32150   30-May-02   30-May-2002
```

# DATE4$

The DATE4$ function returns a string containing a day, month, and year in the form *dd-mmm-yyyy*.

## Format

*str-var* = DATE4$ (*int-exp*)

## Syntax Rules

1. *Int-exp* can have up to 6 digits in the form *yyyddd*, where the characters *yyy* specify the number of years since 1970 and the characters *ddd* specify the day of that year. The day of year must be a value between 1 and the number of days in the specified year.
2. You must fill all three of the *d* positions with digits or zeros before you can fill the *y* positions.

## Remarks

The DATE4$ function is strongly recommended as replacement for the DATE$ function to avoid problems in the year 2000 and beyond. It functions the same as the DATE$ function except that the year portion of the result string contains two more digits indicating the century. For example:

```
PRINT 32150, DATE$ (32150), DATE4$ (32150)
```

Produces the following output:

```
32150   30-May-02   30-May-2002
```

See the description of the DATE$ function for more information.

# DECIMAL

The DECIMAL function converts a numeric expression or numeric string to the DECIMAL data type.

## Format

*decimal-var* = DECIMAL (*exp* [, *int-const1*, *int-const2* ] )

## Syntax Rules

1. *Int-const1* specifies the total number of digits (the precision) and *int-const2* specifies the number of digits to the right of the decimal point (the scale). If you do not specify these values, BASIC uses the d (digits) and s (scale) defaults for the DECIMAL data type.
2. *Int-const1* and *int-const2* must be positive integers from 1 to 31. *Int-const2* cannot exceed the value of *int-const1*.
3. *Exp* can be either numeric or numeric string. If a numeric string, it can contain the ASCII digits 0 to 9, a plus sign (+), a minus sign (-), and a period (.).

## Remarks

1. If *exp* is a string, BASIC ignores leading and trailing spaces and tabs.
2. The DECIMAL function returns a zero when a string argument contains only spaces and tabs, or when it is null.

## Example

```
DECLARE STRING CONSTANT format_string = "##.###"
DECLARE STRING num_value, DECIMAL(5,3) B
INPUT "Enter a numeric value";num_value
B = DECIMAL(num_value,5,3)
PRINT USING format_string, B
```

**Output**

```
Enter a numeric value? 6
 6.000
```

# DECLARE

The DECLARE statement explicitly assigns a name and a data type to a variable, an entire array, a function, or a constant.

## Format

### Variables

DECLARE *data-type* { *decl-item* [,[ *data-type* ] *decl-item* ]},...

### DEF Functions

DECLARE *data-type* FUNCTION { *def-name* [ ( [ *def-param* ],... ) ] },...

### Named Constants

DECLARE *data-type* **CONSTANT** { *const-name* = *const-exp* },...

decl-item: { array-name ( [ *int-const1* **TO** ] *int-const2*,...) | record-var | unsubs-var }

def-param: *data-type*

## Syntax Rules

1. *Data-type* can be any BASIC data type keyword or a data type defined by a RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.
2. Variables
   - *Decl-item* names an array, a record, or a variable.
   - A *decl-item* named in a DECLARE statement cannot be named in another DECLARE statement, or in a DEF, EXTERNAL, FUNCTION, SUB, COMMON, MAP, DIM, HANDLER, or PICTURE statement.
   - Each *decl-item* is associated with the preceding data type. A data type is required for the first *decl-item*.
   - *Decl-items* of data type STRING are dynamic strings.

- When you declare an array, BASIC allows you to specify both lower and upper bounds for each dimension of the array. The upper bound is required; the lower bound is optional.
  - *Int-const1* specifies the lower bounds of the array.
  - *Int-const2* specifies the upper bounds of the array and, when accompanied by *int-const1*, must be preceded by the keyword TO.
  - *Int-const1* must be less than or equal to *int-const2*.
  - If you do not specify *int-const1*, BASIC uses zero as the default lower bound.
  - *Int-const1* and *int-const2* can be any combination of negative or positive values or zero.

3. DEF Functions
   - *Def-name* names the DEF function.
   - *Data-type* specifies the data type of the value the function returns.
   - *Def-params* specify the number and, optionally, the data type of the DEF parameters. Parameters define the arguments the DEF expects to receive when invoked.
     - When you specify a data type, all following parameters are of that data type until you specify a new data type.
     - If you do not specify any data type, parameters take the current default data type and size.
     - The number of parameters equals the number of commas plus 1. For example, empty parentheses specify one parameter of the default type and size; one comma inside the parentheses specifies two parameters of the default type and size; and so on. One data type inside the parentheses specifies one parameter of the specified data type; two data types separated by one comma specifies two parameters of the specified type, and so on.
4. Named Constants
   - *Const-name* is the name you assign to the constant.
   - *Data-type* specifies the data type of the constant. The value of the *const* must be numeric if the data type is numeric and string if the data type is STRING. If the data type is STRING, *const* must be a quoted string or another string constant.

- *Const-exp* cannot be a data type that was defined with the RECORD statement.
- *Data-type* cannot be a data type defined by a record statment.
- String constants cannot exceed 498 characters.
- BASIC allows *const-exp* to be an expression for all data types except DECIMAL. Expressions are not allowed as values when you name DECIMAL constants.
- Allowable operators in DECLARE CONSTANT expressions include all valid arithmetic, relational, and logical operators except exponentiation. Built-in functions cannot be used in DECLARE CONSTANT expressions. The following examples use valid expressions as values:

```
DECLARE DOUBLE CONSTANT max_value = (PI/2)
DECLARE STRING CONSTANT left_arrow = "<-----" + LF + CR
```

## Remarks

1. The DECLARE statement is not executable.
2. The DECLARE statement must lexically precede any reference to the variables, functions, or constants named in it.
3. To declare a virtual or run-time array, use the DIMENSION statement.
4. Variables
   - Subsequent *decl-item*s are associated with the specified data type until you specify another data type.
   - All variables named in a DECLARE statement are initialized to zero if numeric or to the null string if string.
5. DEF Functions
   - The DECLARE FUNCTION statement allows you to name a function defined in a DEF or DEF* statement, specify the data type of the value the function returns, and declare the number and data type of the parameters.
   - Data type keywords must be separated by commas.

- The first specification of a data type for a *def-param* is the default for subsequent arguments until you specify another *def-param*. For example:

  ```
  DECLARE DOUBLE FUNCTION interest(DOUBLE,SINGLE,,)
  ```

  This example declares two parameters of the default type and size, one DOUBLE parameter, and three SINGLE parameters for the function named *interest*.

6. Named Constants

- The DECLARE CONSTANT statement allows you to name a constant value and assign a data type to that value. Note that you can specify only one data type in a DECLARE CONSTANT statement. To declare a constant of another data type, you must use a second DECLARE CONSTANT statement.
- During program execution, you cannot change the value assigned to the constant.
- The specified *data-type* determines the data type of the constant. For example:

  ```
  DECLARE LONG CONSTANT True = -1, False = 0
  DECLARE REAL CONSTANT ZZZ = 123.0
  DECLARE BYTE CONSTANT YYY = '123'L
  PRINT True, False, ZZZ, YYY
  ```

  **Output**

  ```
  -1            0            123            123
  ```

  In this example, BASIC truncates the LONG value assigned to YYY to a BYTE value.

**Note**

Data types specified in a DECLARE statement override any defaults specified in COMPILE command qualifiers or OPTION statements.

## Examples

### Example 1

```
!DEF Functions
DECLARE INTEGER FUNCTION amount(,,DOUBLE,BYTE,,)
```

### Example 2

```
!Named Constants
DECLARE DOUBLE CONSTANT interest_rate = 15.22
```

# DEF

The DEF statement lets you define a single-line or multiline function.

## Format

### Single-line DEF

DEF [ *data-type* ] *def-name* [ ( [ *data-type* ] *var* ,...) ] = *exp*

### multiline DEF

DEF [ *data-type* ] *def-name* [ ( [ *data-type var* ],...) ] [ *statement* ]...
[ statement ]...

{ END DEF / FNEND } [ exp ]

## Syntax Rules

1. *Data-type* can be any BASIC data type keyword or a data type defined in the RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.
2. The data type that precedes the *def-name* specifies the data type of the value returned by the DEF function.
3. *Def-name* is the name of the DEF function. The *def-name* can contain from 1 to 31 characters.
4. If the *def-name* also appears in a DECLARE FUNCTION statement, the following rules apply:
   - A function data type is required.
   - The first character of the *def-name* must be an alphabetic character (A to Z). The remaining characters can be any combination of letters, digits (0 to 9), dollar signs ($), underscores (_), or periods (.).
5. If the *def-name* does not appear in a DECLARE FUNCTION statement, but the DEF statement appears before the first reference to the *def-name*, the following rules apply:
   - The function data type is optional.

- The first character of the *def-name* must be an alphabetic letter (A to Z). The remaining characters can be any combination of letters, digits, dollar signs, underscores, or periods.
- If a function data type is not specified, the last character in the *def-name* must be a percent sign for an INTEGER function, or a dollar sign for a STRING function.

6. If the *def-name* does not appear in a DECLARE FUNCTION statement, and the DEF statement appears after the first reference to the *def-name*, the following rules apply:
   - The function data type cannot be present.
   - The first two characters of the *def-name* must be FN. The remaining characters can be any combination of letters, digits, dollar signs, underscores, or periods, with one restriction: the last character must be a percent sign for an INTEGER function, or a dollar sign for a STRING function.
   - There must be at least one character between the FN characters and the ending dollar sign or percent character. FN$ and FN% are not valid function names.
7. *Var* specifies optional formal DEF parameters. Because the parameters are local to the DEF function, any reference to these variables outside the DEF body creates a different variable.
8. You can specify the data type of DEF parameters with a data type keyword or with a data type defined in a RECORD statement. If you do not include a data type, the parameters are of the default type and size. Parameters that follow a data type keyword are of the specified type and size until you specify another data type.
9. You can specify up to 255 parameters in a DEF statement.
10. Single-Line DEF

    *Exp* specifies the operations the function performs.
11. Multiline DEF
    - *Statements* specifies the operations the function performs.
    - The END DEF or FNEND statement is required to end a multiline DEF.

- BASIC does not allow you to specify any statements that indicate the beginning or end of any SUB, FUNCTION, PICTURE, HANDLER (attached handlers are legal), PROGRAM or DEF in a function definition.
- *Exp* specifies the function result. *Exp* must be compatible with the DEF data type.

## Remarks

1. When BASIC encounters a DEF statement, control of the program passes to the next executable statement after the DEF.
2. The function is invoked when you use the function name in an expression.
3. You cannot specify how parameters are passed. When you invoke a function, BASIC evaluates parameters from left to right and passes parameters to the function so that they cannot be modified. Numeric parameters are passed by value and string parameters are passed by descriptor, where the descriptor points to a local copy. A DEF function can reference variables that are declared within the compilation unit in which the function resides, but it cannot reference variables in other DEF or DEF* functions. A DEF function can, therefore, modify other variables in the program, but not variables within another DEF function.
4. A DEF function is local to the program, subprogram, function, or picture that defines it.
5. You can declare a DEF either by defining it, by using the DECLARE FUNCTION statement, or by implicitly declaring it with a reference to the function in an expression.
6. If your program invokes a function with a name that does not start with FN before the DEF statement defines the function, BASIC signals an error.
7. If the number of parameters, types of parameters, or type of result declared in the invocation disagree with the number or types of parameters defined in the DEF statement, BASIC signals an error.
8. DATA statements in a multiline DEF are not local to the function; they are local to the program module containing the function definition.
9. The function value is initialized to zero or the null string each time you invoke the function.
10. DEF definitions cannot appear inside a protected region. However, DEF can contain one or more protected regions.

11. In DEF definitions that contain handlers, the following rules apply:
    - If the function was invoked from a protected region, the EXIT HANDLER statement transfers control to the handler specified for that protected region.
    - If the function was not invoked from a protected region, the EXIT HANDLER statement transfers control to the default error handler.
12. If an exception is not handled within a DEF function, control is transferred to the module that invoked the DEF function.
13. ON ERROR statements within a DEF function are local to the function.
14. A CONTINUE, GOTO, GOSUB, ON ERROR GOTO, or RESUME statement in a multiline function definition must refer to a line number or label in the same function definition.
15. You cannot transfer control into a multiline DEF except by invoking the function.
16. DEF functions can be recursive. However, BASIC does not detect infinitely recursive DEF functions during compilation.

## Examples

### Example 1

```
!Single-Line DEF
DEF DOUBLE add (DOUBLE A, B, SINGLE C, D, E) = A + B + C + D + E
INPUT 'Enter five numbers to be added';V,W,X,Y,Z
PRINT 'The sum is';ADD(V,W,X,Y,Z)
```

**Output**

```
Enter five numbers to be added? 1,2,3,4,5
The sum is 15
```

### Example 2

```
PROGRAM I_want_a_raise

        OPTION TYPE = EXPLICIT,                                    &
               CONSTANT TYPE = DECIMAL,                            &
               SIZE = DECIMAL (6,2)

        DECLARE DECIMAL CONSTANT Overtime_factor = 0.50
        DECLARE DECIMAL My_hours, My_rate, Overtime
        DECLARE DECIMAL FUNCTION Calculate_pay (DECIMAL,DECIMAL)

        INPUT "Your hours this week";My_hours
        INPUT "Your hourly rate";My_rate

        PRINT "My pay this week is"; Calculate_pay ( My_hours, My_rate )

        DEF DECIMAL Calculate_pay (DECIMAL Hours, Rate)

           IF Hours = 0.0
           THEN
                EXIT DEF 0.0
           END IF

           Overtime = Hours - 40.0

           IF Overtime < 0.0
           THEN
                Overtime = 0.0
           END IF

       END DEF  (Hours * Rate) + (Overtime * (Overtime_factor * Rate) )

END PROGRAM
```

### Output

```
Your hours this week? 45.7
Your pay rate? 20.35
Your pay for the week is 987.95
```

# DEF*

The DEF* statement lets you define a single- or multiline function.

**Note**

The DEF* statement is not recommended for new program development. It is recommended that you use the DEF statement for defining single- and multiline functions.

## Format

### Single-line DEF*

```
DEF*  [ data-type ] def-name [ ( [ data-type ] var ,...) ] = exp
```

### multiline DEF*

```
DEF*  [ data-type ] def-name [ ( [ data-type) ] var ,... ] [ statement ]...)
                [ statement ]...

{ END DEF }
{ FNEND   }  [ exp ]
```

## Syntax Rules

1. *Data-type* can be any BASIC data type keyword or a data type defined in the RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.
2. The data type that precedes the *def-name* specifies the data type of the value returned by the DEF* function.
3. *Def-name* is the name of the DEF* function. The *def-name* can contain from 1 to 31 characters.
4. If the *def-name* also appears in a DECLARE FUNCTION statement, the following rules apply:
   - A function data type is required.
   - The first character of the *def-name* must be an alphabetic character (A to Z). The remaining characters can be any combination of letters, digits (0 to 9), dollar signs ($), underscores (_), or periods (.).

5. If the *def-name* does not appear in a DECLARE FUNCTION statement, but the DEF* statement appears before the first reference to the *def-name*, the following rules apply:
   - The function data type is optional.
   - The first character of the *def-name* must be an alphabetic character (A to Z). The remaining characters can be any combination of letters, digits, dollar signs, underscores, or periods.
   - If a function data type is not specified, the last character in the *def-name* must be a percent sign for an INTEGER function, or a dollar sign for a STRING function.
6. If the *def-name* does not appear in a DECLARE FUNCTION statement, and the DEF* statement appears after the first reference to the *def-name*, the following rules apply:
   - The function data type cannot be present.
   - The first two characters of the *def-name* must be FN. The remaining characters can be any combination of letters, digits, dollar signs, underscores, or periods, with one restriction: the last character must be a percent sign for an INTEGER function, or a dollar sign for a STRING function.
   - There must be at least one character between the FN characters and the ending dollar sign or percent character. FN$ and FN% are not valid function names.
7. *Var* specifies optional formal function parameters.
8. You can specify the data type of function parameters with a data type keyword. If you do not specify a data type, parameters are of the default type and size. Parameters that follow a data type are of the specified type and size until you specify another data type.
9. You can specify up to 8 parameters in a DEF* statement.
10. Single-Line DEF*

    *Exp* specifies the operations the function performs.
11. Multiline DEF*
    - *Statements* specifies the operations the function performs.
    - The END DEF or FNEND statement is required to end a multiline DEF*.

- BASIC does not allow you to specify any statements that indicate the beginning or end of any SUB, FUNCTION, PICTURE, HANDLER, PROGRAM or DEF in a function definition.
- *Exp* specifies the function result. *Exp* must be compatible with the DEF data type.

## Remarks

1. When BASIC encounters a DEF* statement, control of the program passes to the next executable statement after the DEF*.
2. A function defined by the DEF* statement is invoked when you use the function name in an expression.
3. You cannot specify how parameters are passed. When you invoke a DEF* function, BASIC evaluates parameters from left to right and passes parameters to the function so that they cannot be modified. Numeric parameters are passed by value, and string parameters are passed by descriptor, where the descriptor points to a local copy. A DEF* function can reference variables in the program unit where the function is declared, but it cannot reference variables in other DEF or DEF* functions. A DEF* function can, therefore, modify variables in its program unit, but not variables within another DEF* function.
4. The following differences exist between DEF* and DEF statements:
   - You can use the GOTO, ON GOTO, GOSUB, and ON GOSUB statements to a branch outside a multiline DEF*, but they are not recommended.
   - Although other variables used within the body of a DEF* function are not local to the DEF* function, DEF* formal parameters are. However, if you change the value of formal parameters within a DEF* function and then transfer control out of the DEF* function without executing the END DEF or FNEND statement, variables outside the DEF* that have the same names as DEF* formal parameters are also changed.
   - You can pass up to 255 parameters to a DEF function. DEF* functions accept a maximum of 8 parameters.
   - A DEF* function value is not initialized when the DEF* function is invoked. Therefore, if a DEF* function is invoked and no new function value is assigned, the DEF* function returns the value of its previous invocation.

- The error handler of the program module that contains the DEF* is the default error handler for a DEF* function. Parameters return to their original values when control passes to the error handler.

5. A DEF* is local to the program unit or subprogram that defines it.
6. You can declare a DEF* either by defining it, by using the DECLARE FUNCTION statement, or by implicitly declaring it with a reference to the function in an expression.
7. If the number of parameters, types of parameters, or type of result declared in the invocation disagree with the number or types of parameters defined in the DEF* statement, BASIC signals an error.
8. DEF* functions can be recursive.
9. DATA statements in a multiline DEF* are not local to the function; they are local to the program module containing the function definition.
10. DEF* definitions cannot appear inside a protected region, but they can contain one or more protected regions.
11. In DEF* functions that contain handlers, the following rules apply:
    - If the function was invoked from a protected region, the EXIT HANDLER statement transfers control to the handler specified for that protected region.
    - If the function was not invoked from a protected region, the EXIT HANDLER statement transfers control to the default error handler.
12. Only in VAX BASIC can a DEF* function be invoked from within a handler or a DEF function.
13. In Alpha BASIC, if a DEF* function is invoked from within a complex expression, the compiler will generate a warning and reorder the expression to evaluate the DEF* function first. This reordering will not effect the outcome of the expression unless the DEF* modifies one of the variables used within the expression.

## Examples

### Example 1

```
!Single-Line DEF*
DEF* STRING CONCAT(STRING A,B) = A + B
DECLARE STRING word1,word2
INPUT "Enter two words";word1,word2
PRINT CONCAT (word1,word2)
```

**Output**

```
Enter two words? TO
? DAY
TODAY
```

### Example 2

```
!multiline DEF*
DEF* DOUBLE example(DOUBLE A, B, SINGLE C, D, E)
     EXIT DEF IF B = 0
     example = (A/B) + C - (D*E)
END DEF
INPUT "Enter 5 numbers";V,W,X,Y,Z
PRINT example(V,W,X,Y,Z)
```

**Output**

```
Enter 5 numbers? 2,4,6,8,1
-1.5
```

# DELETE

The DELETE statement removes a record from a relative or indexed file.

## Format

```
DELETE  #chnl-exp
```

## Syntax Rules

*Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).

## Remarks

1. The DELETE statement removes the current record from a file. Once the record is removed, you cannot access it.
2. The file specified by *chnl-exp* must have been opened with ACCESS MODIFY or WRITE.
3. You can delete a record only if the last I/O statement executed on the specified channel was a successful GET or FIND operation.
4. The DELETE statement leaves the current record pointer undefined and the next record pointer unchanged.
5. BASIC signals an error when the I/O channel is illegal or not open, when no current record exists, when access is illegal or illogical, or when the operation is illegal.

## Example

```
DECLARE STRING record_num
   .
   .
   .
OPEN "CUS.DAT" FOR INPUT AS #1, RELATIVE FIXED       &
      ACCESS MODIFY, RECORDSIZE 40
   .
   .
   .
INPUT "WHICH RECORD WOULD YOU LIKE TO EXAMINE";record_num
GET #1, RECORD record_num
DELETE #1
   .
   .
   .
```

In this example, the file CUS.DAT is opened for input with ACCESS MODIFY. Once you enter the number of the record you want to retrieve and the GET statement executes successfully, the current record number is deleted.

# DET

The DET function returns the value of the determinant of the last matrix inverted with the MAT INV function.

## Format

real-var = DET

## Syntax Rules

None

## Remarks

1. When a matrix is inverted with the MAT INV statement, BASIC calculates the determinant as a by-product of the inversion process. The DET function retrieves this value.
2. If your program does not contain a MAT INV statement, the DET function returns a value of zero.
3. The value returned by the DET function is a floating-point value of the default size.

## Example

```
MAT INPUT first_array(3,3)
MAT PRINT first_array;
PRINT
MAT inv_array = INV (first_array)
determinant = DET
MAT PRINT inv_array;
PRINT
PRINT determinant
PRINT
MAT mult_array = first_array * inv_array
MAT PRINT mult_array;
```

**Output**

```
? 1,0,0,0,1,0,0,0,1
 1 0 0
 0 1 0
 0 0 1

 1 0 0
 0 1 0
 0 0 1

 1

 1 0 0
 0 1 0
 0 0 1
```

# DIF$

The DIF$ function returns a numeric string whose value is the difference between two numeric strings.

## Format

str-var = DIF$ (str-exp1, str-exp2)

## Syntax Rules

Each *str-exp* can contain up to 60 ASCII digits, an optional decimal point, and an optional leading sign.

## Remarks

1. The DIF$ function does not support E-format notation.
2. BASIC subtracts *str-exp2* from *str-exp1* and stores the result in *str-var*.
3. The difference between two integers takes the precision of the larger integer.
4. The difference between two decimal fractions takes the precision of the more precise fraction, unless trailing zeros generate that precision.
5. The difference between two floating-point numbers takes precision as follows:
   - The difference of the integer parts takes the precision of the larger part.
   - The difference of the decimal fraction part takes the precision of the more precise part.
6. BASIC truncates leading and trailing zeros.

## Example

```
PRINT DIF$ ("689","-231")
```

**Output**

```
920
```

# DIMENSION

The DIMENSION statement creates and names a static, dynamic, or virtual array. The array subscripts determine the dimensions and the size of the array. You can specify the data type of the array and associate the array with an I/O channel.

## Format

### Nonvirtual, Nonexecutable

{ **DIM** | **DIMENSION** } { [*data-type*] *array-name* ([*int-const1* **TO**] *int-const2*,... ) },...

### Executable

{ **DIM** | **DIMENSION** } {[ *data-type* ] *array-name*
( [ *int-var1* **TO** ] *int-var2*,... ) },...

### Virtual

{ **DIM** | **DIMENSION** } #*chnl-exp*, { [ *data-type*] *array-name*
( *int-const*,... ) [ = *int-const* ] },...

## Syntax Rules

1. An array name in a DIM statement cannot also appear in a COMMON, MAP, or DECLARE statement.
2. *Data-type* can be any BASIC data type keyword or a data type defined in a RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.
3. If you do specify a data type and the array name ends in a percent sign (%) or dollar sign ($) suffix character, the variable must be a string or integer data type.
4. If you do not specify a data type, the array name determines the type of data the array holds. If the array name ends in a percent sign, the array stores integer data of the default integer size. If the array name ends in a dollar sign, the array stores string data. Otherwise, the array stores data of the default type and size.

5. An array can have up to 32 dimensions. Nonvirtual array sizes are limited by the virtual memory limits of your system.
6. When you declare a nonvirtual array, BASIC allows you to specify both lower and upper bounds. The upper bound is required; the lower bound is optional.
   - *Int-const1* or *int-var1* specifies the lower bounds of the array.
   - *Int-const2* or *int-var2* specifies the upper bounds of the array and, when accompanied by *int-const1* or *int-var1*, must be preceded by the keyword TO.
   - *Int-const1* must be less than or equal to *int-const2*. *Int-var1* must be less than or equal to *int-var2*.
   - If you do not specify *int-const1* or *int-var1*, BASIC uses zero as the default lower bound.
   - Array dimensions can have either positive or negative values.
7. Nonvirtual, Nonexecutable
   - When all the dimension specifications are integer constants, as in DIM A(15,10,20), the DIM statement is nonexecutable and the array size is static. A static array cannot appear in another DIM statement because BASIC determines storage requirements at compilation time.
   - A nonexecutable DIM statement must lexically precede any reference to the array it dimensions. That is, you must dimension a static array before you can reference array elements.
8. Virtual
   - The virtual array must be dimensioned and the file must be open before you can reference the array.
   - When the data type is STRING, the =*int-const* clause specifies the length of each array element. The default string length is 16 characters. Virtual string array lengths are rounded to the next higher power of 2. Therefore, specifying an element length of 12 results in an actual length of 16. For example:

```
DIM #1, STRING vir_array(100) = 12
OPEN "STATS.BAS" FOR OUTPUT as #1, VIRTUAL
```

**Output**

```
%BASIC-W-STRLENINC, virtual array string VIR_ARRAY length increased
 from 12 to 16
```

9. Executable

   When any of the dimension specifications are integer variables as in DIM A(10%,20%,*Y%*), the DIM statement is executable and the array is dynamic. A dynamic array can be redimensioned with a DIM statement any number of times because BASIC allocates storage at run time when each DIM statement is executed.

## Remarks

1. You can create an array implicitly by referencing an array element without using a DIM statement. This causes BASIC to create an array with dimensions of (10), (10,10), (10,10,10), and so on, depending on the number of bounds specifications in the referenced array element. You cannot create virtual or executable arrays implicitly.
2. BASIC allocates storage for arrays by row, from right to left.
3. Nonvirtual, Nonexecutable
   - You can declare arrays with the COMMON, MAP, and DECLARE statements. Arrays so declared cannot be redimensioned with the DIM statement. Furthermore, string arrays declared with a COMMON or MAP statement are always fixed-length arrays.
   - If you reference an array element declared in an array whose subscripts are smaller than the lower bound or larger than the upper bound specified in the DIM statement, BASIC signals the error "Subscript out of range" (ERR=55).
4. Virtual
   - For new development, using virtual arrays is not recommended.
   - When the rightmost subscript varies faster than the subscripts to the left, fewer disk accesses are necessary to access array elements in virtual arrays.
   - Using the same DIM statement for multiple virtual arrays allocates all arrays in a single disk file. The arrays are stored in the order they were declared.
   - Any program or subprogram can access a virtual array by declaring it in a virtual DIMENSION statement. For example:

     ```
     DIM #1, A(10)
     DIM #1, B(10)
     ```

In this example, array *B* overlays array *A*. You must specify the same channel number, data types, and limits in the same order as they occur in the DIM statement that created the virtual array.

- BASIC stores a string in a virtual array by padding it with trailing nulls to the length of the array element. It removes these nulls when it retrieves the string from the virtual array. Remember that string array element sizes are always rounded to the next power of 2.
- The OPEN statement for a virtual array must include the ORGANIZATION VIRTUAL clause for the channel specified in the DIMENSION statement.
- BASIC does not initialize virtual arrays and treats them as statically allocated arrays. You cannot redimension virtual arrays.
- See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about virtual arrays.

5. Executable

- You create an executable, dynamic array by using integer variables for array bounds, as in DIM A(*Y%,X%*). This eliminates the need to dimension an array to its largest possible size. Array bounds in an executable DIM statement can be constants or variables, but not expressions. At least one bound must be a variable.
- You cannot reference an array named in an executable DIM statement until after the DIM statement executes.
- You can redimension a dynamic array to make the bounds of each dimension larger or smaller, but you cannot change the number of dimensions. For example, you cannot redimension a four-dimensional array to be a five-dimensional array.
- The executable DIM statement cannot be used to dimension virtual arrays, arrays received as formal parameters, or arrays declared in COMMON, MAP, or nonexecutable DIM statements.
- An executable DIM statement always reinitializes the array to zero (for numeric arrays) or to the null string if string.
- If you reference an array element declared in an executable DIM statement whose subscripts are not within the bounds specified in the last execution of the DIM, BASIC signals the error "Subscript out of range" (ERR=55).

## Examples

### Example 1

```
!Nonvirtual, Nonexecutable
DIM STRING name_list(20 TO 100), BYTE age(100)
```

### Example 2

```
!Virtual
DIM #1%, STRING name_list(500), REAL amount(10,10)
```

### Example 3

```
!Executable
DIM DOUBLE inventory(base,markup)
   .
   .
   .
DIM DOUBLE inventory (new_base,new_markup)
```

# ECHO

The ECHO function causes characters to be echoed at a terminal that is opened on a specified channel.

## Format

*int-var* = ECHO (*chnl-exp*)

## Syntax Rules

*Chnl-exp* must specify a terminal.

## Remarks

1. The ECHO function is the complement of the NOECHO function; each function disables the effect of the other.
2. The ECHO function has no effect on an unopened channel.
3. The ECHO function always returns a value of zero.

## Example

```
DECLARE INTEGER Y,                    &
        STRING pass_word
Y = NOECHO(0%)
SET NO PROMPT
INPUT "Enter your password: ";pass_word
Y = ECHO(0%)
IF pass_word = "Darlene"
THEN
    PRINT CR+LF+"YOU ARE CORRECT !"
END IF
```

**Output**

```
Enter your password?
YOU ARE CORRECT !
```

# EDIT$

The EDIT$ function performs one or more string editing functions, depending on the value of its integer argument.

## Format

*str-var* = EDIT$ (*str-exp*, *int-exp*)

## Syntax Rules

None

## Remarks

1. BASIC edits *str-exp* to produce *str-var*.
2. The editing that BASIC performs depends on the value of *int-exp*. Table 4–2 describes EDIT$ values and functions.
3. All values are additive; for example, you can perform the editing functions of values 8, 16, and 32 by specifying a value of 56.
4. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

**Table 4–2 EDIT$ Values**

| Value | Edit Performed |
|---|---|
| 1 | Discards each character's parity bit (bit 7) |
| 2 | Discards all spaces and tabs |
| 4 | Discards all carriage returns <CR>, line feeds <LF>, form feeds <FF>, deletes <DEL>, escapes <ESC>, and nulls <NUL> |
| 8 | Discards leading spaces and tabs |
| 16 | Converts multiple spaces and tabs to a single space |
| 32 | Converts lowercase letters to uppercase letters |

(continued on next page)

**Table 4–2 (Cont.) EDIT$ Values**

| Value | Edit Performed |
|---|---|
| 64 | Converts left bracket ([) to left parenthesis [(] and right bracket (]) to right parenthesis [)] |
| 128 | Discards trailing spaces and tabs (same as TRM$ function) |
| 256 | Suppresses all editing for characters within quotation marks; if the string has only one quotation mark, BASIC suppresses all editing for the characters following the quotation mark |

## Example

```
DECLARE STRING old_string, new_string
old_string = "a value of 32 converts lowercase letters to uppercase"
new_string = EDIT$(old_string,32)
PRINT new_string
```

**Output**

```
A VALUE OF 32 CONVERTS LOWERCASE LETTERS TO UPPERCASE
```

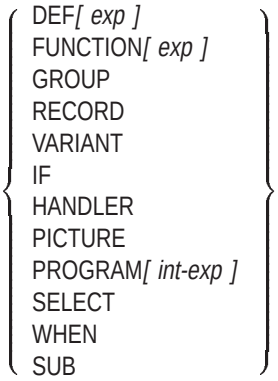
# END

The END statement marks the physical and logical end of a main program, a program module, or a block of statements.

## Format

END [ *block* ]

block:




## Syntax Rules

None

## Remarks

1. The END statement with no *block* keyword marks the end of a main program. The END or END PROGRAM statement must be the last statement on the last lexical line of the main program.
2. The END statement followed by a *block* keyword marks the end of a program, a BASIC SUB, FUNCTION, or PICTURE subprogram, a DEF, an IF, a HANDLER, a PROGRAM, a SELECT statement block or a WHEN block.
3. END RECORD, END GROUP, and END VARIANT mark the end of a RECORD statement, or a GROUP component or VARIANT component of a RECORD statement.

4. END DEF and END FUNCTION

   - When BASIC executes an END DEF or an END FUNCTION statement, it returns the function value to the statement that invoked the function and releases all storage associated with the DEF or FUNCTION.
   - If you specify an optional expression with the END DEF or END FUNCTION statement, the expression must be compatible with the DEF or FUNCTION data type. The expression is the function result unless an EXIT DEF or EXIT FUNCTION statement is executed. This expression supersedes all function assignments.
   - The END DEF statement restores the error handler in effect when the DEF was invoked (this is not true of the DEF* statement).
   - The END FUNCTION statement does not affect I/O operations or files.

5. END HANDLER

   The END HANDLER statement causes BASIC to transfer control to the statement following the WHEN block with the exception cleared.

6. END PROGRAM

   - The END PROGRAM statement allows you to end a program module.
   - An optional integer expression specifies the exit status of the program that is reported to DCL. This status is overridden by a status expression in an EXIT PROGRAM statement.
   - You can specify an END PROGRAM statement without a matching PROGRAM statement.

7. END WHEN

   - The END WHEN statement ends a WHEN block and transfers control to the statement following the WHEN block.
   - If the END WHEN statement ends an attached handler, control is transferred to the statement following the WHEN block with the exception cleared.

8. END SUB

   - The END SUB statement does not affect I/O operations or files.
   - The END SUB statement releases the storage allocated to local variables and returns control to the calling program.

- The END SUB statement cannot be executed in an error handler unless the END SUB is in a subprogram called by the error handler of another routine.

9. When an END or END PROGRAM statement marking the end of a main program executes, BASIC closes all files and releases all program storage.
10. If you use ON ERROR error handling, you must clear any errors with the RESUME statement before executing an END PROGRAM, END SUB, END FUNCTION, or END PICTURE statement.
11. Except for the END PROGRAM statement, BASIC signals an error when a program contains an END *block* statement with no corresponding and preceding *block* keyword.

## Example

```
10   INPUT "Guess a number";A%
     IF A% = 24
     THEN
            PRINT, "YOU GUESSED IT!"
     END IF
     IF A% < 24
     THEN
            PRINT, "BIGGER IS BETTER!"
     GOTO 10
     END IF

     IF A% > 24
     THEN
            PRINT, "SMALLER IS BETTER!"
            GOTO 10
     END IF

     END PROGRAM
```

# ERL

The ERL function returns the number of the BASIC line where the last error occurred.

## Format

*int-var* = ERL

## Syntax Rules

The value of *int-var* returned by the ERL function is a LONG integer.

## Remarks

1. If the ERL function is used before an error occurs or after an error is handled, the results are undefined.
2. The ERL function overrides the /NOLINE qualifier for VAX BASIC.

## Example

```
10 DECLARE LONG int_exp
   WHEN ERROR USE error_routine
20 INPUT "Enter an integer expression";int_exp
30 PRINT DATE$(int_exp)
   END WHEN
   HANDLER error_routine
   IF ERL = 20
   THEN
        PRINT "Invalid input...try again"
        RETRY
   ELSE
        PRINT "UNEXPECTED ERROR"
        EXIT HANDLER
   END IF
   END HANDLER
   END PROGRAM
```

### Output

```
Enter an integer expression? ABCD
Error occurred on line 20
Enter an integer expression? 0
07-Feb-00
```

# ERN$

The ERN$ function returns the name of the main program, subprogram, or DEF function that was executing when the last error occurred.

## Format

*str-var* = ERN$

## Syntax Rules

None

## Remarks

1. If the ERN$ function executes before an error occurs or after an error is handled, ERN$ returns a null string.
2. If you call a subprogram or function compiled with /NOSETUP or containing an OPTION INACTIVE=SETUP statement, the ERN$ function will not have a valid value if an exception occurs in the called procedure.

## Example

```
10 DECLARE LONG int_exp
   !This module's name is DATE
   WHEN ERROR IN
   INPUT "Enter an number";int_exp
   USE
      PRINT "Error in module ";ERN$
      RETRY
   END WHEN
   PRINT Date$(int_exp)
   END
```

**Output**

```
Enter a number? ABCD
Error in module DATE
Enter a number? 0
07-Feb-00
```

# ERR

The ERR function returns the error number of the current run-time error.

## Format

*int-var* = ERR

## Syntax Rules

The value of *int-var* returned by the ERR function is always a LONG integer.

## Remarks

If the ERR function is used before an error occurs or after an error is handled, the results are undefined.

## Example

```
10 DECLARE LONG int_exp
   WHEN ERROR USE error_routine
20 INPUT "Enter an integer expression";int_exp
   PRINT DATE$(int_exp)
   END WHEN
   HANDLER error_routine:
        PRINT "Error number";ERR
        IF ERR = 50  THEN PRINT "DATA FORMAT ERROR"
        ELSE PRINT "UNEXPECTED ERROR"
        END IF
        RETRY
   END HANDLER
        END
```

**Output**

```
Enter an integer expression? ABCD
Error number 50
DATA FORMAT ERROR
Enter an integer expression? 0
07-Feb-00
```

# ERT$

The ERT$ function returns explanatory text associated with an error number.

## Format

*str-var* = ERT$ (*int-exp*)

## Syntax Rules

*Int-exp* is a BASIC error number. The error number should be a valid BASIC error number.

## Remarks

1. The ERT$ function can be used at any time to return the text associated with a specified error number.
2. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.
3. Any error outside the range of valid BASIC RTL errors results in the following error message: "NOTBASIC, Not a BASIC error" (ERR=194).

## Example

```
10 DECLARE LONG int_exp
   WHEN ERROR USE error_routine
20 INPUT "Enter an integer expression";int_exp
   PRINT DATE$(int_exp)
   END WHEN
   HANDLER error_routine
        PRINT "Error number";ERR
        PRINT ERT$(ERR)
        RETRY
   END HANDLER
   END
```

**Output**

```
Enter an integer expression? ABCD
Error number 50
%Data format error
Enter an integer expression? 0
07-Feb-00
```

# EXIT

The EXIT statement lets you exit from a main program, a SUB, FUNCTION, or PICTURE subprogram, a multiline DEF, a statement block, or a handler.

## Format

EXIT *block*

block: { DEF*[ exp ]* | FUNCTION*[ exp ]* | SUB | HANDLER | PICTURE | PROGRAM*[ int-exp ]* | label }

## Syntax Rules

1. The DEF, FUNCTION, SUB, HANDLER, and PROGRAM keywords specify the type of subprogram, multiline DEF, or handler from which BASIC is to exit.
2. If you specify an optional expression with the EXIT DEF statement or with the EXIT FUNCTION statement, the expression becomes the function result and supersedes any function assignment. It also overrides any expression specified on the END DEF or END FUNCTION statement. Note that the expression must be compatible with the FUNCTION or DEF data type.
3. *Label* specifies a statement label for an IF, SELECT, FOR, WHILE, or UNTIL statement block.

## Remarks

1. An EXIT SUB, EXIT FUNCTION, EXIT PROGRAM, EXIT DEF, or EXIT PICTURE statement is equivalent to an unconditional branch to an equivalent END statement. Control then passes to the statement that invoked the DEF or to the statement following the statement that called the subprogram.

2. The EXIT HANDLER statement causes BASIC to transfer control to a specified area.
   - If the current WHEN block is nested, control transfers to the handler associated with the next outer protected region.
   - If an ON ERROR statement is in effect and the current WHEN block is not nested, control transfers to the target of the ON ERROR statement.
   - If neither of the previous conditions is true, an EXIT HANDLER statement transfers control to the calling program or DCL. This action is the equivalent of the ON ERROR GO BACK statement.
3. The EXIT PROGRAM statement causes BASIC to exit from a main program module.
   - An optional integer expression on an EXIT PROGRAM statement specifies the exit status of the program that is reported to DCL.
   - The expression specified by an EXIT PROGRAM statement overrides any integer expression specified by an END PROGRAM statement.
   - BASIC allows you to specify an EXIT PROGRAM statement without a matching PROGRAM statement.
4. The EXIT *label* statement is equivalent to an unconditional branch to the first statement following the end of the IF, SELECT, FOR, WHILE, or UNTIL statement labeled by the specified label.
5. An EXIT FUNCTION, EXIT SUB or EXIT PROGRAM statement cannot be used within a multiline DEF function.
6. When the EXIT FUNCTION, EXIT SUB or EXIT PROGRAM statement executes, BASIC releases all storage allocated to local variables and returns control to the calling program.

## Example

```
DEF emp.bonus(A)
IF A > 10
THEN
    PRINT "OUT OF RANGE"
    EXIT DEF 0
ELSE
    emp.bonus = A * 4
END IF
END DEF
INPUT A
PRINT emp.bonus(A)
END
```

**Output**

```
? 11
OUT OF RANGE
 0
```

# EXP

The EXP function returns the value of the mathematical constant *e* raised to a specified power.

## Format

*real-var* = EXP (*real-exp*)

## Syntax Rules

None

## Remarks

1. The EXP function returns the value of *e* raised to the power of *real-exp*.
2. BASIC expects the argument of the EXP function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.
3. When the default REAL size is SINGLE, DOUBLE, or SFLOAT, EXP allows arguments from -88 to 88. If the default REAL size is GFLOAT or TFLOAT, EXP allows arguments from -709 to 709. If the default REAL size is HFLOAT or XFLOAT, the arguments can be in the range -11356 to 11355. When the argument exceeds the upper limit of a range, BASIC signals an error. When the argument is beyond the lower limit of a range, the EXP function returns a zero and BASIC does not signal an error.

## Example

