ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-116

BASIC

ECMA BASIC-1
ECMA BASIC-2
ECMA GRAPHICS MODULE

June 1986

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BRIEF HISTORY

The first version of the language BASIC, acronym for Beginner's All-purpose Symbolic Instruction Code, was produced in June 1965 at the Dartmouth College in the USA.

In January 1978, ECMA published a Standard for Minimal BASIC, ECMA-55, prepared in cooperation with ANSI X3J2 and fully compatible with the corresponding ANSI standard. This Standard ECMA-55 served as a basis for the ISO Standard on Minimal BASIC.

With the continuation of the work, a draft Standard for full BASIC was agreed by ANSI X3J2, EWICS TC2 and ECMA/TC21 in January 1985. This draft is composed of a mandatory Core module and five optional modules.

Starting from this draft, ECMA/TC21 prepared a Standard for fully defined subsets of the language. These subsets, called ECMA BASIC-1 and ECMA BASIC-2, are designed for business applications, requiring extended file facilities. ECMA BASIC-1 has no exception handling facilities and a reduced set of file operations. In addition, all the keywords in ECMA BASIC-1 are reserved words, reducing the complexity of the interpreter or compiler needed. ECMA BASIC-2 provides full exception handling capabilities, full file operations and fixed decimal capabilities. The set of reserved words is minimal. Both subsets provide the full flow control capabilities provided in the ANSI standard. An additional module (ECMA GRAPHICS) provides a minimum of graphic capabilities and can be used with either subset.

Compatibility with the ANSI standard has been a primary design objective, and the ECMA Standard is fully upward compatible with corresponding implementations of the ANSI Standard.

Approved as an ECMA Standard by the General Assembly of June 26, 1986.

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NOTE

Sections 4 to 15 are further subdivised in:

x.y.1 General Description
x.y.2 Syntax
x.y.3 Examples
x.y.4 Semantics
x.y.5 Exceptions
x.y.6 Remarks

1. INTRODUCTION

1. INTRODUCTION

This Standard is designed to promote the interchangeability of BASIC programs among a variety of automatic data processing systems. Programs conforming to this Standard will be said to be written in ECMA BASIC.

Two levels of the language are specified in this Standard: ECMA BASIC-1 and ECMA BASIC-2. In addition this Standard defines an optional Graphics module.

1.1 Scope

This Standard establishes:

- The syntax of programs written in ECMA BASIC.
- The formats of data and the minimum precision and range of numeric representations and the minimum length and set of characters in strings which are acceptable as input to an automatic data processing system being controlled by a program written in ECMA BASIC.
- The formats of data and the minimum precision and range of numeric representations and the minimum length and set of characters in strings which can be generated as output by an automatic data processing system being controlled by a program written in ECMA BASIC.
- The semantic rules for interpreting the meaning of a program written in ECMA BASIC.
- The errors and exceptional circumstances which shall be detected.

Although the BASIC language was originally designed primarily for interactive use, this Standard describes a language that is not so restricted. This Standard is not meant to preclude the use of any particular implementation technique, for example interpreters, incremental or one-pass compilers.

1.2 Related Standards

ECMA-6	7-Bit Coded Character Set
ECMA-35	Code Extension Techniques
ECMA-53	Representation of Source Program for Program Interchange: - APL, COBOL, FORTRAN, Minimal BASIC and PL/1
ECMA-55	Minimal BASIC
ISO 2014	Writing of Calendar Dates in all-numeric form
ISO 2711	Representation of Ordinal Dates
ISO 3307	Representation of Time of the Day
ISO 7942	GRAPHICAL KERNEL System (GKS)
IEC 559	Binary Floating Point Arithmetic for Microprocessor Systems.
ANSI X3.113-198X	American National Standard for BASIC

2. CONFORMANCE

2. CONFORMANCE

This Standard specifies two levels of the language: ECMA BASIC-1 and ECMA BASIC-2. In addition this Standard defines a Graphics module.

ECMA BASIC-1 includes all the parts defined in Section 4 to 12, with the exception of those portions of Section 11 that describes enhanced files and Section 12.1, Exception Handling. All the keywords, listed in 3.2.19 under the heading BASIC-1 are reserved words.

ECMA BASIC-2 includes all the parts defined in Section 4 to 12 and in Section 15. The keywords, listed in 3.2.19 under the heading BASIC-2 are reserved words.

The graphics module is specified in section 13. It is optional, and it can be used together either with ECMA BASIC-1 or ECMA BASIC-2.

There are two aspects of the conformance to the language defined in this Standard: conformance by a program written in the ECMA BASIC language, and conformance by an implementation which processes such programs.

Broadly speaking, the conformance requirements are structured so that any program conforming to this standard will produce the same results when executed by any implementation conforming to the standard (though some implementation-defined features are noted in Appendix 3).

2.1 Program Conformance

A program conforms to this Standard only when

- the program and each statement or other syntactic element contained therein is syntactically valid according to the syntactic rules specified by this Standard as belonging to that level, and
- the program as a whole violates none of the global constraints imposed by this level of the Standard on the application of the syntactic rules.

2.2 Implementation Conformance

An implementation conforms to a level of this Standard only when

- it accepts and processes all programs conforming to that level of this Standard,
- it reports reasons for rejecting any program which does not conform to this Standard,
- it interprets errors and exceptional circumstances according to the specifications of this Standard,
- it interprets the semantics of each statement of a conforming program according to the specifications in this Standard,
- it interprets the semantics of a conforming program as a whole according to the specifications in this Standard,
- it accepts as input, manipulates, and can generate as output numbers of at least the precision and range specified in this Standard,
- it accepts as input, manipulates, and can generate as output strings of at least the length and composed of at least those characters specified in this Standard,
- it is accompanied by documentation available to the user that describes the actions taken in regard to features referred to as "undefined" or "implementation-defined" in this Standard, and
- it is accompanied by documentation available to the user that describes and identifies all enhancements to the language defined in this Standard.

This Standard makes no requirement concerning the interpretation of the semantics of any statement or program as a whole that does not conform to this Standard.

2.3 Errors

This Standard does not include specific requirements for reporting syntactic errors in the text of a program.

Implementations conforming to this Standard may accept programs written in an enhanced language without having to report all constructs not conforming to this Standard.

Whenever a statement or other program element does not conform to the syntactic rules given herein, and that statement or other program element, does not have a clear, well documented implementation-defined meaning, an error shall be reported. Errors shall be reported in a clear and well documented way and whenever feasible the implementation should indicate the erroneous statement and the position of the error within the statement.

2.4 Exceptions

An exception is a circumstance arising in the course of execution of a program when an implementation recognizes that the semantic rules of this Standard cannot be followed or that some resource constraint is about to be exceeded. All exceptions described in this Standard shall be detected, reported and processed when they occur, unless some mechanism provided in 12.1 (BASIC-2 only) or an enhancement to this Standard has been invoked by the user to handle exceptions.

In the absence of programmer-specified recovery procedures, exceptions shall be handled by the recovery procedures specified in this Standard. If no recovery procedure is specified in this Standard, or if restrictions imposed by the hardware or the operating environment make it impossible to follow the procedure specified in this Standard, then the way in which the exception is handled depends on the context. If the exception occurred in the invocation of a function or subprogram, then the exception is "propagated back" to the invoking statement in the invoking program unit (see 12.1). If this propagation procedure reaches the main-program, or if the exception occurred in the main-program, then the exception shall be handled by terminating the program.

The way in which the exception handling mechanism reports an exception is implementation-defined, except that the contents of the report shall identify at least the exception code and the line number of the line in which the original exception occurred.

Except in the case of files, when several exception are caused by the execution of a single statement of a program, this Standard does not specify an order in which these exceptions shall be detected or reported. If an implementation determines that a particular statement in a conforming program will always cause an exception when executed, the implementation may issue a warning to the user. Nonetheless, the implementation must accept and execute the program, according to the normal semantic rules specified herein.

2.5 Relationship to the ANSI Standard

This Standard ECMA BASIC defines a subset of the ANSI BASIC Standard, ANSI X3.113-198X.

The ANSI standard defines a set of modules, only one of which (the Core module) is mandatory. On the other hand, only the graphics module is optional in the ECMA standard.

Programs written in ECMA BASIC-1 will run on implementations conforming to the ANSI standard if the implementation implements at least the Core module. Provided that the implementation-defined elements are defined in a compatible way in the two implementations, the programs will act in the same way and give the same results.

Programs written in BASIC-2 will run on implementations conforming to the ANSI Standard if the implementation implements at least the Core module and the Enhanced Files module. Provided that the implementation-defined elements are defined in a compatible way in the two implementations, the program will act in the same way and give the same results.