```
DECLARE SINGLE num_val
num_val = EXP(4.6)
PRINT num_val
```

**Output**

```
 99.4843
```

# EXTERNAL

The EXTERNAL statement declares constants, variables, functions, and subroutines external to your program. You can describe parameters for external functions and subroutines.

## Format

### External Constants

EXTERNAL *data-type* CONSTANT *const-name*,...

### External Variables

EXTERNAL *data-type unsubs-var*,...

### External Functions

EXTERNAL *data-type* FUNCTION { *func-name [ pass-mech ]*
[ ( *external-param* ,... ) ] },...

### External Subroutines

EXTERNAL SUB { *sub-name [ pass-mech* ] [ ( *external-param* ,...) ] },...

pass-mech: { BY VALUE | BY REF | BY DESC }

external-param: [ OPTIONAL ] [ param-data-type ] [ DIM( [,]... ) ]
[ = int-const ] [ pass-mech ]

### External Pictures

EXTERNAL PICTURE *pic-name* [ (*param-list* ) ]

## Syntax Rules

1. For external constants, *data-type* can be BYTE, WORD, LONG, INTEGER (if default is not QUAD), SINGLE, SFLOAT, or REAL (if default is SINGLE or SFLOAT).
2. For external variables, the data type can be any valid numeric data type.

3. For external functions and subroutines, the data type can be BYTE, WORD, LONG, QUAD, SINGLE, DOUBLE, GFLOAT, HFLOAT, SFLOAT, TFLOAT, XFLOAT, DECIMAL, STRING, INTEGER, REAL, RFA, or a data type defined with the RECORD statement. See Table 1–2 for more information about data type size, range, and precision.
4. The name of an external constant, variable, function, or subroutine can be from 1 to 31 characters.
5. For all external routine declarations, the name must be a valid BASIC identifier and must not be the same as any other SUB, FUNCTION, PICTURE, or PROGRAM name.

   For more information about external pictures, see *Programming with VAX BASIC Graphics*.
6. *Param-data-type* specifies the data type of a parameter. If you do not specify a data type, parameters are of the default data type and size.
7. *Param-list* is identical to *external-param* except that no OPTIONAL parameter is allowed.
8. Parameters in the *param-list* must agree in number and data type with the parameters in the invocation. *Param-data-type* includes ANY, BYTE, WORD, LONG, QUAD, INTEGER, SINGLE, DOUBLE, GFLOAT, HFLOAT, SFLOAT, TFLOAT, XFLOAT, READ, a user-defined RECORD type, STRING, or RFA.
9. A maximum of 255 parameters may be passed.
10. External Functions and Subroutines
    - The data type that precedes the keyword FUNCTION defines the data type of the function result.
    - *Pass-mech* specifies how parameters are to be passed to the function or subroutine.
      - A *pass-mech* clause outside the parentheses applies to all parameters.
      - A *pass-mech* clause inside the parentheses overrides the previous *pass-mech* and applies only to the specific parameter.
    - *External-param* defines the form of the arguments passed to the external function or subprogram. Empty parentheses indicate that the subprogram expects zero parameters. Missing parentheses indicate that the EXTERNAL statement does not define parameters.

11. Using ANY as a BASIC Data Type

    - The ANY data type should only be used for calling non BASIC procedures. Therefore, the ANY data type is illegal in a PICTURE declaration.
    - If you specify ANY, BASIC does not perform data type checking or conversions. If no passing mechanism is specified, BASIC uses the default passing mechanism for the data type passed in a given invocation.
    - When you specify a data type, all following parameters that are not specifically declared default to the last specified data type. Similarly, when you specify ANY, all following unspecified parameters default to the data type ANY until a new declaration is provided. For example:

      ```
      EXTERNAL SUB allocate (LONG,ANY, )
      ```

12. Passing Optional Parameters

    - The OPTIONAL keyword should be used only for calling non BASIC procedures.
    - If you specify the keyword OPTIONAL, BASIC treats all following parameters as optional. In the following example, the last three parameters are optional:

      ```
      EXTERNAL SUB queue(STRING, OPTIONAL STRING, LONG, ANY)
      ```

    - BASIC still performs type checking and conversion on optional parameters.
    - If you want to omit an optional parameter that appears in the middle of a parameter list, BASIC requires you to insert a comma placeholder. However, if you want to omit an optional parameter that appears at the end of a parameter list, you can omit that parameter without inserting any placeholder.
    - You can specify the keyword OPTIONAL only once in any one parameter list.

13. Declaring Array Dimensions

    The DIM keyword indicates that the parameter is an array. Commas specify array dimensions. The number of dimensions is equal to the number of commas plus 1. For example:

    ```
    EXTERNAL STRING FUNCTION new (DOUBLE, STRING DIM(,), DIM( ))
    ```

This statement declares a function named *new* that has three parameters. The first is a double-precision floating-point value, the second is a two-dimensional string array, and the third is a one-dimensional string array. The function returns a string result.

## Remarks

1. The EXTERNAL statement must precede any program reference to the constant, variable, function, subroutine or picture declared in the statement.
2. The EXTERNAL statement is not executable.
3. A name declared in an EXTERNAL CONSTANT statement can be used in any nondeclarative statement as if it were a constant.
4. A name declared in an EXTERNAL FUNCTION statement can be used as a function invocation in an expression. In addition, you can invoke a function with the CALL statement unless the function data type is DECIMAL, HFLOAT, or STRING.
5. A name declared in an EXTERNAL SUB statement can be used in a CALL statement.
6. The optional *pass-mech* clauses in the EXTERNAL FUNCTION and EXTERNAL SUB statements tell BASIC how to pass arguments to a non BASIC function or subprogram.
   - BY VALUE specifies that BASIC passes the argument's value.
   - BY REF specifies that BASIC passes the argument's address. This is the default for all arguments except strings and entire arrays. If you know the size of string parameters and the dimensions of array parameters, you can improve run-time performance by passing strings and arrays by reference.
   - BY DESC specifies that BASIC passes the address of a BASIC descriptor. For information about the format of a BASIC descriptor for strings and arrays, see Appendix A.
7. If you do not specify the data type ANY or declare parameters as optional, the arguments passed to external functions and subroutines should match the external parameters declared in the EXTERNAL FUNCTION or EXTERNAL SUB statement in number, type, and passing mechanism. BASIC forces arguments to be compatible with declared parameters. If they are not compatible, BASIC signals an error.

## Examples

### Example 1

```
!External Constant
EXTERNAL LONG CONSTANT SS$_NORMAL
```

### Example 2

```
!External Variable
EXTERNAL WORD SYSNUM
```

### Example 3

```
!External Function
EXTERNAL DOUBLE FUNCTION USR$2(WORD,LONG,ANY)
```

**Example 4**

```
!External Subroutine
EXTERNAL SUB calc BY DESC (STRING DIM(,),  BYTE BY REF)
```

# FIELD

The FIELD statement dynamically associates string variables with all or parts of a record buffer. FIELD statements do not move data. Instead, they permit direct access through string variables to sections of a specified record buffer.

**Note**

The FIELD statement is supported only for compatibility with BASIC-PLUS-2. Because data defined in the FIELD statement can be accessed only as string data, you must use the CVT*xx* functions to process numeric data; therefore, you must convert string data to numeric after you move it from the record buffer. Then, after processing, you must convert numeric data back to string data before transferring it to the record buffer. It is recommended that you use the BASIC dynamic mapping feature or multiple maps instead of the FIELD statement and CVT*xx* functions.

## Format

FIELD #*chnl-exp*, *int-exp* AS *str-var*[ , *int-exp* AS *str-var* ]...

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#). A file must be open on the specified channel or BASIC signals an error.
2. *Int-exp* specifies the number of characters in *str-var*. However, a subsequent *int-exp* cannot depend on the return string from a previous *int-exp*. For example, the following statement is illegal because the second *int-exp* depends on the return string A$:

```
FIELD #1%, 1% AS A$, ASCII(A$) AS B$
```

## Remarks

1. A FIELD statement is executable. You can change a buffer description at any time by executing another FIELD statement. For example:

   ```
   FIELD #1%, 40% AS whole_field$
   FIELD #1%, 10% AS A$, 10% AS B$, 10% AS C$, 10% AS D$
   ```

   The first FIELD statement associates the first 40 characters of a buffer with the variable *whole_field$*. The second FIELD statement associates the first 10 characters of the same buffer with *A$*, the second 10 characters with *B$*, and so on. Later program statements can refer to any of the variables named in the FIELD statements to access specific portions of the buffer.

2. You cannot define virtual array strings as string variables in a FIELD statement.

3. A variable named in a FIELD statement cannot be used in a COMMON or MAP statement, as a parameter in a CALL or SUB statement, or in a MOVE statement.

4. Attempting to access an element of a virtual array in a virtual file that has associated FIELD variables, causes BASIC to signal "Illegal operation" (ERR=141).

5. If you name an array in a FIELD statement, you cannot use MAT statements in the following format:

   ```
   MAT array-name1 = array-name2
   MAT array-name1 = NUL$
   ```

   where *array-name1* is named in a FIELD statement. This causes BASIC to signal a compile-time error.

## Example

```
FIELD #8%, 2% AS U$, 2% AS CL$, 4% AS X$, 4% AS Y$
LSET U$ = CVT%$(U%)
LSET CL$ = CVT%$(CL%)
LSET X$ = CVTF$(X)
LSET Y$ = CVTF$(Y)
U% = CVT$%(U$)
CL% = CVT$%(CL$)
X = CVT$F(X$)
Y = CVT$F(Y$)
```

# FIND

The FIND statement locates a specified record in a disk file and makes it the current record for a GET, UPDATE, or DELETE operation. FIND statements are valid on RMS sequential, relative, and indexed files.

## Format

FIND #*chnl-exp* [ , *position-clause* ][ , *lock-clause*]

position-clause: { RFA *rfa-exp* | RECORD *num-exp* | KEY# *key-clause* }

lock-clause: { ALLOW *allow-clause* [ ,WAIT [ int-exp ] ] | WAIT [ int-exp ] | REGARDLESS }

allow-clause: { NONE | READ | MODIFY }

key-clause: *int-exp1 rel-op key-exp*

rel-op: { EQ | GE | NXEQ | GT | NX }

key-exp: { *int-exp2* | *str-exp* | *decimal-exp* | *quadword-exp* }

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. If you specify a *lock-clause*, it must follow the *position-clause*. If the *lock-clause* precedes the *position-clause*, BASIC signals an error.
3. If you specify the REGARDLESS *lock-clause*, you cannot specify another *lock-clause* in the same FIND statement.

## Remarks

1. Position-clause
   - *Position-clause* specifies the position of a record in a file. BASIC signals an error if you specify a *position-clause* and the channel is not associated with a disk file. If you do not specify a *position-clause*, FIND locates records sequentially. Sequential record access is valid on all files.
   - The RFA *position-clause* allows you to randomly locate records by specifying the record file address (RFA) of a record. You specify the disk address of a record, and RMS locates the record at that address. All file organizations can be accessed by RFA.

     *Rfa-exp* in the RFA *position-clause* is a variable of the RFA data type that specifies the record's file address. Note that an RFA expression can only be a variable of the RFA data type or the GETRFA function. Use the GETRFA function to find the RFA of a record.
   - The RECORD *position-clause* allows you to randomly locate records in relative and sequential fixed files by specifying the record number.
     - *Num-exp* in the RECORD *position-clause* specifies the number of the record you want to locate. It must be between 1 and the number of the record with the highest number in the file.
     - When you specify a RECORD clause, *chnl-exp* must be a channel associated with an open relative or sequential fixed file.
   - The KEY *position-clause* allows you to randomly locate records in indexed files by specifying a key of reference, a relational test, and a key value.

- An RFA value is valid only for the life of a specific version of a file. If a new version of a file is created, the RFA values may change.
- Attempting to access a record with an invalid RFA value results in a run-time error.

2. Lock-clause

- *Lock-clause* allows you to control how a record is locked to other access streams, to override lock checking when accessing shared files that may contain locked records, or to specify what action to take in the case of a locked record.
- The type of lock you impose on a record remains in effect until you explicitly unlock it with a FREE or UNLOCK statement, until you close the file, or until you perform a GET, FIND, UPDATE or DELETE on the same channel (unless you specified UNLOCK EXPLICIT).
- The REGARDLESS *lock-clause* specifies that the FIND statement can override lock checking and locate a record locked by another program.
- When you specify a REGARDLESS *lock-clause*, BASIC does not impose a lock on the retrieved record.
- The ALLOW *lock-clause* lets you control how a record is locked to other users and access streams. The file associated with the specified channel must have been opened with the UNLOCK EXPLICIT clause or BASIC signals the error "Illegal record locking clause."
- The ALLOW *allow-clause* can be one of the following:
  - ALLOW NONE denies access to the record. This means that other access streams cannot retrieve the record unless they bypass lock checking with the GET REGARDLESS clause.
  - ALLOW READ provides read access to the record. This means that other access streams can retrieve the record but cannot use the DELETE or UPDATE statements on the record.
  - ALLOW MODIFY provides read and write to the record. This means that other access streams can use the GET, FIND, DELETE, and UPDATE statements on the record.
- If you do not open a file with the ACCESS READ clause or specify an *allow-clause*, locking is imposed as follows:
  - If the file associated with the specified channel was opened with UNLOCK EXPLICIT, BASIC imposes the ALLOW NONE lock on

the retrieved record and the next GET or FIND operation does not unlock the previously locked record.

- If the file associated with the specified channel was not opened with UNLOCK EXPLICIT, BASIC locks the retrieved record and unlocks the previously locked record.

- The WAIT *lock-clause* accepts an optional *int-exp*. *Int-exp* represents a timeout value in seconds. *Int-exp* must be from 0 through 255 or BASIC signals a warning message.
  - WAIT followed by a timeout value causes RMS to wait for a locked record for a given period of time.
  - WAIT followed by no timeout value indicates that RMS should wait indefinitely for the record to become available.
  - If you specify a timeout value and the record does not become available within that period, BASIC signals the run-time error "Keyboard wait exhausted" (ERR=15). VMSSTATUS and RMSSTATUS then return RMS$_TMO. For more information about the RMSSTATUS and VMSSTATUS functions, see this chapter and the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.
  - If you attempt to wait for a record that another user has locked, and consequently that user attempts to wait for the record you have locked, a deadlock condition occurs. When a deadlock condition persists for a period of time (as defined by the SYSGEN parameter DEADLOCK_WAIT), RMS signals the error "RMS$_DEADLOCK" and BASIC signals the error "Detected deadlock error while waiting for GET or FIND" (ERR=193).
  - If you specify a WAIT clause followed by a timeout value that is less than the SYSGEN parameter DEADLOCK_WAIT, BASIC signals the error "Keyboard wait exhausted" (ERR=15) even though a deadlock condition may exist.

3. Key-clause

   - In a *key-clause*, *int-exp1* is the target key of reference. It must be an integer in the range of zero to the highest-numbered key for the file. The primary key is #0, the first alternate key is #1, the second alternate key is #2, and so on. *Int-exp1* must be preceded by a number sign (#) or BASIC signals an error.
   - When you specify a *key-clause*, the specified channel must be a channel associated with an open indexed file.

4. Rel-op

   - *Rel-op* is a relational operator that specifies how *key-exp* is to be compared with *int-exp1* in the *key-clause*.
     - EQ means "equal to"
     - NXEQ means "next or equal to"
     - GE means "greater than or next" (a synonym for NXEQ)
     - NX means "next"
     - GT means "greater than" (a synonym for NX)
   - A successful random FIND operation by key locates the first record whose key satisfies the *key-clause* comparison:
     - With an exact key match (EQ), a successful FIND locates the first record in the file that equals the key value specified in *key-exp*. However, if the characters specified by a *str-exp* key expression are less than the key length, characters specified by *str-exp* are matched approximately rather than exactly. For example, if you specify ABC and the key length is six characters, BASIC locates the first record that begins with ABC. If you specify ABCABC, BASIC locates only a record with the key ABCABC. If no match is possible, BASIC signals the error "Record not found" (ERR=155).
     - If you specify a next or equal to record key match (NXEQ), a successful FIND locates the next record that equals the key length specified in *int-exp* or *str-exp*. If no exact match exists, BASIC locates the next record in the key sort order. If the keys are in ascending order, the next record will have a greater key value. If the keys are in descending order, the next record will have a lesser key value.
     - If you specify a greater than or equal to key match (GE), the behavior is identical to that of next or equal to (NXEQ). (Likewise, the behavior of GT is identical to NX.) However, the use of GE in a descending key file may be confusing, because GE will retrieve the next record in the key sort order, but the next record will have a lesser key value. For this reason, it is recommended that you use NXEQ in new program development, especially if you are using descending key files.

- If you specify a next key match (NX), a successful FIND locates the first record that follows the relational operator in the sort order. If no such record exists, BASIC signals the error "Record not found" (ERR=155).

5. Key-exp
   - *Int-exp2* specifies an integer value to be compared with the key value of a record.
   - *Str-exp* specifies a string value to be compared with the key value of a record. *Str-exp* can contain fewer characters than the key of the record you want to locate, but cannot be a null string.

     *Str-exp* cannot contain more characters than the key of the record you want to locate. If *str-exp* does contain more characters than the key, BASIC signals "Key size too large" (ERR = 145).
   - *Decimal-exp* in the *key-clause* specifies a packed decimal value to be compared with the key value of a record.
   - *Quadword-exp* in the *key-clause* specifies a record or group exactly 8 bytes long to be compared with the key value of a record.
6. The file on the specified channel must have been opened with ACCESS MODIFY, ACCESS READ, or SCRATCH before your program can execute a FIND operation.
7. FIND does not transfer any data to the record buffer. To access the contents of a record, use the GET statement.
8. A successful sequential FIND operation updates both the current record pointers and next record pointers.
   - For sequential files, a successful FIND operation locates the next sequential record (the record pointed to by the next record pointer) in the file, changes the current record pointer to the record just found, and the next record pointer to the next sequential record. If the current record pointer points to the last record in a file, a sequential FIND operation causes BASIC to signal "Record not found" (ERR=155).
   - For relative files, a successful FIND operation locates the record that exists with the next higher record number (or cell number), makes it the current record, and changes the next record pointer to the current record pointer plus 1.

- For indexed files, a successful FIND operation locates the next existing logical record in the current key of reference, makes this the current record, and changes the next record pointer to the current record pointer plus 1.

9. A successful random access FIND operation by RFA or by record changes the current record pointer to the record specified by *rfa-exp* or *int-exp*, but leaves the next record pointer unchanged.
10. A successful random access FIND operation by key changes the current record pointer to the first record whose key satisfies the *key-clause* comparison and leaves the next record pointer unchanged.
11. When a random access FIND operation by RFA, record, or key is not successful, BASIC signals "Record not found" (ERR=155). The values of the current record pointer and next record pointer are undefined.
12. You should not use a FIND statement on a terminal-format or virtual array file.

## Example

```
DECLARE LONG rec-num
MAP (cusrec) WORD cus_num                                    &
    STRING cus_nam=20, cus_add=20, cus_city=10,  cus_zip=9
OPEN "CUS_ACCT.DAT" FOR INPUT AS #1,                         &
      RELATIVE FIXED,                                        &
      ACCESS MODIFY                                          &
      MAP cusrec
INPUT "Which record number would you like to delete";rec_num
FIND #1, RECORD rec_num, WAIT
DELETE #1
CLOSE #1
END
```

# FIX

The FIX function truncates a floating-point value at the decimal point and returns the integer portion represented as a floating-point value.

## Format

*real-var* = FIX (*real-exp*)

## Syntax Rules

None

## Remarks

1. The FIX function returns the integer portion of a floating-point value, not an integer value.
2. BASIC expects the argument of the FIX function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.
3. If *real-exp* is negative, FIX returns the negative integer portion. For example, FIX(-5.2) returns -5.

## Example

```
DECLARE SINGLE result
result = FIX(-3.333)
PRINT FIX(24.566), result
```

**Output**

```
 24          -3
```

# FNEND

The FNEND statement is a synonym for the END DEF statement. See the END statement for more information.

## Format

FNEND [ *exp* ]

# FNEXIT

The FNEXIT statement is a synonym for the EXIT DEF statement. See the EXIT statement for more information.

## Format

FNEXIT [ *exp* ]

# FOR

The FOR statement repeatedly executes a block of statements, while incrementing a specified control variable for each execution of the statement block. FOR loops can be conditional or unconditional, and can modify other statements.

## Format

### Unconditional

FOR *num-unsubs-var* = *num-exp1* TO *num-exp2* [ STEP *num-exp3* ]
[ statement ]...

NEXT *num-unsubs-var*

### Conditional

FOR *num-unsubs-var = num-exp1* [ STEP *num-exp3* ] { UNTIL / WHILE } cond-exp
[ statement ]...

NEXT *num-unsubs-var*

### Unconditional Statement Modifier

*statement* FOR *num-unsubs-var = num-exp1* TO *num-exp2* [ STEP *num-exp3*]

### Conditional Statement Modifier

*statement* FOR *num-unsubs-var = num-exp1* [ STEP *num-exp3* ] { UNTIL / WHILE } cond-exp

## Syntax Rules

1. *Num-unsubs-var* must be a numeric, unsubscripted variable. *Num-unsubs-var* cannot be a record field.
2. *Num-unsubs-var* is the loop variable. It is incremented each time the loop executes.
3. In unconditional FOR loops, *num-exp1* is the initial value of the loop variable; *num-exp2* is the maximum value.
4. In conditional FOR loops, *num-exp1* is the initial value of the loop variable, while the *cond-exp* in the WHILE or UNTIL clause is the condition that controls loop iteration.

5. *Num-exp3* in the STEP clause is the value by which the loop variable is incremented after each execution of the loop.

## Remarks

1. There is a limit to the number of inner loops you can contain within a single outer loop. This number varies according to the complexity of the loops. If you exceed the limit, BASIC signals an error message.
2. An inner loop must be entirely within an outer loop; the loops cannot overlap.
3. You cannot use the same loop variable in nested FOR loops. For example, if the outer loop uses FOR *I* = 1 TO 10, you cannot use the variable *I* as a loop variable in an inner loop.
4. The default for *num-exp3* is 1 if there is no STEP clause.
5. You can transfer control into a FOR loop only by returning from a function invocation, a subprogram call, a subroutine call, or an error handler that was invoked in the loop.
6. The starting, incrementing, and ending values of the loop do not change during loop execution.
7. The loop variable can be modified inside the FOR loop.
8. BASIC converts *num-exp1*, *num-exp2*, and *num-exp3* to the data type of the loop variable before storing them.
9. When an unconditional FOR loop ends, the loop variable contains the value last used in the loop, not the value that caused loop termination.
10. During each iteration of a conditional loop, BASIC tests the value of *cond-exp* before it executes the loop.
    - If you specify a WHILE clause and *cond-exp* is false (value zero), BASIC exits from the loop. If the *cond-exp* is true (value nonzero), the loop executes again.
    - If you specify an UNTIL clause and *cond-exp* is true (value nonzero), BASIC exits from the loop. If the *exp* is false (value zero), the loop executes again.
11. When FOR is used as a statement modifier, BASIC executes the statement until the loop variable equals or exceeds *num-exp2* or until the WHILE or UNLESS condition is satisfied.

12. Each FOR statement must have a corresponding NEXT statement or BASIC signals an error. (This is not the case if the FOR statement is used as a statement modifier.)

## Examples

### Example 1

```
!Unconditional
DECLARE LONG course_num, STRING course_nam
FOR I = 3 TO 12 STEP 3
INPUT "Course number";course_num
INPUT "Course name";course_nam
NEXT I
```

**Output**

```
Course number? 221
Course name? Botany
Course number? 231
Course name? Organic Chemistry
Course number? 237
Course name? Life Science II
Course number? 244
Course name? Programming in BASIC
```

### Example 2

```
!Unconditional Statement Modifier
DECLARE INTEGER counter
PRINT "This is an unconditional statement modifier" FOR counter = 1 TO 3
END
```

**Output**

```
This is an unconditional statement modifier
This is an unconditional statement modifier
This is an unconditional statement modifier
```

### Example 3

```
!Conditional Statement Modifier
DECLARE INTEGER counter, &
        STRING my_name
INPUT "Try and guess my name";my_name FOR counter = 1 UNTIL my_name = "BASIC"
PRINT "You guessed it!"
```

**Output**

```
Try and guess my name? VAX PASCAL
Try and guess my name? VAX SCAN
Try and guess my name? BASIC
You guessed it!
```

# FORMAT$

The FORMAT$ function converts an expression to a formatted string.

## Format

*str-var* = FORMAT$ (*exp*, *str-exp*)

## Syntax Rules

The rules for building a format string are the same as those for printing numbers with the PRINT USING statement. See the description of the PRINT USING statement for more information.

## Remarks

It is recommended that you use compile-time constant expressions for string expressions whenever possible. When you do this, the BASIC compiler compiles the string at compilation time rather than at run time, thus improving the performance of your code.

## Example

```
DECLARE STRING result,         &
        INTEGER num_exp
num_exp = 12345
result = FORMAT$(num_exp,"##,###")
PRINT result
```

**Output**

```
12,345
```

# FREE

The FREE statement unlocks all records and buckets associated with a specified channel.

## Format

FREE #*chnl-exp*

## Syntax Rules

*Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).

## Remarks

1. The file specified by *chnl-exp* must be open.
2. You cannot use the FREE statement with files not on disk.
3. If there are no locked records or buckets on the specified channel, the FREE statement has no effect and BASIC does not signal an error.
4. The FREE statement does not change record buffers or pointers.
5. After a FREE statement has executed, your program must execute a GET or FIND statement before a PUT, UPDATE, or DELETE statement can execute successfully.

## Example

```
OPEN "CUST_ACCT.DAT" FOR INPUT AS #3
   .
   .
   .
INPUT "Enter customer record number to retrieve";cust_rec_num
FREE #3
GET #3
```

In this example, CUST_ACCT.DAT is opened for input. The FREE statement unlocks all records associated with the specified channel contained in the file. Once the FREE statement successfully executes, the user can then obtain a record with either a FIND or GET statement.

# FSP$

The FSP$ function returns a string describing an open file on a specified channel.

## Format

*str-var* = FSP$ (*chnl-exp*)

## Syntax Rules

1. A file must be open on *chnl-exp*.
2. The FSP$ function must come immediately after the OPEN statement for the file.

## Remarks

1. Use the FSP$ function with files opened as ORGANIZATION UNDEFINED. Then use multiple MAP statements to interpret the returned data.
2. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* and the *OpenVMS Record Management Services Reference Manual* for more information about FSP$ values.

**Note**

BASIC supports the FSP$ function for compatibility with BASIC-PLUS-2. It is recommended that you use the USEROPEN routine to identify file characteristics.

## Example

```
10 MAP (A) STRING A = 32
   MAP (A) BYTE org, rat, WORD mrs, LONG alq,  &
           WORD bks_bls, num_keys,LONG mrn
   OPEN "STUDENT.DAT" FOR INPUT AS #1%,        &
         ORGANIZATION UNDEFINED,               &
         RECORDTYPE ANY, ACCESS READ
   A = FSP$(1%)
   PRINT "RMS organization = ";org
   PRINT "RMS record attributes = ";rat
   PRINT "RMS maximum record size = ";mrs
   PRINT "RMS allocation quantity = ";alq
   PRINT "RMS bucket size = ";bks_bls
   PRINT "Number of keys = ";num_keys
   PRINT "RMS maximum record number = ";mrn
```

**Output**

```
RMS organization = 2
RMS record attributes = 2
RMS maximum record size = 5
RMS allocation quantity = 1
RMS bucket size = 0
Number of keys = 0
RMS maximum record number = 0
```

# FUNCTION

The FUNCTION statement marks the beginning of a FUNCTION subprogram and defines the subprogram's parameters.

## Format

```
FUNCTION  data-type func-name [ pass-mech ] [([ formal-param ],...) ]
          [ statement ]...

{ END FUNCTION [ exp ] }
{ FUNCTIONEND [ exp ]  }

pass-mech:      { BY REF   }
                { BY DESC  }
                { BY VALUE }

formal param:   [ data-type ] { unsubs-var                                  }
                              { array-name ( [ int-const ] ,... )           }
                              {            [ ,           ]  ...             }
                [ = int-const ][ pass-mech ]
```

## Syntax Rules

1. Note that both Alpha BASIC and VAX BASIC are able to pass actual parameters by value, but only Alpha BASIC allows formal parameters to be passed in by value. This means that while Alpha BASIC can use BY VALUE in a definition and a call, VAX BASIC can use BY VALUE only in a call. It cannot define a function that takes parameters BY VALUE.
2. *Func-name* names the FUNCTION subprogram.
3. *Func-name* can be from 1 through 31 characters. The first character must be an alphabetic character (A to Z). The remaining characters, if present, can be any combination of letters, digits (0 to 9), dollar signs ($), periods (.), or underscores (_).
4. *Data-type* can be any BASIC data type keyword or a data type defined in the RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.

5. The data type that precedes the *func-name* specifies the data type of the value returned by the function.
6. *Formal-param* specifies the number and type of parameters for the arguments the function expects to receive when invoked.
   - Empty parentheses indicate that the function has no parameters.
   - *Data-type* specifies the data type of a parameter. If you do not specify a data type, parameters are of the default data type and size. When you do specify a data type, all following parameters are of that data type until you specify a new data type.

     If the data type is STRING and the passing mechanism is by reference (BY REF), the =*int-const* clause allows you to specify the length of the string.
   - Parameters defined in *formal-param* must agree in number and type with the arguments specified in the function invocation. BASIC allows you to specify from 1 to 255 formal parameters.
7. *Pass-mech* specifies the parameter-passing mechanism by which the FUNCTION subprogram receives arguments when invoked. A *pass-mech* clause should be specified only when the FUNCTION subprogram is being called by a non BASIC program or when the FUNCTION receives a string or array by reference.
8. A *pass-mech* clause outside the parentheses applies by default to all function parameters. A *pass-mech* clause in the *formal-param* list overrides the specified default and applies only to the immediately preceding parameter.
9. *Exp* specifies the function result, which supersedes any function assignment. *Exp* must be compatible with the function's data type.

## Remarks

1. The FUNCTION statement must be the first statement in the FUNCTION subprogram.
2. Every FUNCTION statement must have a corresponding END FUNCTION or FUNCTIONEND statement.
3. Any BASIC statement except END, PICTURE, END PICTURE, PROGRAM, END PROGRAM, SUB, SUBEND, END SUB, or SUBEXIT can appear in a FUNCTION subprogram.

4. FUNCTION subprograms must be declared with the EXTERNAL statement before your BASIC program can invoke them.
5. FUNCTION subprograms receive parameters by reference, by descriptor, or by value.
   - BY REF specifies that the function receives the argument's address.
   - BY DESC specifies that the function receives the address of a BASIC descriptor. For information about the format of a BASIC descriptor for strings and arrays, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*; for information about other types of descriptors, see the *OpenVMS Calling Standard*.
   - BY VALUE specifies that the function receives a copy of the argument value.

     Alpha BASIC can use BY VALUE in both definitions and calls. VAX BASIC can use BY VALUE only in calls; it cannot define a function that takes parameters BY VALUE.
6. By default, FUNCTION subprograms receive numeric unsubscripted variables by reference, and all other parameters by descriptor. You can override these defaults with a BY clause:
   - If you specify a string length with the *=int-const* clause, you must also specify BY REF. If you specify BY REF and do not specify a string length, BASIC uses the default string length of 16.
   - If you specify array bounds, you must also specify BY REF.
7. All variables and data, except virtual arrays, COMMON areas, MAP areas, and EXTERNAL variables, in a FUNCTION subprogram, are local to the subprogram.
8. BASIC initializes local numeric variables to zero and local string variables to the null string each time the FUNCTION subprogram is invoked.
9. If an exception is not handled within the FUNCTION subprogram, control is transferred back to the main program that invoked the function.

## Example

```
FUNCTION REAL sphere_volume (REAL R)
IF R < 0 THEN EXIT FUNCTION
sphere_volume = 4/3 * PI *R **3
END FUNCTION
```

# FUNCTIONEND

The FUNCTIONEND statement is a synonym for the END FUNCTION statement. See the END statement for more information.

## Format

FUNCTIONEND [ *exp* ]

# FUNCTIONEXIT

The FUNCTIONEXIT statement is a synonym for the EXIT FUNCTION statement. See the EXIT statement for more information.

## Format

FUNCTIONEXIT [ *exp* ]

# GET

The GET statement copies a record from a file to a record buffer and makes the data available for processing. GET statements are valid on sequential, relative, and indexed files.

## Format

GET #*chnl-exp* [ , *position-clause* ] [ , *lock-clause* ]

position-clause: { RFA rfa-exp | RECORD num-exp | KEY# key-clause }

lock-clause: { ALLOW allow-clause [ , WAIT[ int-exp ] ] | WAIT [ int-exp ] | REGARDLESS }

allow-clause: { NONE | READ | MODIFY }

key-clause: int-exp1 rel-op key-exp

rel-op: { EQ | GE | NXEQ | GT | NX }

key-exp { int-exp2 | str-exp | decimal-exp | quadword-exp }

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. If you specify a *lock-clause*, it must follow the *position-clause*. If the *lock-clause* precedes the *position-clause*, BASIC signals an error.
3. If you specify the REGARDLESS *lock-clause*, you cannot specify another *lock-clause* in the same GET statement.

## Remarks

1. Position-clause
   - *Position-clause* specifies the position of a record in a file. BASIC signals an error if you specify a *position-clause* and *chnl-exp* is not associated with a disk file. If you do not specify a *position-clause*, GET retrieves records sequentially. Sequential record access is valid on all files.
   - The RFA *position-clause* allows you to randomly retrieve records by specifying the record file address (RFA); you specify the disk address of a record, and RMS retrieves the record at that address. All file organizations can be accessed by RFA.

     *Rfa-exp* in the RFA *position-clause* is an expression of the RFA data type that specifies the record's file address. An RFA expression must be a variable of the RFA data type or the GETRFA function. Use the GETRFA function to obtain the RFA of a record.
   - The RECORD *position-clause* allows you to randomly retrieve records in relative and sequential fixed files by specifying the record number.
     - *Num-exp* in the RECORD *position-clause* specifies the number of the record you want to retrieve. It must be between 1 and the number of the record with the highest number in the file.
     - When you specify a RECORD clause, *chnl-exp* must be a channel associated with an open relative or sequential fixed file.
   - The KEY *position-clause* allows you to randomly retrieve records in indexed files by specifying a key of reference, a relational test, or a key value.

- An RFA value is valid only for the life of a specific version of a file. If a new version of a file is created, the RFA values may change.
- Attempting to access a record with an invalid RFA value results in a run-time error.

2. Lock-clause

- *Lock-clause* allows you to control how a record is locked to other access streams, to override lock checking when accessing shared files that may contain locked records, or to specify what action to take in the case of a locked record.
- The type of lock you impose on a record remains in effect until you explicitly unlock it with a FREE or UNLOCK statement, until you close the file, or until you perform a GET, FIND, UPDATE or DELETE on the same channel (unless you specified UNLOCK EXPLICIT).
- The REGARDLESS *lock-clause* specifies that the GET statement can override lock checking and read a record locked by another program.
- When you specify a REGARDLESS *lock-clause*, BASIC does not impose a lock on the retrieved record.
- If you specify an ALLOW *lock-clause*, the file associated with *chnl-exp* must have been opened with the UNLOCK EXPLICIT clause or BASIC signals the error "Illegal record locking clause."
- The ALLOW *allow-clause* can be one of the following:
  - ALLOW NONE denies access to the record. This means that other access streams cannot retrieve the record unless they bypass lock checking with the REGARDLESS clause.
  - ALLOW READ provides read access to the record. This means that other access streams can retrieve the record, but cannot DELETE or UPDATE the record.
  - ALLOW MODIFY provides both read and write access to the record. This means that other access streams can GET, FIND, DELETE, or UPDATE the record.
- If you do not open a file with ACCESS READ or specify an ALLOW *lock-clause*, locking is imposed as follows:
  - If the file associated with *chnl-exp* was opened with UNLOCK EXPLICIT, BASIC imposes the ALLOW NONE lock on the retrieved record and the next GET or FIND statement does not unlock the previously locked record.

- If the file associated with *chnl-exp* was not opened with UNLOCK EXPLICIT, BASIC locks the retrieved record and unlocks the previously locked record.

- The WAIT *lock-clause* accepts an optional *int-exp*. *Int-exp* represents a timeout value in seconds. *Int-exp* must be from 0 to 255 or BASIC issues a warning message.
  - WAIT followed by a timeout value causes RMS to wait for a locked record for a given period of time.
  - WAIT followed by no timeout value indicates that RMS should wait indefinitely for the record to become available.
  - If you specify a timeout value and the record does not become available within that period, BASIC signals the run-time error "Keyboard wait exhausted" (ERR=15). VMSSTATUS and RMSSTATUS then return RMS$_TMO. For more information about these functions, see the RMSSTATUS and VMSSTATUS functions in this chapter and the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.
  - If you attempt to wait for a record that another user has locked, and consequently that user attempts to wait for the record you have locked, a deadlock condition occurs. When a deadlock condition persists for a period of time (as defined by the SYSGEN parameter DEADLOCK_WAIT), RMS signals the error "RMS$_DEADLOCK" and BASIC signals the error "Detected deadlock error while waiting for GET or FIND" (ERR=193).
  - If you specify a WAIT clause followed by a timeout value that is less than the SYSGEN parameter DEADLOCK_WAIT, then BASIC signals the error "Keyboard wait exhausted" (ERR=15) even though a deadlock condition may exist.
  - If you specify a WAIT clause on a GET operation to a unit device, the timeout value indicates how long to wait for the input to complete. This is equivalent to the WAIT statement.

3. Key-clause

   - In a *key-clause*, *int-exp1* is the target key of reference. It must be an integer value in the range of zero to the highest-numbered key for the file. The primary key is #0, the first alternate key is #1, the second alternate key is #2, and so on. *Int-exp1* must be preceded by a number sign (#) or BASIC signals an error.

- When you specify a *key-clause*, *chnl-exp* must be a channel associated with an open indexed file.

4. Rel-op
   - *Rel-op* specifies how *key-exp* is to be compared with *int-exp1* in the *key-clause*.
     - EQ means "equal to"
     - NXEQ means "next or equal to"
     - GE means "greater than or equal to" (a synonym for NXEQ)
     - NX means "next"
     - GT means "greater than" (a synonym for NX)
   - With an exact key match (EQ), a successful GET operation retrieves the first record in the file that equals the key value specified in *key-exp*. If the key expression is a *str-exp* whose length is less than the key length, characters specified by the *str-exp* are matched approximately rather than exactly. That is, if you specify a string expression ABC and the key length is six characters, BASIC matches the first record that begins with ABC. If you specify ABCABC, BASIC matches only a record with the key ABCABC. If no match is possible, BASIC signals the error "Record not found" (ERR=155).
   - If you specify a next or equal to key match (NXEQ), a successful GET operation retrieves the first record that equals the key value specified in *key-exp*. If no exact match exists, BASIC retrieves the next record in the key sort order. If the keys are in ascending order, the next record will have a greater key value. If the keys are in descending order, the next record will have a lesser key value.
   - If you specify a greater than key match (GT), a successful GET operation retrieves the first record with a value greater than *key-exp*. If no such record exists, BASIC signals the error "Record not found" (ERR=155).
   - If you specify a next key match (NX), a successful GET operation retrieves the first record that follows the key expression in the key sort order. If no such record exists, BASIC signals the error "Record not found" (ERR=155).

- If you specify a greater than or equal to key match (GE), the behavior is identical to that of next or equal to (NXEQ). Likewise, the behavior of GT is identical to NX. However, the use of GE in a descending key file may be confusing because GE will retrieve the next record in the key sort order, but the next record will have a lesser key value. For this reason, it is recommended that you use NXEQ in new program development, especially if you are using descending key files.

5. Key-exp

   - *Int-exp2* in the *key-clause* specifies an integer value to be compared with the key value of a record.
   - *Str-exp* in the *key-clause* specifies a string value to be compared with the key value of a record. The string expression can contain fewer characters than the key of the record you want to retrieve but it cannot be a null string.

     *Str-exp* cannot contain more characters than the key of the record you want to locate. If *str-exp* does contain more characters than the key, BASIC signals "Key size too large" (ERR = 145).
   - *Decimal-exp* in the *key-clause* specifies a packed decimal value to be compared with the key value of a record.
   - *Quadword-exp* in the *key-clause* specifies a record or group exactly 8 bytes long to be compared with the key value of a record.

6. The file specified by *chnl-exp* must be opened with ACCESS READ or ACCESS MODIFY or SCRATCH before your program can execute a GET statement. The default ACCESS clause is MODIFY.
7. If the last I/O operation was a successful FIND operation, a sequential GET operation retrieves the current record located by the FIND operation and sets the next record pointer to the record logically succeeding the pointer.
8. If the last I/O operation was not a FIND operation, a sequential GET operation retrieves the next record and sets the record logically succeeding the record pointer to the current record.

   - For sequential files, a sequential GET operation retrieves the next record in the file.
   - For relative files, a sequential GET operation retrieves the record with the next higher cell number.
   - For indexed files, a sequential GET operation retrieves the next record in the current key of reference.

9. A successful random GET operation by RFA or by record retrieves the record specified by *rfa-exp* or *int-exp*.
10. A successful random GET operation by key retrieves the first record whose key satisfies the *key-clause* comparison.
11. A successful random GET operation by RFA, record, or key sets the value of the current record pointer to the record just read. The next record pointer is set to the next logical record.
12. An unsuccessful GET operation leaves the record pointers and the record buffer in an undefined state.
13. If the retrieved record is smaller than the receiving buffer, BASIC fills the remaining buffer space with nulls.
14. If the retrieved record is larger than the receiving buffer, BASIC truncates the record and signals an error.
15. A successful GET operation sets the value of the RECOUNT variable to the number of bytes transferred from the file to the record buffer.
16. You should not use a GET statement on a terminal-format or virtual array file.

## Example

```
DECLARE LONG rec-num
MAP (CUSREC) WORD cus_num                                              &
       STRING cus_nam = 20, cus_add = 20, cus_city = 10, cus_zip = 9
OPEN "CUS_ACCT.DAT" FOR INPUT AS  #1                                   &
     RELATIVE FIXED, ACCESS MODIFY,                                    &
     MAP CUSREC
INPUT "Which record number would you like to view";rec_num
GET #1, RECORD REC_NUM, REGARDLESS
PRINT "The customer's number is ";CUS_NUM
PRINT "The customer's name is ";cus_nam
PRINT "The customer's address is ";cus_add
PRINT "The customer's city is ";cus_city
PRINT "The customer's zip code is ";cus_zip
CLOSE #1
END
```

# GETRFA

The GETRFA function returns the record's file address (RFA) of the last record accessed in an RMS file open on a specified channel.

## Format

*rfa-var* = GETRFA (*chnl-exp*)

## Syntax Rules

1. *Rfa-var* is a variable of the RFA data type.
2. *Chnl-exp* is the channel number of an open RMS file. You cannot include a number sign in the channel expression.
3. You must access a record in the file with a GET, FIND, or PUT statement before using the GETRFA function, or BASIC signals "No current record" (ERR=131).

## Remarks

1. There must be a file open on the specified *chnl-exp* or BASIC signals an error.
2. You can use the GETRFA function with RMS sequential, relative, indexed, and block I/O files.
3. The RFA value returned by the GETRFA function can be used only for assignments to and comparisons with other variables of the RFA data type. Comparisons are limited to equal to (=) and not equal to (<>) relational operations.
4. RFA values cannot be printed or used for any arithmetic operations.
5. If you open a file without specifying a file organization (sequential, relative, virtual, or indexed), BASIC defaults to terminal-format. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information.

## Example

```
DECLARE RFA R_ARRAY(1 TO 100)
   .
   .
   .
FOR I% = 1% TO 100%
    PUT #1
    R_ARRAY(I%) = GETRFA(1)
NEXT I%
```

# GOSUB

The GOSUB statement transfers control to a specified line number or label and stores the location of the GOSUB statement for eventual return from the subroutine.

## Format

{ GO SUB | GOSUB } *target*

## Syntax Rules

1. *Target* must refer to an existing line number or label in the same program unit as the GOSUB statement or BASIC signals an error.
2. *Target* cannot be inside a block structure such as a FOR...NEXT, WHILE, or UNTIL loop or a multiline function definition unless the GOSUB statement is also within that block or function definition.

## Remarks

1. You can use the GOSUB statement from within protected regions of a WHEN block. GOSUB statements can also contain protected regions themselves.
2. If you fail to handle an exception that occurs while a statement contained in the body of a subroutine is executing, the exception is handled by the default error handler. The exception is not handled by any WHEN block surrounding the statement that invoked the subroutine.

## Example

```
GOSUB subroutine_1
   .
   .
   .
subroutine_1:
   .
   .
   .
RETURN
```

# GOTO

The GOTO statement transfers control to a specified line number or label.

## Format

{ GO TO | GOTO } *target*

## Syntax Rules

1. *Target* must refer to an existing line number or label in the same program unit as the GOTO statement or BASIC signals an error.
2. *Target* cannot be inside a block structure such as a FOR...NEXT, WHILE, or UNTIL loop or a multiline function definition unless the GOTO statement is also inside that loop or function definition.

## Remarks

1. You can specify the GOTO statement inside a WHEN block if the target is in the same protected region, an outer level protected region, or in a nonprotected region.
2. You cannot specify the GOTO statement inside a WHEN block if the target already resides in another protected region that does not contain the innermost current protected region.

## Example

```
IF answer = 0
    THEN GOTO done
END IF
   .
   .
   .
done:
     EXIT PROGRAM
```

# HANDLER

The handler statement marks the beginning of a detached handler.

## Format

HANDLER *handler-name*

## Syntax Rules

*Handler-name* must be a valid BASIC identifier and must not be the same as any label, DEF, DEF*, SUB, FUNCTION or PICTURE name.

## Remarks

1. A detached handler must be delimited by a HANDLER statement and an END HANDLER statement.
2. A detached handler can be used only with BASIC's exception-handling mechanism. If you attempt to branch into a detached handler, for example with the GOTO statement, BASIC signals a compile-time error.
3. To exit from a detached handler, you must use either END HANDLER, EXIT HANDLER, RETRY or CONTINUE. See these statements for more information.
4. Within a handler, VAX BASIC allows you to specify user-defined function references and procedure invocations as well as BASIC statements.
5. Within a handler, Alpha BASIC allows you to specify user-defined function references except for DEF* references, as well as procedure invocations and BASIC statements.
6. The following statements are illegal inside a handler:
   - EXIT PROGRAM, FUNCTION, SUB, or PICTURE
   - GOTO to a target outside the handler
   - GOSUB to a target outside the handler

- ON ERROR
- RESUME

## Example

```
WHEN ERROR USE err_handler
   .
   .
   .
END WHEN
HANDLER err_handler
   IF ERR = 50 THEN PRINT "Insufficient data"
       RETRY
       ELSE EXIT HANDLER
   END IF
END HANDLER
```

# IF

The IF statement evaluates a conditional expression and transfers program control depending on the resulting value.

## Format

### Conditional

IF *cond-exp* THEN *statement...* [ ELSE *statement...*] END IF

### Statement Modifier

*statement* IF *cond-exp*

## Syntax Rules

1. Conditional
   - *Cond-exp* can be any valid conditional expression.
   - All statements between the THEN keyword and the next ELSE, line number, or END IF are part of the THEN clause. All statements between the keyword ELSE and the next line number or END IF are part of the ELSE clause.
   - BASIC assumes a GOTO statement when the keyword ELSE is followed by a line number. When the target of a GOTO statement is a label, the keyword GOTO is required. The use of this syntax is not recommended for new program development.
   - The END IF statement terminates the most recent unterminated IF statement.
   - A new line number terminates all unterminated IF statements.
2. Statement Modifier
   - IF can modify any executable statement except a block statement such as FOR, WHILE, UNTIL, or SELECT.
   - *Cond-exp* can be any valid conditional expression.

## Remarks

1. Conditional
   - BASIC evaluates the conditional expression for truth or falsity. If true (nonzero), BASIC executes the THEN clause. If false (zero), BASIC skips the THEN clause and executes the ELSE clause, if present.
   - The keyword NEXT cannot be in a THEN or ELSE clause unless the FOR or WHILE statement associated with the keyword NEXT is also part of the THEN or ELSE clause.
   - If a THEN or ELSE clause contains a block statement such as a FOR, SELECT, UNTIL, or WHILE, then a corresponding block termination statement such as a NEXT or END, must appear in the same THEN or ELSE clause.
   - IF statements can be nested to 12 levels.
   - Any executable statement is valid in the THEN or ELSE clause, including another IF statement. You can include any number of statements in either clause.
   - Execution continues at the statement following the END IF or ELSE clause. If the statement does not contain an ELSE clause, execution continues at the next statement after the THEN clause.
2. Statement Modifier
   - BASIC executes the statement only if the conditional expression is true (nonzero).

## Example

```
IF Update_flag = True
THEN
      Weekly_salary = New_rate * 40.0
      UPDATE #1
      IF Dept <> New_dept
      THEN
            GET #1, KEY #1 EQ New_dept
            Dept_employees = Dept_employees + 1
            UPDATE #1
      END IF
      PRINT "Update complete"
ELSE
      PRINT "Skipping update for this employee"
END IF
```

# INKEY$

The INKEY$ function reads a single keystroke from a terminal opened on a specified channel and returns the typed character.

## Format

*string-var* = INKEY$ (*chnl-exp* [ ,WAIT [ *int-exp ]* ])

## Syntax Rules

1. *Chnl-exp* must be the channel number of a terminal.
2. *Int-exp* represents the timeout value in seconds and must be from 0 to 255. Values beyond this range cause BASIC to signal a compile-time or run-time error.

## Remarks

1. Before using the INKEY$ function, specify the DCL command SET TERMINAL/HOSTSYNC. This command controls whether the system can synchronize the flow of input from the terminal. If you specify SET TERMINAL/HOSTSYNC, the system generates a Ctrl/S or a Ctrl/Q to enable or disable the reception of input. This prevents the typeahead buffer from overflowing. If you do not use this command and the typeahead buffer overflows, BASIC signals the error "Data overflow" (ERR=289).
2. Before using the INKEY$ function on a VT200-series terminal, set your terminal to VT200 mode with 7 bit controls.
3. Before using the INKEY$ function, either your terminal or OpenVMS system, but not both, must enable screen wrapping. To enable terminal screen wrapping, use the Set-Up key on your terminal's keyboard to set the terminal to Auto Wrap. Then disable OpenVMS screen wrapping by entering the DCL SET TERMINAL /NOWRAP command. To enable OpenVMS screen wrapping, enter the DCL SET TERMINAL/WRAP command. Then disable terminal screen wrapping by using the Set-Up key to set the terminal to No Auto Wrap.

4. The INKEY$ function behaves as if the terminal were in APPLICATION_ KEYPAD mode. If your terminal is set to NUMERIC_KEYPAD mode, the results may be unpredictable.
5. If the channel is not open, BASIC signals the error "I/O, channel not open" (ERR=9). If a file or a device other than a terminal is open on the channel, BASIC signals the error "Illegal operation" (ERR=141).
6. The optional WAIT clause specifies a timeout interval during which the command will await terminal input. If you specify WAIT *int-exp*, the timeout period will be the specified number of seconds. If you specify a WAIT clause followed by no timeout value, BASIC waits indefinitely for terminal input.
7. BASIC always examines the typeahead buffer first and retrieves the next keystroke in the buffer if the buffer is not empty. If the typeahead buffer is empty and an optional WAIT clause was specified, BASIC waits for a keystroke to be typed for the specified timeout interval (indefinitely if WAIT was specified with no timeout interval). If the typeahead buffer is empty, and the waiting period is either not specified or expired, BASIC returns the error message "Keyboard wait exhausted" (ERR=15).
8. The escape character (ASCII code 27) is not valid as INKEY$ input. If you enter an escape character, normal program execution resumes when the INKEY$ times out. Without a specified timeout value, the program execution cannot resume without error.
9. BASIC returns the error message "Keyboard wait exhausted" (ERR=15) when any key is pressed after the escape character if no timeout is specified or if the specified timeout has not yet occurred.
10. INKEY$ turns off all line editing. As a result, control of all line-editing characters and the arrow keys is passed back to the user.
11. Nonediting characters normally intercepted by the OpenVMS terminal driver are not returned. These include the Ctrl/C, Ctrl/Y, Ctrl/S, and Ctrl/O characters (unless Ctrl/C trapping is enabled). They are handled by the device driver just as in normal input.
12. All ASCII characters are returned in a 1-byte string.
13. All keystrokes that result in an escape sequence are translated to mnemonic strings based on the following key names:
    - PF1–PF4
    - E1–E6
    - F7–F20

- LEFT
- RIGHT
- UP
- DOWN
- KP0 to KP9
- KP–
- KP,
- KP.
- ENTER

## Example

```
    PROGRAM Inkey_demo

    DECLARE STRING KEYSTROKE
Inkey_Loop:
    WHILE 1%
      KEYSTROKE = INKEY$(0%,WAIT)

      SELECT KEYSTROKE
          CASE '26'C
               PRINT "Ctrl/Z to exit"
               EXIT Inkey_Loop
          CASE CR,LF,VT,FF
               PRINT "Line terminator"
          CASE "PF1" TO "PF4"
               PRINT "P function key"
          CASE "E1" TO "E6", "F7" TO "F9", "F10" TO "F20"
               PRINT "VT200 function key"
          CASE "KP0" TO "KP9"
               PRINT "Application keypad key"
          CASE < SP
               PRINT "Control character"
          CASE '127'C
               PRINT "<DEL>"
          CASE ELSE
               PRINT 'Character is "'; KEYSTROKE; '"'
       END SELECT
    NEXT

    END PROGRAM
```

# INPUT

The INPUT statement assigns values from your terminal or from a terminal-format file to program variables.

## Format

INPUT [ #*chnl-exp*, ] [ *str-const1* { , ; } ] var1 [ { , ; } [ str-const2 { , ; } ] var2 ]...

## Syntax Rules

1. You must supply an argument to the INPUT statement. Otherwise, BASIC signals an error message.
2. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
3. You can include more than one string constant in an INPUT statement. *Str-const1* is issued for *var1*, *str-const2* for *var2*, and so on.
4. *Var1* and *var2* cannot be a DEF function name unless the INPUT statement is inside the multiline DEF that defines the function.
5. The separator (comma or semicolon) that directly follows *var1* and *var2* has no formatting effect. BASIC always advances to a new line when you terminate input by pressing Return.
6. The separator that directly follows *str-const1* and *str-const2* determines where the question mark prompt (if requested) is displayed and where the cursor is positioned for input.

   A comma causes BASIC to skip to the next print zone and display the question mark unless a SET NO PROMPT statement has been executed, as follows.

```
DECLARE STRING your_name
INPUT "What is your name",your_name
```

**Output**

```
What is your name          ?
```

A semicolon causes BASIC to display the question mark next to *str-const* unless a SET NO PROMPT statement has been executed. For example:

```
DECLARE STRING your_name
INPUT "What is your name";your_name
```

**Output**

```
What is your name?
```

7. BASIC always advances to a new line when you terminate input with a carriage return.

## Remarks

1. If you do not specify a channel, the default *chnl-exp* is #0 (the controlling terminal). If a *chnl-exp* is specified, a file must be open on that channel with ACCESS READ or MODIFY before the INPUT statement can execute.
2. If input comes from a terminal, BASIC displays the contents of *str-const1*, if present. If the terminal is open on channel #0, BASIC also displays a question mark (?).
3. You can disable the question mark prompt by using the SET NO PROMPT statement. See the SET PROMPT statement for more information.
4. When BASIC receives a line terminator or a complete record, it checks each data element for correct data type and range limits, then assigns the values to the corresponding variables.
5. If you specify a string variable to receive the input text, and the user enters an unquoted string in response to the prompt, BASIC ignores the string's leading and trailing spaces and tabs. An unquoted string cannot contain any commas.
6. If there is not enough data in the current record or line to satisfy the variable list, BASIC takes one of the following actions:
   - If the input device is a terminal and you have not specified SET NO PROMPT, BASIC repeats the question mark, but not the *str-const*, on a new line until sufficient data is entered.
   - If the input device is not a terminal, BASIC signals "Not enough data in record" (ERR=59).
7. If there are more data items than variables in the INPUT response, BASIC ignores the excess.

8. If there is an error while data is being converted or assigned (for example, string data being assigned to a numeric variable), BASIC takes one of the following actions:
   - If there is no error handler in effect and the input device is a terminal, BASIC signals a warning, reexecutes the INPUT statement, and displays *str-const* and the input prompt.
   - If there is an error handler in effect and the input device is not a terminal, BASIC signals "Illegal number" (ERR=52) or "Data format error" (ERR=50).
9. When a RETRY, CONTINUE, or RESUME statement transfers control to an INPUT statement, the INPUT statement retrieves a new record or line regardless of any data left in the previous record or line.
10. After a successful INPUT statement, the RECOUNT variable contains the number of characters transferred from the file or terminal to the record buffer.
11. If you terminate input text with Ctrl/Z, BASIC assigns the value to the variable and signals "End of file on device" (ERR=11) when the next terminal input statement executes. If you are in the VAX BASIC Environment and there is no subsequent INPUT, INPUT LINE, or LINPUT statement in the program, the Ctrl/Z is passed to BASIC as a signal to exit the VAX BASIC Environment. BASIC signals "Unsaved changes have been made, Ctrl/Z or EXIT to exit" if you have made changes to your program or are running a program that has never been saved. If you have not made changes, BASIC exits from the VAX BASIC Environment and does not signal an error.

## Example

```
DECLARE STRING var_1,   &
        INTEGER var_2
INPUT "The first variable";var_1, "The second variable";var_2
```

**Output**

```
The first variable? name
The second variable? 4
```

# INPUT LINE

The INPUT LINE statement assigns a string value (including the line terminator in some cases) from a terminal or terminal-format file to a string variable.

## Format

INPUT LINE [ #*chnl-exp*, ] [ *str-const1* { , ; } ] *str-var1*

[ statement ]...[ { , ; } [ *str-const2* { , ; } ] *str-var2* ]...

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. *Str-var1* or *str-var2* cannot be a DEF function name unless the INPUT LINE statement is inside the multiline DEF that defines the function.
3. You can include more than 1 string constant in an INPUT LINE statement. *Str-const1* is issued for *str-var1*, *str-const2* for *str-var2*, and so on.
4. The separator (comma or semicolon) that directly follows *str-var1* and *str-var2* has no formatting effect. BASIC always advances to a new line when you terminate input with a carriage return.
5. The separator that directly follows *str-const1* and *str-const2* determines where the question mark (if requested) is displayed and where the cursor is positioned for input. Specifically:
   - A comma causes BASIC to skip to the next print zone and display the question mark unless a SET NO PROMPT statement has been executed. For example:

     ```
     DECLARE STRING your_name
     INPUT LINE "Name",your_name
     ```

     **Output**

     ```
     Name            ?
     ```

- A semicolon causes BASIC to display the question mark next to *str-const* unless a SET NO PROMPT statement has been executed. For example:

```
DECLARE STRING your_name
INPUT LINE "Name";your_name
```

**Output**

```
Name?
```

6. BASIC always advances to a new line when you terminate input with a carriage return.

## Remarks

1. The default *chnl-exp* is #0 (the controlling terminal). If a channel is specified, a file must be open on that channel with ACCESS READ before the INPUT LINE statement can execute.
2. BASIC signals an error if the INPUT LINE statement has no argument.
3. If input comes from a terminal, BASIC displays the contents of *str-const1*, if present. If the terminal is open on channel #0, BASIC also displays a question mark (?).
4. You can disable the question mark prompt by using the SET NO PROMPT statement. See the SET PROMPT statement for more information.
5. The INPUT LINE statement assigns all input characters to string variables. In addition, the INPUT LINE statement places the following line terminator characters in the assigned string if they are part of the string value:

| Hex code | ASCII char | Character name |
|---|---|---|
| 0A | LF | Line Feed |
| 0B | VT | Vertical Tab |
| 0C | FF | Form Feed |
| 0D | CR | Carriage Return |
| 0D0A | CRLF | Carriage Return/Line Feed |
| 1B | ESC | Escape |

Any other line terminator, such as Ctrl/D and Ctrl/F when line editing is turned off, is not included in the assigned string.

6. When a RETRY, CONTINUE, or RESUME statement transfers control to an INPUT LINE statement, the INPUT LINE statement retrieves a new record or line regardless of any data left in the previous record or line.
7. After a successful INPUT LINE statement, the RECOUNT variable contains the number of characters transferred from the file or terminal to the record buffer.
8. If you terminate input text with Ctrl/Z, BASIC assigns the value to the variable and signals "End of file on device" (ERR=11) when the next terminal input statement executes. If you are in the VAX BASIC Environment and there is no next INPUT, INPUT LINE, or LINPUT statement in the program, the Ctrl/Z is passed to BASIC as a signal to exit the VAX BASIC Environment. BASIC signals "Unsaved changes have been made, Ctrl/Z or EXIT to exit" if you have made changes to your program. If you have not made changes, BASIC exits from the VAX BASIC Environment and does not signal an error.

## Example

```
DECLARE STRING Z,N,record_string
INPUT LINE "Type two words", Z$,'Type your name';N$
INPUT LINE #4%, record_string$
```

# INSTR

The INSTR function searches for a substring within a string. It returns the position of the substring's starting character.

## Format

*int-var* = INSTR (*int-exp* , *str-exp1*, *str-exp2*)

## Syntax Rules

1. *Int-exp* specifies the character position in the main string at which BASIC starts the search.
2. *Str-exp1* specifies the main string.
3. *Str-exp2* specifies the substring.

## Remarks

1. The INSTR function searches *str-exp1*, the main string, for the first occurrence of a substring, *str-exp2*, and returns the position of the substring's first character.
2. INSTR returns the character position in the main string at which BASIC finds the substring, except in the following situations:
   - If only the substring is null, and if *int-exp* is less than or equal to zero, INSTR returns a value of 1.
   - If only the substring is null, and if *int-exp* is equal to or greater than 1 and less than or equal to the length of the main string, INSTR returns the value of *int-exp*.
   - If only the substring is null, and if *int-exp* is greater than the length of the main string, INSTR returns the main string's length plus 1.
   - If the substring is not null, and if *int-exp* is greater than the length of the main string, INSTR returns a value of zero.
   - If only the main string is null, INSTR returns a value of zero.
   - If both the main string and the substring are null, INSTR returns a 1.

3. If BASIC cannot find the substring, INSTR returns a value of zero.
4. If *int-exp* does not equal 1, BASIC still counts from the beginning of the main string to calculate the starting position of the substring. That is, BASIC counts character positions starting at position 1, regardless of where you specify the start of the search. For example, if you specify 10 as the start of the search and BASIC finds the substring at position 15, INSTR returns the value 15.
5. If *int-exp* is less than 1, BASIC assumes a starting position of 1.
6. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE STRING alpha,   &
        INTEGER result
alpha = "ABCDEF"
result = INSTR(1,alpha,"DEF")
PRINT result
```

**Output**

```
 4
```

# INT

The INT function returns the floating-point value of the largest whole number less than or equal to a specified expression.

## Format

*real-var* = INT (*real-exp*)

## Syntax Rules

BASIC expects the argument of the INT function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.

## Remarks

If *real-exp* is negative, BASIC returns the largest whole number less than or equal to *real-exp*. For example, INT(-5.3) is -6.

## Examples

### Example 1

```
DECLARE SINGLE any_num, result
any_num = 6.667
result = INT(any_num)
PRINT result
```

**Output**

```
 6
```

### Example 2

```
!This example contrasts the INT and FIX functions
DECLARE SINGLE test_num
test_num = -32.7
PRINT "INT OF -32.7 IS: "; INT(test_num)
PRINT "FIX OF -32.7 IS: "; FIX(test_num)
```

**Output**

```
INT OF -32.7 IS: -33
FIX OF -32.7 IS: -32
```

# INTEGER

The INTEGER function converts a numeric expression or numeric string to a specified or default INTEGER data type.

## Format

*int-var* = INTEGER (*exp* [ , BYTE | , WORD | , LONG | , QUAD ] )

## Syntax Rules

*Exp* can be either numeric or string. A string expression can contain the ASCII digits 0 to 9, a plus sign (+), or a minus sign (-).

## Remarks

1. BASIC evaluates *exp*, then converts it to the specified INTEGER size. If you do not specify a size, BASIC uses the default INTEGER size.
2. If *exp* is a string, BASIC ignores leading and trailing spaces and tabs.
3. The INTEGER function returns a value of zero when a string argument contains only spaces and tabs, or when it is null.
4. The INTEGER function truncates the decimal portion of REAL and DECIMAL numbers, or rounds if the /ROUND_DECIMAL qualifier is used.

## Example

```
INPUT "Enter a floating-point number";F_P
PRINT INTEGER(F_P, WORD)
```

**Output**

```
Enter a floating-point number? 76.99
 76
```

# ITERATE

The ITERATE statement allows you to explicitly reexecute a loop.

## Format

ITERATE [ *label* ]

## Syntax Rules

1. *Label* is the label of the first statement of a FOR...NEXT, WHILE, or UNTIL loop.
2. *Label* must conform to the rules for naming variables.

## Remarks

1. ITERATE is equivalent to an unconditional branch to the current loop's NEXT statement. If you supply a label, ITERATE transfers control to the NEXT statement in the specified loop. If you do not supply a label, ITERATE transfers control to the current loop's NEXT statement.
2. The ITERATE statement can be used only within a FOR...NEXT, WHILE, or UNTIL loop.

## Example

```
WHEN ERROR IN
Date_loop:  WHILE 1% = 1%
                  GET #1
                  ITERATE Date_loop IF Day$ <> Today$
                  ITERATE Date_loop IF Month$ <> This_month$
                  ITERATE Date_loop IF Year$ <> This_year$
                  PRINT Item$
            NEXT
USE
   IF ERR = 11
   THEN
            CONTINUE DONE
   ELSE
            EXIT HANDLER
   END IF
END WHEN
Done:  END
```

# KILL

The KILL statement deletes a disk file, removes the file's directory entry, and releases the file's storage space.

## Format

KILL *file-spec*

## Syntax Rules

*File-spec* can be a quoted string constant, a string variable, or a string expression. It cannot be an unquoted string constant.

## Remarks

1. The KILL statement marks a file for deletion but does not delete the file until all users have closed it.
2. If you do not specify a complete file specification, BASIC uses the default device and directory. If you do not specify a file version, BASIC deletes the highest version of the file.
3. The file must exist, or BASIC signals an error.
4. You can delete a file in another directory if you have access to that directory and privilege to delete the file.

## Example

```
KILL "TEMP.DAT"
```

# LBOUND

The LBOUND function returns the lower bounds of a compile-time or run-time dimensioned array.

## Format

*num-var* = LBOUND (*array-name* [ , *num-exp* ])

## Syntax Rules

1. *Array-name* must specify an array that has been either explicitly or implicitly declared.
2. *Num-exp* specifies the number of the dimension for which you have requested the lower bound.

## Remarks

1. If you do not specify a dimension, BASIC automatically returns the lower bounds of the first dimension.
2. If you specify a numeric expression that is less than or equal to zero, BASIC signals an error.
3. If you specify a numeric expression that exceeds the number of dimensions, BASIC signals an error.

## Example

```
DECLARE INTEGER CONSTANT B = 5
DIM A(B)
account_num = 1
FOR dim_num = LBOUND (A) TO 5
    A(dim_num) = account_num
    account_num = account_num + 1
    PRINT A(dim_num)
NEXT dim_num
```

**Output**

```
1
2
3
4
5
6
```

# LEFT$

The LEFT$ function extracts a specified substring from a string's left side, leaving the main string unchanged.

## Format

*str-var* = LEFT[$] (*str-exp*, *int-exp*)

## Syntax Rules

1. *Int-exp* specifies the number of characters to be extracted from the left side of *str-exp*.
2. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Remarks

1. The LEFT$ function extracts a substring from the left of the specified *str-exp* and stores it in *str-var*.
2. If *int-exp* is less than 1, LEFT$ returns a null string.
3. If *int-exp* is greater than the length of *str-exp*, LEFT$ returns the entire string.

## Example

```
DECLARE STRING sub_string, main_string
main_string = "1234567"
sub_string = LEFT$(main_string, 4)
PRINT sub_string
```

**Output**

```
1234
```

# LEN

The LEN function returns an integer value equal to the number of characters in a specified string.

## Format

*int-var* = LEN (*str-exp*)

## Syntax Rules

None

## Remarks

1. If *str-exp* is null, LEN returns a value of zero.
2. The length of *str-exp* includes leading, trailing, and embedded blanks. Tabs in *str-exp* are treated as a single space.
3. The value returned by the LEN function is a LONG integer.

## Example

```
DECLARE STRING alpha, &
        INTEGER length
alpha = "ABCDEFG"
length = LEN(alpha)
PRINT length
```

**Output**

```
 7
```

# LET

The LET statement assigns a value to one or more variables.

## Format

[LET] *var*,... = *exp*

## Syntax Rules

1. *Var* cannot be a DEF or FUNCTION name unless the LET statement occurs inside that DEF block or in that FUNCTION subprogram.
2. The keyword LET is optional.

## Remarks

1. You cannot assign string data to a numeric variable or unquoted numeric data to a string variable.
2. The value assigned to a numeric variable is converted to the variable's data type. For example, if you assign a floating-point value to an integer variable, BASIC truncates the value to an integer.
3. For dynamic strings, the destination string's length equals the source string's length.
4. When you assign a value to a fixed-length string variable (a variable declared in a COMMON, MAP, or RECORD statement), the value is left-justified and padded with spaces or truncated to match the length of the string variable.

## Example

```
DECLARE STRING alpha, &
        INTEGER length
LET alpha = "ABCDEFG"
LET length = LEN(alpha)
PRINT length
```

**Output**

```
 7
```

# LINPUT

The LINPUT statement assigns a string value, without line terminators, from a terminal or terminal-format file to a string variable.

## Format

LINPUT [ #*chnl-exp*, ] [ *str-const1* { , ; } ] str-var1 [ { , ; } [ str-const2 { , ; } ] str-var2 ]...

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. *Str-var1* and *str-var2* cannot be DEF function names unless the LINPUT statement is inside the multiline DEF that defines the function.
3. You can include more than one string constant in a LINPUT statement. *Str-const1* is issued for *str-var1*, *str-const2* for *str-var2*, and so on.
4. The separator (comma or semicolon) that directly follows *str-var1* and *str-var2* has no formatting effect. BASIC always advances to a new line when you terminate input with a carriage return.
5. The separator character that directly follows *str-const1* and *str-const2* determines where the question mark (if requested) is displayed and where the cursor is positioned for input.
   - A comma causes BASIC to skip to the next print zone to display the question mark unless a SET NO PROMPT statement has been executed. For example:

     ```
     DECLARE STRING your_name
     LINPUT "Name",your_name
     ```

     **Output**

     ```
     Name            ?
     ```

- A semicolon causes BASIC to display the question mark next to *str-const* unless a SET NO PROMPT statement has been executed. For example:

```
DECLARE STRING your_name
LINPUT "What is your name";your_name
```

**Output**

```
What is your name?
```

6. BASIC always advances to a new line when you terminate input with a carriage return.

## Remarks

1. The default *chnl-exp* is #0 (the controlling terminal). If you specify a channel, the file associated with that channel must have been opened with ACCESS READ or MODIFY.
2. BASIC signals an error if the LINPUT statement has no argument.
3. If input comes from a terminal, BASIC displays the contents of *str-const1*, if present. If the terminal is open on channel #0, BASIC also displays a question mark (?).
4. You can disable the question mark prompt by using the SET NO PROMPT statement. See the SET PROMPT statement for more information.
5. The LINPUT statement assigns all characters except any line terminators to *str-var1* and *str-var2*. Single and double quotation marks, commas, tabs, leading and trailing spaces, or other special characters in the string are part of the data.
6. If the RETRY, CONTINUE, or RESUME statement transfers control to a LINPUT statement, the LINPUT statement retrieves a new record regardless of any data left in the previous record.
7. After a successful LINPUT statement, the RECOUNT variable contains the number of bytes transferred from the file or terminal to the record buffer.
8. If you terminate input text with Ctrl/Z, BASIC assigns the value to the variable and signals "End of file on device" (ERR=11) when the next terminal input statement executes. If you are in the VAX BASIC Environment and there is no next INPUT, INPUT LINE, or LINPUT statement in the program, the Ctrl/Z is passed to BASIC as a signal to exit the VAX BASIC Environment.

## Example

```
DECLARE STRING last_name
LINPUT "ENTER YOUR LAST NAME";Last_name
LINPUT #2%, Last_name
```

# LOC

The LOC function returns a longword integer specifying the virtual address of a simple or subscripted variable, or the address of an external function. For dynamic strings, the LOC function returns the address of the descriptor rather than the address of the data.

## Format

*int-var* = LOC ( { var / ext-routine } )

## Syntax Rules

1. *Var* can be any local or external, simple or subscripted variable.
2. *Var* cannot be a virtual array element.
3. *Ext-routine* can be the name of an external function.

## Remarks

1. The LOC function always returns a LONG value.
2. The LOC function is useful for passing the address of an external function as a parameter to a procedure. When passing a routine address as a parameter, you should usually pass the address by value. For example, OpenVMS system services expect to receive AST procedure entry masks by reference; therefore, the address of the entry mask should be in the argument list on the stack.

## Example

```
DECLARE INTEGER A, B
A = 12
B = LOC(A)
PRINT B
```

**Output**

```
 2146799372
```

# LOG

The LOG function returns the natural logarithm (base *e*) of a specified number. The LOG function is the inverse of the EXP function.

## Format

*real-var* = LOG (*real-exp*)

## Syntax Rules

None

## Remarks

1. *Real-exp* must be greater than zero. An attempt to find the logarithm of zero or a negative number causes BASIC to signal "Illegal argument in LOG" (ERR=53).
2. The LOG function uses the mathematical constant *e* as a base. VAX BASIC approximates *e* to be 2.718281828459045 (double precision); Alpha BASIC approximates *e* to be 2.71828182845905.
3. The LOG function returns the exponent to which *e* must be raised to equal *real-exp*.
4. BASIC expects the argument of the LOG function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.

## Example

```
DECLARE SINGLE exponent
exponent = LOG(98.6)
PRINT exponent
```

**Output**

```
 4.59107
```

# LOG10

The LOG10 function returns the common logarithm (base 10) of a specified number.

## Format

*real-var* = LOG10 (*real-exp*)

## Syntax Rules

None

## Remarks

1. *Real-exp* must be larger than zero. An attempt to find the logarithm of zero or a negative number causes BASIC to signal "Illegal argument in LOG" (ERR=53).
2. The LOG10 function returns the exponent to which 10 must be raised to equal *real-exp*.
3. BASIC expects the argument of the LOG10 function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.

## Example

```
DECLARE SINGLE exp_base_10
exp_base_10 = LOG10(250)
PRINT exp_base_10
```

**Output**

```
 2.39794
```

# LSET

The LSET statement assigns left-justified data to a string variable. LSET does not change the length of the destination string variable.

## Format

LSET *str-var*,... = *str-exp*

## Syntax Rules

1. *Str-var* is the destination string. *Str-exp* is the string value assigned to *str-var*.
2. *Str-var* cannot be a DEF function or function name unless the LSET statement is inside the multiline DEF or function that defines the function.

## Remarks

1. The LSET statement treats all strings as fixed length. LSET neither changes the length of the destination string nor creates new storage. Rather, it overwrites the current storage of *str-var*.
2. If the destination string is longer than *str-exp*, LSET left-justifies *str-exp* and pads it with spaces on the right. If smaller, LSET truncates characters from the right of *str-exp* to match the length of *str-var*.

## Example

```
DECLARE STRING alpha
alpha = "ABCDE"
LSET alpha = "FGHIJKLMN"
PRINT alpha
```

**Output**

```
FGHIJ
```

# MAG

The MAG function returns the absolute value of a specified expression. The returned value has the same data type as the expression.

## Format

*var* = MAG (*exp*)

## Syntax Rules

None

## Remarks

1. The returned value is always greater than or equal to zero. The absolute value of 0 is zero. The absolute value of a positive number equals that number. The absolute value of a negative number equals that number multiplied by -1.
2. The MAG function is similar to the ABS function in that it returns the absolute value of a number. The ABS function, however, takes a floating-point argument and returns a floating-point value. The MAG function takes an argument of any numeric data type and returns a value of the same data type as the argument. The use of the MAG function rather than the ABS and ABS% functions is recommended, because the MAG function returns a value using the data type of the argument.

## Example

```
DECLARE SINGLE A
A = -34.6
PRINT MAG(A)
```

**Output**

```
 34.6
```

# MAGTAPE

The MAGTAPE function permits your program to control unformatted magnetic tape files.

**Note**

The MAGTAPE function is supported only for compatibility with BASIC-PLUS-2. It is recommended that you do not use the MAGTAPE function for new program development.

## Format

*int-var1* = MAGTAPE (*func-code*, *int-var*, *chnl-exp*)

## Syntax Rules

1. *Func-code* specifies the code for the MAGTAPE function you want to perform. BASIC supports only function code 3, rewind tape. Table 4–3 explains how to perform other MAGTAPE functions with BASIC.
2. *Int-var* is an integer parameter for function codes 4, 5, and 6. However, because BASIC supports only function code 3, *int-var* is not used and always equals zero.
3. *Chnl-exp* is a numeric expression that specifies a channel number associated with the magnetic tape file.

**Table 4–3 MAGTAPE Features in BASIC**

| Code | Function | BASIC Action |
|---|---|---|
| 2 | Write EOF | Close channel with the CLOSE statement. |
| 3 | Rewind tape | Use the RESTORE # statement, the REWIND clause on an OPEN statement, or the MAGTAPE function. |

(continued on next page)

**Table 4–3 (Cont.) MAGTAPE Features in BASIC**

| Code | Function | BASIC Action |
|---|---|---|
| 4 | Skip records | Perform GET operations, ignore data until reaching desired record. |
| 5 | Backspace | Rewind tape, perform GET operations, ignore data until reaching desired record. |
| 6 | Set density or set parity | Use the DCL commands MOUNT/DENSITY and MOUNT/FOREIGN or the $MOUNT system service. |
| 7 | Get status | Use the RMSSTATUS function. |

## Example

```
I = MAGTAPE (3%,0%,2%)
```

# MAP

The MAP statement defines a named area of statically allocated storage called a PSECT, declares data fields in the record, and associates them with program variables.

## Format

MAP (*map-name*) { [ *data-type* ] *map-item* },...

map-item:

{ num-unsubs-var
| num-array-name ( [ int-const1 TO ] int-const2,... )
| record-var
| str-unsubs-var [ = int-const ]
| str-array-name ( [ int-const1 TO ] int-const2,... ) [ = int-const ]
| FILL [ ( int-const ) ] [ = int-const ]
| FILL% [ ( int-const ) ]
| FILL$ [ ( int-const ) ] [ = int-const ] }

## Syntax Rules

1. *Map-name* is global to the program and image. It cannot appear elsewhere in the program unit as a variable name.
2. *Map-name* can be from 1 to 31 characters. The first character of the name must be an alphabetic character (A to Z). The remaining characters, if present, can be any combination of letters, digits (0 to 9), dollar signs ($), periods (.), or underscores (_).
3. *Data-type* can be any BASIC data type keyword or a data type defined by a RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.
4. When you specify a data type, all following *map-items*, including FILL items, are of that data type until you specify a new data type.
5. If you specify a dollar sign ($) or percent sign (%) suffix character, the variable must be a string or integer data type.
6. If you do not specify a data type, a *map-item* without a suffix character (% or $) takes the current default data type and size.

7. *Map-item* declares the name and format of the data to be stored.
   - *Num-unsubs-var* and *num-array-name* specify a numeric variable or a numeric array.
   - *Record-var* specifies a record instance.
   - *Str-unsubs-var* and *str-array-name* specify a fixed-length string variable or array. You can specify the number of bytes to be reserved for the variable with the *=int-const* clause. The default string length is 16.
   - The FILL, FILL%, and FILL$ keywords allow you to reserve parts of the record buffer within or between data elements and to define the format of the storage. *Int-const* specifies the number of FILL items to be reserved. The *=int-const* clause allows you to specify the number of bytes to be reserved for string FILL items. Table 4–1 describes FILL item format and storage allocation.
   - In the applicable formats of FILL, (*int-const*) represents a repeat count, not an array subscript. FILL (*n*), for example, represents *n* elements, not *n* + 1.
8. Variable names, array names and FILL items following a data type other than STRING cannot end with a dollar sign. Variable names, array names and FILL items following a data type other than BYTE, WORD, LONG, QUAD, or INTEGER cannot end with a percent sign.
9. Variables and arrays declared in a MAP statement cannot be declared elsewhere in the program by any other declarative statements.
10. When you declare an array, BASIC allows you to specify both lower and upper bounds. Upper bounds are required; lower bounds are optional.
    - *Int-const2* specifies the upper bounds of the array and, when accompanied by *int-const1*, must be preceded by the keyword TO.
    - *Int-const1* must be less than or equal to *int-const2*.
    - If you do not specify *int-const1*, BASIC uses zero as the default lower bound.
    - *Int-const1* and *int-const2* can be any combination of negative and positive values.

## Remarks

1. BASIC does not execute MAP statements. The MAP statement allocates static storage and defines data at compilation time.
2. A program can have multiple maps with the same name. The allocation for each map overlays the others. Thus, data is accessible in many ways. The actual size of the data area is the size of the largest map. When you link your program, the size of the map area is the size of the largest map with that name.
3. *Map-items* with the same name can appear in different MAP statements with the same map name only if they match exactly in attributes such as data type, position, and so forth. If the attributes are not the same, BASIC signals an error. For example:

   ```
   MAP (ABC) LONG A, B
   MAP (ABC) LONG A, C ! This MAP statement is valid
   MAP (ABC) LONG B, A ! This MAP statement produces an error
   MAP (ABC) WORD A, B ! This MAP statement produces an error
   ```

   The third MAP statement causes BASIC to signal the error "variable <name> not aligned in multiple references in MAP <name>," while the fourth MAP statement generates the error "attributes of overlaid variable <name> don't match."
4. The MAP statement should precede any reference to variables declared in it.
5. Storage space for *map-items* is allocated in order of occurrence in the MAP statement.
6. A MAP area can be accessed by more than one program module, as long as you define the *map-name* in each module that references the MAP.
7. A COMMON area and a MAP area with the same name specify the same storage area and are not allowed in the same program module. However, a COMMON in one module can reference the storage declared by a MAP or COMMON in another module.
8. Variables in a MAP statement are not initialized by BASIC.
9. A map named in an OPEN statement's MAP clause is associated with that file. The file's records and record fields are defined by that map. The size of the map determines the record size for file I/O, unless the OPEN statement includes a RECORDSIZE clause.

## Example

```
MAP (BUF1) BYTE AGE, STRING emp_name = 20           &
    SINGLE emp_num
MAP (BUF1) BYTE FILL, STRING last_name (11) = 12,   &
    FILL = 8, SINGLE FILL
```

# MAP DYNAMIC

The MAP DYNAMIC statement names the variables and arrays whose size and position in a storage area can change at run time. The MAP DYNAMIC statement is used in conjunction with the REMAP statement. The REMAP statement defines or redefines the position in the storage area of variables named in the MAP DYNAMIC statement.

## Format

MAP DYNAMIC (map-dyn-name){ [ data-type ] map-item },...

map-dyn-name: { map-name | static-str-var }

map-item: { num-unsubs-var | num-array-name ( [ int-const1 TO ] int-const2,... ) | record-var | str-unsubs-var [ = int-const ] | str-array-name ( [ int-const1 TO ] int-const2,... ) [ = int-const ] }

## Syntax Rules

1. *Map-dyn-name* can either be a map name or a static string variable.
   - *Map-name* is the storage area named in a MAP statement.
   - If you specify a map name, then a MAP statement with the same name must precede both the MAP DYNAMIC statement and the REMAP statement.
   - When you specify a static string variable, the string must be declared before you can specify a MAP DYNAMIC statement or a REMAP statement.
   - *Static-str-var* must specify a static string variable or a string parameter variable.

- If you specify a *static-str-var*, the following restrictions apply:
  - *Static-str-var* cannot be a string constant.
  - *Static-str-var* cannot be the same as any previously declared *map-item* in a MAP DYNAMIC statement.
  - *Static-str-var* cannot be a subscripted variable.
  - *Static-str-var* cannot be a record component.
  - *Static-str-var* cannot be a parameter declared in a DEF or DEF* function.

2. *Map-item* declares the name and data type of the items to be stored in the storage area. All variable pointers point to the beginning of the storage area until the program executes a REMAP statement.
   - *Num-unsubs-var* and *num-array-name* specify a numeric variable or a numeric array.
   - *Record-var* specifies a record instance.
   - *Str-unsubs-var* and *str-array-name* specify a string variable or array. You cannot specify the number of bytes to be reserved for the variable in the MAP DYNAMIC statement. All string items have a fixed length of zero until the program executes a REMAP statement.
3. When you specify an array name, BASIC allows you to specify both lower and upper bounds. The upper bound is required; the lower bound is optional.
   - *Int-const1* specifies the lower bounds of the array.
   - *Int-const2* specifies the upper bounds of the array and, when accompanied by *int-const1*, must be preceded by the keyword TO.
   - *Int-const1* must be less than or equal to *int-const2*.
   - If you do not specify *int-const1*, BASIC uses zero as the default lower bound.
   - *Int-const1* and *int-const2* can be either negative or positive values.
4. *Data-type* can be any BASIC data type keyword or a data type defined with a RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2 in this manual.
5. When you specify a data type, all following *map-items* are of that data type until you specify a new data type.

6. If you do not specify any data type, *map-items* take the current default data type and size.
7. *Map-items* must be separated with commas.
8. If you specify a dollar sign suffix, the variable must be a STRING data type.
9. If you specify a percent sign suffix, the variable must be a BYTE, WORD, LONG, or QUAD integer data type.

## Remarks

1. All variables and arrays declared in a MAP DYNAMIC statement cannot be declared elsewhere in the program by any other declarative statements.
2. The MAP DYNAMIC statement does not affect the amount of storage allocated to the map buffer declared in a previous MAP statement or the storage allocated to a static string. Until your program executes a REMAP statement, all variable and array element pointers point to the beginning of the MAP buffer or static string.
3. BASIC does not execute MAP DYNAMIC statements. The MAP DYNAMIC statement names the variables whose size and position in the MAP or static string buffer can change and defines their data type.
4. Before you can specify a map name in a MAP DYNAMIC statement, there must be a MAP statement in the program unit with the same map name. Otherwise, BASIC signals the error "Insufficient space for MAP DYNAMIC variables in MAP <name>." Similarly, before you can specify a static string variable in the MAP DYNAMIC statement, the string variable must be declared. Otherwise, BASIC signals the same error message.
5. A static string variable must be either a variable declared in a MAP or COMMON statement or a parameter declared in a SUB, FUNCTION, or PICTURE. It cannot be a parameter declared in a DEF or DEF* function.
6. If a static string variable is the same as a map name, BASIC uses the map name if the name appears in a MAP DYNAMIC statement.
7. The MAP DYNAMIC statement must lexically precede the REMAP statement or BASIC signals the error "MAP variable <name> referenced before declaration."