The reverse will not always be true. In view of the modular nature of the ANSI standard, programs conforming to the ANSI standards will run on an ECMA BASIC implementations only if they use the set of facilities defined in the ECMA BASIC Standard. Real-time programs will not run on ECMA BASIC implementations.

A further difference exists in reserved words. All keywords defined in ECMA BASIC-1 are reserved and cannot be used as identifiers. Only a limited number of keywords is reserved in the ANSI Standard. Thus programs written in ECMA BASIC-1 will run on an ANSI implementation, with the limitations defined above. A program written in ANSI BASIC, and which uses only the facilitites defined in ECMA BASIC-1, is not granted to run on an ECMA BASIC-1 implementation, unless the limitations on identifiers have been observed.

The ECMA graphics module is a subset of the ANSI one. Thus programs conforming to the ECMA module will run on an ANSI implementation, but programs conforming to the ANSI module will not run on an ECMA implementation unless they use only the facilities defined in ECMA BASIC.

3. SYNTAX SPECIFICATION AND DEFINITIONS

3. SYNTAX SPECIFICATION AND DEFINITIONS

3.1 Method of Syntax Specification

The syntax, through a series of rewriting rules known as "productions", defines syntactic objects of various types, such as a program or expression, and describes which strings of symbols are objects of these types.

In the syntax, upper-case-letters, digits, and (possibly hyphenated) lower-case words are used as "metanames", i.e. as names of syntactic objects. Most of these metanames are defined by productions in terms of other metanames. In order that this process terminates, certain metanames are designated as "terminal" metanames, and productions for them are not included in the syntax. With the exception of the construct "[implementation-defined]", all terminal metanames occur for the first time and are defined in 4.1. It should be noted in particular that all upper-case-letters are terminal metanames which denote both themselves and their lower-case equivalents (except in the productions defining upper-case-letters and lower-case-letters, in which the letters denote only themselves). The digits are terminal metanames which denote themselves. In addition, the construct "[implementation-defined]" is not a unique syntactic object, but each occurrence of it is defined by each implementation in an appropriate fashion for the object in question. In some cases a recommendation as to the representation of the object is given in the corresponding remarks section.

We illustrate further details of the syntax by considering some examples from 5.1. The production

```
fraction = period integer
```

indicates that a fraction is a period followed by an integer. Since "period" is a terminal metaname (i.e., it does not occur on the left-hand side of any production), the semantics in 4.1 identify the particular character denoted by a period.

What is integer? The production

```
integer = digit digit*
```

indicates that an integer is a digit followed by an arbitrary number of other digits. An asterisk is a syntactic operator indicating that the object it follows may be repeated any number of time, including zero times.

What is a digit? In 4.1 the production

```
digit = 0 / 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9
```

indicates that a digit is either a 0, a 1, ..., or a 9. The slant is a syntactic operator meaning "or" and is used to indicate that a metaname can be rewritten in one of several ways.

Since the digits are terminal metanames, our decipherment of the syntax for a fraction comes to an end. The semantics in 4.1 identify the digits in terms of the characters they represent.

A question-mark is a syntactic operator like the asterisk, indicating that the object it follows may be omitted. For example, the production

```
exrad = E sign? integer
```

indicates that an exrad consists of the letter E or e followed by an optional sign followed by an integer.

Parentheses may be used to group sequences of metanames together. For example,

```
variable-list = variable (comma variable)*
```

defines a variable-list to consist of a variable followed by an arbitrary number of other variables separated by commas. If we wish parentheses actually to appear in syntactic objects, rather than just wish to use them to describe syntactic objects, then we indicate their presence by the metanames "left-parenthesis" and "right-parenthesis".

When several syntactic operators occur in the same production, the following order of precedence is employed. The operators "?" and "*" apply only to the word or parenthesized expression they immediately follow. The operator "/" applies to the sequence of words and expressions, separated by spaces, which occur since the beginning of the entire expression, the last "/", or the last unmatched left parenthesis. Thus, for example,

significand = integer period? / integer? fraction

is equivalent to

significand = (integer (period)?) / ((integer)? fraction)

Spaces in the syntax are used to separate terms in a production from each other. Special conventions are observed regarding spaces in BASIC programs (see 4.1).

Some syntactic objects are defined by more than one production. For example, in 5.2 we find

simple-variable > simple-numeric-variable

and in 6.2 we find

simple-variable > simple-string-variable.

Those two productions are equivalent to the single production below (provided no other definition of simple-variable exists)

simple-variable = simple-numeric-variable / simple-string-variable.

In all cases, a greater-than-sign is used in place of an equals-sign to indicate a multiple definition, such definitions are equivalent to a single definition containing the various right-hand sides separated by slants.

In order to maintain the same numbering of productions in the ECMA and ANSI standards productions not used in the ECMA Standard are identified by the construct: [deleted].

As an illustration of the method of syntax specification, following is a description of the syntax of this method. The terminal metanames occurring below are defined in 4.1.

1. production = metanames spaces (equals-sign / greater-than-sign) spaces syntax-expression
2. metaname = lower-case-letter metacharacters*
3. metacharacter = lower-case-letter / hyphen
4. spaces = space* end-of-line? space* space
5. syntax-expression = syntax-term (spaces ? slant spaces? syntax-term)*
6. syntax-term = syntax-factor (spaces syntax-factor)*
7. syntax-factor = syntax-primary repetition?
8. syntax-primary = metaname / digit digit* / upper-case-letter upper-case-letter* / left-parenthesis space* syntax-expression space* right-parenthesis
9. repetition = asterisk / question-mark

3.2 Definitions of Terms

For the purpose of this Standard, the following terms have the meanings indicated.

3.2.1 BASIC

A term applied as a name to members of a special class of languages which possess similar syntaxes and semantic meanings, acronym for Beginner's All-purpose Symbolic Instruction Code.

3.2.2 Batch-mode

The processing of programs in an environment where no provision is made for user interaction.

3.2.3 Can

The word "can" is used in a descriptive sense to indicate that standard-conforming programs are allowed to contain certain constructions and that standard-conforming implementations are required to process such programs correctly.

3.2.4 End-of-line

The character(s) or indicator which identifies the termination of a line. Lines of three kinds may be identified in BASIC: program lines, print lines, and input-reply lines. End-of-lines may vary between the three cases and may also vary depending upon context. Thus, for example, the end-of-line in an input-reply may vary on a given system depending on the source for input being used in interactive or batch mode.

Typical examples of end-of-line are carriage-return, carriage-return line-feed, and end of record (such as end of card).

3.2.5 Error

A flaw in the syntax of a program which causes the program to be incorrect.

3.2.6 Exception

A circumstance arising in the course of executing a program when an implementation recognizes that the semantic rules of this Standard cannot be followed or that some resource constraint is about to be exceeded. Certain exceptions (nonfatal exceptions) may be handled by automatic recovery procedures specified in this Standard. These and other exceptions may also be handled by recovery procedures specified in the program (see 12.1, BASIC-2 only). If no recovery procedure is given in this Standard (fatal exceptions) or if restrictions imposed by the hardware or operating environment make it impossible to follow the given procedure, and if no recovery procedure is specified in the program, then the way in which the exception is handled depends on the context. If the exception occurred in an invocation of a function, picture, or subprogram, then the exception is 'propagated back' to the invoking statement of the invoking program unit (see 12.1, BASIC-2 only). If this propagation procedure reaches the main program, or if the exception occurred in the main program, then the exception shall be handled by terminating the program.

3.2.7 External

With respect to procedures, refers to a procedure lexically not contained within a larger program-unit.

3.2.8 Identifier

A character string used to name a variable, an array, an array-value, an exception-handler, a function, subprogram, or a program.

3.2.9 Interactive mode

The processing of programs in an environment which permits the user to respond directly to the actions of individual programs and to control the initiation and termination of these programs.

3.2.10 Internal

With respect to record-type, refers to data representations such that both the type and exact value of the written data are preserved and retrievable by subsequent read operations.

With respect to procedures, refers to a procedure lexically contained within a larger program: unit and sharing data with that unit.

3.2.11 Keyword

A character string, usually with the spelling of a commonly used or mnemonic word, which provides a distinctive identification of a statement or a component of a statement of a programming language.