## Example

```
100     MAP (MY.BUF) STRING DUMMY = 512
        MAP DYNAMIC (MY.BUF) STRING LAST, FIRST, MIDDLE,      &
                             BYTE AGE, STRING EMPLOYER,       &
                             STRING CHARACTERISTICS
```

# MAR

The MAR function returns the current margin width of a specified channel.

## Format

*int-var* = MAR[%] (*chnl-exp*)

## Syntax Rules

The file associated with *chnl-exp* must be open.

## Remarks

1. If *chnl-exp* specifies a terminal and you have not set a margin width with the MARGIN statement, the MAR function returns a value of zero. If you have set a margin width, the MAR function returns that number.
2. The value returned by the MAR function is a LONG integer.

## Example

```
DECLARE INTEGER width
MARGIN #0, 80
width = MAR(0)
PRINT width
```

**Output**

```
 80
```

# MARGIN

The MARGIN statement specifies the margin width for a terminal or for records in a terminal-format file.

## Format

MARGIN [ #*chnl-exp*, ] *int-exp*

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. *Int-exp* specifies the margin width.

## Remarks

1. If you do not specify a channel, BASIC sets the margin on the controlling terminal.
2. The file associated with *chnl-exp* must be an open terminal-format file or terminal.
3. BASIC signals the error "Illegal operation" (ERR=141) if the file associated with *chnl-exp* is not a terminal-format file.
4. If *chnl-exp* does not correspond to a terminal, and if *int-exp* is zero, BASIC sets the right margin to the size specified by the RECORDSIZE clause in the OPEN statement, if the clause is present. If no RECORDSIZE clause is present, BASIC sets the margin to 72 (or, in the case of channel 0, to the width of SYS$OUTPUT).
5. If *chnl-exp* is not present or if it corresponds to a terminal, and if *int-exp* is zero, BASIC sets the right margin to the size specified by the RECORDSIZE clause in the OPEN statement, if the clause is present. If no RECORDSIZE clause is present, BASIC sets the margin to 72.
6. BASIC prints as much of a specified record as the margin setting allows on one line before going to a new line. Numeric fields are never split across lines.

7. If you specify a margin larger than the channel's record size, BASIC signals an error. The default record size for a terminal or terminal format file is 132.
8. The MARGIN statement applies to the specified channel only while the channel is open. If you close the channel and then reopen it, BASIC uses the default margin.

## Example

```
OPEN "EMP.DAT" FOR OUTPUT AS #1
MARGIN #1, 132
   .
   .
   .
```

# MAT

The MAT statement lets you implicitly create and manipulate one- and two-dimensional arrays. You can use the MAT statement to assign values to array elements, or to redimension a previously dimensioned array. You can also perform matrix arithmetic operations such as multiplication, addition, and subtraction, and other matrix operations such as transposing and inverting matrices.

## Format

### Numeric Initialization

MAT *num-array* = { CON | IDN | ZER } [ ( *int-exp1* [, int-exp2 ] ) ]

### String Initialization

MAT *str-array* = NUL$ [ ( *int-exp1* [, *int-exp2* ] ) ]

### Array Arithmetic

MAT *num-array1* = *num-array2* [ { + | - | * } num-array3 ]

MAT num-array1 = *num-array2* ***** *num-array3* [ ***** *num-array4* ] ,...

### Scalar Multiplication

MAT *num-array4* = ( *num-exp* ) ***** *num-array5*

### Inversion and Transposition

MAT num-array6 = { TRN | INV } ( num-array7)

## Syntax Rules

1. *Int-exp1* and *int-exp2* define the upper bounds of the array being implicitly created or the new dimensions of an existing array.
2. If you are creating an array, *int-exp1* and *int-exp2* cannot exceed 10.
3. If you do not specify bounds, BASIC creates the array and dimensions it to (0 TO 10) or (0 TO 10, 0 TO 10).

4. If you specify bounds, BASIC creates the array with the specified bounds. If the bounds exceed (0 TO 10) or (0 TO 10, 0 TO 10), BASIC signals "Redimensioned array" (ERR=105).
5. The lower bounds must be zero.

## Remarks

1. To perform MAT operations on arrays larger than (10,10), create the input and output arrays with the DIM statement.
2. When the array exists, the following rules apply:
   - If you specify upper bounds, BASIC redimensions the array to the specified size. However, MAT operations cannot increase the total number of array elements.
   - All arrays specified with the MAT statement must have lower bounds of zero. If you supply a nonzero value, BASIC signals either a compile-time or a run-time error.
   - If you do not specify bounds, BASIC does not redimension the array.
   - An array passed to a subprogram and redimensioned with a MAT statement remains redimensioned when control returns to the calling program, with two exceptions:
     - When the array is within a record and is passed by descriptor
     - When the array is passed by reference
3. You cannot use the MAT statement on arrays of more than two dimensions.
4. You cannot use the MAT statement on arrays of data type DECIMAL or on arrays named in a RECORD statement.
5. Unless the arrays are declared with a DIM or DECLARE statement, the data type will be the default floating-point data type.
6. Initialization
   - CON sets all elements of *num-array* to 1, except those in row and column zero.
   - IDN creates an identity matrix from *num-array*. The number of rows and columns in *num-array* must be identical. IDN sets all elements to zero except those in row and column zero, and those on the diagonal from *num-array*(1,1) to *num-array*(n,n), which are set to 1.

- ZER sets all array elements to zero, except those in row and column zero.
- NUL$ sets all elements of a string array to the null string, except those in row and column zero.

7. Array Arithmetic
   - The equal sign (=) assigns the results of the specified operation to the elements in *num-array1*.
   - If *num-array3* is not specified, BASIC assigns the values of *num-array2*'s elements to the corresponding elements of *num-array1*. *Num-array1* must have at least as many rows and columns as *num-array2*. *Num-array1* is redimensioned to match *num-array2*.
   - Use the plus sign (+) to add the elements of two arrays. *Num-array2* and *num-array3* must have identical bounds.
   - Use the minus sign (-) to subtract the elements of two arrays. *Num-array2* and *num-array3* must have identical bounds.
   - Use the asterisk (*) to perform matrix multiplication on the elements of *num-array2* and *num-array3* and to assign the results to *num-array1*. This operation gives the dot product of *num-array2* and *num-array3*. All three arrays must be two-dimensional, and the number of columns in *num-array2* must equal the number of rows in *num-array3*. BASIC redimensions *num-array1* to have the same number of rows as *num-array2* and the same number of columns as *num-array3*. Neither *num-array2* nor *num-array3* may be the same as *num-array1*.
   - With matrix multiplication, you can specify more than two numeric arrays; however, each array must be two-dimensional. Moreover, in each dimension, the lower bound of each array must be zero and the upper bound must be 4. You can use the graphics transformation functions, which will automatically create arrays with these dimensions. See the DRAW statement in *Programming with VAX BASIC Graphics* for more information.
8. Scalar Multiplication
   - BASIC multiplies each element of *num-array5* by *num-exp* and stores the results in the corresponding elements of *num-array4*.

9. Inversion and Transposition
   - TRN transposes *num-array7* and assigns the results to *num-array6*. If *num-array7* has *m* rows and *n* columns, *num-array6* will have *n* rows and *m* columns. Both arrays must be two-dimensional.
   - You cannot transpose a matrix to itself: MAT A = TRN(A) is invalid.
   - INV inverts *num-array7* and assigns the results to *num-array6*. *Num-array7* must be a two-dimensional array that can be reduced to the identity matrix with elementary row operations. The row and column dimensions must be identical.
10. You cannot increase the number of array elements or change the number of dimensions in an array when you redimension with the MAT statement. For example, you can redimension an array with dimensions (5,4) to (4,5) or (3,2), but you cannot redimension that array to (5,5) or to (10). The total number of array elements includes those in row and column zero.
11. If an array is named in both a DIM statement and a MAT statement, the DIM statement must lexically precede the MAT statement.
12. MAT statements do not operate on elements in the zero element (one-dimensional arrays) or in the zero row or column (two-dimensional arrays). MAT statements use these elements to store results of intermediate calculations. Therefore, you should not depend on values in row and column zero if your program uses MAT statements.

## Examples

### Example 1

```
!Numeric Initialization
MAT CONVERT = zer(10,10)
```

### Example 2

```
!Initialization
MAT na_me$ = NUL$(5,5)
```

### Example 3

```
!Array Arithmetic
MAT new_int = old_int - rslt_int
```

### Example 4

```
!Scalar Multiplication
MAT Z40 = (4.24) * Z
```

**Example 5**

```
!Inversion and Transposition
MAT Q% = INV (Z)
```

# MAT INPUT

The MAT INPUT statement assigns values from a terminal or terminal-format file to array elements.

## Format

MAT INPUT [ #*chnl-exp* , ] { *array* [ ( *int-exp1* [, *int-exp2* ] ) ] },...

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. The file associated with *chnl-exp* must be an open terminal-format file or terminal. If *chnl-exp* is not specified, BASIC takes data from the controlling terminal.
3. *Int-exp1* and *int-exp2* define the upper bounds of the array being implicitly created or the dimensions of an existing array.
4. If you are creating an array, *int-exp1* and *int-exp2* cannot exceed 10.

## Remarks

1. You cannot use the MAT INPUT statement on arrays of more than two dimensions.
2. You cannot use the MAT INPUT statement on arrays of data type DECIMAL or on arrays named in a RECORD statement.
3. All arrays specified with the MAT INPUT statement must have lower bounds of zero.
4. If you do not specify bounds, BASIC creates the array and dimensions it to (10,10).
5. If you do specify upper bounds, BASIC creates the array with the specified bounds. If the bounds exceed (10) or (10,10), BASIC signals "Redimensioned array" (ERR=105).

6. To use the MAT INPUT statement with arrays larger than (10,10), create the input and output arrays with the DIM statement.
7. When the array exists, the following rules apply:
   - If you specify bounds, BASIC redimensions the array to the specified size. However, MAT INPUT cannot increase the total number of array elements.
   - If you do not specify bounds, BASIC does not redimension the array.
8. For terminals open on channel zero only, the MAT LINPUT statement prompts with a question mark (?) unless a SET NO PROMPT statement has been executed. See the description of the SET PROMPT statement for more information.
9. Use commas to separate data elements and a line terminator to end the input of data. Use an ampersand (&) before the line terminator to continue data over more than one line.
10. The MAT INPUT statement assigns values by row. For example, it assigns values to all elements in row 1 before beginning row 2.
11. The MAT INPUT statement assigns the row number of the last data element transferred into the array to the system variable NUM.
12. The MAT INPUT statement assigns the column number of the last data element transferred into the array to the system variable NUM2.
13. If there are fewer elements in the input data than there are array elements, BASIC does not change the remaining array elements.
14. If there are more data elements in the input stream than there are array elements, BASIC ignores the excess.
15. Row zero and column zero are not changed.
16. For information about graphics input in VAX BASIC, see the MAT LOCATE and the MAT GET statements in *Programming with VAX BASIC Graphics*.

## Example

```
MAT INPUT XYZ(5,5)
MAT PRINT XYZ;
```

**Output**

```
? 1,2,3,4,5
 1  2  3  4  5
 0  0  0  0  0
 0  0  0  0  0
 0  0  0  0  0
 0  0  0  0  0
```

# MAT LINPUT

The MAT LINPUT statement receives string data from a terminal or terminal-format file and assigns it to string array elements.

## Format

MAT LINPUT [ #*chnl-exp* , ] { *str-array* [ ( *int-exp1* [, *int-exp2* ] ) ] }, ...

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file or terminal. It must be immediately preceded by a number sign (#).
2. The file associated with *chnl-exp* must be an open terminal-format file or terminal. If a channel is not specified, BASIC takes data from the controlling terminal.
3. *Int-exp1* and *int-exp2* define the upper bounds of the array being implicitly created or the dimensions of an existing array.
4. If you are creating an array, *int-exp1* and *int-exp2* cannot exceed 10.

## Remarks

1. You cannot use the MAT LINPUT statement on arrays of more than two dimensions.
2. You cannot use the MAT LINPUT statement on arrays of data type other than STRING or on arrays named in a RECORD statement.
3. If you do not specify bounds, BASIC creates the array and dimensions it to (10,10).
4. If you do specify upper bounds, BASIC creates the array with the specified bounds. If the bounds exceed (10) or (10,10), BASIC signals "Redimensioned array" (ERR=105).
5. All arrays specified with the MAT LINPUT statement must have lower bounds of zero.

6. To use MAT LINPUT with arrays larger than (10,10), create the input arrays with the DIM statement.
7. When the array exists, the following rules apply:
   - If you specify bounds, BASIC redimensions the array to the specified size. However, MAT LINPUT cannot increase the total number of array elements.
   - If you do not specify bounds, BASIC does not redimension the array.
8. For terminals open on channel zero only, the MAT LINPUT statement prompts with a question mark (unless a SET NO PROMPT statement has been executed) for each string array element, starting with element (1,1). BASIC assigns values to all elements of row 1 before beginning row 2.
9. The MAT LINPUT statement assigns the row number of the last data element transferred into the array to the system variable NUM.
10. The MAT LINPUT statement assigns the column number of the last data element transferred into the array to the system variable NUM2.
11. Typing only a line terminator in response to the question mark prompt causes BASIC to assign a null string to that string array element.
12. MAT LINPUT does not change row and column zero.

## Example

```
DIM cus_rec$(3,3)
MAT LINPUT cus_rec$(2,2)
PRINT cus_rec$(1,1)
PRINT cus_rec$(1,2)
PRINT cus_rec$(2,1)
PRINT cus_rec$(2,2)
```

**Output**

```
? Babcock
? Santani
? Lloyd
? Kelly
Babcock
Santani
Lloyd
Kelly
```

# MAT PRINT

The MAT PRINT statement prints the contents of a one- or two-dimensional array on your terminal or assigns the value of each array element to a record in a terminal-format file.

## Format

MAT PRINT [ #*chnl-exp* , ] { array [ ( *int-exp1* [, *int-exp2* ] ) ] [ , ; ] }...

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file or terminal. It must be immediately preceded by a number sign (#).
2. The file associated with *chnl-exp* must be an open terminal-format file or terminal. If you do not specify a channel, BASIC prints data on the controlling terminal.
3. *Int-exp1* and *int-exp2* define the upper bounds of the array being implicitly created or the dimensions of an existing array.
4. The separator (comma or semicolon) determines the output format for the array.
   - If you use a comma, BASIC prints each array element in a new print zone and starts each row on a new line.
   - If you use a semicolon, BASIC separates each array element with a space and starts each row on a new line.
   - If you do not use a separator character, BASIC prints each array element on its own line.

## Remarks

1. You cannot use the MAT PRINT statement on arrays of more than two dimensions.
2. You cannot use the MAT PRINT statement on arrays of data type DECIMAL or on arrays named in a RECORD statement.
3. When you use the MAT PRINT statement to print more than one array, each array name except the last must be followed with either a comma or a semicolon. BASIC prints a blank line between arrays.
4. If the array does not exist, the following rules apply:
   - If you do not specify bounds, BASIC creates the array and dimensions it to (10,10).
   - If you specify upper bounds, BASIC creates the array with the specified bounds. If the bounds exceed (10) or (10,10), BASIC prints the elements (1) through (10) or (1,1) through (1,10) and signals "Subscript out of range" (ERR=55).
5. All arrays specified with the MAT PRINT statement must have lower bounds of zero.
6. When the array exists, the following rules apply:
   - If the specified bounds are smaller than the maximum bounds of a dimensioned array, BASIC prints a subset of the array, but does not redimension the array. For example, if you use the DIM statement to dimension A(20,20), and then MAT PRINT A(2,2), BASIC prints elements (1,1), (1,2), (2,1), and (2,2) only; array A(20,20) does not change.
   - If you do not specify bounds, BASIC prints the entire array.
7. The MAT PRINT statement does not print elements in row or column zero.
8. The MAT PRINT statement cannot redimension an array.

## Example

```
DIM cus_rec$(3,3)
MAT LINPUT cus_rec$(2,2)
MAT PRINT cus_rec$(2,2)
```

**Output**

```
? Babcock
? Santani
? Lloyd
? Kelly
Babcock
Santani
Lloyd
Kelly
```

# MAT READ

The MAT READ statement assigns values from DATA statements to array elements.

## Format

MAT READ { *array* [ ( *int-exp1* [, *int-exp2* ] ) ] },...

## Syntax Rules

1. *Int-exp1* and *int-exp2* define the upper bounds of the array being implicitly created or the dimensions of an existing array.
2. If you are creating an array, *int-exp1* and *int-exp2* cannot exceed 10.

## Remarks

1. If you do not specify bounds, BASIC creates the array and dimensions it (10,10).
2. If you specify bounds, BASIC creates the array with the specified bounds. If the bounds exceed (10) or (10,10), BASIC signals "Redimensioned array" (ERR=105).
3. To read arrays larger than (10,10), create the array with the DIM statement.
4. All arrays specified with the MAT statement must have lower bounds of zero.
5. When the array exists, the following rules apply:
   - If you specify upper bounds, BASIC redimensions the array to the specified size. However, MAT READ cannot increase the total number of array elements.
   - If you do not specify bounds, BASIC does not redimension the array.
6. All the DATA statements must be in the same program unit as the MAT READ statement.
7. The MAT READ statement assigns data items by row. For example, it assigns data items to all elements in row 1 before beginning row 2.

8. The MAT READ statement does not read elements into row or column zero.
9. The MAT READ statement assigns the row number of the last data element transferred into the array to the system variable, NUM.
10. The MAT READ statement assigns the column number of the last data element transferred into the array to the system variable, NUM2.
11. You cannot use the MAT READ statement on arrays of more than two dimensions.
12. You cannot use the MAT READ statement on arrays of data type DECIMAL or on arrays named in a RECORD statement.

## Example

```
MAT READ A(3,3)
MAT READ B(3,3)
PRINT
PRINT "Matrix A"
PRINT
MAT PRINT A;
PRINT
PRINT "Matrix B"
PRINT
MAT PRINT B;
DATA 1,2,3,4,5,6
```

**Output**

```
Matrix A

 1  2  3
 4  5  6
 0  0  0

Matrix B

 0  0  0
 0  0  0
 0  0  0
```

# MAX

The MAX function compares the values of two or more numeric expressions and returns the highest value.

## Format

*num-var* = MAX ( *num-exp1* , *num-exp2* [ , *num-exp3* ,...])

## Syntax Rules

BASIC allows you to specify up to eight numeric expressions.

## Remarks

1. If you specify values with different data types, BASIC performs data type conversions to maintain precision.
2. BASIC returns a function result whose data type is compatible with the values you supply.

## Example

```
DECLARE REAL John_grade, &
            Bob_grade,  &
            Joe_grade,  &
            highest_grade
INPUT "John's grade";John_grade
INPUT "Bob's grade";Bob_grade
INPUT "Joe's grade";Joe_grade
highest_grade = MAX(John_grade, Bob_grade, Joe_grade)
PRINT "The highest grade is";highest_grade
```

**Output**

```
John's grade? 90
Bob's grade? 95
Joe's grade? 79
The highest grade is 95
```

# MID$

MID$ can be used either as a statement or as a function. The MID$ statement performs substring insertion into a string. The MID$ function extracts a specified substring from a string expression.

## Format

### MID$ statement

MID[$] ( *str-var*, *int-exp1* [ , *int-exp2* ] ) = *str-exp*

### MID$ function

*str-var* = MID[$] (*str-exp*, *int-exp1*, *int-exp2*)

## Syntax Rules

1. *Int-exp1* specifies the position of the substring's first character.
2. *Int-exp2* specifies the length of the substring.

## Remarks

1. If *int-exp1* is less than 1, BASIC assumes a starting character position of 1.
2. If *int-exp2* is less than or equal to zero, BASIC assumes a length of zero.
3. If you specify a floating-point expression for *int-exp1* or *int-exp2*, BASIC truncates it to a LONG integer.
4. MID$ statement
   - The MID$ statement replaces a specified portion of *str-var* with *str-exp*.
   - If *int-exp1* is greater than the length of *str-var*, *str-var* remains unchanged.

- The length of *str-var* does not change regardless of the value of *int-exp2*.
- If the optional *int-exp2* is not specified, BASIC assumes *int-exp2* to be the length of *str-exp* minimized by the length of *str-var* minus *int-exp1*. For example:

```
A$ = "ABCDEFG"
MID$ (A$,3) = "123456789"
PRINT A$
```

**Output**

```
"AB12345"
```

- If *int-exp2* is less than or equal to zero, *str-var* remains unchanged.
- If *int-exp2* is greater than the length of *str-var*, BASIC assumes *int-exp2* to be equal to the length of *str-var*.
- *Int-exp2* is always minimized against the length of *str-var* minus *int-exp1*.

5. MID$ function
   - The MID$ function extracts a substring from *str-exp* and stores it in *str-var*.
   - If *int-exp1* is greater than the length of *str-exp*, MID$ returns a null string.
   - If *int-exp2* is greater than the length of *str-exp*, BASIC returns the string that begins at *int-exp1* and includes all characters remaining in *str-exp*.
   - If *int-exp2* is less than or equal to zero, MID$ returns a null string.

## Examples

### Example 1

```
!MID$ Function
DECLARE STRING old_string, new_string
old_string = "ABCD"
new_string = MID$(old_string,1,3)
PRINT new_string
```

**Output**

```
ABC
```

### Example 2

```
!MID$ Statement
DECLARE STRING old_string, replace_string
old_string = "ABCD"
replace_string = "123"
PRINT old_string
MID$(old_string,1,3) = replace_string
PRINT old_string
```

**Output**

```
ABCD
123D
```

# MIN

The MIN function compares the values of two or more numeric expressions and returns the smallest value.

## Format

*num-var* = MIN ( *num-exp1*, *num-exp2* [ , *num-exp3* ,... ])

## Syntax Rules

BASIC allows you to specify up to eight numeric expressions.

## Remarks

1. If you specify values with different data types, BASIC performs data type conversions to maintain precision.
2. BASIC returns a function result whose data type is compatible with the values you supply.

## Example

```
DECLARE REAL John_grade, &
            Bob_grade,  &
            Joe_grade,  &
            lowest_grade
INPUT "John's grade";John_grade
INPUT "Bob's grade";Bob_grade
INPUT "Joe's grade";Joe_grade
lowest_grade = MIN(John_grade, Bob_grade, Joe_grade)
PRINT "The lowest grade is";lowest_grade
```

**Output**

```
John's grade? 95
Bob's grade? 100
Joe's grade? 84
The lowest grade is 84
```

# MOD

The MOD function divides a numeric value by another numeric value and returns the remainder.

## Format

*num-var* = MOD ( *num-exp1*, *num-exp2* )

## Syntax Rules

*Num-exp1* is divided by *num-exp2*.

## Remarks

1. If you specify values with different data types, BASIC performs data type conversions to maintain precision.
2. BASIC returns a function result whose data type is compatible with the values you supply.
3. The function result is either a positive or negative value, depending on the value of the first numeric expression. For example, if the first numeric expression is negative, then the function result will also be negative.

## Example

```
DECLARE REAL A,B
A = 500
B = MOD(A,70)
PRINT "The remainder equals";B
```

**Output**

```
The remainder equals 10
```

# MOVE

The MOVE statement transfers data between a record buffer and a list of variables.

## Format

MOVE { TO / FROM } *#chnl-exp* , *move-item*,...

move-item: {
num-var
num-array ( [,]...)
str-var [ = int-exp ]
str-array ( [,]...) [ = int-exp ]
[ data-type ] FILL [ ( int-exp ) ] [ = int-const ]
FILL% [ ( int-exp ) ]
FILL$ [ ( int-exp ) ] [ = int-exp ]
}

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. *Move-item* specifies the variable or array to which or from which data is to be moved.
3. Parentheses indicate the number of dimensions in a numeric array. The number of dimensions is equal to the number of commas plus 1. Empty parentheses indicate a one-dimensional array, one comma indicates a two-dimensional array, and so on.
4. *Str-var* and *str-array* specify a fixed length string variable or array. Parentheses indicate the number of dimensions in a string array. The number of dimensions is equal to the number of commas plus 1. You can specify the number of bytes to be reserved for the variable or array elements with the =*int-exp* clause. The default string length for a MOVE FROM statement is 16. For a MOVE TO statement, the default is the string's length.

5. The FILL, FILL%, and FILL$ keywords allow you to transfer fill items of a specific data type. Table 4–1 shows FILL item formats, representations, and storage requirements.
   - If you specify a data type before the FILL keyword, the fill is of that data type. If you do not specify a data type, the fill is of the default data type. *Data-type* can be any BASIC data type keyword or a data type defined by a RECORD statement. Data type keywords, size, range, and precision are listed in Table 1–2.
   - FILL items following a data type other than STRING cannot end with a dollar sign. FILL items following a data type other than BYTE, WORD, LONG, QUAD, or INTEGER cannot end with a percent sign.
   - FILL% indicates integer fill. FILL$ indicates string fill. The *=int-exp* clause specifies the number of bytes to be moved for string FILL items.
   - *Int-exp* specifies the number of FILL items to be moved. In the applicable formats of FILL, *(int-exp)* represents a repeat count, not an array subscript. FILL (*n*), for example, represents *n* elements, not *n* + 1.
6. You cannot use an expression or function reference as a *move-item*.

## Remarks

1. Before a MOVE FROM statement can execute, the file associated with *chnl-exp* must be open and there must be a record in the record buffer.
2. A MOVE statement neither transfers data to or from external devices, nor invokes OpenVMS Record Management Services (RMS). Instead, it transfers data between user areas. Thus, a record should first be fetched with the GET statement before you use a MOVE FROM statement, and a MOVE TO statement should be followed by a PUT or UPDATE statement that writes the record to a file.
3. MOVE FROM transfers data from the record buffer to the *move-item*.
4. MOVE TO transfers data from the *move-item* to the record buffer.
5. The MOVE statement does not affect the record buffer's size. If a MOVE statement partially fills a buffer, the rest of the buffer is unchanged. If there is more data in the variable list than in the buffer, BASIC signals "MOVE overflows buffer" (ERR=161).

6. Each MOVE statement to or from a channel transfers data starting at the beginning of the buffer. For example:

   ```
   MOVE FROM #1%, I%, A$ = I%
   ```

   In this example, BASIC assigns the first value in the record buffer to *I%*; the value of *I%* is then used to determine the length of *A$*.

7. If a MOVE statement operates on an entire array, the following conditions apply:

   - BASIC transfers elements of row and column zero (in contrast to the MAT statements).
   - The storage size of the array elements and the size of the array determine the amount of data moved. A MOVE statement that transfers data from the buffer to a longword integer array transfers the first four bytes of data into the first element (for example, (0,0)), the next four bytes of data into element (0,1), and so on.

8. If the MOVE TO statement specifies an explicit string length, the following restrictions apply:

   - If the string is equal to or longer than the explicit string length, BASIC moves only the specified number of characters into the buffer.
   - If the string is shorter than the explicit string length, BASIC moves the entire string and pads it with spaces to the specified length.

9. BASIC does not check the validity of data during the MOVE operation.

## Example

```
MOVE FROM #4%, RUNS%, HITS%, ERRORS%, RBI%, BAT_AVERAGE
MOVE TO #9%, FILL$ = 10%, A$ = 10%, B$ = 30%, C$ = 2%
```

# NAME...AS

The NAME...AS statement renames the specified file.

## Format

NAME *file-spec1* AS *file-spec2*

## Syntax Rules

1. *File-spec1* and *file-spec2* must be string expressions.
2. There is no default file type in *file-spec1* or *file-spec2*. If the file to be renamed has a file type, *file-spec1* must include both the file name and the file type.
3. If you specify only a file name, BASIC searches for a file with no file type. If you do not specify a file type for *file-spec2*, BASIC names the file, but does not assign a file type.
4. *File-spec2* can include a directory name but not a device name. If you specify a directory name with *file-spec2*, the file will be placed in the specified directory. If you do not specify a directory name, the default is the current directory.
5. File version numbers are optional. BASIC renames the highest version of *file-spec1* if you do not specify a version number.

## Remarks

1. If the file specified by *file-spec1* does not exist, BASIC signals "Can't find file or account" (ERR=5).
2. If you use the NAME...AS statement on an open file, BASIC does not rename the file until it is closed.
3. You cannot use the NAME...AS statement to move a file between devices. You can only change the directory, name, type, or version number.

## Example

```
$ Directory USER$$DISK:[BASIC_PROG]
Directory USER$$DISK:[BASIC_PROG]

FIRST_PROG.BAS;1
Total of 1 file.
$ BASIC

BASIC V3.4
Ready

NAME "FIRST_PROG.BAS" AS "SECOND_PROG.BAS"
Ready

EXIT

$ Directory USER$$DISK:[BASIC_PROG]

Directory USER$$DISK:[BASIC_PROG]

SECOND_PROG.BAS;1

Total of 1 file.
```

# NEXT

The NEXT statement marks the end of a FOR, UNTIL, or WHILE loop.

## Format

NEXT [ *num-unsubs-var* ]

## Syntax Rules

1. *Num-unsubs-var* is required in a FOR...NEXT loop and must correspond to the *num-unsubs-var* specified in the FOR statement.
2. *Num-unsubs-var* is not allowed in an UNTIL or WHILE loop.
3. *Num-unsubs-var* must be a numeric, unsubscripted variable.

## Remarks

Each NEXT statement must have a corresponding FOR, UNTIL, or WHILE statement or BASIC signals an error.

## Example

```
PROGRAM calculating_pay
DECLARE INTEGER no_hours, &
        SINGLE weekly_pay, minimum_wage
minimum_wage = 3.65
no_hours = 40
WHILE no_hours > 0
  INPUT "Enter the number of hours you intend to work this week";no_hours
  weekly_pay = no_hours * minimum_wage
  PRINT "If you worked";no_hours;"hours, your pay would be";weekly_pay
NEXT
END PROGRAM
```

**Output**

```
Enter the number of hours you intend to work this week? 35
If you worked 35 hours, your pay would be 127.75
Enter the number of hours you intend to work this week? 23
If you worked 23 hours, your pay would be 83.95
Enter the number of hours you intend to work this week? 0
If you worked 0 hours your pay would be 0
```

# NOECHO

The NOECHO function disables echoing of input on a terminal.

## Format

*int-var* = NOECHO (*chnl-exp*)

## Syntax Rules

*Chnl-exp* must specify a terminal.

## Remarks

1. If you specify NOECHO, BASIC accepts characters typed on the terminal as input, but the characters do not echo on the terminal.
2. The NOECHO function is the complement of the ECHO function; NOECHO disables the effect of ECHO and vice versa.
3. NOECHO always returns a value of zero.

## Example

```
DECLARE INTEGER Y,      &
        STRING pass_word
Y = NOECHO(0)
INPUT "Enter your password";pass_word
IF pass_word = "DARLENE" THEN PRINT "Confirmed"
Y = ECHO(0)
```

**Output**

```
Enter your password?
Confirmed
```

# NOMARGIN

The NOMARGIN statement removes the right margin limit set with the MARGIN statement for a terminal or a terminal-format file.

## Format

NOMARGIN [ #*chnl-exp* ]

## Syntax Rules

*Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).

## Remarks

1. When you specify NOMARGIN, the right margin is set to 132.
2. *Chnl-exp*, if specified, must be an open terminal-format file or a terminal.
3. If you do not specify a channel, BASIC sets the margin on the controlling terminal to 132.
4. The NOMARGIN statement applies to the specified channel only while the channel is open. If you close the channel and then reopen it, BASIC uses the default margin of 72.

## Example

```
OPEN "EMP.DAT" FOR OUTPUT AS #1
NOMARGIN #1
   .
   .
   .
```

# NUM

The NUM function returns the row number of the last data element transferred into an array by a MAT I/O statement.

## Format

*int-var* = NUM

## Syntax Rules

None

## Remarks

1. NUM returns a value of zero if it is invoked before BASIC has executed any MAT I/O statements.
2. For a two-dimensional array, NUM returns an integer specifying the row number of the last data element transferred into the array. For a one-dimensional array, NUM returns the number of elements entered.
3. The value returned by the NUM function is an integer of the default size.

## Example

```
OPEN "STU_ACCT" FOR INPUT AS #2
DIM stu_rec$(3,3)
MAT INPUT #2, stu_rec$
PRINT "Row count =";NUM
PRINT "Column number =";NUM2
```

**Output**

```
Row count = 1
Column number = 1
```

# NUM2

The NUM2 function returns the column number of the last data element transferred into an array by a MAT I/O statement.

## Format

*int-var* = NUM2

## Syntax Rules

None

## Remarks

1. NUM2 returns a value of zero if it is invoked before BASIC has executed any MAT I/O statements or if the last array element transferred was in a one-dimensional list.
2. The NUM2 function returns an integer specifying the column number of the last data element transferred into an array.
3. The value returned by the NUM2 function is an integer of the default size.

## Example

```
OPEN "STU_ACCT" FOR INPUT AS #2
DIM stu_rec$(3,3)
MAT INPUT #2, stu_rec$
PRINT "Row count =";NUM
PRINT "Column number =";NUM2
```

**Output**

```
Row count = 1
Column number = 1
```

# NUM$

The NUM$ function evaluates a numeric expression and returns a string of characters in PRINT statement format, with leading and trailing spaces.

## Format

*str-var* = NUM$ (*num-exp*)

## Syntax Rules

None

## Remarks

1. If *num-exp* is positive, the first character in the string expression is a space. If *num-exp* is negative, the first character is a minus sign (-).
2. The NUM$ function does not include trailing zeros in the returned string. If all digits to the right of the decimal point are zeros, NUM$ omits the decimal point as well.
3. When *num-exp* is a floating-point variable and has an integer portion of 6 decimal digits or less (for example, 1234.567), BASIC rounds the number to 6 digits (1234.57). If *num-exp* has 7 decimal digits or more, BASIC rounds the number to 6 digits and prints it in E format.
4. When *num-exp* is from 0.1 to 1 and contains more than 6 digits, BASIC rounds it to 6 digits. When *num-exp* is smaller than 0.1, BASIC rounds it to 6 digits and prints it in E format.
5. If *num-exp* is an integer variable, the maximum number of digits in the returned string is as follows, depending on the data type of *num-exp*:

| Type | Maximum Digits |
|---|---|
| Byte | 3 |
| Word | 5 |
| Longword | 10 |
| Quadword | 19 |

6. If *num-exp* is a DECIMAL value, the returned string can have up to 31 digits.
7. The last character in the returned string is a space.

## Example

```
DECLARE STRING number
number = NUM$(34.5500/31.8)
PRINT number
```

**Output**

```
 1.08648
```

# NUM1$

The NUM1$ function changes a numeric expression to a numeric character string without leading and trailing spaces and without rounding.

## Format

*str-var* = NUM1$ (*num-exp*)

## Syntax Rules

None

## Remarks

1. The NUM1$ function returns a string consisting of numeric characters and a decimal point that corresponds to the value of *num-exp*. Leading and trailing spaces are not included in the returned string.
2. The NUM1$ function returns a maximum of the following number of significant digits:
   - 3 for BYTE integers
   - 5 for WORD integers
   - 6 for SINGLE and SFLOAT floating-point numbers
   - 10 for LONG integers
   - 19 for QUAD integers
   - 16 for DOUBLE floating-point numbers
   - 15 for GFLOAT and TFLOAT floating-point numbers
   - 33 for HFLOAT and XFLOAT floating-point numbers
   - 31 for DECIMAL numbers

   Alpha BASIC does not support HFLOAT. VAX BASIC does not support SFLOAT, TFLOAT, XFLOAT, and QUAD.
3. The returned string does not use E-format notation.

## Example

```
DECLARE STRING number
number = NUM1$(PI/2)
PRINT number
```

**Output**

```
1.5708
```

# ON ERROR GO BACK

Under certain conditions, an ON ERROR GO BACK statement executed in a subprogram or DEF function transfers control to the calling program.

**Note**

The ON ERROR GO BACK statement is supported for compatibility with other versions of BASIC. For new program development, it is recommended that you use WHEN blocks.

## Format

{ ONERROR / ON ERROR } GO BACK

## Syntax Rules

The ON ERROR GO BACK statement is illegal inside a protected region or within an attached or detached handler. Use the EXIT HANDLER statement instead.

## Remarks

1. If there is no error outstanding, execution of an ON ERROR GO BACK statement causes subsequent errors to return control to the calling program's error handler.
2. If there is an error outstanding, execution of an ON ERROR GO BACK statement immediately transfers control to the calling program's error handler.
3. By default, DEF functions and subprograms resignal errors to the calling program.
4. The ON ERROR GO BACK statement remains in effect until the program unit completes execution, until BASIC executes another ON ERROR statement, or until BASIC enters a protected region.

5. An ON ERROR GO BACK statement executed in the main program is equivalent to an ON ERROR GOTO 0 statement.
6. If a main program calls a subprogram named SUB1, and SUB1 calls the subprogram named SUB2, an ON ERROR GO BACK statement executed in SUB2 transfers control to SUB1's error handler when an error occurs in SUB2. If SUB1 also has executed an ON ERROR GO BACK statement, BASIC transfers control to the main program's error handling routine.
7. For current program development, see the WHEN ERROR statement.
8. It is not recommended that you mix ON ERROR statements with protected regions in the same program unit. For more information, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## Example

```
IF ERR = 11
   THEN
        RESUME err_hand
   ELSE
        ON ERROR GO BACK
END IF
```

# ON ERROR GOTO

The ON ERROR GOTO statement transfers program control to a specified line or label in the current program unit when an error occurs under certain conditions.

**Note**

The ON ERROR GOTO statement is supported for compatibility with other versions of BASIC. For new program development, it is recommended that you use WHEN blocks.

## Format

{ ONERROR } { GO TO } target
{ ON ERROR } { GOTO }

## Syntax Rules

1. You cannot specify an ON ERROR GOTO statement within a protected region or handler.
2. *Target* must be a valid BASIC line number or label and must exist in the same program unit as the ON ERROR GOTO statement.
3. If an ON ERROR GOTO statement is in a DEF function, *target* must also be in that function definition.

## Remarks

1. BASIC transfers program control to a specified line number or label under two conditions:
   - If an error occurred outside a protected region of a WHEN block
   - If an error occurred within the protected region of a WHEN block and was propagated by the handler associated with the WHEN block
2. Execution of an ON ERROR GOTO statement causes subsequent errors to transfer control to the specified target.

3. The ON ERROR GOTO statement remains in effect until the program unit completes execution or until BASIC executes another ON ERROR statement.
4. BASIC does not allow recursive error handling. If a second error occurs during execution of an error-handling routine, control passes to the BASIC error handler and the program stops executing.
5. For current program development, see the WHEN ERROR statement.
6. It is not recommended that you mix ON ERROR statements with protected regions within the same program unit. For more information, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## Example

```
SUB LIST (STRING A)
DECLARE STRING B
ON ERROR GOTO err_block
OPEN A FOR INPUT AS FILE #1
Input_loop:
   LINPUT #1, B
   PRINT B
   .
   .
   .
   GOTO Input_loop
err_block:
   IF (ERR=11%)
   THEN
      CLOSE #1%
      RESUME done
   ELSE
      ON ERROR GOTO 0
   END IF
done:
END SUB
```

# ON ERROR GOTO 0

The ON ERROR GOTO 0 statement disables ON ERROR error handling and passes control to the BASIC error handler when an error occurs.

**Note**

The ON ERROR GOTO 0 statement is supported for compatibility with other versions of BASIC. For new program development, it is recommended that you use WHEN blocks.

## Format

{ ON ERROR } { GO TO } 0
{ ONERROR } { GOTO }

## Syntax Rules

BASIC does not allow you to specify an ON ERROR GOTO 0 statement within an attached or detached handler or within a protected region.

## Remarks

1. If an error is outstanding, execution of an ON ERROR GOTO 0 statement immediately transfers control to the BASIC error handler. The BASIC error handler will report the error and exit the program.
2. If there is no error outstanding, execution of an ON ERROR GOTO 0 statement causes subsequent errors to transfer control to the BASIC error handler.
3. When an ON ERROR GOTO 0 statement is executed, control is transferred to the BASIC error handler if an error occurred outside a protected region of a WHEN block.
4. If an error occurs within the protected region of a WHEN block and was propagated by the handler associated with the WHEN block, BASIC transfers control to the specified line number or label contained in the subprogram or DEF.

5. For current program development, see the WHEN ERROR statement.
6. It is not recommended that you mix ON ERROR statements with attached or detached handlers within the same program unit. For more information, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## Example

```
ON ERROR GOTO err_routine
FOR I = 1% TO 10%
    PRINT "Please type a number"
    INPUT A
NEXT I
err_routine:
IF ERR = 50
   THEN
      RESUME
   ELSE
      ON ERROR GOTO 0
END IF
```

**Output**

```
Please type a number
? Ctrl/Z

%BAS-F-ILLUSADEV, Illegal usage for device
-BAS-I-ON_CHAFIL, on channel 0 for file SYS$INPUT:[TUTTI]SYSINPUT.DAT;
                                                  at user PC 00000632
-RMS-F-DEV, error in device name or inappropriate device type for operation
-BAS-I-FROLINMOD, from line 10 in module BADUSER
```

# ON...GOSUB

The ON...GOSUB statement transfers program control to one of several subroutines, depending on the value of a control expression.

## Format

ON *int-exp* GOSUB *target* ,... [ OTHERWISE *target ]*

## Syntax Rules

1. *Int-exp* determines which target BASIC selects as the GOSUB argument. If *int-exp* equals 1, BASIC selects the first target. If *int-exp* equals 2, BASIC selects the second target, and so on.
2. *Target* must be a valid BASIC line number or label and must exist in the current program unit.

## Remarks

1. Control cannot be transferred into a statement block (such as FOR...NEXT, UNTIL...NEXT, WHILE...NEXT, DEF...END DEF, SELECT...END SELECT, WHEN...END WHEN, or HANDLER...END HANDLER).
2. If there is an OTHERWISE clause, and if *int-exp* is less than 1 or greater than the number of targets in the list, BASIC selects the target of the OTHERWISE clause.
3. If there is no OTHERWISE clause, and if *int-exp* is less than 1 or greater than the number of targets in the list, BASIC signals "ON statement out of range" (ERR=58).
4. If a target specifies a nonexecutable statement, BASIC transfers control to the first executable statement that lexically follows the target.
5. You can only use the ON...GOSUB statement inside a handler if all the targets are contained within the handler.
6. If you fail to handle an exception that occurs while an ON...GOSUB statement in the body of a subroutine is executing, the exception is handled by the default error handler. The exception is not handled by any WHEN block surrounding the ON...GOSUB statement that invoked the subroutine.

7. You can specify the ON...GOSUB statement inside a WHEN block if the ON...GOSUB target is in the same protected region, an outer protected region, or in a nonprotected region.
8. You cannot specify an ON...GOSUB statement inside a WHEN block if the ON...GOSUB target already resides in another protected region that does not contain the most current protected region.
9. The target cannot be more than 32,767 bytes away from the ON...GOSUB statement.

## Example

```
100    INPUT "Please enter 1, 2 or 3"; A%
       ON A% GOSUB 1000, 2000, 3000 OTHERWISE err_routine
       GOTO done

1000   PRINT "That was a 1"
       RETURN
2000   PRINT "That was a 2"
       RETURN
3000   PRINT "That was a 3"
       RETURN

   err_routine:
      PRINT "Out of range:
      RETURN
   done:
      END PROGRAM
```

# ON...GOTO

The ON...GOTO statement transfers program control to one of several lines or targets, depending on the value of a control expression.

## Format

ON *int-exp* { GO TO / GOTO } *target* ,... [ OTHERWISE target ]

## Syntax Rules

1. *Int-exp* determines which target BASIC selects as the GOTO argument. If *int-exp* equals 1, BASIC selects the first target. If *int-exp* equals 2, BASIC selects the second target, and so on.
2. *Target* must be a valid BASIC line number or a label and must exist in the current program unit.

## Remarks

1. Control cannot be transferred into a statement block (such as FOR...NEXT, UNTIL...NEXT, WHILE...NEXT, DEF...END DEF, SELECT...END SELECT, WHEN...END WHEN, or HANDLER...END HANDLER).
2. If there is an OTHERWISE clause, and if *int-exp* is less than one or greater than the number of targets in the list, BASIC transfers control to the target of the OTHERWISE clause.
3. If there is no OTHERWISE clause, and if *int-exp* is less than 1 or greater than the number of line numbers in the list, BASIC signals "ON statement out of range" (ERR=58).
4. If a target specifies a nonexecutable statement, BASIC transfers control to the first executable statement that lexically follows the target.
5. You can only use the ON...GOTO statement inside a handler if all the targets are contained within the handler.
6. You can specify the ON...GOTO statement inside a WHEN block if the ON...GOTO target is in the same protected region, an outer protected region, or in a nonprotected region.

7. You cannot specify an ON...GOTO statement inside a WHEN block if the ON...GOTO target already resides in another protected region that does not contain the most current protected region.

## Example

```
ON INDEX% GOTO 700,800,900 OTHERWISE finish
   .
   .
   .
finish:
    END PROGRAM
```

# OPEN

The OPEN statement opens a file for processing. It transfers user-specified file characteristics to OpenVMS Record Management Services (RMS) and verifies the results.

## Format

OPEN *file-spec1* [ { FOR INPUT / FOR OUTPUT } ] AS [ FILE ] [#] *chnl-exp*

[, *open-clause* ]...

open-clause:

[ ACCESS { APPEND / READ / WRITE / MODIFY / SCRATCH } ]

[ ALLOW { NONE / READ / WRITE / MODIFY } ]

[ BUFFER *int-exp4* ]

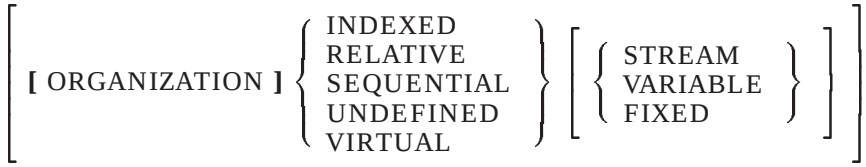
[ CONTIGUOUS ]

[ DEFAULTNAME *file-spec2* ]

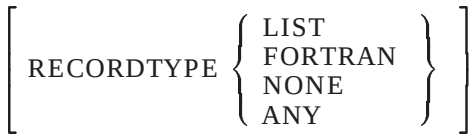
[ EXTENDSIZE *int-exp5* ]

[ FILESIZE *int-exp2* ]

[ MAP *map-name* ]




**[** RECORDSIZE *int-exp1* **]**




**[** TEMPORARY **]**

**[** UNLOCK EXPLICIT **]**

**[** USEROPEN *func-name* **]**

**[** WINDOWSIZE *int-exp3* **]**

**Sequential Files Only**

**[** BLOCKSIZE *int-exp8* **]**

**[** NOREWIND **]**

**[** NOSPAN **]**

**[** SPAN **]**

**Relative and Indexed Files Only**

**[** BUCKETSIZE *int-exp9* **]**

**Indexed Files Only**

```
[ ALTERNATE [ KEY ] key-clause [ DUPLICATES ] [ CHANGES ]
      [ { ASCENDING  }
        { DESCENDING } ]                                  ]

[ CONNECT chnl-exp2 ]

[ PRIMARY [ KEY ] key-clause [ DUPLICATES ] [ { ASCENDING  } ] ]
                                             [ { DESCENDING } ]

key-clause:  { int-unsubs-var
             { decimal-unsubs-var
             { str-unsubs-var
             { (str-unsubs-var1 ,... str-unsubs-var8 )
             { quad-record-group
```

## Syntax Rules

1. *File-spec1* specifies the file to be opened and associated with *chnl-exp*. It can be any valid string expression and must be a valid VMS file specification. BASIC passes these values to RMS without editing, alteration, or validity checks.

   BASIC does not supply any default file specifications, unless you include the **DEFAULTNAME clause** in the OPEN statement.

2. The **FOR clause** determines how BASIC opens a file.

   - If you open a file with FOR INPUT, the file must exist or BASIC signals an error.
   - If you open a file with FOR OUTPUT, BASIC creates the file if it does not exist. If the file does exist, BASIC creates a new version of the file.
   - If you do not use FOR INPUT or FOR OUTPUT to open an indexed file, you must specify a primary key in the event the file does not exist.

- If you do not specify either FOR INPUT or FOR OUTPUT, BASIC tries to open an existing file. If there is no such file, BASIC creates one.

3. *Chnl-exp* is a numeric expression that specifies a channel number to be associated with the file being opened. It can be preceded by an optional number sign (#) and must be in the range of 1 to 119. Note that channels 100 to 119 are usually reserved for allocation by the RTL routines, LIB$GET_LUN and LIB$FREE_LUN.
4. A statement that accesses a file cannot execute until you open that file and associate it with a channel.

## Remarks

1. The OPEN statement does not retrieve records.
2. Channel #0, the terminal, is always open. If you try to open channel zero, BASIC signals the error "Illegal I/O channel" (ERR=46).
3. If a program opens a file on a channel already associated with an open file, BASIC closes the previously opened file and opens the new one.
4. The **ACCESS clause** determines how the program can use the file.
   - ACCESS READ allows only FIND, GET, or other input statements on the file. The OPEN statement cannot create a file if the ACCESS READ clause is specified.
   - ACCESS WRITE allows only PUT, UPDATE, or other output statements on the file.
   - ACCESS MODIFY allows any I/O statement except SCRATCH on the file. ACCESS MODIFY is the default.
   - ACCESS SCRATCH allows any I/O statement valid for a sequential or terminal-format file.
   - ACCESS APPEND is the same as ACCESS WRITE for sequential files, except that BASIC positions the file pointer after the last record when it opens the file. You cannot use ACCESS APPEND on relative or indexed files.

   For an illustration of the interaction of ACCESS and ALLOW, see No. 5.

5. The **ALLOW clause** can be used in the OPEN statement to specify file sharing of relative, indexed, sequential, and virtual files.

   - ALLOW NONE lets no other users access the file. This is the default if any access other than READ is specified. Note that you must have write access to the file to specify ALLOW NONE.
   - ALLOW READ lets other users have read access to the file.
   - ALLOW WRITE lets other users have write access to the file.
   - ALLOW MODIFY lets other users have unlimited access to the file.

   The following scenario may help clarify the interaction of the ACCESS and ALLOW clauses: Suppose you specify ACCESS WRITE and ALLOW READ for a file. Your program then can access and write to the file, but other users (both new and preexisting) can only read the file. However, if another user has already opened the file for writing, an error is signaled. For further information, refer to the OpenVMS Record Management Services (RMS) documentation.

6. The **BUFFER clause** can be used with all file organizations except UNDEFINED.

   - For RELATIVE and INDEXED files, *int-exp4* specifies the number of device or file buffers RMS uses for file processing.
   - For SEQUENTIAL files, *int-exp4* specifies the size of the buffer; for example, BUFFER 8 for a SEQUENTIAL file sets the buffer size to eight 512-byte blocks.
   - It is recommended that you accept the system defaults or change the defaults with the DCL SET RMS_DEFAULT command.

7. The **CONTIGUOUS clause** causes RMS to try to create the file as a contiguous-best-try sequence of disk blocks. The CONTIGUOUS clause does not affect existing files or nondisk files.

   The CONTIGUOUS clause does not guarantee that the file will occupy contiguous disk space. If RMS can locate the file in a contiguous area, it will do so. However, if there is not enough free contiguous space for a file, RMS allocates the largest possible contiguous space and does not signal an error. See the *OpenVMS Record Management Services Reference Manual* for more information about contiguous disk allocation.

8. The **DEFAULTNAME clause** lets you supply a default file specification. If *file-spec1* is not a complete file specification, *file-spec2* in the DEFAULTNAME clause supplies the missing parts. For example:

```
10      INPUT 'FILE NAME';fnam$
20      OPEN fnam$ FOR INPUT AS FILE #1%,   &
                   DEFAULTNAME "USER$$DISK:.DAT"
```

If you type "ABC" for the file name, BASIC tries to open USER$$DISK:[ ]ABC.DAT.

9. The **EXTENDSIZE clause** lets you specify the increment by which RMS extends a file after its initial allocation is filled. The value of *int-exp5* is in 512-byte disk blocks. The EXTENDSIZE clause has no effect on an existing file.
10. The **FILESIZE clause** lets you pre-extend a new file to a specified size.
    - The value of *int-exp2* is the initial allocation of disk blocks.
    - The FILESIZE clause has no effect on an existing file.
11. The **MAP clause** specifies that a previously declared map is associated with the file's record buffer. The MAP clause determines the record buffer's address and length unless overridden by the RECORDSIZE clause.
    - The size of the specified map must be as large or larger than the longest record length or maximum record size. For files with a fixed record size, the specified map must match exactly.
    - The size of the largest MAP with the same map name in the current program unit becomes the file's record size if the OPEN statement does not include a RECORDSIZE clause.
    - It is recommended that you do not use both the MAP and RECORDSIZE clauses in an OPEN statement. However, if you do use both the MAP and RECORDSIZE clauses in an OPEN statement, the following rules apply:
      - The RECORDSIZE clause overrides the record size set by the MAP clause.
      - The map must be as large or larger than the specified RECORDSIZE.
    - If there is no MAP clause, the record buffer space that BASIC allocates is not directly accessible; therefore, MOVE statements are needed to access data in the record buffer.
    - You must have a MAP clause when creating an indexed file; you cannot use KEY clauses without MAP statements because keys serve as offsets into the buffer.
    - The size of the specified map cannot exceed 32,767 bytes.

12. The **ORGANIZATION clause** specifies the file organization. When present, it must precede all other clauses. When you specify an ORGANIZATION clause, you must also specify one of the following organization options: VIRTUAL, UNDEFINED, INDEXED, SEQUENTIAL or RELATIVE. Specify ORGANIZATION UNDEFINED if you do not know the actual organization of the file. If you do not specify an ORGANIZATION clause, BASIC opens a terminal format file by default.

    - When you specify ORGANIZATION VIRTUAL, you create a sequentially fixed file with a record size of 512 (or a multiple of 512). You can then access the file with the FIND, GET, PUT, or UPDATE statements or through one or more virtual arrays. BASIC allows you to overwrite existing records in a file not containing virtual arrays and opened as ORGANIZATION VIRTUAL by using the PUT statement with a RECORD clause. All other organizations require the UPDATE statement to change an existing record. It is recommended that you also use the UPDATE statement to change existing records in VIRTUAL files that do not contain virtual arrays.
    - When you do not know the organization of a file, you can open a file for input and specify ORGANIZATION UNDEFINED. You can then use the FSP$ function or a USEROPEN routine to determine the attributes of the file. You will usually want to specify the RECORDTYPE ANY clause with the ORGANIZATION UNDEFINED clause. The combination of these two clauses should allow you to access any file sequentially.
    - When you specify ORGANIZATION INDEXED, you create an indexed file whose data records are sorted in ascending or descending order according to a *primary index key value*.
        - Use a PRIMARY KEY clause in the OPEN statement.
        - The index keys you specify determine the order in which records are stored.
        - Index keys must be variables declared in a MAP statement associated with the OPEN statement for the file.
        - BASIC allows you to specify an indexed file as either variable or fixed length.
    - When you specify ORGANIZATION SEQUENTIAL, you create a file that stores records in the order that they are written.
        - Sequential files can contain records of any valid BASIC record format: fixed-length, variable-length, or stream.

- If you open an existing file using stream as a record format option, the file must be one of the following stream record formats defined by RMS:
  - STREAM records can be delimited by any special character.
  - STREAM_LF must be delimited by a line-feed character.
  - STREAM_CR must be delimited by a carriage return.

  If the file is not one of these stream formats, BASIC signals the error "RECATTNOT, record attributes not matched."

- When you specify ORGANIZATION RELATIVE, you create a file that contains a series of records that are numbered consecutively. BASIC allows you to specify either fixed-length or variable-length records.
- If you omit the ORGANIZATION clause entirely, a terminal-format file is opened.
  - Terminal-format files are implemented as RMS sequential variable files and store ASCII characters in variable-length records.
  - Carriage control is performed by the operating system; the record does not contain carriage returns or line feeds.
  - You use essentially the same syntax to access terminal-format files as when reading from or writing to the terminal (INPUT and PRINT).

13. The **RECORDSIZE clause** specifies the file's record size. Note that there are restrictions on the maximum record size allowed for various file and record formats. See the *OpenVMS Record Management Services Reference Manual* for more information.
    - For fixed-length records, *int-exp1* specifies the size of all records.
    - For variable-length records, *int-exp1* specifies the size of the largest record.
    - It is recommended that you do not use both the MAP and RECORDSIZE clauses in an OPEN statement. However, if you do use both the MAP and RECORDSIZE clauses in an OPEN statement, the following rules apply:
      - The RECORDSIZE clause overrides the record size set by the MAP clause.
      - The map must be as large or larger than the specified RECORDSIZE.

- If you specify a MAP clause but no RECORDSIZE clause, the record size is equal to the map size.
- If there is no MAP clause, the RECORDSIZE clause determines the record size.
- When creating a relative or indexed file, you must specify either a MAP or RECORDSIZE clause; otherwise, BASIC signals an error.
- For fixed files, the record size must match exactly.
- If you do not specify a RECORDSIZE clause when opening an existing file, BASIC retrieves the record size value from the file.
- When you print to a terminal-format file, you must supply a record size if the margin is to exceed 72 characters. For example, if you want to print a 132-character line, specify RECORDSIZE 132 or use the MARGIN and NOMARGIN statements.
- When creating SEQUENTIAL files, BASIC supplies a default record size of 132.
- The record size is always 512 for VIRTUAL files, unless you specify a RECORDSIZE.

14. The **RECORDTYPE clause** specifies the file's record attributes.
    - LIST specifies implied carriage control, <CR>. This is the default for all file organizations except VIRTUAL.
    - FORTRAN specifies a control character in the record's first byte.
    - NONE specifies no attributes. This is the default for VIRTUAL files.

      If you open a terminal-format file with RECORDTYPE NONE, you must explicitly insert carriage control characters into the records your program writes to the file.
    - ANY specifies a match with any file attributes when opening an existing file. If you create a new file, ANY is treated as LIST for all organizations except VIRTUAL. For VIRTUAL, it is treated as None.
15. The **TEMPORARY clause** causes BASIC to delete the output file as soon as the program closes it.
16. The **UNLOCK EXPLICIT clause** allows you to retain locks on records until they are explicitly unlocked.
    - The type of lock you impose on a record with a GET or FIND statement remains in effect until you explicitly unlock the record or file with a FREE or UNLOCK statement or until you close the file.

- If you specify UNLOCK EXPLICIT, and do not specify an ALLOW clause with a GET or FIND statement, BASIC imposes the ALLOW NONE lock by default and the next GET or FIND operation does not unlock the previously locked record.
- You must open a file with UNLOCK EXPLICIT before you can explicitly lock records with the ALLOW clause on GET and FIND statements. See the sections on GET and FIND and the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about explicit record locking and unlocking.

17. The **USEROPEN clause** lets you open a file with your own FUNCTION subprogram.
    - *Func-name* must be a separately compiled FUNCTION subprogram and must conform to FUNCTION statement rules for naming subprograms.
    - You do not need to declare the USEROPEN routine as an external function.
    - BASIC calls the user program after it fills the FAB (File Access Block), the RAB (Record Access Block), and the XABs (Extended Attribute Blocks). The subprogram must issue the appropriate RMS calls, including $OPEN and $CONNECT, and return the RMS status as the value of the function. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about the USEROPEN routine.

**Note**

Future releases of the OpenVMS Run-Time Library may alter the use of some RMS fields. Therefore, you may have to alter your USEROPEN procedures accordingly.

18. The **WINDOWSIZE clause** followed by *int-exp3* lets you specify the number of block retrieval pointers you want to maintain in memory for the file.

    Retrieval pointers are associated with the file header and point to contiguous blocks on disk.
    - By keeping retrieval pointers in memory you can reduce the I/O associated with locating a record, as the operating system does not have to access the file header for pointers as frequently.

- The number of retrieval pointers in memory at any one time is determined by the system default or by the WINDOWSIZE clause.
- The default number of retrieval pointers on OpenVMS systems is 7.
- A value of zero specifies the default number of retrieval pointers. A value of -1 means to map the entire file, if possible. Values from -128 to -2 are reserved.

19. The **BLOCKSIZE clause** specifies the physical block size of magnetic tape files. The BLOCKSIZE clause can be used for magnetic tape files only.
    - The value of *int-exp8* is the number of records in a block. Therefore, the block size in bytes is the product of the RECORDSIZE and the BLOCKSIZE value.
    - The default blocksize is one record.
20. The **NOREWIND clause** controls tape positioning on magnetic tape files. The NOREWIND clause can be used for magnetic tape files only.
    - If you specify NOREWIND, the OPEN statement does not position the tape at the beginning. Your program can search for records from the current position.
    - If you do not specify either ACCESS APPEND or NOREWIND, the OPEN statement positions the tape at its beginning and then searches for the file.
21. The **NOSPAN clause** specifies that sequential records cannot cross block boundaries.
    - SPAN specifies that records can cross block boundaries. SPAN is the default.
    - The NOSPAN clause does not affect nondisk files.
22. The **BUCKETSIZE clause** applies only to relative and indexed files. It specifies the size of an RMS bucket in terms of the number of records one bucket should hold.
    - The value of *int-exp9* is the number of records in a bucket.
    - The default is one record.
23. The **CONNECT clause** permits multiple record streams to be connected to the file.
    - The CONNECT clause must specify an INDEXED file already opened on *chnl-exp2* with the primary OPEN statement.

- You cannot connect to a connected channel; you can connect only to the initially opened channel.
- You can connect more than one stream to an open channel.
- All clauses of the two files to be connected must be identical except MAP, CONNECT, and USEROPEN.
- Do not use the CONNECT clause when accessing files over DECnet or BASIC will signal the error "Cannot open file" (ERR=162).

24. The **PRIMARY KEY clause** lets you specify an indexed file's key. You must specify a primary key when opening an indexed file. The **ALTERNATE KEY clause** lets you specify up to 254 alternate keys. The ALTERNATE KEY clause is optional.

    - RMS creates one index list for each primary and alternate key you specify. These indexes are part of the file and contain pointers to the records. Each key you specify corresponds to a sorted list of record pointers.
    - You can specify each key as ASCENDING or DESCENDING; ASCENDING is the default. In an ASCENDING key, lower key values occur toward the beginning of the index. In a DESCENDING key, higher key values occur toward the beginning of the index.
    - The keys you specify determine the order in which records in the file are stored. All keys must be variables declared in the file's corresponding MAP statement. The position of the key in the MAP statement determines its position in the record. The data type and size of the key are as declared in the MAP statement.
    - A key can be an unsubscripted string, a WORD, LONG, QUAD, or packed decimal variable, or a record or group that is exactly eight bytes long.
    - You can also create a segmented index key for string keys by separating the string variable names with commas and enclosing them in parentheses. You can then reference a segment of the specified key by referencing one of the string variables instead of the entire key. A string key can have up to eight segments.
    - The order of appearance of keys determines key numbers. The primary key, which must appear first, is key #0. The first alternate key is #1, and so on.

- DUPLICATES in the PRIMARY and ALTERNATE key clauses specifies that two or more records can have the same key value. If you do not specify DUPLICATES, the key value must be unique in all records.
- CHANGES in the ALTERNATE KEY clause specifies that you can change the value of an alternate key when updating records. If you do not specify CHANGES when creating the file, you cannot change the value of a key. You cannot specify CHANGES with the PRIMARY KEY clause.
- KEY clauses are optional for existing files. If you do specify a key, it must match a key in the file.

## Examples

### Example 1

```
OPEN "FILE.DAT" AS FILE #4
```

### Example 2

```
OPEN "INPUT.DAT" FOR INPUT AS FILE #4,                  &
         ORGANIZATION SEQUENTIAL FIXED,                 &
         RECORDSIZE 200,                                &
         MAP ABC,                                       &
         ALLOW MODIFY, ACCESS MODIFY

OPEN Newfile$ FOR OUTPUT AS FILE #3,                    &
         INDEXED VARIABLE,                              &
         MAP Emp_name,                                  &
         DEFAULTNAME "USER$$DISK:.DAT",                 &
         PRIMARY KEY Last$ DUPLICATES,                  &
         ALTERNATE KEY First$ CHANGES

MAP (SEGKEY) STRING last_name = 15,                     &
          MI = 1, first_name = 15

OPEN "NAMES.IND" FOR OUTPUT AS FILE #1,                 &
         ORGANIZATION INDEXED,                          &
         PRIMARY KEY (last_name, first_name, MI),       &
         MAP SEGKEY
```

**Example 3**

```
MAP (OWNERKEYS) STRING owner_id = 6, dog_reg_no = 7,    &
        last_name = 25, first_name = 20

OPEN "OWNERS.IND" FOR OUTPUT AS FILE #1,                &
        ORGANIZATION INDEXED,                           &
        PRIMARY KEY (owner_id),                         &
        ALTERNATE KEY (last_name) DUPLICATES CHANGES,   &
        ALTERNATE (dog_reg_no) DESCENDING,              &
        MAP OWNERKEYS
```

The MAP statement describes the three string variables used as index keys in the file OWNERS.IND. The OPEN statement declares an indexed file with two alternate keys in addition to the primary key. The alternate key *dog_reg_no* is a DESCENDING key; the other keys are ASCENDING by default.

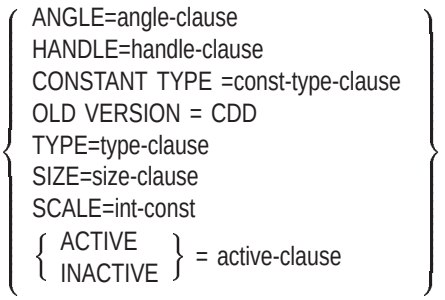
# OPTION

The OPTION statement allows you to set compilation qualifiers such as default data type, size, and scale factor. You can also set compilation conditions such as severity of run-time errors to handle, constant type checking, subscript checking, overflow checking, decimal rounding, and setup in a source program. The options you set affect only the program module in which the OPTION statement occurs.

## Format

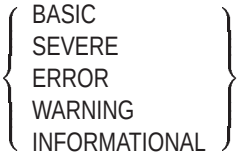
OPTION *option-clause*,...

option-clause:

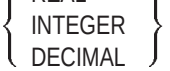


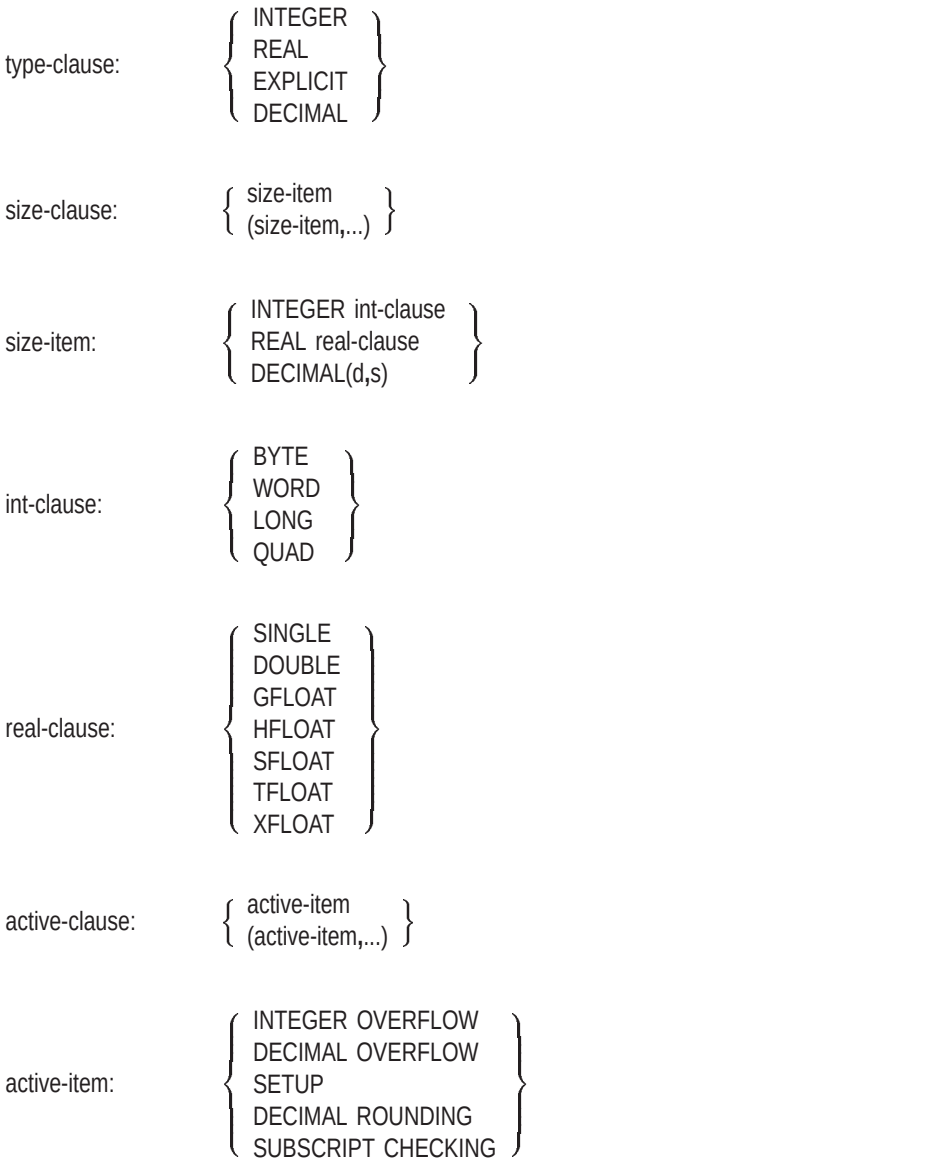

angle-clause:


handle-clause:




const-type-clause:




type-clause:
INTEGER
REAL
EXPLICIT
DECIMAL
size-clause:
size-item
(size-item,...)
size-item:
INTEGER int-clause
REAL real-clause
DECIMAL(d,s)
int-clause:
BYTE
WORD
LONG
QUAD
real-clause:
SINGLE
DOUBLE
GFLOAT
HFLOAT
SFLOAT
TFLOAT
XFLOAT
active-clause:
active-item
(active-item,...)
active-item:
INTEGER OVERFLOW
DECIMAL OVERFLOW
SETUP
DECIMAL ROUNDING
SUBSCRIPT CHECKING

## Syntax Rules

None

## Remarks

1. **Option-clause** specifies the compilation qualifiers to be in effect for the program module.
2. **Angle-clause** specifies whether angles are to be evaluated in radians or in degrees. If you do not specify an *angle-clause*, BASIC uses radians as the default.
3. **Handle-clause** specifies the severity level of the errors that are to be handled by an error handler.
   - If you do not specify an OPTION HANDLE statement, BASIC uses OPTION HANDLE = BASIC as the default. Only those errors that can be trapped and that map onto a BASIC ERR value will transfer control to the current error handler. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for a list of BASIC run-time errors.
   - If you specify a severity level, all errors of the specified severity or less, whether or not they can be trapped, transfer control to the current error handler. This includes non BASIC errors. For example, OPTION HANDLE = ERROR implies ERROR, WARNING, and INFORMATIONAL errors but not SEVERE errors.
   - If you specify OPTION HANDLE = SEVERE, you can handle fatal errors. However, in most cases, a fatal error indicates that the program environment is badly corrupted and you should not continue program execution.
4. **Const-type-clause** specifies the data type for all constants that do not end in a data type suffix or are not in explicit literal notation with a data type supplied.
5. **Type-clause** sets the default data type for variables that have not been explicitly declared and for constants if no constant type clause is specified. You can specify only one *type-clause* in a program module.

6. **Size-clause** sets the default data subtypes for floating-point, integer, and packed decimal data. **Size-item** specifies the data subtype you want to set. You can specify an INTEGER, REAL or DECIMAL *size-item*, or a combination. Multiple *size-items* in an OPTION statement must be enclosed in parentheses and separated by commas.

7. *SCALE* controls the scaling of double precision floating-point variables. *Int-const* specifies the power of 10 you want as the scaling factor. It must be an integer from 0 to 6 or BASIC signals an error. See the description of the SCALE command in Chapter 2 for more information about scaling.

8. *OLD VERSION = CDD* is provided for compatibility with previous versions of BASIC. When bounds are specified in the CDD array, BASIC changes the lower bound to zero and adjusts the upper bound of the array. By default, if you do not specify OLD VERSION = CDD, BASIC compiles the program with the bounds specified in the CDD data definition.

9. **Active-clause** specifies the decimal rounding, integer and decimal overflow checking, setup, and subscript checking conditions you want in effect for the program module. *Active-item* specifies the conditions you want to set. Multiple *active-items* in an OPTION statement must be enclosed in parentheses and separated by commas.

   ACTIVE specifies the conditions that are to be in effect for a particular program module. INACTIVE specifies the conditions that are not to be in effect for a particular program module. If a condition does not appear in an *active-clause*, BASIC uses the current environment default for the condition.

   See the description of the COMPILE command in Chapter 2 and the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about the INTEGER_OVERFLOW, DECIMAL_OVERFLOW, SETUP, DECIMAL_ROUNDING, and SUBSCRIPT_CHECKING compilation qualifiers. These qualifiers correspond to *active-clause* conditions (INTEGER OVERFLOW, DECIMAL OVERFLOW, SETUP, DECIMAL ROUNDING, and SUBSCRIPT CHECKING).

10. You can have more than one option in an OPTION statement, or you can use multiple OPTION statements in a program module. However, each OPTION statement must lexically precede all other source code in the program module, with the exception of comment fields, REM, PICTURE, PROGRAM, SUB, FUNCTION, and OPTION statements.

11. OPTION statement specifications apply only to the program module in which the statement appears and affect all variables in the module, including SUB and FUNCTION parameters.

12. BASIC signals an error in the case of conflicting options. For example, you cannot specify more than one *type-clause* or SCALE factor in the same program unit.
13. If you do not specify a *type-clause* or a *subtype-clause*, BASIC uses the current environment default data types.
14. If you do not specify a scale factor, BASIC uses the current environment default scale factor.

## Example

```
FUNCTION REAL DOUBLE monthly_payment,                  &
        (DOUBLE interest_rate,                         &
          LONG   no_of_payments,                       &
          DOUBLE principle)
OPTION TYPE = REAL,                                    &
       SIZE = (REAL DOUBLE, INTEGER LONG),             &
       SCALE = 4
```

# PLACE$

The PLACE$ function explicitly changes the precision of a numeric string. PLACE$ returns a numeric string, truncated or rounded, according to the value of an integer argument you supply.

## Format

*str-var* = PLACE$ (*str-exp*, *int-exp*)

## Syntax Rules

1. *Str-exp* specifies the numeric string you want to process. It can contain an optional minus sign (-), ASCII digits, and an optional decimal point.
2. *Int-exp* specifies the numeric precision of *str-exp*. Table 4–4 shows examples of rounding and truncation and the values of *int-exp* that produce them.

## Remarks

1. The PLACE$ function does not support E-format notation.
2. If *str-exp* has more than 60 characters, BASIC signals the error "Illegal number" (ERR=52).
3. *Str-exp* is rounded or truncated, or both, according to the value of *int-exp*.
4. If *int-exp* is from -60 to 60, rounding and truncation occur as follows:
   - For positive integer expressions, rounding occurs to the right of the decimal place. For example, if *int-exp* is 1, rounding occurs one digit to the right of the decimal place (the number is rounded to the nearest tenth). If *int-exp* is 2, rounding occurs two digits to the right of the decimal place (the number is rounded to the nearest hundredth), and so on.
   - If *int-exp* is zero, BASIC rounds to the nearest unit.
   - For negative integer expressions, rounding occurs to the left of the decimal point. If *int-exp* is -1, for example, BASIC moves the decimal point one place to the left, then rounds to units. If *int-exp* is -2, rounding occurs two places to the left of the decimal point; BASIC moves the decimal point two places to the left, then rounds to tens.

5. If *int-exp* is from 9940 to 10,060, truncation occurs as follows:
   - If *int-exp* is 10,000, BASIC truncates the number at the decimal point.
   - If *int-exp* is greater than 10,000 (10,000 plus *n*), BASIC truncates the numeric string *n* places to the right of the decimal point. For example, if *int-exp* is 10,001 (10,000 plus 1), BASIC truncates the number starting one place to the right of the decimal point. If *int-exp* is 10,002 (10,000 plus 2), BASIC truncates the number starting two places to the right of the decimal point, and so on.
   - If *int-exp* is less than 10,000 (10,000 minus *n*), BASIC truncates the numeric string *n* places to the left of the decimal point. For example, if *int-exp* is 9999 (10,000 minus 1), BASIC truncates the number starting one place to the left of the decimal point. If *int-exp* is 9998 (10,000 minus 2), BASIC truncates starting two places to the left of the decimal point, and so on.
6. If *int-exp* is not from -60 to 60 or 9940 to 10,060, BASIC returns a value of zero.
7. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.
8. Table 4–4 shows examples of rounding and truncation and the values of *int-exp* that produce them. The number used is 123456.654321.

**Table 4–4 Rounding and Truncation of 123456.654321**

| Int-exp | Effect | Value Returned |
|---|---|---|
| -5 | Rounded to 100,000s and truncated | 1 |
| -4 | Rounded to 10,000s and truncated | 12 |
| -3 | Rounded to 1000s and truncated | 123 |
| -2 | Rounded to 100s and truncated | 1235 |
| -1 | Rounded to 10s and truncated | 12346 |
| 0 | Rounded to units and truncated | 123457 |
| 1 | Rounded to tenths and truncated | 123456.7 |
| 2 | Rounded to hundredths and truncated | 123456.65 |
| 3 | Rounded to thousandths and truncated | 123456.654 |
| 4 | Rounded to ten-thousandths and truncated | 123456.6543 |

(continued on next page)

**Table 4–4 (Cont.) Rounding and Truncation of 123456.654321**

| Int-exp | Effect | Value Returned |
|---|---|---|
| 5 | Rounded to hundred-thousandths and truncated | 123456.65432 |
| 9,995 | Truncated to 100,000s | 1 |
| 9,996 | Truncated to 10,000s | 12 |
| 9,997 | Truncated to 1000s | 123 |
| 9,998 | Truncated to 100s | 1234 |
| 9,999 | Truncated to 10s | 12345 |
| 10,000 | Truncated to units | 123456 |
| 10,001 | Truncated to tenths | 12345.6 |
| 10,002 | Truncated to hundredths | 123456.65 |
| 10,003 | Truncated to thousandths | 123456.654 |
| 10,004 | Truncated to ten-thousandths | 123456.6543 |
| 10,005 | Truncated to hundred-thousandths | 123456.65432 |

## Example

```
DECLARE STRING str_exp, str_var
str_exp = "9999.9999"
str_var = PLACE$(str_exp,3)
PRINT str_var
```

**Output**

```
10000
```

# POS

The POS function searches for a substring within a string and returns the substring's starting character position.

## Format

*int-var* = POS (*str-exp1*, str-exp2, *int-exp*)

## Syntax Rules

1. *Str-exp1* specifies the main string.
2. *Str-exp2* specifies the substring.
3. *Int-exp* specifies the character position in the main string at which BASIC starts the search.

## Remarks

1. The POS function searches *str-exp1*, the main string, for the first occurrence of *str-exp2*, the substring, and returns the position of the substring's first character.
2. If *int-exp* is greater than the length of the main string, POS returns a value of zero.
3. POS always returns the character position in the main string at which BASIC finds the substring, with the following exceptions:
   - If only the substring is null, and if *int-exp* is less than or equal to zero, POS returns a value of 1.
   - If only the substring is null, and if *int-exp* is equal to or greater than 1 and less than or equal to the length of the main string, POS returns the value of *int-exp*.
   - If only the substring is null and if *int-exp* is greater than the length of the main string, POS returns the main string's length plus 1.
   - If only the main string is null, POS returns a value of zero.
   - If both the main string and the substring are null, POS returns 1.