The keywords in ECMA BASIC are:

ACCESS, AND, ANGLE, AREA, ARITHMETIC, ARRAY, ASK, AT, BASE, BEGIN, BREAK, CALL, CASE, CAUSE, CHAIN, CLEAR, CLIP, CLOSE, COLLATE, COLOR, DATA, DATUM, DEBUG, DECIMAL, DECLARE, DEF, DEGREES, DELETE, DEVICE, DIM, DISPLAY, DO, ELAPSED, ELSE, ELSEIF, END, ERASE, ERASABLE, EXIT, EXLINE, EXTERNAL, EXTYPE, FILETYPE, FIXED, FOR, FUNCTION, GO, GOSUB, GOTO, HANDLER, IF, IMAGE, IN, INPUT, INTERNAL, IS, KEY, KEYED, LENGTH, LET, LINE, LINES, LOOP, MARGIN, MAT, MISSING, NAME, NATIVE, NEXT, NOT, NUMERIC, OF, OFF, ON, OPEN, OPTION, OR, ORGANIZATION, OUTIN, OUTPUT, POINT, POINTER, POINTS, PRINT, PROGRAM, PROMPT, RADIANS, RANDOMIZE, READ, RECORD, RECSIZE, RECTYPE, RELATIVE, REM, REST, RESTORE, RETRY, RETURN, REWRITE, SAME, SELECT, SEQUENTIAL, SET, SETTER, SIZE, SKIP, STANDARD, STATUS, STEP, STOP, STRING, STYLE, SUB, TAB, TEMPLATE, TEXT, THEN, THERE, TIME, TIMEOUT, TO, TRACE, UNTIL, USE, USING, VARIABLE, VIEWPORT, WHEN, WHILE, WINDOW, WITH, WRITE, ZONEWIDTH.

Keywords may also be spelled using lower-case letters or mixed upper-case and lower-case letters.

3.2.12 Line

Two types of lines are described in the Standard, a physical line and a logical line. A physical line is an ordered sequence of characters which terminates with an end-of-line. A physical line starts with a line-number or with an ampersand. A logical line consists of a line-number followed by an ordered sequence of text where each line-continuation has logically been replaced by a space.

3.2.13 Machine Infinitesimal

The smallest positive value (other than zero) which can be represented and manipulated by a BASIC implementation.

3.2.14 May

The word "may" is used in a permissive sense to indicate that a standard-conforming implementation may or may not provide a particular feature.

3.2.15 Native

With respect to record-type, refers to a record with a specified structure for the fields within the record, so as to be compatible with records generated by other languages on the same system. With respect to numeric or string data, refers to data for which certain semantic rules are left implementation-defined (e.g. collating sequence, precision) so as to be directly implementable on the host hardware.

3.2.16 Overflow

With respect to numeric operations, the term applied to the condition which exists when a prior operation has attempted to generate a result which exceeds MAXNUM (see 5.4.4), or which exceeds the maximum value that can be represented by the declared

format of a fixed point variable or array. With respect to string operations, the term applied to the condition which exists when a prior operation has attempted to generate a result which has more characters than can be contained in a string of maximal length, as determined by the language processor. With respect to string assignment, the term applied to the condition which exists when a prior operation has attempted to assign a value that is longer than the declared or default maximum of a string-variable or string-defined-function.

3.2.17 Print Zone

A contiguous set of character positions in a printed output line which may contain an evaluated print-statement element.

3.2.18 Program Unit

A self-contained part of a BASIC program consisting either of the main-program, which is the sequence of lines up to and including the line containing an END statement, or of an external-sub-def or external-function-def.

3.2.19 Reserved Word

BASIC-1

A character string whose usage as a routine-identifier, string-identifier or numeric-identifier is forbidden in an ECMA BASIC-1 program.These words are:

- the no-argument supplied function names: DATE, EXLINE, EXTYPE, MAXNUM, PI, RND, TIME, TRANSFORM, DATE$, and TIME$,
- the identifier used in array-values: CON, IDN, ZER, and NUL$,
- the following keywords: ACCESS, AND, ANGLE, AREA, ARITHMETIC, ASK, AT, BASE, BEGIN, BREAK, CALL, CASE, CHAIN, CLEAR, CLIP, CLOSE, COLLATE, COLOR, DATA, DATUM, DEBUG, DECIMAL, DECLARE, DEF, DEGREES, DEVICE, DEVICE, DIM, DISPLAY, DO, ELAPSED, ELSE, ELSEIF, END, ERASE, ERASABLE, EXIT, EXTERNAL, FILETYPE, FOR, FUNCTION, GO, GOSUB, GOTO, GRAPH, IF, IMAGE, INPUT, INTERNAL, IS, LENGTH, LET, LINE, LINES, LOOP, MARGIN, MAT, MISSING, NAME, NATIVE, NEXT, NOT, NUMERIC, OFF, ON, OPEN, OPTION, OR, ORGANIZATION, OUTIN, OUTPUT, POINT, POINTER, POINTS, PRINT, PROGRAM, PROMPT, RADIANS, RANDOMIZE, READ, RECSIZE, RECTYPE, REM, REST, RESTORE, RETURN, SAME, SELECT, SEQUENTIAL, SET, SETTER, SIZE, SKIP, STANDARD, STATUS, STEP, STOP, STREAM, STRING, STYLE, SUB, TAB, TEXT, THEN, THERE, TIMEOUT, TO, TRACE, UNTIL, USING, VARIABLE, VIEWPORT, WHILE, WINDOW, WITH, WRITE, ZONEWIDTH.

The function names EXLINE and EXTYPE are not used in ECMA BASIC-1, but are reserved for compatibility with ECMA BASIC-2.

BASIC-2

A character string whose usage as a routine-identifier, string-identifier or numeric-identifier is forbidden in an ECMA BASIC-2 program.These words are:

- the no-argument supplied function names: DATE, EXLINE, EXTYPE, MAXNUM, PI, RND, TIME, TRANSFORM, DATE$ and TIMES$,
- the identifiers used in array-values: CON, IDN, ZER, and NUL$,
- the keywords NOT, ELSE, PRINT and REM.

3.2.20 Rounding

The process by which a representation of a value with lower precision is generated from a representation of higher precision taking into account the value of that portion of the original number which is to be omitted. For example, rounding X to the nearest integer may be accomplished by INT(X+0.5) (see 5.4).

3.2.21 Shall

The word "shall" is used in an imperative sense to indicate that a program is required to be constructed, or that an implementation is required to act, as specified in order to meet the constraints of standard conformance.

3.2.22 Significant Digits

The contiguous sequence of digits between the high-order nonzero digit and the low-order digit, without regard for the location of the radix point. Commonly, in a normalized floating point internal representation, only the significant digits of a representation are maintained in the significand. In fixed-point representation, the low order digit is the rightmost one explicitly specified, and non-significant high order digits may be maintained.

3.2.23 Truncation

The process by which a representation of a value with lower precision is generated from a representation of higher precision by merely deleting the unwanted low-order digits of the original representation.

3.2.24 Underflow

With respect to numeric operations, the terms applied to the condition which exists when a prior operation has attempted to generate a result, other than zero, which is less in magnitude than machine infinitesimal.

4. PROGRAM ELEMENTS

4. PROGRAM ELEMENTS

A BASIC program is a sequence of lines containing statements. Each line is itself a sequence of characters.

4.1 Characters

4.1.1 General Description

The character set for ECMA BASIC is contained in the Standard ECMA-6.

4.1.2 Syntax

1. character = quotation-mark / non-quote-character
2. quoted-string-character = double-quote / non-quote-character
3. non-quote-character = ampersand / apostrophe / asterisk / circumflex-accent / colon / comma / dollar-sign / equals-sign / exclamation-mark / greater-than-sign / left-parenthesis / less-than-sign / number-sign / percent-sign / question-mark / right-parenthesis / semicolon / slant / underline / unquoted-string-character
4. double-quote = quotation-mark quotation-mark
5. unquoted-string-character = space / plain-string-character
6. plain-string-character = digit / letter / period / plus-sign / minus-sign
7. digit = 0/1/2/3/4/5/6/7/8/9
8. letter = upper-case-letter / lower-case-letter
9. upper-case-letter = A/B/C/D/E/F/G/H/I/J/K/L/M/N/O/P/Q/R/S/T/U/V/W/X/Y/Z
10. lower-case-letter = a/b/c/d/e/f/g/h/i/j/k/l/m/n/o/p/q/r/s/t/u/v/w/x/y/z
11. other character = [implementation-defined]

The syntax as described generates programs which contain no spaces other than those occurring in remark-strings, in certain quoted-strings, unquoted-strings, and literal-strings, or where the presence of a space is explicitly indicated by the metaname space.

Special conventions shall be observed regarding spaces. With the following exceptions, spaces may occur anywhere in a BASIC program without affecting the execution of that program and may be used to improve the appearance and readability of the program. Spaces shall not appear:

- immediately preceding the line-number of a line
- within line-numbers
- within keywords
- within identifiers
- within numeric-constants
- within multicharacter relation symbols.

In addition, spaces which appear in quoted-strings, unquoted-strings, and format-strings shall be significant (though spaces which precede or follow an unquoted-string are not part of that string).