4. If BASIC cannot find the substring, POS returns a value of zero.
5. If *int-exp* is less than 1, BASIC assumes a starting position of 1.
6. If *int-exp* does not equal 1, BASIC still counts from the string's beginning to calculate the starting position of the substring. That is, BASIC counts character positions starting at position 1, regardless of where you specify the start of the search. For example, if you specify 10 as the start of the search and BASIC finds the substring at position 15, POS returns the value 15.
7. If you know that the substring is not near the beginning of the string, specifying a starting position greater than 1 speeds program execution by reducing the number of characters BASIC must search.
8. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE STRING main_str,   &
              sub_str
DECLARE INTEGER  first_char
main_str = "ABCDEFG"
sub_str = "DEF"
first_char = POS(main_str, sub_str, 1)
PRINT first_char
```

**Output**

```
 4
```

# PRINT

The PRINT statement transfers program data to a terminal or a terminal-format file.

## Format

PRINT [ *#chnl-exp* , ] [ *output-list* ]

output-list: [ exp ] [ { , ; } exp ]... [ , ; ]

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#). If you do not specify a channel, BASIC prints to the controlling terminal.
2. *Output-list* specifies the expressions to be printed and the print format to be used.
3. *Exp* can be any valid expression.
4. A separator character (comma or semicolon) must separate each *exp*. Separator characters control the print format as follows:
   - A comma (,) causes BASIC to skip to the next print zone before printing the expression.
   - A semicolon (;) causes BASIC to print the expression immediately after the previous expression.

## Remarks

1. A terminal or terminal-format file must be open on the specified channel. (Your current terminal is always open on channel #0.)
2. A PRINT line has an integral number of print zones. Note, however, that the number of print zones in a line differs from terminal to terminal.

3. The right margin setting, if set by the MARGIN statement, controls the width of the PRINT line. The default right margin is 72.
4. The PRINT statement prints string constants and variables exactly as they appear, with no leading or trailing spaces.
5. BASIC prints quoted string literals exactly as they appear. Therefore, you can print quotation marks, commas, and other characters by enclosing them in quotation marks.
6. A PRINT statement with no *output-list* prints a blank line.
7. An expression in the *output-list* can be followed by more than one separator character. That is, you can omit an expression and specify where the next expression is to be printed by the use of multiple separator characters. For example:

   ```
   PRINT "Name",,"Address and ";"City"
   ```

   **Output**

   ```
   Name                        Address and City
   ```

   In this example, the double commas after "Name" cause BASIC to skip two print zones before printing "Address and ". The semicolon causes the next expression, "City", to be printed immediately after the preceding expression. Multiple semicolons have the same effect as a single semicolon.
8. When printing numeric fields, BASIC precedes each number with a space or minus sign (-) and follows it with a space.
9. BASIC does not print trailing zeros to the right of the decimal point. If all digits to the right of the decimal point are zeros, BASIC omits the decimal point as well.
10. For REAL numbers (SINGLE, DOUBLE, GFLOAT, SFLOAT, TFLOAT, XFLOAT, and HFLOAT), BASIC does not print more than 6 digits in explicit notation. If a number requires more than 6 digits, BASIC uses E format and precedes positive exponents with a plus sign (+). BASIC rounds a floating-point number with a magnitude from 0.1 to 1.0 to 6 digits. For magnitudes smaller than 0.1, BASIC rounds the number to 6 digits and prints it in E format.
11. The PRINT statement can print up to:
    - Three digits of precision for BYTE integers
    - Five digits of precision for WORD integers
    - Ten digits of precision for LONG integers

- Nineteen digits of precision for QUAD integers
- Thirty-one digits of precision for DECIMAL numbers
- The string length for STRING values

BASIC prints both INTEGER and DECIMAL values according to the previous rules. However, for REAL values, BASIC displays a maximum of 6 digits.

12. If there is a comma or semicolon following the last item in *output-list*, BASIC does the following:
    - When printing to a terminal, BASIC does not generate a line terminator after printing the last item. The next item printed with a PRINT statement is printed at the position specified by the separator character following the last item in the first PRINT statement.
    - When printing to a terminal-format file, BASIC does not write out the record until a PRINT statement without trailing punctuation executes.
13. If no punctuation follows the last item in the *output-list*, BASIC does the following:
    - When printing to a terminal, BASIC generates a line terminator after printing the last item.
    - When printing to a terminal-format file, BASIC writes out the record after printing the last item.
14. If a string field does not fit on the current line, BASIC does the following:
    - When printing string elements to a terminal, BASIC prints as much as will fit on the current line and prints the remainder on the next line.
    - When printing string elements to a terminal-format file, BASIC prints the entire element on the next line.
15. If a numeric field is the first field in a line, and the numeric field spans more than one line, BASIC prints part of the number on one line and the remainder on the next; otherwise, numeric fields are never split across lines. If the entire field cannot be printed at the end of one line, the number is printed on the next line.
16. When a number's trailing space does not fit in the last print zone, the number is printed without the trailing space.

## Example

```
PRINT "name "; "age", "height "; "weight"
```

**Output**

```
name age       height weight
```

# PRINT USING

The PRINT USING statement generates output formatted according to a format string (either numeric or string) to a terminal or a terminal-format file.

## Format

PRINT [ *#chnl-exp* ] USING *str-exp* { , ; } output-list

output-list: [ exp ] [ { , ; } exp ]... [ , ; ]

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#). If you do not specify a channel, BASIC prints to the controlling terminal.
2. *Str-exp* is the format string. It must contain at least one valid format field and must be followed by a separator (comma or semicolon) and at least one expression.

   **Note**

   It is recommended that you use compile-time constant expressions for *str-exp* whenever possible. When you do this, the BASIC compiler compiles the string at compilation time rather than at run time, thus improving the performance of your program.

3. *Output-list* specifies the expressions to be printed.
   - *Exp* can be any valid expression.
   - A comma or semicolon must separate each expression.
   - A comma or semicolon is optional after the last expression in the list.

## Remarks

1. The PRINT USING statement can print up to:
   - Three digits of precision for BYTE integers
   - Five digits of precision for WORD integers
   - Ten digits of precision for LONG integers
   - Nineteen digits of precision for QUAD integers
   - Six digits of precision for SINGLE floating-point numbers
   - Sixteen digits of precision for DOUBLE floating-point numbers
   - Fifteen digits of precision for GFLOAT floating-point numbers
   - Thirty-three digits of precision for HFLOAT floating-point numbers
   - Six digits of precision for SFLOAT floating-point numbers
   - Fifteen digits of precision for TFLOAT floating-point numbers
   - Thirty-three digits of precision for XFLOAT floating-point numbers
   - Thirty-one digits of precision for DECIMAL numbers
   - The string length for STRING values
2. A terminal or terminal-format file must be open on the specified channel or BASIC signals an error.
3. The separator characters (comma or semicolon) in the PRINT USING statement do not control the print format as in the PRINT statement. The print format is controlled by the format string; therefore, it does not matter whether you use a comma or semicolon.
4. Formatting Numeric Output
   - The number sign (#) reserves space for one sign or digit.
   - The comma (,) causes BASIC to insert commas before every third significant digit to the left of the decimal point. In the format field, the comma must be to the left of the decimal point, and to the right of the rightmost dollar sign, asterisk, or number sign. A comma reserves space for a comma or digit.
   - The period (.) inserts a decimal point. The number of reserved places on either side of the period determines where the decimal point appears in the output.

- The hyphen (-) reserves space for a sign and specifies trailing minus sign format. If present, it must be the last character in the format field. It causes BASIC to print negative numbers with a minus sign after the last digit, and positive numbers with a trailing space. The hyphen (-) can be used as part of a dollar sign ($$) format field.
- The letters CD (Credit/Debit) enclosed in angle brackets (<CD>) print CR (Credit Record) after negative numbers or zero and DR (Debit Record) after positive numbers. If present, they must be the last characters in the format field. The Credit/Debit format can be used as part of a dollar sign ($$) format field.
- Four carets(^^^^) specify E-format notation for floating-point and DECIMAL numbers. They reserve four places for SINGLE, DOUBLE, SFLOAT, and DECIMAL values; five places for GFLOAT and TFLOAT values; and six places for HFLOAT and XFLOAT values. If present, they must be the last characters in the format field.
- Two dollar signs ($$) reserve space for a dollar sign and a digit and cause BASIC to print a dollar sign immediately to the left of the most significant digit.
- Two asterisks (**) reserve space for two digits and cause BASIC to fill the left side of the numeric field with leading asterisks.
- A zero enclosed in angle brackets (<0>) prints leading zeros instead of leading spaces.
- A percent sign enclosed in angle brackets (<%>) prints all spaces in the field if the value of the print item is zero.

**Note**

You cannot specify the dollar sign ($$), asterisk-fill (**), and zero-fill (<0>) formats within the same print field. Similarly, BASIC does not allow you to specify the zero-fill (<0>) and the blank-if-zero (<%>) formats within the same print field.

- An underscore (_) forces the next formatting character in the format string to be interpreted as a literal. It affects only the next character. If the next character is not a valid formatting character, the underscore has no effect and will itself be printed as a literal.

5. BASIC interprets any other characters in a numeric format string as string literals.

6. Depending on usage, the same format string characters can be combined to form one or more print fields within a format string. For example:

   - When a dollar sign (\$\$) or asterisk-fill (**) format precedes a number sign (#) , it modifies the number sign format. The dollar sign or asterisk-fill format reserves two places, and with the number signs forms one print field. For example:

     | | |
     |---|---|
     | \$\$### | Forms one field and reserves five spaces |
     | **## | Forms one field and reserves four spaces |

     When these formats are not followed by a number sign or a blank-if-zero (<%>) format, they reserve two places and form a separate print field.

   - When a zero-fill (<0>) or blank-if-zero format precedes a number sign, it modifies the number sign format. The <0> or <%> reserves one place, and with the number signs forms one print field. For example:

     | | |
     |---|---|
     | <0>#### | Forms one field and reserves five spaces |
     | <%>### | Forms one field and reserves four spaces |

     When these formats are not followed by a number sign, they reserve one space and form a separate print field.

   - When a blank-if-zero (<%>) format follows a dollar sign or asterisk-fill format (**), it modifies the dollar sign (\$\$) or asterisk fill (**) format string. The blank-if-zero reserves one space, and with the dollar signs or asterisks forms one print field. For example:

     | | |
     |---|---|
     | \$\$<%>### | Forms one field and reserves six spaces |
     | **<%>## | Forms one field and reserves five spaces |

     When the blank-if-zero precedes the dollar signs or asterisks, it reserves one space and forms a separate print field.

7. The comma (digit separator), dollar sign (currency symbol), and decimal point (radix point) are the defaults for U.S. currency. On VMS systems, you can change the digit separator, currency symbol and radix point by assigning the logical names SYS\$DIGIT_SEP, SYS\$CURRENCY and SYS\$RADIX_POINT. Once you make each assignment, the PRINT USING statement accesses these logical names for these symbols.

8. For E-format notation, PRINT USING left-justifies the number in the format field and adjusts the exponent to compensate, except when printing zero. When printing zero in E-format notation, BASIC prints leading spaces, leading zeros, a decimal point, and zeros in the fractional portion if

the PRINT USING string contains these formatting characters, and then the string "E+00".

9. Zero cannot be negative. If a small negative number rounds to zero, it is represented as a positive zero.
10. If there are reserved positions to the left of the decimal point, and the printed number is less than 1, BASIC prints one zero to the left of the decimal point and pads with spaces to the left of the zero.
11. If there are more reserved positions to the right of the decimal point than fractional digits, BASIC prints trailing zeros in those positions.
12. If there are fewer reserved positions to the right of the decimal point than fractional digits, BASIC rounds the number to fit the reserved positions.
13. If a number does not fit in the specified format field, BASIC prints a percent sign warning symbol (%), followed by the number in PRINT format.
14. Formatting String Output
    - Format string characters control string output and can be entered as either uppercase or lowercase characters. All format characters except the backslash and exclamation point must start with a single quotation mark ('). A single quote by itself reserves one character position. A single quote followed by any format characters marks the beginning of a character format field and reserves one character position.
    - L reserves one character position. The number of Ls plus the leading single quote determines the field's size. BASIC left-justifies the print expression and pads with spaces if the print expression is less than or equal to the field's width. If the print expression is larger than the field, BASIC left-justifies the expression and truncates its right side to fit the field.
    - R reserves one character position. The number of Rs plus the leading single quote determines the field's size. BASIC right-justifies the print expression and pads with spaces if the print expression is less than or equal to the field's width. If the print expression is larger than the field, BASIC truncates the right side to fit the field.
    - C reserves one character position. The number of Cs plus the leading single quote determines the field's size. If the string does not fit in the field, BASIC truncates its right side; otherwise, BASIC centers the print expression in this field. If the string cannot be centered exactly, it is offset one character to the left.

- E reserves one character position. The number of Es plus the leading single quote determines the field's size. BASIC left-justifies the print expression if it is less than or equal to the field's width and pads with spaces; otherwise, BASIC expands the field to hold the entire print expression.
- Two backslashes (\ \) when separated by *n* spaces reserve *n*+2 character positions. PRINT USING left-justifies the string in this field. BASIC does not allow a leading quotation mark with this format.
- An exclamation point (!) creates a 1-character field. The exclamation point both starts and ends the field. BASIC does not allow a leading quotation mark with this format.

15. BASIC interprets any other characters in the format string as string literals and prints them exactly as they appear.
16. If a comma or semicolon follows the last item in *output-list*:
    - When printing to a terminal, BASIC does not generate a line terminator after printing the last item. The next item printed with a PRINT statement is printed at the position specified by the separator character following the last item in the first PRINT statement.
    - When printing to a terminal-format file, BASIC does not write out the record until a PRINT statement without trailing punctuation executes.
17. If no punctuation follows the last item in *output-list*:
    - When printing to a terminal, BASIC generates a line terminator after printing the last item.
    - When printing to a terminal-format file, BASIC writes out the record after printing the last item.

## Examples

### Example 1

```
PRINT USING "###.###",-12.345
PRINT USING "##.###",12.345
```

**Output**

```
-12.345
12.345
```

### Example 2

```
INPUT "Your Name";Winner$
       Jackpot = 10000.0
PRINT USING "CONGRATULATIONS, 'EEEEEEEEE, YOU WON $$#####.##", Winner$, Jackpot
END
```

**Output**

```
Your Name? Hortense Corabelle
CONGRATULATIONS, Hortense Corabelle, YOU WON $10000.00
```

# PROD$

The PROD$ function returns a numeric string that is the product of two numeric strings. The precision of the returned numeric string depends on the value of an integer argument.

## Format

*str-var* = PROD$ (*str-exp1*, *str-exp2*, *int-exp*)

## Syntax Rules

1. *Str-exp1* and *str-exp2* specify the numeric strings you want to multiply. A numeric string can contain an optional minus sign (-), ASCII digits, and an optional decimal point (.).
2. If *str-exp* consists of more than 60 characters, BASIC signals the error "Illegal number" (ERR=52).
3. *Int-exp* specifies the numeric precision of *str-exp*. Table 4–4 shows examples of rounding and truncation and the values of *int-exp* that produce them.

## Remarks

1. The PROD$ function does not support E-format notation.
2. *Str-exp* is rounded or truncated, or both, according to the value of *int-exp*.
3. If *int-exp* is from -60 to 60, rounding and truncation occur as follows:
   - For positive integer expressions, rounding occurs to the right of the decimal place. For example, if *int-exp* is 1, rounding occurs one digit to the right of the decimal place (the number is rounded to the nearest tenth). If *int-exp* is 2, rounding occurs two digits to the right of the decimal place (the number is rounded to the nearest hundredth), and so on.
   - If *int-exp* is zero, BASIC rounds to the nearest unit.

- For negative integer expressions, rounding occurs to the left of the decimal point. If *int-exp* is -1, for example, BASIC moves the decimal point one place to the left, then rounds to units. If *int-exp* is -2, rounding occurs two places to the left of the decimal point; BASIC moves the decimal point two places to the left, then rounds to tens.

4. If *int-exp* is from 9940 to 10,060, truncation occurs as follows:
   - If *int-exp* is 10,000, BASIC truncates the number at the decimal point.
   - If *int-exp* is greater than 10,000 (10000 plus *n*), BASIC truncates the numeric string *n* places to the right of the decimal point. For example, if *int-exp* is 10,001 (10,000 plus 1), BASIC truncates the number starting one place to the right of the decimal point. If *int-exp* is 10,002 (10,000 plus 2), BASIC truncates the number starting two places to the right of the decimal point, and so on.
   - If *int-exp* is less than 10,000 (10,000 minus *n*), BASIC truncates the numeric string *n* places to the left of the decimal point. For example, if *int-exp* is 9999 (10,000 minus 1), BASIC truncates the number starting one place to the left of the decimal point. If *int-exp* is 9998 (10,000 minus 2), BASIC truncates starting two places to the left of the decimal point, and so on.
5. If *int-exp* is not from -60 to 60 or 9940 to 10,060, BASIC returns a value of zero.
6. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE STRING num_exp1, &
              num_exp2, &
              product
num_exp1 = "34.555"
num_exp2 = "297.676"
product = PROD$(num_exp1, num_exp2, 1)
PRINT product
```

**Output**

```
10286.2
```

# PROGRAM

The PROGRAM statement allows you to identify a main program with a name other than the file name.

## Format

PROGRAM *prog-name*

## Syntax Rules

1. *Prog-name* specifies the module name of the compiled source and cannot be the same as any SUB, FUNCTION, or PICTURE name.
2. *Prog-name* also defines the global entry point name for the main program.
3. The first character of a *prog-name* must be an alphabetic character (A to Z). The remaining characters, if any, can be any combination of alphabetic characters, digits (0 to 9), dollar signs ($), periods (.), and underscores (_).
4. *Prog-name* cannot be a quoted name.

## Remarks

1. The PROGRAM statement must be the first statement in a main program and can be preceded only by comment fields and lexical directives.
2. If you insert the program into a text or object library or examine it using the OpenVMS Debugger, the program name you specify will be the module name used.
3. A PROGRAM statement does not require a matching END PROGRAM statement.
4. The PROGRAM statement is optional; BASIC allows you to specify an END PROGRAM statement and an EXIT PROGRAM statement without a matching PROGRAM statement.

## Example

```
PROGRAM first_test
   .
   .
   .
END PROGRAM
```

# PUT

The PUT statement transfers data from the record buffer to a file. PUT statements are valid on RMS sequential, relative, and indexed files. You cannot use PUT statements on terminal-format files or virtual array files.

## Format

PUT #*chnl-exp* [ , RECORD *num-exp*] [ , COUNT *int-exp* ]

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. The RECORD clause allows you to randomly write records to a relative or sequential fixed file by specifying the record number. *Num-exp* must be between 1 and the maximum record number allowed for the file. BASIC does not allow you to use the RECORD clause on sequential variable, sequential stream, or indexed files.
3. *Int-exp* in the COUNT clause specifies the record's size. If there is no COUNT clause, the record's size is that defined by the MAP or RECORDSIZE clause in the OPEN statement. The RECORDSIZE clause overrides the MAP clause.
   - If you write a record to a file with variable-length records, *int-exp* must be between zero and the maximum record size specified in the OPEN statement.
   - If you write a record to a file with fixed-length records, the COUNT clause serves no purpose. If used, *int-exp* must equal the record size specified in the OPEN statement.

## Remarks

1. For sequential access, the file associated with *chnl-exp* must be open with ACCESS WRITE, MODIFY, SCRATCH, or APPEND.
2. To add records to an existing sequential file, open it with ACCESS APPEND. If you are not at the end of the file when attempting a PUT to a sequential file, BASIC signals "Not at end of file" (ERR=149).
3. After a PUT statement executes, there is no current record pointer. The next record pointer is set as follows:
   - For sequential files, variable and stream PUT operations set the next record pointer to the end of the file.
   - For relative files, a sequential PUT operation sets the next record pointer to the next record plus 1.
   - For relative and sequential fixed files, a random PUT operation leaves the next record pointer unchanged.
   - For indexed files, a PUT operation leaves the next record pointer unchanged.
4. When you specify a RECORD clause, BASIC evaluates *num-exp* and uses this value as the relative record number of the target cell.
   - If the target cell is empty or occupied by a deleted record, BASIC places the record in that cell.
   - If there is a record in the target cell and the file has not been opened as a VIRTUAL file, the PUT statement fails, and BASIC signals the error "Record already exists" (ERR=153).
5. A PUT statement with no RECORD clause writes records to the file as follows:
   - For sequential variable and stream files, a PUT operation adds a record at the end of the file.
   - For relative and sequential fixed files, a PUT operation places the record in the empty cell pointed to by the next record pointer. If the file is empty, the first PUT operation places a record in cell number 1, the second in cell number 2, and so on.
   - For indexed files, RMS stores records in order of ascending primary key value and updates all indexes so that they point to the record.

6. When you open a file as ORGANIZATION VIRTUAL, the file you open is a sequential fixed file with a record size that is a multiple of 512 bytes. You can then access the file with the FIND, GET, PUT, or UPDATE statements or through one or more virtual arrays. BASIC allows you to overwrite existing records in a file not containing virtual arrays and opened as ORGANIZATION VIRTUAL by using the PUT statement with a RECORD clause. All other organizations require the UPDATE statement to change an existing record. It is recommended that you also use the UPDATE statement to change existing records in VIRTUAL files that do not contain virtual arrays.
7. If an existing record in an indexed file has a record with the same key value as the one you want to put in the file, BASIC signals the error "Duplicate key detected" (ERR=134) if you did not specify DUPLICATES for the key in the OPEN statement. If you specified DUPLICATES, RMS stores the duplicate records in a first-in/first-out sequence.
8. The number specified in the COUNT clause determines how many bytes are transferred from the buffer to a file:
   - If you have not completely filled the record buffer before executing a PUT statement, BASIC pads the record with nulls to equal the specified value.
   - If the specified COUNT value is less than the buffer size, the record is truncated to equal the specified value.
   - The number in the COUNT clause must not exceed the size specified in the MAP or RECORDSIZE clause in the OPEN statement or BASIC signals "Size of record invalid" (ERR=156).
   - For files with fixed length records, the number in the COUNT clause must match the record size.

## Examples

### Example 1

```
!Sequential, Relative, Indexed, and Virtual Files
PUT #3, COUNT 55%
```

### Example 2

```
!Relative and Virtual Files Only
PUT #5, RECORD 133, COUNT 16%
```

# QUO$

The QUO$ function returns a numeric string that is the quotient of two numeric strings. The precision of the returned numeric string depends on the value of an integer argument.

## Format

*str-var* = QUO$ (*str-exp1*, *str-exp2*, *int-exp*)

## Syntax Rules

1. *Str-exp1* and *str-exp2* specify the numeric strings you want to divide. A numeric string can contain an optional minus sign (-), ASCII digits, and an optional decimal point (.).
2. *Int-exp* specifies the numeric precision of *str-exp*. Table 4–4 shows examples of rounding and truncation and the values of *int-exp* that produce them.

## Remarks

1. The QUO$ function does not support E-format notation.
2. If *str-exp* consists of more than 60 characters, BASIC signals the error "Illegal number" (ERR=52).
3. *Str-exp* is rounded or truncated, or both, according to the value of *int-exp*.
4. If *int-exp* is from -60 to 60, rounding and truncation occur as follows:
   - For positive integer expressions, rounding occurs to the right of the decimal place. For example, if *int-exp* is 1, rounding occurs one digit to the right of the decimal place (the number is rounded to the nearest tenth). If *int-exp* is 2, rounding occurs two digits to the right of the decimal place (the number is rounded to the nearest hundredth), and so on.
   - If *int-exp* is zero, BASIC rounds to the nearest unit.

- For negative integer expressions, rounding occurs to the left of the decimal point. If *int-exp* is -1, for example, BASIC moves the decimal point one place to the left, then rounds to units. If *int-exp* is -2, rounding occurs two places to the left of the decimal point; BASIC moves the decimal point two places to the left, then rounds to tens.

5. If *int-exp* is from 9940 to 10,060, truncation occurs as follows:
   - If *int-exp* is 10,000, BASIC truncates the number at the decimal point.
   - If *int-exp* is greater than 10,000 (10,000 plus *n*), BASIC truncates the numeric string *n* places to the right of the decimal point. For example, if *int-exp* is 10,001 (10,000 plus 1), BASIC truncates the number starting one place to the right of the decimal point. If *int-exp* is 10,002 (10,000 plus 2), BASIC truncates the number starting two places to the right of the decimal point, and so on.
   - If *int-exp* is less than 10,000 (10,000 minus *n*), BASIC truncates the numeric string *n* places to the left of the decimal point. For example, if *int-exp* is 9999 (10,000 minus 1), BASIC truncates the number starting one place to the left of the decimal point. If *int-exp* is 9998 (10,000 minus 2), BASIC truncates starting two places to the left of the decimal point, and so on.
6. If *int-exp* is not from -60 to 60 or 9940 to 10,060, BASIC returns a value of zero.
7. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE STRING num_str1,  &
              num_str2,  &
              quotient
num_str1 = "458996.43"
num_str2 = "123222.444"
quotient = QUO$(num_str1, num_str2, 2)
PRINT quotient
```

**Output**

```
3.72
```

# RAD$

The RAD$ function converts a specified integer in Radix-50 format to a 3-character string.

**Note**

The RAD$ function is supported only for compatibility with BASIC-PLUS-2. It is recommended that you do not use the RAD$ function for new program development.

## Format

*str-var* = RAD$ (*int-var*)

## Syntax Rules

None

## Remarks

1. The RAD$ function does not support E-format notation.
2. The RAD$ function converts *int-var* to a 3-character string in Radix-50 format and stores it in *str-var*. Radix-50 format allows you to store three characters of data as a 2-byte integer.
3. BASIC supports the RAD$ function, but not its complement, the FSS$ function.
4. If you specify a floating-point variable for *int-var*, BASIC truncates it to an integer of the default size.

## Example

```
DECLARE STRING radix
radix = RAD$(999)
```

# RANDOMIZE

The RANDOMIZE statement gives the random number function, RND, a new starting value.

## Format

```
{ RANDOMIZE }
{ RANDOM    }
```

## Syntax Rules

None

## Remarks

1. Without the RANDOMIZE statement, successive runs of the same program generate the same random number sequence.
2. If you use the RANDOMIZE statement before invoking the RND function, the starting point changes for each run. Therefore, a different random number sequence appears each time.

## Example

```
DECLARE REAL random_num
RANDOMIZE
    FOR I = 1 TO 2
       random_num = RND
       PRINT random_num
    NEXT I
```

**Output**

```
 .379784
 .311572
```

# RCTRLC

The RCTRLC function disables Ctrl/C trapping.

## Format

*int-var* = RCTRLC

## Syntax Rules

None

## Remarks

1. After BASIC executes the RCTRLC function, Ctrl/C typed at the terminal returns you to DCL command level or to the VAX BASIC Environment.
2. RCTRLC always returns a value of zero.

## Example

```
Y = RCTRLC
```

# RCTRLO

The RCTRLO function cancels the effect of Ctrl/O typed on a specified channel.

## Format

*int-var* = RCTRLO (*chnl-exp*)

## Syntax Rules

*Chnl-exp* must refer to a terminal.

## Remarks

1. If you type Ctrl/O to cancel terminal output, nothing is printed on the specified terminal until your program executes the RCTRLO or until you enter another Ctrl/O, at which time normal terminal output resumes.
2. The RCTRLO function always returns a value of zero.
3. RCTRLO has no effect if the specified channel is open to a device that does not use the Ctrl/O convention.

## Example

```
PRINT "A" FOR I% = 1% TO 10%
Y% =  RCTRLO(0%)
PRINT "Normal output is resumed"
```

**Output**

```
A
A
A
A
Ctrl/O
Output off

Normal output is resumed
```

# READ

The READ statement assigns values from a DATA statement to variables.

## Format

READ *var*,...

## Syntax Rules

*Var* cannot be a DEF function name, unless the READ statement is inside the multiline DEF body.

## Remarks

1. If your program has a READ statement without DATA statements, BASIC signals a compile-time error.
2. When BASIC initializes a program unit, it forms a data sequence of all values in all DATA statements. An internal pointer points to the first value in the sequence.
3. When BASIC executes a READ statement, it sequentially assigns values from the data sequence to variables in the READ statement variable list. As BASIC assigns each value, it advances the internal pointer to the next value.
4. BASIC signals the error "Out of data" (ERR=57) if there are fewer data elements than READ statements. Extra data elements are ignored.
5. The data type of the value must agree with the data type of the variable to which it is assigned or BASIC signals "Data format error" (ERR=50).
6. If you read a string variable, and the DATA element is an unquoted string, BASIC ignores leading and trailing spaces. If the DATA element contains any commas, they must be inside quotation marks.

7. BASIC evaluates subscript expressions in the variable list after it assigns a value to the preceding variable, and before it assigns a value to the subscripted variable. In the following example, BASIC assigns the value of 10 to variable *A*, then assigns the string, LESTER, to array element *A$(A)*.

```
READ A, A$(A)
   .
   .
   .
DATA 10, LESTER
```

The string, LESTER, is assigned to *A$(10)*.

## Example

```
DECLARE STRING A,B,C
READ A,B,C
DATA "X", "Y", "Z"
PRINT A + B + C
```

**Output**

```
 XYZ
```

# REAL

The REAL function converts a numeric expression or numeric string to a specified or default floating-point data type.

## Format

*real-var* = REAL (exp [ , SINGLE | , DOUBLE | , GFLOAT | , SFLOAT | , TFLOAT | , XFLOAT | , HFLOAT ] )

## Syntax Rules

*Exp* can be either numeric or string. If a string, it can contain the ASCII digits 0 to 9, uppercase E, a plus sign (+), a minus sign (-), and a period (.).

## Remarks

1. BASIC evaluates *exp*, then converts it to the specified REAL size. If you do not specify a size, BASIC uses the default REAL size.
2. BASIC ignores leading and trailing spaces and tabs if *exp* is a string.
3. The REAL function returns a value of zero when a string argument contains only spaces and tabs, or when the argument is null.
4. Alpha BASIC does not support the HFLOAT floating-point data type. VAX BASIC does not support the SFLOAT, TFLOAT, and XFLOAT floating-point data types.

## Example

```
DECLARE STRING any_num
INPUT "Enter a number";any_num
PRINT REAL(any_num, DOUBLE)
```

**Output**

```
Enter a number? 123095959
 .123096E+09
```

# RECORD

The RECORD statement lets you name and define data structures in a BASIC program and provides the BASIC interface to Oracle CDD/Repository. You can use the defined RECORD name anywhere a BASIC data type keyword is valid if all data types are valid in that context.

## Format

```
RECORD   rec-name
         rec-component
                .
                .
                .
END RECORD   [ rec-name ]

    rec-component:  { data-type rec-item [ ,... ]
                    { group-clause
                    { variant-clause

    rec-item:       { unsubs-var [ = int-const ]
                    { array ( [ int-const1 TO ] int-const2 ,...)  [ = int-const ]
                    { FILL [ ( int-const ) ] [ = int-const ]

    group-clause:   GROUP group-name ([ int-const1 TO ] int-const2,...])
                        rec-component
                                .
                                .
                                .
                    END GROUP [ group-name ]

    variant-clause: VARIANT
                        case-clause
                                .
                                .
                                .
                    END VARIANT

    case-clause:    CASE
                        [ rec-component ]
```

.
.
.

## Syntax Rules

1. Each line of text in a RECORD, GROUP, or VARIANT block can have an optional line number.
2. *Data-type* can be a BASIC data type keyword or a previously defined RECORD name. Table 1–2 lists and describes BASIC data type keywords.
3. If the data type of a *rec-item* is STRING, the string is fixed-length. You can supply an optional string length with the = *int-const* clause. If you do not specify a string length, the default is 16.
4. When you create an array of components with GROUP or create an array as a *rec-item*, BASIC allows you to specify both lower and upper bounds. The upper bound is required; the lower bound is optional.
   - *Int-const1* specifies the lower bounds of the array.
   - *Int-const2* specifies the upper bounds of the array and when accompanied by *int-const1*, must be preceded by the keyword TO.
   - *Int-const1* must be less than or equal to *int-const2*.
   - If you do not specify *int-const1*, BASIC uses zero as the default lower bound.

## Remarks

1. The total size of a RECORD cannot exceed 65,535 bytes. Also, a RECORD that is used as an array component is limited to 32,767 bytes.
2. The declarations between the RECORD statement and the END RECORD statement are called a RECORD block.
3. Variables and arrays in a RECORD definition are also called RECORD components.
4. There must be at least one *rec-component* in a RECORD block.
5. The RECORD statement names and defines a data structure called a RECORD template, but does not allocate any storage. When you use the RECORD template as a data type in a statement such as DECLARE, MAP,

or COMMON, you declare a RECORD instance. This declaration of the RECORD instance allocates storage for the RECORD. For example:

```
DECLARE EMPLOYEE emp_rec
```

This statement declares a variable named *emp_rec*, which is an instance of the user-defined data type EMPLOYEE.

6. Rec-item

   - The *rec-name* qualifies the *group-name* and the *group-name* qualifies the *rec-item*. You can access a particular *rec-item* within a record by specifying *rec-name::group-name::rec-item*. This specification is called a fully qualified reference. The full qualification of a *rec-item* is also called a component path name.
   - *Rec-item* must conform to the rules for naming BASIC variables.
   - Whenever you access an elementary record component, that is, a variable named in a RECORD definition, you do it in the context of the record instance; therefore, *rec-item* names need not be unique in your program. For example, you can have a variable called *first_name* in any number of different RECORD definitions. However, you cannot use a BASIC reserved keyword as a *rec-item* name and you cannot have two variables or arrays with the same name at the same level in the RECORD or GROUP definition.
   - The *group-name* is optional in a *rec-item* specification unless there is more than one *rec-item* with the same name or the *group-name* has subscripts. For example:

```
DECLARE EMPLOYEE Emp_rec
   .
   .
   .
RECORD Address
       STRING Street, City, State, Zip
END RECORD Address
RECORD Employee
       GROUP Emp_name
             STRING First = 15
             STRING Middle = 1
             STRING Last = 15
       END GROUP Emp_name
       ADDRESS Work
       ADDRESS Home
END RECORD Employee
```

You can access the *rec-item* "Last" by specifying only "Emp_rec::Last" because only one *rec-item* is named "Last"; however, if you try to reference "Emp_rec::City", BASIC signals an error because "City" is an ambiguous field. "City" is a component of both "Work" and "Home"; to access it, either "Emp_rec::Work::City" or "Emp_rec::Home::City" must be specified.

7. Group-clause
   - The declarations between the GROUP keyword and the END GROUP keyword are called a GROUP block. The GROUP keyword is valid only within a RECORD block.
   - A subscripted group is similar to an array within the record. The group can have both lower and upper bounds for one or more dimensions. Each group element consists of all the record items contained within the subscripted group including other groups.
8. Variant-clause
   - The declarations between the VARIANT keyword and the END VARIANT keywords are called a VARIANT block.
   - The amount of space allocated for a VARIANT field in a RECORD is equal to the space needed for the variant field requiring the most storage.
   - A variant defines the record items that overlay other items, allowing you to redefine the same storage one or more ways.
9. Case-clause
   - Each case in a variant starts at the position in the record where the variant begins.
   - The size of a variant is the size of the longest case in that variant.

## Example

```
1000    RECORD Employee
                GROUP Emp_name
                        STRING Last = 15
                        STRING First = 14
                        STRING Middle = 1
                END GROUP Emp_name
                GROUP Emp_address
                        STRING Street = 15
                        STRING City = 20
                        STRING State = 2
                        DECIMAL(5,0) Zip
                END GROUP Emp_address
                STRING Wage_class = 2
                VARIANT
                        CASE
                           GROUP Hourly
                              DECIMAL(4,2) Hourly_wage
                              SINGLE Regular_pay_ytd
                              SINGLE Overtime_pay_ytd
                           END GROUP Hourly
                        CASE
                           GROUP Salaried
                              DECIMAL(7,2) Yearly_salary
                              SINGLE Pay_ytd
                           END GROUP Salaried
                        CASE
                           GROUP Executive
                              DECIMAL(8,2) Yearly_salary
                              SINGLE Pay_ytd
                              SINGLE Expenses_ytd
                           END GROUP Executive
                END VARIANT
            END RECORD Employee
```

# RECOUNT

The RECOUNT function returns the number of characters transferred by the last input operation.

## Format

*int-var* = RECOUNT

## Syntax Rules

None

## Remarks

1. The RECOUNT value is reset by every input operation on any channel, including channel #0.
   - After an input operation from your terminal, RECOUNT contains the number of characters (bytes), including line terminators, transferred.
   - After accessing a file record, RECOUNT contains the number of characters in the record.
2. Because RECOUNT is reset by every input operation on any channel, you should copy the RECOUNT value to a different storage location before executing another input operation.
3. If an error occurs during an input operation, the value of RECOUNT is undefined.
4. RECOUNT is unreliable after a Ctrl/C interrupt because the Ctrl/C trap may have occurred before BASIC set the value for RECOUNT.
5. The RECOUNT function returns a LONG value.

## Example

```
DECLARE INTEGER character_count
INPUT "Enter a sequence of numeric characters";character_count
character_count = RECOUNT
PRINT character_count;"characters received (including CR and LF)"
```

**Output**

```
Enter a sequence of numeric characters? 12345678
 10 characters received (including CR and LF)
```

# REM

The REM statement allows you to document your program.

## Format

REM [*comment*]

## Syntax Rules

1. REM must be the only statement on the line or the last statement on a multistatement line.
2. BASIC interprets every character between the keyword REM and the next line number as part of the comment.
3. BASIC does not allow you to specify the REM statement in programs that do not contain line numbers.

## Remarks

1. Because the REM statement is not executable, you can place it anywhere in a program, except where other statements, such as SUB and END SUB, must be the first or last statement in a program unit.
2. When the REM statement is the first statement on a line-numbered line, BASIC treats any reference to that line number as a reference to the next higher-numbered executable statement.
3. The REM statement is similar to the comment field that begins with an exclamation point, with one exception: the REM statement must be the last statement on a BASIC line. The exclamation point comment field can be ended with another exclamation point or a line terminator and followed by a BASIC statement. See Chapter 1 for more information about the comment field.

## Example

```
10 REM This is a multiline comment
   All text up to BASIC line 20
   is part of this REM statement.
   Any BASIC statements on line 10
   are ignored.  PRINT "This does not
   execute".
20 PRINT "This will execute"
```

**Output**

```
This will execute
```

# REMAP

The REMAP statement defines or redefines the position in the storage area of variables named in the MAP DYNAMIC statement.

## Format

REMAP (*map-dyn-name*) *remap-item*,...

map-dyn-name: { map-name | static-str-var }

remap-item: { num-var | num-array-name ( [ int-exp,... ] ) | str-var [ = int-exp ] | str-array-name ( [ int-exp,...] )[ = int-exp ] | [ data-type ] FILL [ ( int-exp) ] [ = int-exp ] | FILL% [ ( int-exp ) ] | FILL$ [ ( int-exp ) ][ = int-exp ] }

## Syntax Rules

1. *Map-dyn-name* can be either a map name or a static string variable.
   - *Map-name* is the storage area named in a MAP statement.
   - If you specify a map name, then a MAP statement with the same name must precede both the MAP DYNAMIC statement and the REMAP statement.
   - When you specify a static string variable, the string must be declared before you can specify a MAP DYNAMIC statement or a REMAP statement.
   - If you specify a *static-str-var*, the following restrictions apply:
     - *Static-str-var* cannot be a string constant.
     - *Static-str-var* cannot be the same as any previously declared *map-item* in a MAP DYNAMIC statement.
     - If *static-str-var* is a parameter to the subprogram containing the REMAP statement, *static-str-var* cannot be a RECORD component.

- *Static-str-var* cannot be a subscripted variable.
- *Static-str-var* cannot be a parameter declared in a DEF or DEF* function.

2. *Remap-item* names a variable, array, or array element declared in a preceding MAP DYNAMIC statement:
   - *Num-var* specifies a numeric variable or array element. *Num-array-name* followed by a set of empty parentheses specifies an entire numeric array.
   - *Str-var* specifies a string variable or array element. *Str-array-name* followed by a set of empty parentheses, specifies an entire fixed-length string array. You can specify the number of bytes to be reserved for string variables and array elements with the *=int-exp* clause. The default string length is 16.
3. *Remap-item* can also be a FILL item. The FILL, FILL%, and FILL$ keywords let you reserve parts of the record buffer. *Int-exp* specifies the number of FILL items to be reserved. The *=int-exp* clause allows you to specify the number of bytes to be reserved for string FILL items. Table 4–1 describes FILL item format and storage allocation.

   **Note**

   In the FILL clause, *(int-exp)* represents a repeat count, not an array subscript. FILL (*n*), for example, represents *n* elements, not *n* + 1.

4. All *remap-items*, except FILL items, must have been named in a previous MAP DYNAMIC statement, or BASIC signals an error.
5. *Data-type* can be any BASIC data type keyword or a data type defined in a RECORD statement. Data type keywords and their size, range, and precision are listed in Table 1–2. You can specify a data type only for FILL items.
   - When you specify a data type before a FILL keyword in a REMAP statement, the FILL item is of that data type. The specified data type applies only to that one FILL item.
   - If you do not specify any data type for a FILL item, the FILL item takes the current default data type and size.
6. *Remap-items* must be separated with commas.

## Remarks

1. The REMAP statement does not affect the amount of storage allocated to the map area.
2. Each time a REMAP statement executes, BASIC sets record pointers to the named map area for the specified variables from left to right.
3. The REMAP statement must be preceded by a MAP DYNAMIC statement or BASIC signals the error "No such MAP area <name>." The MAP statement or static string variable creates a named area of static storage, the MAP DYNAMIC statement specifies the variables whose positions can change at run time, and the REMAP statement specifies the new positions for the variables named in the MAP DYNAMIC statement.
4. Before you can specify a map name in a REMAP statement, there must be a MAP statement in the program unit with the same map name; otherwise, BASIC signals the error "<Name> is not a DYNAMIC MAP variable of MAP <name>." Similarly, before you can specify a static string variable in a REMAP statement, the string variable must be declared; otherwise, BASIC signals the same error message.
5. If a static string variable is the same as a map name, BASIC overrides the static string name and uses the map name.
6. Until the REMAP statement executes, all variables named in the MAP DYNAMIC statement point to the first byte of the MAP area and all string variables have a length of zero. When the REMAP statement executes, BASIC sets the internal pointers as specified in the REMAP statement. For example:

```
100     MAP (DUMMY) STRING map_buffer = 50
        MAP DYNAMIC (DUMMY) LONG A, STRING B, SINGLE C(7)
        REMAP (DUMMY) B=14, A, C()
```

   The REMAP statement sets a pointer to byte 1 of *DUMMY* for string variable *B*, a pointer to byte 15 for LONG variable *A*, and pointers to bytes 19, 23, 27, 31, 35, 39, 43, and 47 for the elements in SINGLE array *C*.

7. You can use the REMAP statement to redefine the pointer for an array element or variable more than once in a single REMAP statement. For example:

```
100     MAP (DUMMY) STRING FILL = 48
        MAP DYNAMIC (DUMMY) LONG A, B(10)
        REMAP (DUMMY) B(), B(0)
```

This REMAP statement sets a pointer to byte 1 in *DUMMY* for array *B*. Because array *B* uses a total of 44 bytes, the pointer for the first element of array *B*, *B*(0) points to byte 45. References to array element *B*(0) will be to bytes 45 to 48. Pointers for array elements 1 to 10 are set to bytes 5, 9, 13, 17 and so on.

8. Because the REMAP statement is local to a program module, it affects pointers only in the program module in which it executes.

## Examples

### Example 1

```
DECLARE LONG CONSTANT emp_fixed_info = 4 + 9 + 2
MAP (emp_buffer) LONG badge,                    &
                 STRING social_sec_num = 9,     &
                 BYTE name_length,              &
                      address_length,           &
                      FILL (60)

MAP DYNAMIC (emp_buffer) STRING emp_name,       &
                                emp_address

WHILE 1%
        GET #1
        REMAP (emp_buffer) STRING FILL = emp_fixed_info,        &
                                  emp_name = name_length,       &
                                  emp_address = address_length

        PRINT emp_name
        PRINT emp_address
        PRINT

NEXT

END
```

### Example 2

```
SUB deblock (STRING input_rec, STRING item())
 MAP DYNAMIC (input_rec) STRING A(1 TO 3)
 REMAP (input_rec) &
     A(1) = 5, &
     A(2) = 3, &
     A(3) = 4
 FOR I = LBOUND(A) TO UBOUND(A)
   item(I) = A(I)
 NEXT I
END SUB
```

# RESET

The RESET statement is a synonym for the RESTORE statement. See the RESTORE statement for more information.

## Format

RESET [ #*chnl-exp* [, KEY #*int-exp* ] ]

# RESTORE

The RESTORE statement resets the DATA pointer to the beginning of the DATA sequence, or sets the record pointer to the first record in a file.

## Format

RESTORE [ #*chnl-exp* [, KEY #*int-exp* ] ]

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. *Int-exp* must be between zero and the number of keys in the file minus 1. It must be immediately preceded by a number sign (#).

## Remarks

1. If you do not specify a channel, RESTORE resets the DATA pointer to the beginning of the DATA sequence.
2. RESTORE affects only the current program unit. Thus, executing a RESTORE statement in a subprogram does not affect the DATA pointer in the main program.
3. If there is no channel specified, and the program has no DATA statements, RESTORE has no effect.
4. The file specified by *chnl-exp* must be open.
5. If *chnl-exp* specifies a magnetic tape file, BASIC rewinds the tape to the first record in the file.
6. The KEY clause applies to indexed files only. It sets a new key of reference equal to *int-exp* and sets the next record pointer to the first logical record in that key.
7. For indexed files, the RESTORE statement without a KEY clause sets the next record pointer to the first logical record specified by the current key of reference. If there is no current key of reference, the RESTORE statement sets the next record pointer to the first logical record of the primary key.

8. If you use the RESTORE statement on any file type other than indexed, BASIC sets the next record pointer to the first record in the file.
9. The RESTORE statement is not allowed on virtual array files or on files opened on unit record devices.
10. For information about the RESTORE GRAPHICS statement, see *Programming with VAX BASIC Graphics*.

## Example

```
RESTORE #7%, KEY #4%
```

# RESUME

The RESUME statement marks an exit point from an ON ERROR error-handling routine. BASIC clears the error condition and returns program control to a specified line number or label or to the program block in which the error occurred.

**Note**

The RESUME statement is supported for compatibility with other versions of BASIC. For new program development, it is recommended that you use WHEN blocks.

## Format

RESUME [ *target* ]

## Syntax Rules

*Target* must be a valid BASIC line number or label and must exist in the same program unit.

## Remarks

1. The following restrictions apply:
   - The RESUME statement cannot appear within a protected region, or within an attached or detached handler.
   - The target of a RESUME statement cannot exist within a protected region or handler.
   - The RESUME statement cannot be used in a multiline DEF unless the target is also in the DEF function definition.
   - The execution of a RESUME with no target is illegal if there is no error active.

- A RESUME statement cannot transfer control out of the current program unit. Therefore, a RESUME statement with no target cannot terminate an error handler if the error handler is handling an error that occurred in a subprogram or an external function, and the error was passed to the calling program's error handler by an ON ERROR GO BACK statement or by default.

2. When no target is specified in a RESUME statement, BASIC transfers control based on where the error occurs. If the error occurs on a numbered line containing a single statement, BASIC always transfers control to that statement. When the error occurs within a multistatement line under the following conditions, BASIC acts as follows:
   - After a loop or SELECT block, BASIC transfers control to the statement that follows the NEXT or END SELECT statement.
   - If not after a loop or SELECT block, but within a FOR, WHILE, or UNTIL loop, BASIC transfers control to the first statement that follows the FOR, WHILE, or UNTIL statement.
   - If not after a loop or SELECT block, but within a SELECT block, BASIC transfers control to the start of the CASE block in which the error occurs.
   - If none of the above conditions occurs, BASIC transfers control back to the statement that follows the most recent line number.
3. A RESUME statement with a specified line number transfers control to the first statement of a multistatement line, regardless of which statement caused the error.
4. A RESUME statement with a specified label transfers control to the block of code indicated by that label.

## Example

```
Error_routine:
IF ERR = 11
   THEN
      CLOSE #1
      RESUME end_of_prog
ELSE
      RESUME
END IF
end_of_prog: END
```

# RETRY

The RETRY statement clears an error condition and reexecutes the statement that caused the error inside a protected region of a WHEN block.

## Format

RETRY

## Syntax Rules

The RETRY statement must appear lexically inside of a handler associated with a WHEN block.

## Remarks

The following rules apply to errors that occur during execution of loop control statements (not the statements inside the loop body):

- In FOR...NEXT loops, the RETRY statement reexecutes the FOR statement if the error occurs while BASIC is evaluating the limit or increment values.
- In FOR...NEXT loops, if the error occurs while BASIC is evaluating the index variable, the RETRY statement reexecutes the NEXT statement.
- In a FOR...UNTIL or FOR...WHILE loop, if an error occurs while BASIC is evaluating the relational expression, the RETRY statement reexecutes the NEXT statement.

## Example

```
10 DECLARE LONG YOUR_AGE
   WHEN ERROR IN
        INPUT "Enter your age";your_age
   USE
        IF ERR = 50
           THEN RETRY
           ELSE EXIT HANDLER
        END IF
   END WHEN
```

# RETURN

The RETURN statement transfers control to the statement immediately following the most recently executed GOSUB or ON...GOSUB statement in the current program unit.

## Format

```
RETURN
```

## Syntax Rules

None

## Remarks

1. Once the RETURN is executed in a subroutine, no other statements in the subroutine are executed, even if they appear after the RETURN statement.
2. Execution of a RETURN statement before the execution of a GOSUB or ON...GOSUB causes BASIC to signal "RETURN without GOSUB" (ERR=72).

## Example

```
GOSUB subroutine_1
   .
   .
   .
subroutine_1:
   .
   .
   .
RETURN
```

# RIGHT$

The RIGHT$ function extracts a substring from a string's right side, leaving the string unchanged.

## Format

*str-var* = RIGHT[$] (*str-exp*, *int-exp*)

## Syntax Rules

None

## Remarks

1. The RIGHT$ function extracts a substring from *str-exp* and stores the substring in *str-var*. The substring begins with the character in the position specified by *int-exp* and ends with the rightmost character in the string.
2. If *int-exp* is less than or equal to zero, RIGHT$ returns the entire string.
3. If *int-exp* is greater than the length of *str-exp*, RIGHT$ returns a null string.
4. If you specify a floating-point expression for *int-exp*, BASIC truncates it to a LONG integer.

## Example

```
DECLARE STRING main_str,   &
              end_result
main_str = "1234567"
end_result = RIGHT$(main_str, 3)
PRINT end_result
```

**Output**

```
34567
```

# RMSSTATUS

The RMSSTATUS function returns the RMS status or the status value of the last I/O operation on a specified open I/O channel.

## Format

*long-var* = RMSSTATUS ( *chnl-exp* { , STATUS / , VALUE } )

## Syntax Rules

1. *Chnl-exp* must be the number of a channel opened from a BASIC routine.
2. *Chnl-exp* cannot be zero.

## Remarks

1. If *chnl-exp* does not represent an open channel, BASIC signals the error "I/O channel not open" (ERR=9).
2. If you do not specify either *STATUS* or *VALUE*, RMSSTATUS returns the *STATUS* value by default.
3. If you specify STATUS, RMSSTATUS returns the FAB$L_STS or the RAB$L_STS status value. However, if you specify VALUE, RMSSTATUS returns the FAB$L_STV or the RAB$L_STV status value.
4. Use the RMSSTATUS function to return the status of the following operations:
   - RESTORE
   - GET
   - PUT
   - UPDATE
   - UNLOCK
   - PRINT and PRINT USING
   - INPUT, INPUT LINE, and LINPUT

- SCRATCH
- FREE
- Virtual array references

To determine the reason for the failure of an OPEN, CLOSE, KILL, or NAME...AS statement, use the VMSSTATUS function within an error handler.

## Examples

### Example 1

```
%TITLE "RMSSTATUS Example"
%SBTTL "Reference Manual Examples"
%IDENT "V1.0"

PROGRAM Demo_RMSSTATUS_function
    OPTION CONSTANT TYPE = INTEGER

    OPEN "DOES_NOT_EXIST.LIS" FOR OUTPUT AS 1,  &
        SEQUENTIAL VARIABLE,                    &
        RECORDSIZE 80

    WHEN ERROR IN
        GET #1
    USE
        PRINT "GET Operation failed"
        PRINT "RMS Status ="; RMSSTATUS(1,STATUS)
        PRINT "RMS Status Value ="; RMSSTATUS(1,VALUE)
    END WHEN

END PROGRAM
```

### Example 2

```
    OPTION TYPE=EXPLICIT
    EXTERNAL LONG CONSTANT RMS$_OK_DUP

    MAP (ORDER) LONG ORD_ENTRY, STRING ORD_CUST_NO = 6%,   &
        STRING ORD_REMARK = 50%

    OPEN "ORD_DB" FOR INPUT AS FILE 1%,             &
        ORGANIZATION INDEXED FIXED,                 &
        MAP ORDER,                                  &
        PRIMARY ORD_ENTRY NODUPLICATES,             &
        ALTERNATE ORD_CUST_NO DUPLICATES
    INPUT "Enter order number";ORD_ENTRY
    INPUT "Enter customer number";ORD_CUST_NO
    INPUT "Remark";ORD_REMARK
```

```
!
! Enter the order in the order database
! Check if the customer has other orders
!
PUT #1%
IF RMSSTATUS( 1%, STATUS ) = RMS$_OK_DUP
THEN
    !
    ! The customer has other orders; compute the customer's
    ! discount for other orders
    !
END IF

CLOSE 1%
END
```

# RND

The RND function returns a random number greater than or equal to zero and less than 1.

## Format

*real-var* = RND

## Syntax Rules

None

## Remarks

1. If the RND function is preceded by a RANDOMIZE statement, BASIC generates a different random number or series of numbers each time a program executes.
2. The RND function returns a pseudorandom number if not preceded by a RANDOMIZE statement; that is, each time a program runs, BASIC generates the same random number or series of random numbers.
3. The RND function returns a floating-point SINGLE value.
4. The RND function returns values over a uniform distribution from 0 to 1. For example, a value from 0 to .1 is as likely as a value from .5 to .6. Note the difference between this and a bell-curve distribution where the probability of values in the range .3 to .7 is higher than the outer ranges.

## Example

```
DECLARE REAL random_num
RANDOMIZE
FOR I = 1 TO 3   !FOR loop causes BASIC to print three random numbers
        random_num = RND
        PRINT random_num
NEXT I
```

**Output**

```
.865243
.477417
.734673
```

# RSET

The RSET statement assigns right-justified data to a string variable. RSET does not change a string variable's length.

## Format

RSET *str-var*,... = *str-exp*

## Syntax Rules

*Str-var* cannot be a DEF function name unless the RSET statement is inside the DEF function definition.

## Remarks

1. The RSET statement treats strings as fixed-length. It does not change the length of *str-var*, nor does it create new storage locations.
2. If *str-var* is longer than *str-exp*, RSET right-justifies the data and pads it with spaces on the left.
3. If *str-var* is shorter than *str-exp*, RSET truncates *str-exp* on the left.

## Example

```
DECLARE STRING test
test = "ABCDE"
RSET test = "123"
PRINT "X" + test
```

**Output**

```
X  123
```

# SCRATCH

The SCRATCH statement deletes the current record and all following records in a sequential file.

## Format

SCRATCH *#chnl-exp*

## Syntax Rules

*Chnl-exp* is a numeric expression that specifies a channel associated with a file. It must be immediately preceded by a number sign (#).

## Remarks

1. Before you execute the SCRATCH statement, the file must be opened with ACCESS SCRATCH.
2. The SCRATCH statement applies to ORGANIZATION SEQUENTIAL files only.
3. The SCRATCH statement has no effect on terminals or unit record devices.
4. For disk files, the SCRATCH statement discards the current record and all that follows it in the file. The physical length of the file does not change.
5. For magnetic tape files, the SCRATCH statement overwrites the current record with two end-of-file marks.
6. Use of the SCRATCH statement on shared sequential files is not recommended.

## Example

```
SCRATCH #4%
```

# SEG$

The SEG$ function extracts a substring from a main string, leaving the original string unchanged.

## Format

*str-var* = SEG$ (*str-exp*, *int-exp1*, *int-exp2*)

## Syntax Rules

None

## Remarks

1. BASIC extracts the substring from *str-exp*, the main string, and stores the substring in *str-var*. The substring begins with the character in the position specified by *int-exp1* and ends with the character in the position specified by *int-exp2*.
2. If *int-exp1* is less than 1, BASIC assumes a value of 1.
3. If *int-exp1* is greater than *int-exp2* or the length of *str-exp*, the SEG$ function returns a null string.
4. If *int-exp1* equals *int-exp2*, the SEG$ function returns the character at the position specified by *int-exp1*.
5. Unless *int-exp2* is greater than the length of *str-exp*, the length of the returned substring equals *int-exp2* minus *int-exp1* plus 1. If *int-exp2* is greater than the length of *str-exp*, the SEG$ function returns all characters from the position specified by *int-exp1* to the end of *str-exp*.
6. If you specify a floating-point expression for *int-exp1* or *int-exp2*, BASIC truncates it to a LONG integer.

## Example

```
DECLARE STRING alpha, center
alpha = "ABCDEFGHIJK"
center = SEG$(alpha, 4, 8)
PRINT center
```

**Output**

```
DEFGH
```

# SELECT

The SELECT statement lets you specify an expression, a number of possible values the expression may have, and a number of alternative statement blocks to be executed for each possible case.

## Format

```
SELECT  exp1
        case-clause
              .
              .
              .
        [ else-clause ]
END SELECT

case-clause:    CASEcase-item,...
                [ statement ]...

case-item:      { [rel-op] exp2                                  }
                { exp3 TO exp4 [ ,exp5 TO exp6 ] ,...            }

else-clause:    CASE ELSE
                [ statement ]...
```

## Syntax Rules

1. *Exp1* is the expression to be tested against the *case-clauses* and the *else-clause*. It can be numeric or string.
2. *Case-clause* consists of the CASE keyword followed by a *case-item* and statements to be executed when the *case-item* is true.
3. *Else-clause* consists of the CASE ELSE keywords followed by statements to be executed when no previous *case-item* has been selected as true.
4. *Case-item* is either an expression to be compared with *exp1* or a range of values separated with the keyword TO.
   - *Rel-op* is a relational operator specifying how *exp1* is to be compared to *exp2*. If you do not include a *rel-op*, BASIC assumes the equals (=)

operator. BASIC executes the statements in the CASE block when the specified relational expression is true.

- *Exp3* and *exp4* specify a range of numeric or string values separated by the keyword TO. Multiple ranges must be separated with commas. BASIC executes the statements in the CASE block when *exp1* falls within any of the specified ranges.

## Remarks

1. A SELECT statement can have only one *else-clause*. The *else-clause* is optional and, when present, must be the last CASE block in the SELECT block.
2. Each statement in a SELECT block can have its own line number.
3. The SELECT statement begins the SELECT block and the END SELECT keywords terminate it. BASIC signals an error if you do not include the END SELECT keywords.
4. Each CASE keyword establishes a CASE block. The next CASE or END SELECT keyword ends the CASE block.
5. You can nest SELECT blocks within a CASE or CASE ELSE block.
6. BASIC evaluates *exp1* when the SELECT statement is first encountered; BASIC then compares *exp1* with each *case-clause* in order of occurrence until a match is found or until a CASE ELSE block or END SELECT is encountered.
7. The following conditions constitute a match:
   - *Exp1* satisfies the relationship to *exp2* specified by *rel-op*.
   - *Exp1* is greater than or equal to *exp3*, but less than or equal to *exp4*, greater than or equal to *exp5* but less than or equal to *exp6*, and so on.
8. When a match is found between *exp1* and a *case-item*, BASIC executes the statements in the CASE block where the match occurred. If ranges overlap, the first match causes BASIC to execute the statements in the CASE block. After executing CASE block statements, control passes to the statement immediately following the END SELECT keywords.
9. If no CASE match occurs, BASIC executes the statements in the *else-clause*, if present, and then passes control to the statement immediately following the END SELECT keywords.

10. If no CASE match occurs and you do not supply a *case-else* clause, control passes to the statement following the END SELECT keywords.

## Example

```
100     SELECT A% + B% + C%
                CASE = 100
                        PRINT 'THE VALUE IS EXACTLY 100'
                CASE 1 TO 99
                        PRINT 'THE VALUE IS BETWEEN 1 AND 99'
                CASE > 100
                        PRINT 'THE VALUE IS GREATER THAN 100'
                CASE ELSE
                        PRINT 'THE VALUE IS LESS THAN 1'
        END SELECT
```

# SET PROMPT

The SET PROMPT statement enables a question mark prompt to appear after BASIC executes either an INPUT, LINPUT, INPUT LINE, MAT INPUT, or MAT LINPUT statement on channel #0. The SET NO PROMPT statement disables the question mark prompt.

## Format

SET [NO] PROMPT

## Syntax Rules

None

## Remarks

1. If you do not specify a SET PROMPT statement, the default is SET PROMPT.
2. SET NO PROMPT disables BASIC from issuing a question mark prompt for the INPUT, LINPUT, INPUT LINE, MAT INPUT, and MAT LINPUT statements on channel #0.
3. Prompting is reenabled when either a SET PROMPT statement or a CHAIN statement is executed, or when a NEW, OLD, RUN or SCRATCH command is executed in the VAX BASIC Environment.
4. The SET NO PROMPT statement does not affect the string constant you specify as the input prompt with the INPUT statement.

## Example

```
DECLARE STRING your_name, your_age, your_grade
INPUT "Enter your name";your_name
SET NO PROMPT
INPUT "Enter your age"; your_age
SET PROMPT
INPUT "Enter the last school grade you completed";your_grade
```

### Output

```
Enter your name? Katherine Kelly
Enter your age   15
Enter the last school grade you completed? 9
```

# SGN

The SGN function determines whether a numeric expression is positive, negative, or zero. It returns 1 if the expression is positive, -1 if the expression is negative, and zero if the expression is zero.

## Format

*int-var* = SGN (*real-exp*)

## Syntax Rules

None

## Remarks

1. If *real-exp* does not equal zero, SGN returns MAG(*real-exp*)/*real-exp*.
2. If *real-exp* equals zero, SGN returns a value of zero.
3. SGN returns an integer.

## Example

```
DECLARE INTEGER sign
sign = SGN(46/23)
PRINT sign
```

**Output**

```
 1
```

# SIN

The SIN function returns the sine of an angle in radians or degrees.

## Format

*real-var* = SIN (*real-exp*)

## Syntax Rules

*Real-exp* is an angle specified in radians or degrees depending upon which angle clause you choose with the OPTION statement.

## Remarks

1. The returned value is from -1 to 1.
2. BASIC expects the argument of the SIN function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size and returns a value of the default floating-point size.

## Example

```
OPTION ANGLE = RADIANS
DECLARE REAL s1_angle
s1_angle = SIN(PI/2)
PRINT s1_angle
```

**Output**

```
 1
```

# SLEEP

The SLEEP statement suspends program execution for a specified number of seconds or until a carriage return is entered from the controlling terminal.

## Format

SLEEP *int-exp*

## Syntax Rules

1. *Int-exp* is the number of seconds BASIC waits before resuming program execution.
2. *Int-exp* must be from 0 to the largest allowed positive integer value; if it is greater, BASIC signals the error "Integer error or overflow" (ERR=51).

## Remarks

1. Pressing the Return key on the controlling terminal cancels the effect of the SLEEP statement.
2. All characters typed while SLEEP is in effect, including a Return entered to terminate the SLEEP statement, remain in the typeahead buffer. Therefore, if you type RETURN without preceding data, an INPUT statement that follows SLEEP completes without data.

## Example

```
SLEEP 120%
```

# SPACE$

The SPACE$ function creates a string containing a specified number of spaces.

## Format

*str-var* = SPACE$ (*int-exp*)

## Syntax Rules

*Int-exp* specifies the number of spaces in the returned string.

## Remarks

1. BASIC treats an *int-exp* less than 0 as zero.
2. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer.

## Example

```
DECLARE STRING A, B
A = "1234"
B = "5678"
PRINT A + SPACE$(5%) + B
```

**Output**

```
1234     5678
```

# SQR

The SQR function returns the square root of a positive number.

## Format

*real-var* = { SQRT / SQR } (*real-exp*)

## Syntax Rules

None

## Remarks

1. BASIC signals the error "Imaginary square roots" (ERR=54) when *real-exp* is negative.
2. BASIC assumes that the argument of the SQR function is a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC returns a value of the default floating-point size.

## Example

```
DECLARE REAL root
root = SQR(20*5)
PRINT root
```

**Output**

```
 10
```

# STATUS

The STATUS function returns an integer value containing information about the last opened channel. Your program can test each bit to determine the status of the channel.

**Note**

The STATUS function is supported only for compatibility with other versions of BASIC. It is recommended that you use the RMSSTATUS function for new program development.

## Format

*int-var* = STATUS

## Syntax Rules

None

## Remarks

1. The STATUS function returns a LONG integer.
2. The value returned by the STATUS function is undefined until BASIC executes an OPEN statement.
3. The STATUS value is reset by every input operation on any channel; therefore, you should copy the STATUS value to a different storage location before your program executes another input operation.
4. If an error occurs during an input operation, the value of STATUS is undefined. When no error occurs, the 6 low-order bits of the returned value contain information about the type of device accessed by the last input operation. Table 4–5 lists STATUS bits set by BASIC.

**Table 4–5 BASIC STATUS Bits**

| Bit Set | Device Type |
|---|---|
| 0 | Record-oriented device |
| 1 | Carriage-control device |
| 2 | Terminal |
| 3 | Directory device |
| 4 | Single directory device |
| 5 | Sequential block-oriented device (magnetic tape) |

## Example

```
150       Y% = STATUS
```

# STOP

The STOP statement halts program execution allowing you to optionally continue execution.

## Format

STOP

## Syntax Rules

None

## Remarks

1. The STOP statement cannot appear before a PROGRAM, SUB, or FUNCTION statement.
2. The STOP statement does not close files.
3. When a STOP statement executes in a program executed with the RUN command in the VAX BASIC Environment, BASIC prints the line number and module name associated with the STOP statement, then displays the Ready prompt. In response to the prompt, you can type immediate mode statements, CONTINUE to resume program execution, or any valid compiler command. See the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual* for more information about immediate mode.
4. When a STOP statement is in an executable image, the line number, module name, and a number sign (#) prompt are printed. In response to the prompt, you can type CONTINUE to continue program execution or EXIT to end the program. If the program module was compiled with the /NOLINE qualifier, no line number is displayed.

## Example

```
PROGRAM Stopper
    PRINT "Type CONTINUE when the program stops"
    INPUT "Do you want to stop now"; Quit$

    IF Quit$ = "Y"
    THEN
        STOP
    ELSE
        PRINT "So what are you waiting for?"
        STOP
    END IF

    PRINT "You told me to continue... thank you"
END PROGRAM
```

**Output**

```
Type CONTINUE when the program stops
Do you want to stop now?n
So what are you waiting for?
Stop
In module STOPPER
Ready

continue
You told me to continue... thank you
Ready
```

# STR$

The STR$ function changes a numeric expression to a numeric character string without leading and trailing spaces.

## Format

*str-var* = STR$ (*num-exp*)

## Syntax Rules

None

## Remarks

1. If *num-exp* is negative, the first character in the returned string is a minus sign (-).
2. The STR$ function does not return leading or trailing spaces.
3. When you print a floating-point number that has 6 decimal digits or more but the integer portion has 6 digits or less (for example, 1234.567), BASIC rounds the number to 6 digits (1234.57). If a floating-point number's integer part is 7 decimal digits or more, BASIC rounds the number to 6 digits and prints it in E format.
4. When you print a floating-point number with magnitude from 0.1 to 1, BASIC rounds it to 6 digits. When you print a number with magnitude smaller than 0.1, BASIC rounds it to 6 digits and prints it in E format.
5. The STR$ function returns up to 10 digits for LONG integers and up to 31 digits for DECIMAL numbers.

## Example

```
DECLARE STRING new_num
new_num = STR$(1543.659)
PRINT new_num
```

**Output**

```
1543.66
```

# STRING$

The STRING$ function creates a string containing a specified number of identical characters.

## Format

*str-var* = STRING$ (*int-exp1*, *int-exp2*)

## Syntax Rules

1. *Int-exp1* specifies the character string's length.
2. *Int-exp2* is the decimal ASCII value of the character that makes up the string. This value is treated modulo 256.

## Remarks

1. BASIC signals the error "String too long" (ERR=227) if *int-exp1* is greater than 65535.
2. If *int-exp1* is less than or equal to zero, BASIC treats it as zero.
3. BASIC treats *int-exp2* as an unsigned 8-bit integer. For example, -1 is treated as 255.
4. If either *int-exp1* or *int-exp2* is a floating-point expression, BASIC truncates it to an integer.

## Example

```
DECLARE STRING output_str
output_str = STRING$(10%, 50%)  !50 is the ASCII value of the
PRINT output_str                !character "2"
```

**Output**

```
2222222222
```

# SUB

The SUB statement marks the beginning of a BASIC subprogram and specifies the number and data type of its parameters.

## Format

SUB *sub-name* [ *pass-mech* ] [ ( [ *formal-param* ],... ) ]
[ statement ]...

{ END SUB | SUBEND }

pass-mech: { BY REF | BY DESC | BY VALUE }

formal-param: [ data-type ] { unsubs-var | array-name ( [ int-const ] ,... ) }
[ = int-const ] [ pass-mech ]

## Syntax Rules

1. Note that both Alpha BASIC and VAX BASIC are able to pass actual parameters by value, but only Alpha BASIC allows formal parameters to be passed in by value.
2. *Sub-name* is the name of the separately compiled subprogram.
3. *Formal-param* specifies the number and type of parameters for the arguments the SUB subprogram expects to receive when invoked.
   - Empty parentheses indicate that the SUB subprogram has no parameters.
   - *Data-type* specifies the data type of a parameter. If you do not specify a data type, parameters are of the default data type and size. When you do specify a data type, all following parameters are of that data type until you specify a new data type. Data type keywords and their size, range, and precision are listed in Table 1–2.

4. *Sub-name* can have from 1 to 31 characters and must conform to the following rules:
   - The first character of an unquoted name must be an alphabetic character (A to Z). The remaining characters, if present, can be any combination of letters, digits (0 to 9), dollar signs ($), periods (.), or underscores (_).
   - A quoted name can consist of any combination of printable ASCII characters.
5. *Data-type* can be any BASIC data type keyword or a data type defined by a RECORD statement.
6. *Pass-mech* specifies the parameter passing mechanism by which the subprogram receives arguments.
7. A *pass-mech* clause outside the parentheses applies by default to all SUB parameters. A *pass-mech* clause in the *formal-param* list overrides the specified default and applies only to the immediately preceding parameter.

## Remarks

1. The SUB statement must be the first statement in the SUB subprogram.
2. Compiler directives and comment fields created with an exclamation point (!), can precede the SUB statement because they are not BASIC statements. Note that REM is a BASIC statement; therefore, it cannot precede the SUB statement.
3. Every SUB statement must have a corresponding END SUB statement or SUBEND statement.
4. If you do not specify a passing mechanism, the SUB program receives arguments by the default passing mechanisms.
5. Parameters defined in *formal-param* must agree in number, type, ordinality, and passing mechanism with the arguments specified in the CALL statement of the calling program.
6. You can specify up to 255 parameters.
7. Any BASIC statement except those that refer to other program unit types (FUNCTION, PICTURE or PROGRAM) can appear in a SUB subprogram.
8. All variables, except those named in MAP and COMMON statements are local to that subprogram.

9. BASIC initializes local variables to zero or the null string.
10. SUB subprograms receive parameters by reference, by descriptor, or by value.
    - BY REF specifies that the subprogram receives the argument's address.
    - BY DESC specifies that the subprogram receives the address of a BASIC descriptor. For information about the format of a BASIC descriptor for strings and arrays, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*. For information about other types of descriptors, see the *VAX Architecture Handbook*.
    - BY VALUE specifies that the subprogram receives a copy of the argument value.

      Note that both Alpha BASIC and VAX BASIC are able to pass actual parameters by value, but only Alpha BASIC allows formal parameters to be passed in by value.
11. By default, BASIC subprograms receive numeric unsubscripted variables by reference, and all other parameters by descriptor. You can override these defaults for strings and arrays with a BY clause:
    - If you specify a string length with the *=int-const* clause, you must also specify BY REF. If you specify BY REF and do not specify a string length, BASIC uses the default string length of 16.
    - If you specify array bounds, you must also specify BY REF.
12. Subprograms can be called recursively.

## Example

```
SUB SUB3 BY REF (DOUBLE A, B,      &
    STRING Emp_nam BY DESC,        &
    wage(20))
   .
   .
   .
END SUB
```

# SUBEND

The SUBEND statement is a synonym for the END SUB statement. See the END statement for more information.

## Format

SUBEND

# SUBEXIT

The SUBEXIT statement is a synonym for the EXIT SUB statement. See the EXIT statement for more information.

## Format

SUBEXIT

# SUM$

The SUM$ function returns a string whose value is the sum of two numeric strings.

## Format

*str-var* = SUM$ (*str-exp1*, *str-exp2*)

## Syntax Rules

None

## Remarks

1. The SUM$ function does not support E-format notation.
2. Each string expression can contain up to 60 ASCII digits and an optional decimal point and sign.
3. BASIC adds *str-exp2* to *str-exp1* and stores the result in *str-var*.
4. If *str-exp1* and *str-exp2* are integers, *str-var* takes the precision of the larger string unless trailing zeros generate that precision.
5. If *str-exp1* and *str-exp2* are decimal fractions, *str-var* takes the precision of the more precise fraction, unless trailing zeros generate that precision.
6. SUM$ omits trailing zeros to the right of the decimal point.
7. The sum of two fractions takes precision as follows:
   - The sum of the integer parts takes the precision of the larger part.
   - The sum of the decimal fraction part takes the precision of the more precise part.
8. SUM$ truncates leading and trailing zeros.

## Example

```
DECLARE STRING A, B, Total
A = "45.678"
B = "67.89000"
total = SUM$ (A,B)
PRINT Total
```

**Output**

```
113.568
```

# SWAP%

The SWAP% function transposes a WORD integer's bytes.

**Note**

The SWAP% function is supported only for compatibility with BASIC-PLUS-2. It is recommended that you do not use the SWAP% function for new program development.

## Format

*int-var* = SWAP% (*int-exp*)

## Syntax Rules

None

## Remarks

1. SWAP% is a WORD function. BASIC evaluates *int-exp* and converts it to the WORD data type, if necessary.
2. BASIC transposes the bytes of *int-exp* and returns a WORD integer.

## Example

```
DECLARE INTEGER word_int
word_int = SWAP%(23)
PRINT word_int
```

**Output**

```
 5888
```

# TAB

When used with the PRINT statement, the TAB function moves the cursor or print mechanism to a specified column.

When used outside the PRINT statement, the TAB function creates a string containing the specified number of spaces.

## Format

*str-var* = TAB (*int-exp*)

## Syntax Rules

1. When used with the PRINT statement, *int-exp* specifies the column number of the cursor or print mechanism.
2. When used outside the PRINT statement, *int-exp* specifies the number of spaces in the returned string.

## Remarks

1. You cannot tab beyond the current MARGIN restriction.
2. The leftmost column position is zero.
3. If *int-exp* is less than the current cursor position, the TAB function has no effect.
4. The TAB function can move the cursor or print mechanism only from the left to the right.
5. You can use more than one TAB function in the same PRINT statement.
6. Use semicolons to separate multiple TAB functions in a single statement. If you use commas, BASIC moves to the next print zone before executing the TAB function.
7. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer.

## Example

```
PRINT "Number 1"; TAB(15); "Number 2"; TAB(30); "Number 3"
```

**Output**

```
Number 1      Number 2       Number 3
```

# TAN

The TAN function returns the tangent of an angle in radians or degrees.

## Format

*real-var* = TAN (*real-exp*)

## Syntax Rules

*Real-exp* is an angle specified in radians or degrees, depending on which angle clause you choose with the OPTION statement.

## Remarks

BASIC expects the argument of the TAN function to be a real expression. When the argument is a real expression, BASIC returns a value of the same floating-point size. When the argument is not a real expression, BASIC converts the argument to the default floating-point size.

## Example

```
OPTION ANGLE = DEGREES
DECLARE REAL tangent
tangent = TAN(45.0)
PRINT tangent
```

**Output**

```
 1
```

# TIME

The TIME function returns the time of day (in seconds) as a floating-point number. The TIME function can also return process CPU time and connect time.

## Format

*real-var* = TIME(*int-exp*)

## Syntax Rules

None

## Remarks

1. The value returned by the TIME function depends on the value of *int-exp*.
2. If *int-exp* equals zero, TIME returns the number of seconds since midnight.
3. BASIC also accepts values 1 and 2 and returns values as shown in Table 4–6. All other arguments to the TIME function are undefined and cause BASIC to signal "Not implemented" (ERR=250).
4. The TIME function returns a SINGLE floating-point value.
5. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer.

**Table 4–6 TIME Function Values**

| Argument Value | BASIC Returns |
|---|---|
| 0 | The amount of time elapsed since midnight in seconds |
| 1 | The CPU time of the current process in tenths of a second |
| 2 | The connect time of the current process in minutes |

## Example

```
PRINT TIME(0)
```

**Output**

```
 49671
```

# TIME$

The TIME$ function returns a string displaying the time of day in the form *hh:mm* AM or *hh:mm* PM.

## Format

*str-var* = TIME$(*int-exp*)

## Syntax Rules

*Int-exp* specifies the number of minutes since midnight.

## Remarks

1. If *int-exp* equals zero, TIME$ returns the current time of day.
2. The value of *int-exp* must be from 0 to 1440 or BASIC signals an error.
3. The TIME$ function uses a 12-hour, AM/PM clock. Before 12:00 noon, TIME$ returns *hh:mm* AM; after 12:00 noon, *hh:mm* PM.
4. If you specify a floating-point expression for *int-exp*, BASIC truncates it to an integer.

## Example

```
DECLARE STRING current_time
current_time = TIME$(0)
PRINT current_time
```

**Output**

```
01:51 PM
```

# TRM$

The TRM$ function removes all trailing blanks and tabs from a specified string.

## Format

*str-var* = TRM$(*str-exp*)

## Syntax Rules

None

## Remarks

The returned *str-var* is identical to *str-exp*, except that it has all the trailing blanks and tabs removed.

## Example

```
DECLARE STRING old_string, new_string
old_string = "ABCDEFG        "
new_string = TRM$(old_string)
PRINT old_string;"XYZ"
PRINT new_string;"XYZ"
```

**Output**

```
ABCDEFG       XYZ
ABCDEFGXYZ
```

# UBOUND

The UBOUND function returns the upper bounds of a compile-time or run-time dimensioned array.

## Format

*num-var* = UBOUND (*array-name* [ , *num-exp* ])

## Syntax Rules

1. *Array-name* must specify an array that has been previously explicitly or implicitly declared.
2. *Num-exp* specifies the number of the dimension for which you have requested the upper bound.

## Remarks

1. If you do not specify a numeric expression, BASIC automatically returns the upper bound of the first dimension.
2. If you specify a numeric expression that is less than or equal to zero, BASIC signals an error message.
3. If you specify a numeric expression that exceeds the number of dimensions, BASIC signals an error message.

## Example

```
DECLARE INTEGER CONSTANT B = 5
DIM A(B)
account_num = 1
FOR dim_num = 0 TO UBOUND(A)
   A(dim_num) = account_num
   account_num = account_num + 1
   PRINT A(dim_num)
NEXT dim_num
```

**Output**

```
1
2
3
4
5
6
```

# UNLESS

The UNLESS qualifier modifies a statement. BASIC executes the modified statement only if a conditional expression is false.

## Format

*statement* UNLESS *cond-exp*

## Syntax Rules

None

## Remarks

1. The UNLESS statement cannot be used on nonexecutable statements or on statements such as SELECT, IF, and DEF that establish a statement block.
2. BASIC executes the statement only if *cond-exp* is false (value zero).

## Example

```
PRINT "A DOES NOT EQUAL 3" UNLESS A% = 3%
```

# UNLOCK

The UNLOCK statement unlocks the current record or bucket locked by the last FIND or GET statement.

## Format

UNLOCK #*chnl-exp*

## Syntax Rules

*Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).

## Remarks

1. A file must be opened on the specified channel before UNLOCK can execute.
2. The UNLOCK statement only applies to files on disk.
3. If the current record is not locked by a previous GET or FIND statement, the UNLOCK statement has no effect and BASIC does not signal an error.
4. The UNLOCK statement does not affect record buffers.
5. After BASIC executes the UNLOCK statement, you cannot update or delete the current record.
6. Once the UNLOCK statement executes, the position of the current record pointer is undefined.

## Example

```
UNLOCK #10%
```

# UNTIL

The UNTIL statement marks the beginning of an UNTIL loop or modifies the execution of another statement.

## Format

### Conditional

UNTIL *cond-exp*
[ statement ]...
.
.
.
NEXT

### Statement Modifier

*statement* UNTIL *cond-exp*

## Syntax Rules

None

## Remarks

1. Conditional
   - A NEXT statement must end the UNTIL loop.
   - BASIC evaluates *cond-exp* before each loop iteration. If the expression is false (value zero), BASIC executes the loop. If the expression is true (value nonzero), control passes to the first executable statement after the NEXT statement.
2. Statement Modifier

   BASIC executes the statement repeatedly until *cond-exp* is true.

## Examples

### Example 1

```
!Conditional
UNTIL A >= 5
      A  = A + .01
      TOTAL = TOTAL + 1
NEXT
```

### Example 2

```
!Statement Modifier
A = A + 1 UNTIL A >= 200
```

# UPDATE

The UPDATE statement replaces a record in a file with a record in the record buffer. The UPDATE statement is valid on sequential, relative, and indexed files.

## Format

UPDATE #*chnl-exp* [ , COUNT *int-exp* ]

## Syntax Rules

1. *Chnl-exp* is a numeric expression that specifies a channel number associated with a file. It must be immediately preceded by a number sign (#).
2. *Int-exp* specifies the size of the new record.

## Remarks

1. The file associated with *chnl-exp* must be a disk file opened with ACCESS MODIFY.
2. Each UPDATE statement must be preceded by a successful GET or FIND operation or BASIC signals "No current record" (ERR=131). FIND locates but does not retrieve records. Therefore, you must specify a COUNT clause when retrieving variable-length records when the preceding operation was a FIND. *Int-exp* must exactly match the size of the old record.
3. If you are updating a variable-length record, and the record that you want to write out is not the same size as the record you retrieved, you must use a COUNT clause.
4. After an UPDATE statement executes, there is no current record pointer. The next record pointer is unchanged.
5. The length of the new record must be the same as that of the existing record for all files with fixed-length records and for all sequential files. If you specify a COUNT clause, the *int-exp* must match the size of the existing record.

6. For relative files with variable-length records, the new record can be larger or smaller than the record it replaces.
   - The new record must be smaller than or equal to the maximum record size set with the MAP or RECORDSIZE clause when the file was opened.
   - You must use the COUNT clause to specify the size of the new record if it is different from that of the record last accessed by a GET operation on that channel.
7. For indexed files with variable-length records, the new record can be larger or smaller than the record it replaces. When the program does not permit duplicate primary keys, the new record can be no longer than the size specified by the MAP or RECORDSIZE clause when the file was opened. The record must include at least the primary key field.
8. An indexed file alternate key for the new record can differ from that of the existing record only if the OPEN statement for that file specified CHANGES for the alternate key.

## Example

```
UPDATE #4%, COUNT 32
```

# VAL

The VAL function converts a numeric string to a floating-point value.

**Note**

It is recommended that you use the DECIMAL, REAL, and INTEGER functions to convert numeric strings to numeric data types.

## Format

*real-var* = VAL (*str-exp*)

## Syntax Rules

*Str-exp* can contain the ASCII digits 0 to 9, uppercase E, a plus sign (+), a minus sign (-), and a period (.).

## Remarks

1. The VAL function ignores spaces and tabs.
2. If *str-exp* is null, or contains only spaces and tabs, VAL returns a value of zero.
3. The value returned by the VAL function is of the default floating-point size.

## Example

```
DECLARE REAL real_num
real_num = VAL("990.32")
PRINT real_num
```

**Output**

```
 990.32
```

# VAL%

The VAL% function converts a numeric string to an integer.

**Note**

It is recommended that you use the DECIMAL, REAL, and INTEGER functions to convert numeric strings to numeric data types.

## Format

*int-var* = VAL% (*str-exp*)

## Syntax Rules

*Str-exp* can contain the ASCII digits 0 to 9, a plus sign (+), or a minus sign (-).

## Remarks

1. The VAL% function ignores spaces and tabs.
2. If *str-exp* is null or contains only spaces and tabs, VAL% returns a value of zero.
3. The value returned by the VAL% function is an integer of the default size.

## Example

```
DECLARE INTEGER ret_int
ret_int = VAL%("789")
PRINT ret_int
```

**Output**

```
 789
```

# VMSSTATUS

VMSSTATUS returns the underlying OpenVMS condition code when control is transferred to a BASIC error handler.

## Format

*int-var* = VMSSTATUS

## Syntax Rules

None

## Remarks

1. If ERR contains the value 194, you can specify VMSSTATUS to examine the actual error that was signaled to BASIC.
2. If an error is raised by an underlying system component such as the Run-Time Library, you can specify VMSSTATUS to determine the underlying error.
3. If you are writing a utility routine that may be called from languages other than BASIC, you can specify VMSSTATUS in a call to LIB$SIGNAL to signal the underlying error to the caller of the utility routine.
4. When there is no error pending, VMSSTATUS remains undefined.
5. VMSSTATUS always returns a LONG integer.

## Example

```
PROGRAM
WHEN ERROR USE global_handler
   .
   .
   .
END WHEN
   .
   .
   .
HANDLER global_handler
final_status% = VMSSTATUS
END HANDLER
END PROGRAM final_status%
```

# WAIT

The WAIT statement specifies the number of seconds the program waits for terminal input before signaling an error.

## Format

WAIT *int-exp*

## Syntax Rules

*Int-exp* must be from 0 to 255; if it is greater than 255, BASIC assumes a value of 255.

## Remarks

1. The WAIT statement must precede a GET operation to a terminal or an INPUT, INPUT LINE, LINPUT, MAT INPUT, or MAT LINPUT statement. Otherwise, it has no effect.
2. *Int-exp* is the number of seconds BASIC waits for input before signaling the error, "Keyboard wait exhausted" (ERR=15).
3. After BASIC executes a WAIT statement, all input statements wait the specified amount of time before BASIC signals an error.
4. WAIT 0 disables the WAIT statement.

## Example

```
10  DECLARE STRING your_name
    WAIT 60
    INPUT "You have sixty seconds to type your name";your_name
    WAIT 0
```

### Output

```
You have sixty seconds to type your name?
%BAS-F-KEYWAIEXH, Keyboard wait exhausted
-BAS-I-ON_CHAFIL, on channel 0 for file SYS$INPUT:.; at user PC 00000644
-RMS-W-TMO, timeout period expired
-BAS-I-FROLINMOD, from line 10 in module WAIT
%TRACE-F-TRACEBACK, symbolic stack dump follows
module name     routine name                    line       rel PC   abs PC

                                                        00007334 00007334
----- above condition handler called with exception 001A807C:
%BAS-F-KEYWAIEXH, keyboard wait exhausted
-BAS-I-ON_CHAFIL, on channel 0 for file SYS$INPUT:.; at user PC 00000644
-RMS-W-TMO, timeout period expired
----- end of exception message
                                                        00011618  00011618
                                                        0000F02F  0000F02F
                                                        0000E3F6  0000E3F6
                                                        0001387A  0001387A
WAIT$MAIN       WAIT$MAIN                          3    00000044  00000644
```

# WHEN ERROR

The WHEN ERROR statement marks the beginning of a WHEN ERROR construct. The WHEN ERROR construct contains a protected region and can include an attached handler or identify a detached handler.

## Format

### With an Attached Handler

```
WHEN ERROR IN
    protected-statement
    [ protected-statement,... ]
USE
    handler-statement
    [ handler-statement,... ]
END WHEN
```

### With a Detached Handler

```
WHEN ERROR USE   handler-name
    protected-statement
    [ protected-statement,... ]
END WHEN
HANDLER   handler-name
    [ handler-statement,... ]
END HANDLER
```

## Syntax Rules

1. *Protected-statement* specifies a statement that appears within a protected region. A protected region is a special block of code that is monitored by BASIC for the occurrence of a run-time error.
2. *Handler-statement* specifies the statement that appears inside an error handler.
3. With an Attached Handler
   - The keyword USE marks the start of handler statements.
   - An attached handler must be delimited by a USE and END WHEN statement.
4. With a Detached Handler
   - The keyword USE names the associated handler for the protected region.
   - *Handler-name* must be a valid BASIC identifier and cannot be the same as any label, DEF, DEF*, SUB, FUNCTION, or PICTURE name within the same program unit.
   - A detached handler must be delimited by a HANDLER and END HANDLER statement.
   - You can specify the same detached handler with more than one WHEN ERROR USE statement.

## Remarks

1. The WHEN ERROR statement designates the start of a block of protected statements.
2. If an error occurs inside a protected region, BASIC transfers control to the error handler associated with the WHEN ERROR statement.
3. BASIC does not allow you to branch into a WHEN block.
4. When BASIC encounters an END WHEN statement for an attached handler or an END HANDLER statement for a detached handler, BASIC clears the exception and transfers control to the following statement.

5. BASIC allows you to nest WHEN blocks. If an exception occurs within a nested protected region, BASIC transfers control to the handler associated with the innermost protected region in which the error occurred.
6. WHEN blocks cannot exist inside a handler.
7. WHEN blocks cannot cross other block structures.
8. You cannot specify a RESUME statement within a WHEN ERROR construct.
9. You cannot specify an ON ERROR statement within a protected region.
10. An attached handler must immediately follow the protected region of a WHEN ERROR IN block.
11. Exit from a handler must occur through a RETRY, CONTINUE, or EXIT HANDLER statement, or by reaching the end of the handler delimited by END WHEN or END HANDLER.
12. For more information about detached handlers, see the HANDLER statement.

## Examples

### Example 1

```
!With an attached handler
PROGRAM salary
DECLARE REAL hourly_rate, no_of_hours, weekly_pay
WHEN ERROR IN
     INPUT "Enter your hourly rate";hourly_rate
     INPUT "Enter the number of hours you worked this week";no_of_hours
     weekly_pay = no_of_hours * hourly_rate
     PRINT "Your pay for this week is";weekly_pay

USE
     SELECT ERR
         CASE = 50
               PRINT "Invalid data"
               RETRY
         CASE ELSE
              EXIT HANDLER
     END SELECT
END WHEN
END PROGRAM
```

**Output**

```
Enter your hourly rate? 35.00
Enter the number of hours you worked this week? 45
Your pay for this week is 1575
```

### Example 2

```
!With a detached handler
PROGRAM salary
DECLARE REAL hourly_rate, no_of_hours, weekly_pay
WHEN ERROR USE patch_work
     INPUT "Enter your hourly rate";hourly_rate
     INPUT "Enter the number of hours you worked this week";no_of_hours
     weekly_pay = no_of_hours * hourly_rate
     PRINT "Your pay for this week is";weekly_pay
END WHEN

HANDLER patch_work
     SELECT ERR
         CASE = 50
               PRINT "Invalid data"
               RETRY
         CASE ELSE
              EXIT HANDLER
     END SELECT
END HANDLER
END PROGRAM
```

### Output