All keywords in a program, when used as such, shall be preceded and followed by some character other than a letter, digit, underline or dollar-sign. A keyword may also be followed by an end-of-line.

4.1.3 Examples

None.

4.1.4 Semantics

The letters shall be the set of capital (upper-case) and small (lower-case) latin letters contained in the character set in positions 4/1 to 5/10 and 6/1 to 7/10, respectively.

The digits shall be the set of Arabic digits contained in the character set in position 3/0 to 3/9.

The remaining characters shall correspond to the remaining graphic characters in position 2/0 to 2/15, 3/10 to 3/15, 5/14, and 5/15 of the ECMA character set.

The names of the characters are specified in Table 1. Table 1 shall apply when the standard collating sequence is in effect, either by default or by explicit use of a COLLATE option (see 6.4, 6.6, and 8.1). The coding for the native collating sequence shall be implementation-defined.

All characters other than letters denote themselves. Letters denote themselves within quoted-strings, unquoted-strings and line-input-replies. Corresponding upper-case-letters and lower-case-letters shall be equivalent when used in identifiers and keywords. Quoted-string-characters also denote themselves, except for the double-quote, which denotes one occurrence of the quotation-mark in the value of the string.

4.1.5 Exceptions

None.

4.1.6 Remarks

Other-characters may be defined by an implementation to be part of the character set for BASIC. These characters may be used in strings and may be accepted as characters in data supplied in response to a request for input or generated as the value of the CHR$ function (see 6.4). The effects of these other-characters are implementation-defined.

Programs written using other-characters (except for end-of-line characters) are not themselves standard-conforming programs.

4.2 Programs, Lines, and Blocks

4.2.1 General Description

A BASIC program is a sequence of lines. Each line contains a unique line-number which facilitates program editing and serves as a label for the statement contained in that line.

A BASIC program is divided logically into a number of program-units The first of these is the main-program, which is terminated by an end-line. Following the main-program may be zero or more external-sub-def or external-function-def. Certain logical groupings of lines within a BASIC program are called blocks.

4.2.2 Syntax

The syntax elements available only in ECMA BASIC-2 are printed in bold.

1. program	> program-name-line? main-program procedure-par
2. program-name-line	= line-number PROGRAM program-name function-parm-list? tail
3. program-name	= routine-identifier
4. main-program	= unit-block* end-line
5. unit-block	= internal-proc-def / block
6. internal-proc-def	> internal-function-def / internal-sub-def / **detached-handler**

```
 7. block                    > statement-line / loop / if-block / select-block /
                               image-line / protection-block
 8. statement-line           = line-number statement tail
 9. line-number              = digit digit*
10. statement                > declarative-statement / imperative-statement /
                               conditional-statement
11. declarative-statement    > data-statement / declare-statement /
                               dimension-statement / null-statement /
                               option-statement / remark-statement
12. imperative-statement     > array-assignment / array-input-statement /
                               array-line-input-statement /
                               array-print-statement / array-read-statement /
                               array-write-statement / ask-statement /
                               break-statement / call-statement /
                               cause-statement / chain-statement /
                               close-statement / debug-statement /
                               erase-statement / exit-do-statement /
                               exit-for-statement / exit-function-statement /
                               exit-handler-statement / exit-sub-statement /
                               gosub-statement / goto-statement /
                               handler-return-statement / input-statement /
                               let-statement / line-input-statement /
                               numeric-function-let-statement /
                               open-statement / print-statement /
                               randomize-statement / read-statement /
                               restore-statement / return-statement /
                               set-statement / stop-statement /
                               string-function-let-statement /
                               trace-statement / write-statement
13. stop-statement           = STOP
14. conditional-statement    = if-statement / on-gosub-statement / on-goto-statement
15. tail                     = tail-comment? end-of-line
16. end-of-line              = [implementation-defined]
17. end-line                 = line-number end-statement tail
18. end-statement            = END
19. procedure-part           = remark-line* procedure
20. procedure                > external-function-def / external-sub-def
21. remark-line              = line-number (null-statement / remark-statement)
                               end-of-line
22. line                     > case-line / case-else-line / do-line / else-line /
                               elseif-then-line / end-function-line /
                               end-handler-line / end-if-line / end-line /
                               end-select-line / end-sub-line / end-when-line
                               / external-function-line / external-sub-line /
                               for-line / handler-line / internal-def-line /
                               internal-function-line / internal-sub-line /
                               if-then-line / image-line / loop-line /
                               next-line / program-name-line / remark-line /
                               select-line / statement-line / use-line /
                               when-line / when-use-name-line
23. program-unit             > main-program / procedure
24. line-continuation        = ampersand space* tail ampersand
```

A program shall be composed of a sequence of lines. Exactly one of these lines shall be an end-line; the lines up to and including this end-line constitutes the main-program.

Line-number zero is not allowed; leading zeroes shall have no effect. Lines shall occur in ascending line-number order. All references to line-numbers within a program-unit shall be to line-numbers of lines within that program-unit. The number of digits in a line-number shall not exceed 5. The value of a line-number shall not exceed 50000.

The manner in which the end of a line is detected is determined by the implementation; e.g., the end-of-line may be a carriage-return character, a carriage-return character followed by a line-feed character, or the end of a physical record.

A physical line in a program shall contain at most 132 characters before each end-of-line indicator.

At any place where a space may be used, except in quoted-strings, unquoted-strings, literal-strings, and remark-strings (see 4.1 and 4.3), a line-continuation may be substituted for a space with no effect other than that of the space it replaces.

Parameters in the program-name-line shall not be explicitly dimensioned or declared in the main-program.

4.2.3 Examples

```
  2. 100 PROGRAM Graphic          & ! This program draws a graph
     &           (x,              & ! x is x-coordinate
     &               y)             ! y is y-coordinate
 18. 999 END
```

4.2.4 Semantics

The program-name-line is the operand of the chain-statement (see 9.3). The relationship between the program-name and the program-designator in a program executing a chain-statement is implementation-defined. Parameters in the program-name-line are evaluated as described in 9.1. Their scope is the main-program. For a program executed in isolation, the program-name has no effect. The effect of a parameter-list in a program-name-line for a program executed in isolation is implementation-defined.

Lines in a program shall be executed in sequential order, starting with the first line, until

- some other action is dictated by execution of a line, or
- an exception occurs (unless, in BASIC-2, it is a nonfatal exception which is not handled by a user defined exception-handler), or
- a chain-statement is executed, or
- a stop-statement or end-statement is executed.

The end-statement shall serve both to mark the physical end of the main-program and to terminate execution of the program when encountered.

Execution of a stop-statement shall also cause termination of execution of the program.

4.2.5 Exceptions

None.

4.2.6 Remarks

References to non-existent line-numbers in a program-unit are syntax errors. Implementations may therefore treat them as exceptions, if they are documented as such.

4.3. Program Annotation

4.3.1 General Description

BASIC programs may be annotated by comments at the end of program lines or by separate remark-statements.

4.3.2 Syntax

1. remark-statement = REM remark-string
2. remark-string = character*
3. null-statement = tail-comment
4. tail-comment = exclamation-mark remark-string

Line-continuation shall not occur in remark-strings.

4.3.3 Examples

```
1. REM FINAL CHECK
4. ! COMPUTE AVERAGE
```

4.3.4 Semantics

If the execution of a program reaches a line containing a remark-statement or null-statement, then it shall proceed to the next line with no other effect.

A tail-comment has no effect upon the execution of the line in which it occurs. The remark-string in the tail-comment serves solely as a comment about the line.

4.3.5 Exceptions

None.

4.3.6 Remarks

None.

4.4 Identifiers

4.4.1 General Description

Identifiers are used to name variables, arrays, array-values, functions, programs, subprograms and exception-handlers.

4.4.2 Syntax

1. identifier > numeric-identifier / string-identifier / routine-identifier
2. numeric-identifier = letter identifier-characters*
3. identifier-character = letter / digit / underline
4. string-identifier = letter identifier-character*dollar-sign
5. routine-identifier = letter identifier-character*

An identifier shall contain at most 31 characters, including the dollar-sign in the case of a string identifier.

A given numeric-identifier may name a simple-numeric-variable, a one-dimensional, two-dimensional or three-dimensional numeric-array, a numeric-function, or a numeric-array-value, but not more than one of these in a program-unit. Likewise, a given string-identifier may name a simple-string-variable, a one-dimensional, two-dimensional or three-dimensional string-array, a string-function, or a string-array-value, but not more than one of these in a program-unit.

A given identifier may name an internal-subprogram, an internal-function-def or a detached-handler but not more than one of these in a program-unit.

A given routine-identifier shall not name more than one of an external-function-def, an external-sub-def or a main-program in a program.

A numeric-identifier which names an external-function-def may not be used as a routine-identifier.

The names of the no-argument supplied functions or array-values CON, DATE, EXLINE, EXTYPE, IDN, MAXNUM, PI, RND, TIME, TRANSFORM and ZER shall not be used as numeric-identifiers to name any other entity. The names of the no-argument supplied functions or array-values DATE$, NUL$, and TIME$ shall not be used as string-identifiers to name any other entity. The keywords listed in 3.2.19 shall not be used as identifiers. Note that the list in 3.2.19 is different for BASIC-1 and BASIC-2.

4.4.3 Examples

2. X
   sum
4. A$
   last_names$
5. INVERT

4.4.4 Semantics

Each program-unit is a distinct entity in that identifiers used to name variables, arrays, detached-handlers, internal-function-definitions, or internal-procedures defined within program-units shall be local to each invocation of the program-unit in which they occur; i.e., they shall name different objects in different program-units and in different invocations of the same program-unit. Identifiers used to name supplied-functions or program-units, however, shall be global to the entire program; i.e., they shall name the same object wherever they occur.

If the name of implementation-supplied function or the keyword TAB is implicitly or explicitly defined or declared as the identifier of a user-defined function, array, or variable, then the defined declared interpretation of the identifier shall override the interpretation specified by the Standard within the scope of the definition or declaration. Therefore, within that scope, the implementation-supplied function or the tab-call shall be unavailable.

Within any program-unit, identifiers which differ only in the cases of the letters they contain shall denote the same objects (e.g., X1 identifies the same object as x1). Identifiers which differ in any other respect shall denote different objects.

4.4.5 Exceptions

None.

4.4.6 Remarks

No implementation-defined enhancement to this Standard may extend the list of words unavailable for use as simple-variables. Since all arrays must be declared (see 7.1.), and since all defined-functions must be declared or defined in the program-unit in which they are referenced, implementations may supply built-in functions other than those specified in this Standard provided that any declaration for such identifiers within a program overrides the implementation-supplied interpretation. Note, however, that in some cases the use of a parameterless function supplied by an implementation as an enhancement would be syntactically indistinguishable from a

variable having the same name. Therefore, implementations which provide such functions must also provide a syntactic means for identifying them as functions. Examples of such syntax are a requirement to declare such functions explicitly in any program-unit where they are used or requiring the use of empty parentheses (e.g. "NEWFUNCTION()") with reference to such functions.

An operating system may impose additional restrictions on the length and form or identifiers for procedures which are compiled independently of the main-program.

A supplied-function may be overridden by defining a user-defined function or simple-variable with the same name.

In ECMA BASIC-2, an identifier may have the same spelling as a keyword (other than PRINT, ELSE, REM or NOT).

5. NUMBERS

5. NUMBERS

Numbers constitute one of two primitive data types in BASIC (the other is strings). With numbers are associated constants, variables, and implementation-supplied functions, from which expressions can be formed.

5.1 Numeric Constants

5.1.1 General Description

Numeric-constants denote scalar numeric values. A numeric-constant is a decimal representation, in positional-notation, of a number. There are four general syntactic forms of numeric-constants:

- implicit point unscaled representation d...d
- explicit point unscaled representation ds..drd...d
- explicit point scaled representation sd...drd...dEsd...d
- implicit point scaled representation sd...dEsd...d

where d is a digit, r is a period, s is an optional sign, and E is the explicit character E or e. A numeric-constant not preceded by a sign is assumed to be positive.

5.1.2 Syntax

```
1. constant          > numeric-constant
2. numeric-constant  = sign? numeric-rep
3. sign              = plus-sign / minus-sign
4. numeric-rep       = significand exrad?
5. significand       = integer period? / integer? fraction
6. integer           = digit digit*
7. fraction          = period integer
8. exrad             = E sign? integer
```

5.1.3 Examples

```
2. -21
4. 1E10
   5e-1
   .4E+1
5. 500.
   1.2
7. .255
```

5.1.4 Semantics

The value of a numeric-constant is the number represented by that constant. "E" and "e" stand for "times ten to the power"; if no sign follows the symbols E and e, then a plus-sign is understood.

A program can contain numeric-constants which have an arbitrary number of digits. An implmentation must retain either the exact value of a numeric-constant, or that value rounded to an implementation-defined precision. The implementation-defined precision for numeric constants shall not be less than ten or six significant decimal digits, depending on upon whether the arithmetic option in force is DECIMAL or NATIVE respectively. Numeric-constants can also have an arbitrary number of digits in the exrad, though nonzero constants whose magnitude is outside an implementation-defined range may be treated as exceptions (see 5.6). Nonzero constants whose magnitudes are less than machine infinitesimal shall be replaced by zero, while constants whose magnitudes are larger than MAXNUM shall be reported as causing an overflow.

5.1.5 Exceptions

- The evaluation of a numeric-constant causes an overflow (1001, fatal).

5.1.6 Remarks

It is recommended that implementations report constants whose magnitudes are less than machine infinitesimal as underflows (1501, nonfatal replace by zero and continue). In BASIC-2 implementation, this permits interception by exception handlers.

Although this Standard contains no provision for named constants, their effect can be achieved through no-argument defined-functions (see 9.1).

5.2 Numeric Variables

5.2.1 General Description

Numeric-variables may be either simple-numeric-variables or references to elements of numeric-arrays.

5.2.2 Syntax

1.	variable	> numeric-variable
2.	numeric-variable	= simple-numeric-variable / numeric-array-element
3.	simple-numeric-variable	= numeric-identifier
4.	numeric-array-element	= numeric-array subscript-part
5.	numeric-array	= numeric-identifier
6.	subscript-part	= left-parenthesis subscript (comma subscript)* right-parenthesis
7.	subscript	= index
8.	index	= numeric-expression
9.	simple-variable	> simple-numeric-variable
10.	array-name	> numeric-array

The number of subscripts in a subscript-part shall be one, two, or three.

5.2.3 Examples

3. X
   sum
4. V(4)
   table(i, j+1)

5.2.4 Semantics

At any instant in the execution of a program, a numeric-variable is associated with a single numeric value. The value associated with a numeric-variable may be changed by the execution of statements in the program.

Simple-numeric-variables are declared implicitly through their appearance in a program-unit. The scope of a numeric-variable shall be the program-unit in which it appears, unless it is a parameter of an internal-function-definition (see 9.1).

An index is a numeric-expression whose value shall be rounded to the nearest integer; the rounded value of X is defined to be INT(X+.5).

A numeric-array-element is called a subscripted numeric-variable and refers to the element in the array selected by the value(s) of the subscript(s). The acceptable range of values must be explicitly declared in a dimension-statement or a declare-statement (see 7.1). Subscripts shall have values within the appropriate range.

At the initiation of execution the values associated with all numeric-variables shall be implementation-defined.

5.2.5 Exceptions

- A subscript is not in the range of the declared bounds (2001, fatal).

5.2.6 Remarks

Since initialization of variables is not specified, and hence may vary from implementation to implementation, programs that are intended to be transportable should explicitly assign a value to each variable before any expression involving that variable is evaluated.

There are many commonly used alternatives for associating implementation-defined initial values with variables; it is recommended that all variables be recognizably undefined in the sense that an exception will result from any attempt to access the value of any variable before that variable is explicitly assigned a value (3101, nonfatal: supply an implementation-defined value and continue).

5.3 Numeric Expressions

5.3.1 General Description

Numeric-expressions may be constructed from numeric-variables, numeric-reps, and numeric-function-refs using the operations of addition, subtraction, multiplication, division, and exponentiation (i.e., raising to a power).

5.3.2 Syntax

```
 1. expression              > numeric-expression
 2. numeric-expression      = sign? term (sign term)*
 3. term                    = factor (multiplier factor)*
 4. factor                  = primary (circumflex-accent primary)*
 5. primary                 = numeric-rep numeric-variable / numeric-function-ref /
                              left-parenthesis numeric-expression
                              right-parenthesis
 6. numeric-function-ref    > numeric-function function-arg-list?
 7. numeric-function        = numeric-defined-function / numeric-supplied-function
 8. function-arg-list       = left-parenthesis function-argument (comma
                              function-argument)*right-parenthesis
 9. function-argument       = expression / actual-array
10. actual-array            = array-name
11. multiplier              = asterisk / slant
```

The number and types of arguments in a numeric-function-ref shall agree with the number and types of corresponding parameters in the definition of the numeric-function. An actual-array shall have the same number of dimensions as the corresponding parameter.

Whenever numeric arguments are passed to an external-function-definition, the ARITHMETIC options in effect for the external-function-definition and the invoking program-unit must agree.