```
Enter your hourly rate?  Nineteen dollars and fifty cents
Invalid data
Enter your hourly rate? 19.50
Enter the number of hours you worked this week? 40
Your pay for this week is 780
```

# WHILE

The WHILE statement marks the beginning of a WHILE loop or modifies the execution of another statement.

## Format

### Conditional

```
WHILE  cond-exp
       [ statement ]...
              .
              .
              .
NEXT
```

### Statement Modifier

*statement* WHILE *cond-exp*

## Syntax Rules

A NEXT statement must end the WHILE loop.

## Remarks

1. Conditional

   BASIC evaluates *cond-exp* before each loop iteration. If the expression is true (value nonzero), BASIC executes the loop. If the expression is false (value zero), control passes to the first executable statement after the NEXT statement.

2. Statement Modifier

   BASIC executes the statement repeatedly as long as *cond-exp* is true.

## Examples

### Example 1

```
!Conditional
WHILE X < 100
    X = X + SQR(X)
NEXT
```

### Example 2

```
!Statement Modifier
X% = X% + 1% WHILE X% < 100%
```

# XLATE$

The XLATE$ function translates one string to another by referencing a table string you supply.

## Format

*str-var* = XLATE[$] (*str-exp1*, *str-exp2*)

## Syntax Rules

1. *Str-exp1* is the input string.
2. *Str-exp2* is the table string.

## Remarks

1. *Str-exp2* can contain up to 256 ASCII characters, numbered from 0 to 255; the position of each character in the string corresponds to an ASCII value. Because 0 is a valid ASCII value (null), the first position in the table string is position zero.
2. XLATE$ scans *str-exp1* character by character, from left to right. It finds the ASCII value *n* of the first character in *str-exp1* and extracts the character it finds at position *n* in *str-exp2*. XLATE$ then appends the character from *str-exp2* to *str-var*. XLATE$ continues this process, character by character, until the end of *str-exp1* is reached.
3. The output string may be smaller than the input string for the following reasons:
   - XLATE$ does not translate nulls. If the character at position *n* in *str-exp2* is a null, XLATE$ does not append that character to *str-var*.
   - If the ASCII value of the input character is outside the range of positions in *str-exp2*, XLATE$ does not append any character to *str-var*.

## Example

```
DECLARE STRING A, table, source
A = "abcdefghijklmnopqrstuvwxyz"
table = STRING$(65, 0) + A
LINPUT " Type a string of uppercase letters"; source
PRINT XLATE$(source, table)
```

**Output**

```
Type a string of uppercase letters? ABCDEFG
abcdefg
```

# A

# ASCII Character Codes

ASCII is a 7-bit character code with an optional parity bit (8) added for many devices. Programs normally use seven bits internally with the eighth bit being zero; the extra bit is either stripped (on input) or added by a device driver (on output) so the program will operate with either parity- or nonparity-generating devices. The eighth bit is reserved for future standardization.

The International Reference Version (IRV) of ISO Standard 646 is identical to the IRV in CCITT Recommendation V.3 (International alphabet No. 5). The character sets are the same as ASCII except that the ASCII dollar sign (hexadecimal 24) is the international currency sign (###).

ISO Standard 646 and CCITT V.3 also specify the structure for national character sets, of which ASCII is the U.S. national set. Certain specific characters are reserved for national use. Table A–1 contains the values and symbols.

**Table A–1 ASCII Characters Reserved for National Use**

| Hexadecimal Value | IRV | ASCII |
|---|---|---|
| 23 | # | # |
| 24 | ### | $ (General currency symbol vs. dollar sign) |
| 40 | @ | @ |
| 5B | [ | [ |
| 5C | \ | \ |
| 5D | ] | ] |
| 5E | ^ | ^ |
| 60 | ` | ` |

(continued on next page)

**Table A–1 (Cont.) ASCII Characters Reserved for National Use**

| Hexadecimal Value | IRV | ASCII |
|---|---|---|
| 7B | { | { |
| 7C | \| | \| |
| 7D | } | } |
| 7E | ~ | Tilde |

ISO Standard 646 and CCITT Recommendation V.3 (International Alphabet No. 5) are identical to ASCII except that the number sign (23) is represented as ## instead of #, and certain characters are reserved for national use. Table A–2 list the ASCII codes.

**Table A–2 ASCII Codes**

| Decimal Code | 8-Bit Hexadecimal Code | Character | Remarks |
|---|---|---|---|
| 0 | 00 | NUL | Null (tape feed) |
| 1 | 01 | SOH | Start of heading (^A) |
| 2 | 02 | STX | Start of text (end of address, ^B) |
| 3 | 03 | ETX | End of text (^C) |
| 4 | 04 | EOT | End of transmission (shuts off the TWX machine ^D) |
| 5 | 05 | ENQ | Enquiry (WRU, ^E) |
| 6 | 06 | ACK | Acknowledge (RU, ^F) |
| 7 | 07 | BEL | Bell (^G) |
| 8 | 08 | BS | Backspace (^H) |
| 9 | 09 | HT | Horizontal tabulation (^I) |
| 10 | 0A | LF | Line feed (^J) |
| 11 | 0B | VT | Vertical tabulation (^K) |
| 12 | 0C | FF | Form feed (page, ^L) |
| 13 | 0D | CR | Carriage return (^M) |
| 14 | 0E | SO | Shift out (^N) |

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**Table A–2 (Cont.) ASCII Codes**

| Decimal Code | 8-Bit Hexadecimal Code | Character | Remarks |
|---|---|---|---|
| 15 | 0F | SI | Shift in (^O) |
| 16 | 10 | DLE | Data link escape (^P) |
| 17 | 11 | DC1 | Device control 1 (^Q) |
| 18 | 12 | DC2 | Device control 2 (^R) |
| 19 | 13 | DC3 | Device control 3 (^S) |
| 20 | 14 | DC4 | Device control 4 (^T) |
| 21 | 15 | NAK | Negative acknowledge (ERR, ^U) |
| 22 | 16 | SYN | Synchronous idle (^V) |
| 23 | 17 | ETB | End-of-transmission block (^W) |
| 24 | 18 | CAN | Cancel (^X) |
| 25 | 19 | EM | End of medium (^Y) |
| 26 | 1A | SUB | Substitute (^Z) |
| 27 | 1B | ESC | Escape (prefix of escape sequence) |
| 28 | 1C | FS | File separator |
| 29 | 1D | GS | Group separator |
| 30 | 1E | RS | Record separator |
| 31 | 1F | US | Unit separator |
| 32 | 20 | SP | Space |
| 33 | 21 | ! | Exclamation point |
| 34 | 22 | " | Double quotation mark |
| 35 | 23 | # | Number sign |
| 36 | 24 | $ | Dollar sign |
| 37 | 25 | % | Percent sign |
| 38 | 26 | & | Ampersand |
| 39 | 27 | ’ | Apostrophe |
| 40 | 28 | ( | Left (open) parenthesis |
| 41 | 29 | ) | Right (close) parenthesis |

(continued on next page)

**Table A–2 (Cont.) ASCII Codes**

| Decimal Code | 8-Bit Hexadecimal Code | Character | Remarks |
|---|---|---|---|
| 42 | 2A | * | Asterisk |
| 43 | 2B | + | Plus sign |
| 44 | 2C | , | Comma |
| 45 | 2D | – | Minus sign, hyphen |
| 46 | 2E | . | Period (decimal point) |
| 47 | 2F | / | Slash (slant) |
| 48 | 30 | 0 | Zero |
| 49 | 31 | 1 | One |
| 50 | 32 | 2 | Two |
| 51 | 33 | 3 | Three |
| 52 | 34 | 4 | Four |
| 53 | 35 | 5 | Five |
| 54 | 36 | 6 | Six |
| 55 | 37 | 7 | Seven |
| 56 | 38 | 8 | Eight |
| 57 | 39 | 9 | Nine |
| 58 | 3A | : | Colon |
| 59 | 3B | ; | Semicolon |
| 60 | 3C | < | Less than (left angle bracket) |
| 61 | 3D | = | Equal sign |
| 62 | 3E | > | Greater than (right angle bracket) |
| 63 | 3F | ? | Question mark |
| 64 | 40 | @ | Commercial at |
| 65 | 41 | A | Uppercase A |
| 66 | 42 | B | Uppercase B |
| 67 | 43 | C | Uppercase C |
| 68 | 44 | D | Uppercase D |

(continued on next page)

**Table A–2 (Cont.) ASCII Codes**

| Decimal Code | 8-Bit Hexadecimal Code | Character | Remarks |
|---|---|---|---|
| 69 | 45 | E | Uppercase E |
| 70 | 46 | F | Uppercase F |
| 71 | 47 | G | Uppercase G |
| 72 | 48 | H | Uppercase H |
| 73 | 49 | I | Uppercase I |
| 74 | 4A | J | Uppercase J |
| 75 | 4B | K | Uppercase K |
| 76 | 4C | L | Uppercase L |
| 77 | 4D | M | Uppercase M |
| 78 | 4E | N | Uppercase N |
| 79 | 4F | O | Uppercase O |
| 80 | 50 | P | Uppercase P |
| 81 | 51 | Q | Uppercase Q |
| 82 | 52 | R | Uppercase R |
| 83 | 53 | S | Uppercase S |
| 84 | 54 | T | Uppercase T |
| 85 | 55 | U | Uppercase U |
| 86 | 56 | V | Uppercase V |
| 87 | 57 | W | Uppercase W |
| 88 | 58 | X | Uppercase X |
| 89 | 59 | Y | Uppercase Y |
| 90 | 5A | Z | Uppercase Z |
| 91 | 5B | [ | Left square bracket |
| 92 | 5C | \ | Backslash (reverse slant) |
| 93 | 5D | ] | Right square bracket |
| 94 | 5E | ^ | Circumflex (caret) |
| 95 | 5F | _ | Underscore (underline) |

(continued on next page)

**Table A–2 (Cont.) ASCII Codes**

| Decimal Code | 8-Bit Hexadecimal Code | Character | Remarks |
|---|---|---|---|
| 96 | 60 | ` | Grave accent |
| 97 | 61 | a | Lowercase a |
| 98 | 62 | b | Lowercase b |
| 99 | 63 | c | Lowercase c |
| 100 | 64 | d | Lowercase d |
| 101 | 65 | e | Lowercase e |
| 102 | 66 | f | Lowercase f |
| 103 | 67 | g | Lowercase g |
| 104 | 68 | h | Lowercase h |
| 105 | 69 | i | Lowercase i |
| 106 | 6A | j | Lowercase j |
| 107 | 6B | k | Lowercase k |
| 108 | 6C | l | Lowercase l |
| 109 | 6D | m | Lowercase m |
| 110 | 6E | n | Lowercase n |
| 111 | 6F | o | Lowercase o |
| 112 | 70 | p | Lowercase p |
| 113 | 71 | q | Lowercase q |
| 114 | 72 | r | Lowercase r |
| 115 | 73 | s | Lowercase s |
| 116 | 74 | t | Lowercase t |
| 117 | 75 | u | Lowercase u |
| 118 | 76 | v | Lowercase v |
| 119 | 77 | w | Lowercase w |
| 120 | 78 | x | Lowercase x |
| 121 | 79 | y | Lowercase y |
| 122 | 7A | z | Lowercase z |

(continued on next page)

**Table A–2 (Cont.) ASCII Codes**

| Decimal Code | 8-Bit Hexadecimal Code | Character | Remarks |
|---|---|---|---|
| 123 | 7B | { | Left brace |
| 124 | 7C | \| | Vertical line |
| 125 | 7D | } | Right brace |
| 126 | 7E | ~ | Tilde |
| 127 | 7F | DEL | Delete (rubout) |

# B

# BASIC Keywords

The following is a list of the BASIC keywords. Most of the keywords are reserved; unreserved keywords are marked with a dagger (†).

%ABORT
%CDD†
%CROSS
%DEFINE
%ELSE
%END
%FROM
%IDENT
%IF
%INCLUDE
%LET
%LIBRARY
%LIST
%NOCROSS
%NOLIST
%PAGE
%PRINT
%SBTTL
%THEN
%TITLE
%UNDEFINE
%VARIANT
ABORT
ABS
ABS%
ACCESS
ACCESS%
ACTIVATE
ACTIVE

† Unreserved keyword

## BASIC Keywords

ALIGNED
ALLOW
ALTERNATE
AND
ANGLE†
ANY
APPEND
AREA†
AS
ASC
ASCENDING
ASCII
ASK
AT†
ATN
ATN2
BACK
BASE
BASIC
BEL
BINARY
BIT
BLOCK
BLOCKSIZE
BS
BUCKETSIZE
BUFFER
BUFSIZ
BY
BYTE
CALL
CASE
CAUSE
CCPOS
CHAIN
CHANGE
CHANGES
CHECKING
CHOICE†
CHR$
CLEAR

† Unreserved keyword

CLIP†
CLK$
CLOSE
CLUSTERSIZE
COLOR†
COM
COMMON
COMP%
CON
CONNECT
CONSTANT
CONTIGUOUS
CONTINUE
COS
COT
COUNT
CR
CTRLC
CVTF$
CVT$F
CVT$$
CVT$%
CVT%$
DAT
DAT$
DATA
DATE$
DEACTIVATE
DECIMAL
DECLARE
DEF
DEF*
DEFAULTNAME
DEL
DELETE
DESC
DESCENDING
DET
DEVICE
DIF$
DIM

† Unreserved keyword

## BASIC Keywords

DIMENSION
DOUBLE
DOUBLEBUF
DRAW
DUPLICATES
DYNAMIC
ECHO
EDIT$
ELSE
END
EQ
EQV
ERL
ERN$
ERR
ERROR
ERT$
ESC
EXIT
EXP
EXPAND†
EXPLICIT
EXTEND
EXTENDSIZE
EXTERNAL
FF
FIELD
FILE
FILESIZE
FILL
FILL$
FILL%
FIND
FIX
FIXED
FLUSH
FNAME$
FNEND
FNEXIT
FONT†
FOR

† Unreserved keyword

FORMAT$
FORTRAN
FREE
FROM
FSP$
FSS$
FUNCTION
FUNCTIONEND
FUNCTIONEXIT
GE
GET
GETRFA
GFLOAT
GO
GOBACK
GOSUB
GOTO
GRAPH
GRAPHICS†
GROUP
GT
HANDLE
HANDLER
HEIGHT†
HFLOAT
HT
IDN
IF
IFEND
IFMORE
IMAGE
IMP
IN†
INACTIVE
INDEX†
INDEXED
INFORMATIONAL
INITIAL
INKEY$
INPUT
INSTR

† Unreserved keyword

## BASIC Keywords

INT
INTEGER
INV
INVALID
ITERATE
JSB
KEY
KILL
LBOUND
LEFT
LEFT$
LEN
LET
LF
LINE
LINES†
LINO
LINPUT
LIST
LOC
LOCKED
LOG
LOG10
LONG
LSET
MAG
MAGTAPE
MAP
MAR
MAR%
MARGIN
MAT
MAX
METAFILE†
MID
MID$
MIN
MIX†
MOD
MOD%
MODE

† Unreserved keyword

MODIFY
MOVE
MULTIPOINT†
NAME
NEXT
NO†
NOCHANGES
NODATA
NODUPLICATES
NOECHO
NOEXTEND
NOMARGIN
NONE
NOPAGE
NOREWIND
NOSPAN
NOT
NUL$
NUM
NUM$
NUM1$
NUM2
NX
NXEQ
OF
ON
ONECHR
ONERROR
OPEN
OPTION
OPTIONAL
OR
ORGANIZATION
OTHERWISE
OUTPUT
OVERFLOW
PAGE
PATH†
PEEK
PI
PICTURE

† Unreserved keyword

PLACE$
PLOT
POINT†
POINTS†
POS
POS%
PPS%
PRIMARY
PRINT
PRIORITY†
PROD$
PROGRAM
PROMPT†
PUT
QUAD
QUO$
RAD$
RANDOM
RANDOMIZE
RANGE†
RCTRLC
RCTRLO
READ
REAL
RECORD
RECORDSIZE
RECORDTYPE
RECOUNT
REF
REGARDLESS
RELATIVE
REM
REMAP
RESET
RESTORE
RESUME
RETRY
RETURN
RFA
RIGHT
RIGHT$
RMSSTATUS
RND

ROTATE
ROUNDING
RSET
SCALE
SCRATCH
SEG$
SELECT
SEQUENTIAL
SET
SETUP
SEVERE
SFLOAT
SGN
SHEAR
SHIFT
SI
SIN
SINGLE
SIZE
SLEEP
SO
SP
SPACE†
SPACE$
SPAN
SPEC%
SQR
SQRT
STATUS
STEP
STOP
STR$
STREAM
STRING
STRING$
STYLE†
SUB
SUBEND
SUBEXIT
SUBSCRIPT
SUM$

† Unreserved keyword

SWAP%
SYS
TAB
TAN
TEMPORARY
TERMINAL
TEXT†
TFLOAT
THEN
TIM
TIME
TIME$
TO
TRAN†
TRANSFORM
TRANSFORMATION†
TRM$
TRN
TYP
TYPE
TYPE$
UBOUND
UNALIGNED
UNDEFINED
UNIT†
UNLESS
UNLOCK
UNTIL
UPDATE
USAGE$
USEROPEN
USING
USR$
VAL
VAL%
VALUE
VARIABLE
VARIANT
VFC
VIEWPORT†
VIRTUAL

† Unreserved keyword

VPS%
VT
WAIT
WARNING
WHEN
WHILE
WINDOW†)
WINDOWSIZE
WITH†
WORD
WRITE
XFLOAT
XLATE
XLATE$
XOR
ZER

† Unreserved keyword

# C

# Differences Between Alpha BASIC and VAX BASIC

Compaq BASIC for OpenVMS Alpha systems (hereafter referred to as Alpha BASIC) is based on and compatible with Compaq BASIC for OpenVMS VAX systems (hereafter referred to as (VAX BASIC).

Alpha BASIC supports most of the VAX BASIC features. This appendix describes the differences between Alpha BASIC and VAX BASIC.

## C.1 Feature Differences

This section describes the following:

- VAX BASIC features that are not available in Alpha BASIC
- Alpha BASIC features that are not available in VAX BASIC

### C.1.1 VAX BASIC Features Not Available in Alpha BASIC

Table C–1 describes the VAX BASIC features not available in Alpha BASIC. There are no plans for Alpha BASIC to support these features.

**Table C–1 VAX BASIC Features Not Available in Alpha BASIC**

| Features | Comments |
|---|---|
| /[NO]ANSI_STANDARD | Enforces the ANSI Minimal BASIC standard. |
| VAX BASIC Environment | The VAX BASIC Environment provides features specific to BASIC for program development. The RUN command and immediate mode are not supported. |
| /[NO]SYNTAX_CHECK | Specifies syntax checking after every entered line. |
| /[NO]FLAG=[BP2COMPATIBILITY] | Notifies VAX BASIC users of VAX BASIC features that are not compatible with PDP–11 BASIC/PLUS2. |
| /[NO]FLAG=[AXPCOMPATIBILITY] | Notifies VAX BASIC users of VAX BASIC features that are not supported by Alpha BASIC. |
| Graphics statements | Graphics statements are not supported. |
| HFLOAT data type | Specifies floating-point format for floating-point data. Additionally, the HFLOAT argument to the REAL built-in function is not supported. |
| /[NO]DESIGN | There is no support for the Program Design Facility (PDF). The compiler does not attempt to compile a program when /DESIGN is specified. |

## C.1.2 Alpha BASIC Features Not Available in VAX BASIC

Table C–2 describes Alpha BASIC command line qualifiers not available in VAX BASIC. For detailed information about all the BASIC qualifiers, see the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual.*

**Table C–2 Alpha BASIC Qualifiers Not Available in VAX BASIC**

| Qualifier | Comments |
|---|---|
| /INTEGER_SIZE=QUAD | Allows you to specify that integers should be quadwords (that is, 64 bits in size). |

(continued on next page)

**Table C–2 (Cont.) Alpha BASIC Qualifiers Not Available in VAX BASIC**

| Qualifier | Comments |
|---|---|
| /OPTIMIZE=LEVEL=*n* | Controls the level of optimization done by the compiler. (/OPTIMIZE without the LEVEL is available in VAX BASIC; see Section C.2.1.) |
| /REAL_SIZE= { SFLOAT \| TFLOAT \| XFLOAT } | Allows you to specify one of the IEEE floating-point data types, SFLOAT, TFLOAT, or XFLOAT. |
| /SEPARATE_COMPILATION | Controls whether an individual compilation unit becomes a separate module in an object file. |
| /SYNCHRONOUS_EXCEPTIONS | Controls whether or not the compiler emits additional code to emulate VAX BASIC exception behavior. |
| /WARNINGS=ALIGNMENT | Instructs the compiler to flag all occurrences of non-naturally aligned RECORD fields, variables within COMMONs and MAPs, and RECORD arrays. |

## C.2 Behavior Differences

This section describes the behavior differences between Alpha BASIC and VAX BASIC.

### C.2.1 Optimization

In both Alpha BASIC and VAX BASIC, the /[NO]OPTIMIZE qualifier controls whether optimization is turned on or off, and for both the default is /OPTIMIZE (unless /DEBUG is specified).

The difference is that Alpha BASIC allows you to specify which of four levels of optimization the compiler should perform. The default is /OPTIMIZE=LEVEL=4 (full optimization). In VAX BASIC, you cannot specify a level of optimization. For more information, see the section on BASIC command qualifiers in the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

## C.2.2 Data Types

The following data types are discussed in this section:

- QUAD, SFLOAT, TFLOAT, and XFLOAT
- Implicit use of HFLOAT
- Double
- HFLOAT and HFLOAT Complex in Oracle CDD/Repository

### C.2.2.1 QUAD, SFLOAT, TFLOAT, and XFLOAT

Alpha BASIC has four data types not available in VAX BASIC:

- QUAD allows you to specify a size of 64 bits (quadword) for integers.
- SFLOAT, TFLOAT, and XFLOAT are IEEE floating-point data types requiring Version 7.1 or higher of the OpenVMS Alpha operating system.

These four data types allow the Alpha BASIC user to take advantage of the 64-bit Alpha architecture.

### C.2.2.2 Implicit Use of the HFLOAT Data Type

VAX BASIC performs some intermediate calculations in the HFLOAT data type, even if the source code does not explicitly specify its use. This generally occurs when mixed data type operations are performed between large DECIMAL items and floating-point items. For more information about VAX BASIC behavior, see Section 1.6.1.1.

Alpha BASIC performs these operations in GFLOAT. As a result, some loss of precision is possible. Alpha BASIC issues the following compile-time warning message if source code is encountered that results in this difference:

```
OPEPERGFL, operation performed in GFLOAT, loss of precision possible
```

### C.2.2.3 Double Data Type

The Alpha hardware does not completely support the D-floating data type. Alpha BASIC performs BASIC DOUBLE operations (+, -, and so on) in G-floating (consistent with other languages on OpenVMS Alpha systems). As a result, the operations lose three bits of precision.

Alpha BASIC performs mixed operations between GFLOAT and DOUBLE in GFLOAT, not HFLOAT. VAX BASIC performs mixed operations between GFLOAT and DOUBLE in HFLOAT.

Conversions between the human world of decimal numbers and the binary world of computers cause rounding errors. For example, .1 (1/10) cannot be represented exactly in either D_floating or G_floating data type. It must be rounded. Because the D_floating and G_floating representations provide differing amounts of precision, the rounding error may be slightly different. As a result, the D_floating and G_floating representations of the same decimal number are not always the same when converted back to decimal.

#### C.2.2.4 HFLOAT Data Type and HFLOAT COMPLEX Data Type in Oracle CDD/Repository

Alpha BASIC does not support HFLOAT. Neither Alpha BASIC nor VAX BASIC support the HFLOAT COMPLEX data type. The following sections discuss the translations that occur when reading records from Oracle CDD/Repository.

##### HFLOAT Data Type

In Alpha BASIC, HFLOAT data types generate a GROUP using the name of the HFLOAT item specified in Oracle CDD/Repository. The GROUP contains a single 16 byte string item. Because HFLOAT is not supported, the compiler generates an informational message similiar to those caused by other unsupported data types.

Example C–1 is an Alpha BASIC example. Example C–2 is a VAX BASIC example.

**Example C–1 Alpha BASIC HFLOAT Translation**

```
GROUP MY_H_REAL
    STRING STRING_VALUE = 16
END GROUP
```

**Example C–2 VAX BASIC HFLOAT Translation**

```
HFLOAT MY_H_REAL
```

### HFLOAT COMPLEX Data Type

In Alpha BASIC, the Oracle CDD/Repository data type HFLOAT COMPLEX maps to a GROUP of two 16-byte static strings. Example C–3 shows Oracle CDD/Repository output on Alpha BASIC.

**Example C–3 Oracle CDD/Repository HFLOAT COMPLEX Data Type with Alpha BASIC**

```
GROUP MY_H_COMPLEX
    STRING HFLOAT_R_VALUE = 16
    STRING HFLOAT_I_VALUE = 16
END GROUP
```

Example C–4 shows Oracle CDD/Repository output on VAX BASIC.

**Example C–4 Oracle CDD/Repository HFLOAT COMPLEX Data Type with VAX BASIC**

```
GROUP MY_H_COMPLEX
    HFLOAT HFLOAT_R_VALUE
    HFLOAT HFLOAT_I_VALUE
END GROUP
```

### C.2.3 Array Parameters

The following are differences in the way Alpha BASIC and VAX BASIC handle array parameters:

- Both Alpha BASIC and VAX BASIC perform parameter checking when an entire array is passed to a subprogram or function. When the array that was passed does not match the array that is expected by the subprogram or function, the compiler issues the error message "Arguments don't match." VAX BASIC performs this check each time the array is referenced. Alpha BASIC performs this check once at the start of the subprogram or function.

  Alpha BASIC processes array parameters more efficiently. The following differences exist between Alpha BASIC and VAX BASIC in the way each processes array parameters:

  – In Alpha BASIC, if a subprogram or function declares an array in its parameter list, the calling program must pass an array when calling the subprogram or function. If this is not done, an unexpected failure can occur. For example, passing a null parameter instead of an array causes a memory management violation and the program fails. In VAX BASIC, it is valid for the program to pass a null parameter if the array is not accessed in the subprogram.

  – In Alpha BASIC, the subprogram cannot trap the "Arguments don't match" error. The error is signaled, but can only be trapped by the calling program.

- When passing an entire array by descriptor, VAX BASIC creates a DSC$K_CLASS_A descriptor; Alpha BASIC creates a DSC$K_CLASS_NCA descriptor.

  For most BASIC applications, this is not noticeable because both the calling program and the called subprogram use NCA descriptors. However, a program that relies on individual descriptor fields may have to be modified to work with descriptors produced by Alpha BASIC.

  For more information about DSC$K_CLASS_A and DSC$K_CLASS_NCA descriptors, see the *OpenVMS Calling Standard*.

- VAX BASIC performs no scale or precision checking when passing entire decimal arrays to a subprogram or function.

  Alpha BASIC subprograms and functions check all decimal arrays received by descriptor to verify that precision, scale factor, and bound information match those of the parameter in the calling program. For example, the following program causes the error "Arguments don't match" when the subprogram *test_func* starts to execute:

```
10 declare decimal(5,2) a(10)
20 call test_func(a())
30 print a(1)
35 end

40 sub test_func(decimal(10,4) b())
45 b(1) = 12.12
50 end sub
```

- VAX BASIC performs minimal checking when receiving an array of records from a caller. For example, in the following program, VAX BASIC does not check whether the size of the array passed is equal to the size declared in the subprogram.

  Alpha BASIC checks that the size of the array elements are the same and that the number of dimensions match. The following program produces the error "Arguments don't match" when the subprogram *test_func* starts to execute:

```
10 record rec1
    long a
    long b
   end record
   declare rec1 a(10)
   call test_func(a())
   end
```

```
40 sub test_func(rec2 a())
    record rec2
        long x
        long y
        long z
    end record
    a(2)::x = 1
50  end sub
```

- VAX BASIC always performs bounds checking on arrays received as descriptor parameters.

  Alpha BASIC does not perform bounds checking on arrays received as descriptor parameters if the /CHECK=NOBOUNDS qualifier is specified. In this way, arrays received as parameters are consistent with all other arrays.

### C.2.4 DEF* Routines

In Alpha BASIC, DEF* routines cannot be called from within DEF routines or WHEN handlers. If such calls are attempted, the following error message is issued:

```
%BASIC-E-DEFSNOTALL, DEF* reference not allowed in DEF or handler
```

Alpha BASIC gives highest precedence to DEF* routines that are called from within an expression. Thus, a DEF* routine call is evaluated first. When the DEF* routine directly modifies the values of variables used within the same expression, this can affect the result of the expression. If the compiler changes the order of a DEF* call in an expression, it issues the following warning message:

```
%BASIC-W-DEFEXPCOM, expression with DEF* too complex, moving <name> invocation
```

You can avoid this by simplifying the expression.

### C.2.5 /LINES Qualifier

In Alpha BASIC, the /LINES qualifier affects only the ERL function and determines whether BASIC line numbers are reported in run-time error messages. The following differences exist in Alpha BASIC:

- /NOLINES is the default.
- You do not have to use /LINES to use the RESUME statement without a target.
- Using /LINES in programs that have line numbers on most lines can negatively affect run-time performance.

### C.2.6 Appending Files at the DCL Command Line

VAX BASIC requires that source files using the plus sign (+) to append source files use line numbers within the files; otherwise, an error message is issued.

Alpha BASIC does not require line numbers in either of the source files. The plus sign is treated as an OpenVMS append operator. Alpha BASIC appends and compiles the separate files as if they were a single source file.

### C.2.7 Unreachable Code Error

Alpha BASIC performs extensive analysis when searching for unreachable code and may report more occurrences than VAX BASIC.

In Alpha BASIC, the compile-time error message for unreachable code, UNREACH, is an informational message. In VAX BASIC, the compile-time error message for unreachable code, INACOFOL, is a warning.

Alpha BASIC checks for DEF functions that are never referenced and issues the informational message "UNCALLED, routine *xxxx* can never be called."

### C.2.8 Line Numbers

In Alpha BASIC, unlike VAX BASIC, you cannot have duplicate line numbers or line numbers not in ascending numerical order. This restriction applies to single source files or source files concatenated with a plus sign (+) at the DCL command line. Duplicate line numbers or line numbers not in ascending order cause "E" level compilation errors.

VAX BASIC does allow duplicates and lines out of order. Alpha BASIC provides an example TPU command procedure to help work around this difference. It can be used to append source files and sort BASIC line numbers into ascending numerical order from one or more source files.

After installation of Alpha BASIC, the location of the TPU command procedure is:

SYS$COMMON:[SYSHLP.EXAMPLES.BASIC]BASIC$ENV.TPU.

Instructions for its use are in the file.

**Note**

Although there are no known problems, the TPU command procedure has not been thoroughly tested. As a result, it is not supported by Compaq.

### C.2.9 Error Handling Semantics

To achieve the most efficient performance, the Alpha BASIC compiler may reorder the execution of arithmetic instructions. Rarely does this result in error handling semantics that are incompatible with VAX BASIC; most programs are not affected by this change.

Use the Alpha BASIC /SYNCHRONOUS_EXCEPTIONS qualifier for those programs that require exact VAX BASIC behavior.

### C.2.10 Generation of Object Modules

In Alpha BASIC, the default behavior places all routines (SUBs, FUNCTIONs, and main programs) compiled within a single source program into a single module in the object file. VAX BASIC generates each routine as a separate module. Use the Alpha BASIC /SEPARATE_COMPILATION qualifier to duplicate VAX BASIC behavior. See the information on qualifiers on the BASIC command line in the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

### C.2.11 RESUME and DEF

VAX BASIC does not enforce the documented restriction that a RESUME statement lexically outside a DEF statement (without a target specified) cannot resume program execution within a DEF statement. Alpha BASIC enforces this restriction at run time.

### C.2.12 Exceptions

When the Alpha BASIC compiler determines that the result of an expression is never used, the compiler does not generate code to evaluate that expression. This causes an incompatibility with VAX BASIC if the removed expression causes an exception. In the following example, the program generates a divide-by-zero error in VAX BASIC. It runs without error in Alpha BASIC because Alpha BASIC, recognizing that the variable *A* is never used, does not generate code to evaluate the expression that is assigned to *A*:

```
B = 5
A = B / 0
END
```

### C.2.13 Compiler Message Differences

There is a small difference in the way compiler messages are reported. In VAX BASIC the source information appears before the message text, and includes both source and listing line numbers. In Alpha BASIC the source information appears after the message text and includes only source line numbers.

When the Alpha BASIC compiler reports source line information, the message looks like:

```
%BASIC-E-xxxxxxxxx, xxxxxxxxxxxxx at line number YY in file xxxxxxxxxxx
```

In both Alpha BASIC and VAX BASIC, the reported line number is the physical source line in the file. It is not the BASIC line number that might occur in the source program.

### C.2.14 Error Status Returned to DCL

When errors occur, the Alpha BASIC and VAX BASIC compilers at times return a different status to DCL. For example, when the file specified at the DCL command line cannot be found, Alpha BASIC returns BASIC–F–ABORT; VAX BASIC returns BASIC–F–OPENIN.

### C.2.15 SYS$INPUT

In Alpha BASIC, when you specify SYS$INPUT as the input file specification at the DCL command line, the object file and the listing file are named differently from VAX BASIC. In Alpha BASIC, the compiler names the files with the file types .OBJ and .LIS (with nothing preceding). In VAX BASIC, the compiler names the files NONAME.OBJ and NONAME.LIS.

### C.2.16 FSS$ Function

The VAX BASIC compiler compiles a program that uses the FSS$ function, but if the FSS$ function is invoked at run time, the following run-time error is generated:

```
%BAS-F-NOTIMP, Not implemented
```

The Alpha BASIC compiler reports all uses of the FSS$ function by generating the following error at compile time:

```
%BAS-E-BLTFUNNOT, built-in function not supported
```

### C.2.17 BAS$K_FAC_NO Constant

The BAS$K_FAC_NO constant is not defined on OpenVMS Alpha systems. You should replace all occurrences of the EXTERNAL LONG CONSTANT BAS$K_FAC_NO with EXTERNAL LONG CONSTANT BAS$_ FACILITY. OpenVMS VAX systems use the constant BAS$K_FAC_NO to communicate the facility number between SYS$LIBRARY:BASRTL.EXE and SYS$LIBRARY:BASRTL2.EXE; it is not needed on OpenVMS Alpha systems.

### C.2.18 Math Functions with Different Results

Some math function results differ between Alpha BASIC and VAX BASIC, because underlying OpenVMS Alpha system routines use improved algorithms to perform these operations.

### C.2.19 Floating Point Errors

Some programs that run successfully on OpenVMS VAX systems may fail on OpenVMS Alpha systems with division by zero or other floating-point errors. Examine your failing program for a dirty floating point zero. A **dirty floating point zero** is a number represented by a zero exponent and a nonzero mantissa. Most OpenVMS VAX system instructions treat the invalid floating-point number as a zero, but it causes an exception to be generated by some OpenVMS Alpha instructions.

You cannot create a dirty zero by using BASIC arithmetic expessions. You can create a dirty zero by reading it from a file. BASIC I/O statements, such as GET and MOVE FROM, move bytes of data to a variable without checking that the data is valid for the variable.

Correct the problem in one of the following ways:

- Determine how the dirty zero was created and make the correction. This is the preferred way.
- Write a routine to clean any floating-point numbers that receive a dirty zero value.

The following is an example of a routine that cleans a single precision floating-point number (you can write similiar routines to clean double or G-floating numbers):

```
SUB CLEAN_SINGLE( SINGLE A )
    MAP (OVER) SINGLE B
     MAP (OVER) WORD W1,W2
     B = A
     IF (W1 AND 32640%) = 0% THEN
           A = 0
     END IF
END SUB
```

The routine accepts a floating-point number, checks for a zero exponent, and clears the mantissa. It redefines the floating-point number as an integer so that the proper bits are tested.

For more information on floating-point formats and dirty zeros, see the Alpha Architecture Reference Manual.

## C.2.20 Error Detection on Illegal MAT Operations

Following are two differences in error detection on illegal MAT operations:

- Alpha BASIC correctly reports ILLOPE (Error 141 - Illegal operation) if an attempt is made to perform matrix multiplication when the destination matrix is identical to either source matrix. VAX BASIC does *not* correctly detect and report the ILLOPE message if an attempt is made to perform the following matrix multiplication, where B is a virtual array, and A is either a virtual array or an in-memory array:

  ```
  MAT B = A * B
  ```

- Under certain conditions, VAX BASIC does not enforce the documented restriction that arrays used in MAT operations must have zero lower bounds. Alpha BASIC always reports either a LOWNOTZER error at compile time, or a MATDIMERR error at run time, when attempting to perform MAT operations on arrays with nonzero lower bounds.

## C.2.21 Debugging Differences

There are debugging differences between VAX BASIC and Alpha BASIC, especially during use of the debugger STEP command around exception handlers, DEF functions, external subprograms, and GOSUB routines.

These differences are described below and in the *Compaq BASIC for OpenVMS Alpha and VAX Systems User Manual*.

When the debugger STEP command is used in source code containing an error, differences occur in the Debugger behavior between OpenVMS VAX and OpenVMS Alpha. These differences are due to architectural differences in the hardware and software of the two systems.

In Alpha BASIC, a STEP at a statement that causes an exception might never return control to the debugger. The debugger cannot determine what statement in the BASIC source code will execute after the exception occurs. Therefore, set explicit breaks if you use STEP on statements that cause exceptions.

The following hints should help when you use the STEP command to debug programs that handle errors:

- When you STEP at a statement that takes an error, the debugger will not regain control unless the program reaches an explicit breakpoint or the next statement that would have executed if no error had occurred. Set explicit breaks if you want the program to stop in any other place.
- Use of the STEP command at a statement that takes an error does not return control to the debugger when the program reaches the error handler code. If you want the program to break when program execution enters an error handler, explicitly set a breakpoint at the error handler. This applies to both ON ERROR handlers and WHEN handlers.
- If you are within a WHEN handler, a STEP at a statement that terminates execution within the WHEN handler (CONTINUE, RETRY, END WHEN, END HANDLER, EXIT HANDLER) will not stop unless program flow reaches a point where an explicit breakpoint is set.
- A STEP at a RESUME statement in an ON ERROR handler stops program execution at the first line of non-error-handler code.
- Use SET BREAK/EXCEPTION at the beginning of the debugging session to prevent unexpected errors from occurring. This breakpoint is not necessary if you have set explicit breakpoints at all error handlers. However, use of this command will break at all exceptions, allowing you to check that you have the proper breakpoints to stop program execution following the exception.

### C.2.22 Listing File Differences

Following are differences in listing files between Alpha BASIC and VAX BASIC:

- /MACHINE/LIST - In VAX BASIC, if you specify BASIC/MACHINE, you get a listing file containing a machine language listing but no source code listing. In Alpha BASIC, if you specify BASIC/MACHINE, you do not get either listing. You must specify /LIST to get listing files. In Alpha BASIC, specifying /MACHINE/LIST gives you both the machine language and the source code in the listing file.

When VAX BASIC creates a listing file for a program with more than one routine, it places the machine code for each routine after the source code for that routine. The listing file produced by the Alpha BASIC compiler contains the source listing for all the routines followed by the machine code listing for all the routines, unless you use the /SEPARATE_COMPILATION qualifier.

- %PAGE - In Alpha BASIC, the %PAGE directive appears on the page following the page break. In VAX BASIC, the %PAGE directive appears on the page before the page break.
- %TITLE and %SBTTL strings - These are truncated at 31 characters in Alpha BASIC, and 45 characters in VAX BASIC.
- Form feeds - VAX BASIC treats form feeds as %PAGE directives. Alpha BASIC does no special processing with form feeds. When a form feed occurs in the source file, that form feed occurs in the listing file, but no listing header information accompanies the form feed.
- /SHOW=MAP qualifier - The following differences occur in Alpha BASIC when you use the /SHOW=MAP qualifier:
  - Alpha BASIC leaves the offset field in the allocation map blank in cases where the values are not applicable, or not available to the listing phase.
  - In dynamic maps of arrays, VAX BASIC reports the size of the array descriptors; Alpha BASIC reports the size of the array.
- Message placement - The placement of some error messages in the listing file may differ between VAX BASIC and Alpha BASIC. For example, in Alpha BASIC, errors that require flow analysis such as "unreachable code" and "routine can never be called" appear in the listing after the source code and allocation map listing. In listings for source files that contain more than one routine, these errors appear after the source and allocation listing for all routines in the compilation, unless the /SEPARATE_COMPILATION is specified.

## C.3 Common Language Environment Differences

This section describes differences between Alpha BASIC, VAX BASIC, and other languages within the common language environment.

### C.3.1 Creating PSECTs with COMMON and MAP Statements

In Alpha BASIC, the PSECT attributes are different from those in VAX BASIC, as follows:

| Alpha BASIC | VAX BASIC |
|---|---|
| NOPIC | PIC |
| NOSHR | SHR |
| Alignment of OCTAWORD | Alignment of LONG |

In Alpha BASIC, the lengths of the PSECTs that the COMMON and MAP statements create are rounded up to a multiple of 16. The size of COMMON or MAP does not change; the size of the PSECT does. This change is visible only to applications that use shareable images in a multilanguage environment.

Both Alpha BASIC and VAX BASIC create PSECTs that are compatible with those of other languages on the same platform, with the exception of MACRO. You can link with modules written in languages other than MACRO without changing code. If you link against MACRO modules that reference these PSECTs, you may need to make corresponding changes in the MACRO code.

### C.3.2 64-Bit Floating-Point Data

In most other Compaq languages, the default 64-bit floating-point data type has changed from D_floating on OpenVMS VAX systems to G_floating on OpenVMS Alpha systems. If you communicate BASIC DOUBLE (OpenVMS D_floating) data between BASIC and one of the other languages that have made this change, you need to do one of the following:

- In the compiler command line of the other language, change the 64-bit floating-point data type to D_floating to match the behavior of Alpha BASIC.
- In your BASIC program, change the data type of the 64-bit floating-point data from DOUBLE to GFLOAT to match the other language.

## C.4 LIB$ROUTINES and BASIC$STARLET.TLB Routines Unsupported by Alpha BASIC

Direct use of the following routines by Alpha BASIC programs is unsupported. Attempts to execute any of these routines will result in an error.

**In LIB$ROUTINES module:**

LIB$INSERT_TREE_64

LIB$SHOW_VM_64
LIB$SHOW_VM_ZONE_64

**In STARLET module:**

SYS$CREATE_BUFOBJ_64
SYS$CREATE_GFILE
SYS$CREATE_GPFILE
SYS$CREATE_REGION_64
SYS$CRETVA_64
SYS$CRMPSC_FILE_64
SYS$CRMPSC_GFILE_64
SYS$CRMPSC_GPFILE_64
SYS$DELTVA_64
EXPREG_64
SYS$IO_CLEANUP
SYS$IO_PERFORM
SYS$IO_PERFORMW
SYS$LCKPAG_64
SYS$LKWSET_64
SYS$MGBLSC_64
SYS$PURGE_WS
SYS$SETPRI_64
SYS$ULKPAG_64
SYS$ULWSET_64
SYS$UPDESC_64
SYS$UPDSEC_64W

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