Each numeric-function referenced in an expression within a program-unit shall either be implementation-supplied, or shall be defined in an internal-function-def or declared in a declare-statement occuring in a lower-numbered line, within the same program-unit, than the first reference to that numeric-function.

5.3.3 Examples

```
2. 3*X - Y^2
   cost*quantity + overhead
4. 2^(-X)
5. SQR(X^2+Y^2)
6. value(X, Y, a$)
```

5.3.4 Semantics

The formation and evaluation of numeric-expressions follows the normal algebraic rules. The symbols circumflex-accent (^), asterisk (*), slant (/), plus-sign (+), and minus-sign (-) represent the operations of exponentiation, multiplication, division, addition, and subtraction or negation, respectively. Unless parenthesis dictate otherwise, exponen-tiations shall be performed first, then multiplications and divisions, and finally additions, subtractions, and negations. In the absence of parenthesis, operations of the same precedence shall be evaluated from left to right. Thus A-B-C shall be interpreted as (A-B)-C; A^B^C, as (A^B)^C; A/B/C, as (A/B)/C; -A+B as (-A)+B; and -A^B as -(A^B).

If an underflow occurs in the evaluation of a numeric-expression, then the value generated by the operation which resulted in the underflow shall be replaced by zero.

For those mathematical operators which are associative, commutative, or both, full use of these properties may be made in order to revise the order of evaluation of the numeric-expression except where constrained by the use of parenthesis.

0^0 is defined to be 1.

A numeric-function-ref is a notation for the invocation of a predefined algorithm, into which the argument values, if any, shall be substituted for the parameters (see 5.4, 6.4 and 9.1) used in the function-definition. The result of evaluating a numeric-function, achieved by the execution of the defining algorithm, shall be a scalar numeric value which replaces the numeric-function-ref in the numeric-expression.

5.3.5 Exceptions

- Evaluation of a numeric-expression results in division by zero (3001, fatal).
- Evaluation of a numeric-expression results in an overflow (1002, fatal).
- Evaluation of the operation of exponentiation results in a negative number being raised to a non-integral power (3002, fatal).
- Evaluation of the operation of exponentiation results in zero being raised to a negative power (3003, fatal).

5.3.6 Remarks

The accuracy with which the evaluation of a numeric expression takes place may vary from implementation to implementation, subject to the constraints of 5.6.

It is recommended that implementations report underflow as an exception (1502, nonfatal: replace by zero and continue). In BASIC-2 implementation, this permits interception by exception handlers.

Implementations may evaluate primaries and operations within a numeric-expression in any order which is consistent with the semantics of 5.3.4. Of course, an operation must be evaluated after its operands. For example, in the expression "A+B+C+D*E", the primaries and additions may be evaluated in any order. However, the multiplication must be performed before the addition implied by the third plus-sign, since the product "D*E" is one of the operands of that addition.

5.4 Implementation-Supplied Numeric Functions

5.4.1 General Description

Predefined algorithms are supplied by the implementation for the evaluation of commonly used numeric functions. Additional functions related to other features of this Standard are defined in 6.4, 7.1 and 7.2.

5.4.2 Syntax

1. numeric-supplied-function > ABS / ACOS / ANGLE / ASIN / ATN / CEIL / COS / COSH / COT / CSC / DATE / DEG / EPS / EXP / FP / MAXNUM / INT / IP / LOG / LOG10 / LOG2 / MAX / MIN / MOD / PI / RAD / REMAINDER / RND / ROUND / SEC / SGN / SIN / SINH / SQR / TAN / TANH / TIME / TRUNCATE
2. randomize-statement = RANDOMIZE

5.4.3 Examples

2. RANDOMIZE

5.4.4 Semantics

The values of the numeric-supplied functions, as well as the number of arguments required for each function, shall be as described below. In all cases, X and Y stand for numeric-expressions, and N stands for an index, i.e., the rounded integer value of a numeric-expression. Each function accepts numeric arguments within the range of the negative number with the largest magnitude to the largest positive number, except where noted. For functions which return a value in angle measure (ACOS, ANGLE, ASIN and ATN), the value shall be in radians unless OPTION ANGLE DEGREES is in effect (see 5.6), when the value shall be in degrees. In the semantics below, "pi" (lower-case) stands for the true value of that constant.

Function

Function value

ABS(X)

The absolute value of X.

ACOS(X)

The arccosine of X in radians or degrees (see 5.6), where $0 \leq$ ACOS(X) $\leq$ pi; X shall be in the range $-1 \leq X \leq 1$.

ANGLE(X, Y)

The angle in radians or degrees (see 5.6) between the positive x-axis and the vector joining the origin to the point with coordinates (X, Y), where -pi < ANGLE(X, Y) $\leq$ pi. X and Y must not both be 0. Note that counterclockwise is positive, e.g., ANGLE(1,1) = 45 degrees.

ASIN(X)

The arcsine of X in radians or degrees (see 5.6), where $-pi/2 \leq$ ASIN(X) $\leq$ $pi/2$; X shall be in the range $-1 \leq X \leq 1$.

ATN(X)

The arctangent of X in radians or degrees (see 5.6), i.e., the angle whose tangent is X, where $-(pi/2) <$ ATN(X) $< (pi/2)$.

CEIL(X)

The smallest integer not less than X.

COS(X)

The cosine of X, where X is in radians or degrees (see 5.6).

COSH(X)

The hyperbolic cosine of X.

COT(X)

The cotangent of X, where X is in radians or degrees (see 5.6).

CSC(X)

The cosecant of X, where X is in radians or degrees (see 5.6).

DATE

The current date in decimal form YYDDD, where YY are the last two digits of the year and DDD is the ordinal number of the current day of the year; e.g., the value of DATE on May 9, 1977 was 77129. If there is no calendar available, then the value of DATE shall be -1.

DEG(X)

The number of degrees in X radians.

EPS(X)

The maximum of (X-X', X"-X, sigma) where X' and X" are the predecessor and successor of X and sigma is the smallest positive value representable.If X has no predecessor then X'=X and if X has no successor then X"=X". Note EPS(0) is the smallest positive number representable by the implementation, and is therefore implementation-defined. Note also that PS may produce different results for different arithmetic options (see 5.6).

EXP(X)

The exponential of X, i.e., the value of the base of natural logarithms (e = 2.71828...) raised to the power X; if EXP(X) is less than machine infinitesimal, then its value shall be replaced by zero.

FP(X)

The fractional part of X, i.e., X - IP(X).

INT(X)

The largest integer not greater than X; e.g., INT(1.3)=1 and INT(-1.3)=-2.

IP(X)

The integer part of X, i.e., SGN(X)*INT(ABS(X)).

LOG(X)

The natural logarithm of X; X shall be greater than zero.

LOG10(X)

The common logarithm of X; X shall be greater than zero.

LOG2(X)

The base 2 logarithm of X; X shall be greater than zero.

MAX(X, Y)

The larger (algebraically) of X and Y.

MAXNUM

The largest finite positive number representable and manipulable by the implementation; implementation-defined. MAXNUM may represent different numbers for different arithmetic options (see 5.6).

MIN(X, Y)

The smaller (algebraically) of X and Y.

MOD(X, Y)

X modulo Y, i.e., X-Y*INT(X/Y). Y shall not equal zero.

PI

The constant 3.14159... which is the ratio of the circumference of a circle to its diameter.

RAD(X)

The number of radians in X degrees.

REMAINDER(X, Y)

The remainder function, i.e., X-Y*IP(X/Y). Y shall not equal zero.

RND

The next pseudo-random number in an implementation-defined sequence of pseudo-random numbers uniformly distributed in the range $0 \leq RND < 1$.

ROUND(X, N)

The value of X rounded to N decimal digits to the right of the decimal point (or -N digits to the left if $N < 0$); i.e., INT(X*10^N+.5)/10^N.

SEC(X)

The secant of X, where X is in radians or degrees (see 5.6).

SGN(X)

The sign of X: -1 if $X < 0$, 0 if $X = 0$, and +1 if $X > 0$.

SIN(X)

The sine of X, where X is in radians or degrees (see 5.6).

SINH(X)

The hyperbolic sine of X.

SQR(X)

The non-negative square root of X; X shall be non-negative.

TAN(X)

The tangent of X, where X is in radians or degrees (see 5.6).

TANH(X)

The hyperbolic tangent of X.

TIME

The time elapsed since the previous midnight, expressed in seconds; e.g., the value of TIME at 11:15 AM is 40500. If there is no clock available, then the value of TIME shall be -1. The value of TIME at midnight shall be zero (not 86400).

TRUNCATE(X, N)

The value of X truncated to N decimal digits to the right of the decimal point (or -N digits to the left if $N < 0$); i.e., IP(X*10^N)/10^N.

If OPTION ANGLE DEGREES is in effect, the term "in radians or degrees" in the above list of function values shall mean degrees. If OPTION ANGLE RADIANS is in effect, the term "in radians or degrees" shall mean radians. The accuracy requirements (see 5.6.4) for the periodic trigonometric functions SIN, COS, TAN, SEC, CSC, COT are limited to providing full accuracy of m+1 decimal digits only for arguments n the range of -2*pi to 2*pi. Loss of accuracy outside this range is limited to the result of loss of precision in performing those range reductions on arguments necessary to compute values of these functions, i.e., "SIN (x)" may be evaluated as if it were written "SIN (MOD (x, 2*pi))" and similarly for the other functions.

If no randomize-statement is executed, then the RND function shall generate the same sequence of pseudo-random numbers each time a program is run. Execution of a randomize-statement shall override this implementation-supplied sequence of pseudo-random numbers, generating a new (and unpredictable) starting point for the list of pseudo-random numbers used subsequently by the RND function. The sequence of pseudo-random numbers shall be global to the entire program, not local to individual program-units.

5.4.5 Exceptions

- The value of the argument of the LOG, LOG10, or LOG2 function is zero or negative (3004, fatal).
- The value of the argument of the SQR function is negative (3005, fatal).
- The magnitude of the value of a numeric-supplied-function is larger than MAXNUM or is mathematical infinity (1003, fatal).
- The value of the second argument of the MOD or REMAINDER function is zero (3006, fatal).
- The value of the argument of the ACOS or ASIN function is less than -1 or greater than 1 (3007, fatal).
- An attempt is made to evaluate ANGLE(0,0) (3008, fatal).

5.4.6 Remarks

In the case of implementations which do not have access to a randomizing device such as a real-time clock, the randomize-statement may be implemented by means of an interaction with the user.

This Standard requires that overflows be reported only for the final values of numeric-supplied-functions; exceptions which occur in the evaluation of these functions need not be reported, though implementations shall take appropriate actions in the event of such exceptions to insure the accuracy of the final values. When overflows are reported for the final values of numeric-supplied-functions, it is recommended that the name of the function generating the overflow be reported also.

It is recommended that, if the magnitude of the value of a numeric-supplied-function is nonzero, but less than machine infinitesimal, implementations report this as an underflow, set the value to zero (1503, nonfatal: return zero and continue). In BASIC-2 implementations, this permits interception by exception handlers.

The time-zone used for DATE and TIME is implementation-defined.

It may not be possible, for reasons of overflow, to express the year in full format in DATE. When this full format is needed, the function DATE$ should be used.

5.5 Numeric Assignment Statement

5.5.1 General Description

A let-statement provides for the simultaneous assignment of the computed value of a numeric-expression to a list of numeric-variables.

5.5.2 Syntax

```
1. let-statement            > numeric-let-statement
2. numeric-let-statement    = LET numeric-variable-list equals-sign
                              numeric-expression
3. numeric-variable-list    = numeric-variable (comma numeric-variable)*
```

5.5.3 Examples

```
2. LET P = 3.14159
   LET A(X,3) = SIN(X)*Y + 1
   LET A, Y(1), Z = I+1
   LET T(I,J), I, J = I + J
```

5.5.4 Semantics

The subscripts, if any, of variables in the numeric-variable-list shall be evaluated in sequence from left to right. Next the numeric-expression on the right of the equals-sign shall be evaluated (see 5.3). Finally, the value of that numeric-expression, if necessary rounded to the nearest value which can be retained by the variable, shall be assigned to the numeric-variables in the numeric-variable-list in order from left to right.

5.5.5 Exceptions

None.

5.5.6 Remarks

Note that:

```
LET A = 1
LET A, B(A) = 2
```

is not equivalent to:

```
LET A = 1
LET A = 2
LET B(A) = 2
```

5.6 Numeric Arithmetic and Angle

5.6.1 General Description

Unless specified otherwise, the values of all numeric-variables shall behave logically as floating-point decimal numbers with an implementation-defined precision of at least ten decimal digits. By use of an option-statement, a program may choose to take advantage of a more efficient, but possibly less accurate, representation for numeric values.

Unless specified otherwise the trigonometric functions (see 5.4) require arguments or generate values in radian measure. By use of an option-statement, a program may change the angle measure of all such functions to degrees.

5.6.2 Syntax

```
1. option-statement         = OPTION option-list
2. option-list              = option (comma option)*
3. option                   > ARITHMETIC (DECIMAL / NATIVE / FIXED) / ANGLE
                              (DEGREES / RADIANS)
```

4. declare-statement = DECLARE type-declaration
5. type-declaration > numeric-type
6. numeric-type > NUMERIC numeric-declaration (comma numeric-declaration)*
7. numeric-declaration > simple-numeric-variable

An option-statement with an ARITHMETIC option, if present at all, shall occur in a lower-numbered line than any numeric-expression, or a dimension-statement or a declare-statement referencing a numeric-array or fixed-declaration in the same program-unit.

The option ARITHMETIC FIXED is relevant only to BASIC-2.

A program-unit shall contain at most one ARITHMETIC option.

An ANGLE option, if present at all, shall occur in a lower-numbered line than any reference to any numeric-supplied-function in the same program-unit.

A program-unit shall contain at most one ANGLE option.

A declare-statement, if present at all, must occur in a lower-numbered line than any reference to the variables declared therein.

5.6.3 Examples

1. OPTION ARITHMETIC DECIMAL, ANGLE DEGREES

5.6.4 Semantics

The ARITHMETIC option controls the logical behavior of numeric entities within the program-unit containing the option.

If OPTION ARITHMETIC DECIMAL is specified, or if no ARITHMETIC option is specified, then the values of the numeric-variables shall behave logically as decimal floating-point numbers, with an implementation-defined precision, say m, of at least ten significant decimal digits and with an implementation-defined range of at least 1E-38 to 1E+38.

The results of decimal computations can be described in terms of floating-point decimal intermediate results with at least m+1 decimal digits of precision (but may be implemented in some other equivalent fashion). The value of a numeric-variable shall be assumed to be exact. Numeric-constants shall be evaluated accurately to at least m decimal digits of precision. Numeric operations and functions shall also be evaluated accurately to at least m+1 decimal digits of precision with respect to the computed value of their operands and arguments (which may themselves be intermediate results). In all cases, the intermediate result of an evaluation shall be represented as a floating-point decimal number with at least m+1 decimal digits of precision, thus, when the true result can be expressed as a decimal number with m+1 significant digits, the computed result shall be exact. In no case shall the error for evaluation of an individual constant, operation, or function be greater than 5 in the (m+2)nd significant digit. Implementations are free to use any method of numeric evaluation which always yields results whose absolute error (with respect to the true result) is no greater than the absolute error of the results generated by the preceding specification.

If OPTION ARITHMETIC NATIVE is specified, then the values of numeric variables and constants shall be represented and manipulated in an implementation-defined fashion, with an implementation-defined precision of at least six decimal digits and with an implementation-defined range of at least 2E-38 to 1E+38. Decimal values need not be represented exactly, as long as the error is within the limits of this precision.

The ANGLE option controls the evaluation of the trigonometric functions within the program-unit containing the option. If OPTION ANGLE RADIANS is specified, or if no ANGLE option is specified, then the numeric-supplied-functions COS, COT, CSC, SEC, SIN, and TAN use arguments in radian measure, and the numeric-supplied-functions ACOS, ANGLE, ASIN and ATN generate results in radian measure.

If OPTION ANGLE DEGREES is specified, then the numeric-supplied-functions COS, COT, CSC, SEC, SIN, and TAN use arguments in degree measure, and the numeric-supplied-functions ACOS, ANGLE, ASIN, and ATN generate results in degree measure.

If the execution of a program reaches a line containing an option-statement, then it shall proceed to the next line with no further effect.

A simple-numeric-variable that appears in a numeric-type shall establish that variable as a simple-numeric-variable.

If execution reaches a line containing a declare-statement, it shall proceed to the next line with no further effect.

5.6.5 Exceptions

None.

5.6.6 Remarks

The representations chosen for numeric values when OPTION ARITHMETIC NATIVE is specified may be the same as that for OPTION ARITHMETIC DECIMAL.

No minimum accuracy is specified for the evaluation of numeric expressions and functions when OPTION ARITHMETIC NATIVE has been chosen. However, it is recommended that implementations maintain at least six decimal digits of precision.

The value 2E-38 is specified for the maximum value of the lower bound of positive numbers to allow an implementation employing the IEC 559 floating point binary arithmetic to be standard conforming.

6. STRINGS

6. STRINGS

Character strings constitute one of two primitive data types in BASIC (the other is numbers). Strings consist of arbitrary sequences of characters. Their lengths are variable, not fixed, although a maximum length for a string may be specified. With strings are associated constants, variables, and implementation-supplied functions, from which expressions can be formed.

6.1 String Constants

6.1.1 General Description

A string-constant is a character string of fixed length enclosed within quotation-marks. A quotation-mark itself may be included in a string-constant by representing it by two adjacent quotation-marks.

6.1.2 Syntax

1. constant > string-constant
2. string-constant = quoted-string
3. quoted-string = quotation-mark quoted-string-character* quotation-mark

The length of a string-constant, i.e., the number of quoted-string-characters contained between the quotation-marks, shall be limited only by the implementation-defined maximum number of characters preceding each of end-of-line indicator (i.e., at least 132).

6.1.3 Examples

2. "XYZ"
   "1E10"
   "He said, ""Don't""."

6.1.4 Semantics

The value of a string-constant shall be the sequence of all quoted-string-characters between the initial and final quotation-marks. The double-quote, when appearing inside a quoted-string,shall denote a single quotation-mark. Spaces in string-constants, including trailing spaces, shall be significant. A string consisting only of two quotation-marks shall represent the null string. Upper-case-letters and lower-case-letters shall be distinct within string-constants.

6.1.5 Exceptions

None.

6.1.6 Remarks

The maximum length of a string-constant is constrained by the maximum length of a physical line. The maximum length of the constant would therefore be 3 less than that for the line, allowing for a continuation character ("&"), and the leading and trailing quotation-mark, e.g.:

```
100 LET A$ = &
&"abc...unseen characters here...xyz"
```

As the maximum physical line length must be at least 132, the maximum string-constant length must be at least 129.

6.2 String Variables

6.2.1 General Description

String-variables may be either simple-string-variables or references to elements of one-dimensional, two-dimensional, or three-dimensional string-arrays.

Explicit declarations of simple-string-variables are not required. A dollar-sign serves to distinguish a string-variable from a numeric-variable.

6.2.2 Syntax

```
1. variable                 > string-variable
2. string-variable          = (simple-string-variable / string-array-element)
                              substring-qualifier?
3. simple-string-variable   = string-identifier
4. string-array-element     = string-array subscript-part
5. string-array             = string-identifier
6. substring-qualifier      = left-parenthesis index colon index right-parenthesis
7. simple-variable          > simple-string-variable
8. array-name               > string-array
```

6.2.3 Examples

```
2. K$
   name$(X:Y)
   ITEM$(1,n)(z:z+5)
4. A$(4)
   table$(I,J)
```

6.2.4 Semantics

At any instant in the execution of a program, a string-variable is associated with a single string-value. The value associated with a string-variable may be changed by the execution of statements in the program.

The length of the character string associated with a string-variable can vary during the execution of a program from a length of zero characters (signifying the null or empty string) to the maximum allowed for that string-variable (see 6.6.4).

Simple-string-variables may be declared explicitly (see 6.6) or may be declared implicitly through their appearance in a program-unit. The scope of a string-variable shall be the program-unit in which it appears, unless it is a parameter of an internal-proc-def, in which case its scope is that definition.

A string-array element is called a subscripted string-variable and refers to the element in the one-dimensional, two-dimensional or three-dimensional array selected by the value(s) of the subscript(s). Subscripts shall have values within the appropriate range (see 7.1).

The substring-qualifier provides a means for specifying a portion of the value associated with a string-variable. A$(M:N) shall specify that substring of the value associated with A$ from its Mth through Nth characters (M and N are indices).

Characters in a string shall be numbered from the left starting with one. There are no exceptions associated with substring-qualifiers; if either M or N is not in the range from 1 to LEN(A$), the M shall be considered to be MAX(M,1) and N shall be considered to be MIN(N,LEN(A$)). If M > N, even after this adjustment, then A$(M:N) shall be the null string occuring before the Mth character of A$ if M < LEN(A$) or

the null string immediately following A$ if M > LEN(A$). For example, if A$ = "1.234", then A$(1:1) = "1", A$(1:3) = "123", A$(0:3) = "123", A$(2:5) = "234", A$(3:2) is the null string preceding the third character of A$, and A$(5:7) is the null string following A$. At the initiation of execution the values associated with all string-variables shall be implementation-defined.

6.2.5 Exceptions

- A subscript is not in the range of the declared bounds (2001, fatal).

6.2.6 Remarks

Since initialization of variables is not specified, and hence may vary from implementation to implementation, programs that are intended to be transportable should explicitly assign a value to each variable before any expression involving that variable is evacuated.

There are many commonly used alternatives for associating implementation-defined initial values with variables; it is recommended that all variables be recognizably undefined in the sense that an exception will result from any attempt to access the value of any variable before that variable is explicitly assigned a value (3102, non-fatal: supply an implementation-defined value and continue).

6.3 String Expressions

6.3.1 General Description

String-expressions are composed of string-variables, string-constants, string-function-references, or a concatenation of these.

6.3.2 Syntax

```
1. expression              > string-expression
2. string-expression       = string-primary (concatenation string-primary)*
3. string-primary          = string-constant / string-variable /
                             string-function-ref / left-parenthesis
                             string-expression right-parenthesis
4. string-function-ref     = string-function function-arg-list?
5. string-function         = string-defined-function / string-supplied-function
6. concatenation           = ampersand
```

The number and types of arguments in a string-function-ref shall agree with the number and types of the corresponding parameters specified in the definition of the string-function. An actual-array shall have the same number of dimensions as the corresponding parameter.

Each string-function referenced in an expression within a program-unit shall either be implementation-supplied, or shall be defined in an internal-function-def or declared in a declare-statement occurring in a lower-numbered line, within the same program-unit, than the first reference to that string-function.

6.3.3 Examples

```
2. A2$ & B$(4:22) & "223"
3. X$(1,3)(I:J)
```

6.3.4 Semantics

The value of a string-expression shall be the concatenation of the values of the string-primaries in the expression (e.g., if A$ = "COME " and B$ = "IN", then A$ & B$ = "COME IN" and B$ & A$ = "INCOME ").

Within a string-expression, string-primaries shall be evaluated from left to right. For each string-primary, first the subscripts, if any, shall be evaluated, then the substring-qualifiers, and then the value of the primary itself.

A string-function-ref is a notation for the invocation of a predefined algorithm, into which the argument values, if any, shall be substituted for the parameters (see 6.4 and 9.1) used in the function-def. The result of evaluating a string-function, achieved by the execution of the defining algorithm, shall be a scalar string value which replaces the string-function-ref in the string-expression.

6.3.5 Exception

- Evaluation of a string-expression causes a string overflow (1051, fatal).

6.3.6 Remarks

The ampersand is used both for concatenation and line-continuation. Thus:

```
100 PRINT "ABC" &&
& "XYZ"
```

will print the sequence of characters ABCXYZ.

6.4 Implementation-Supplied String Functions

6.4.1 General Description

Predefined algorithms are supplied by the implementation for the evaluation of commonly used string-valued functions and numeric-valued functions whose arguments are strings.

6.4.2 Syntax

1. string-supplied-function > (CHR / DATE / LCASE / LTRIM / REPEAT / RTRIM / STR / TIME / UCASE / USING) dollar-sign
2. numeric-supplied-function > LEN / ORD / POS / VAL
3. numeric-function-ref > MAXLEN left-parenthesis (simple-string-variable / string-array) right-parenthesis

6.4.3 Examples

None.

6.4.4 Semantics

The values of the implementation-supplied functions, as well as the number and types of arguments required for each function, are described below. In all cases, M represents an index, i.e., the rounded integer value of some numeric-expression; X stands for a numeric-expression; V$ represents a simple-string-variable or string-array; and A$ and B$ stand for string-expressions.

Function

Function value

CHR$(M)

The one-character string consisting of the character occupying ordinal position M+1 in the collating sequence for the declared character set, i.e., the first character is returned for an argument of zero. M shall be at least zero and less than the number of characters in the declared character set (see table 1). For example, for the standard character set, CHR$(53) = "5", and CHR$(65) = "A". The values of CHR$ for the native character set are implementation-defined.

DATE$

The date in the string representation "YYYYMMDD" according to ISO 2014. For example, the value of DATE$ on May 9, 1977 was "19770509". If there is no calendar available, then the value of DATE$ shall be "00000000".

LCASE$(A$)

The string of characters resulting from the value associated with A$ by replacing each upper-case-letter in the string by its lower-case version.

LEN(A$)

The number of characters in the value associated with A$. Note that LEN("""") = 1, since the value of the string constant consists of precisely one quotation-mark.

LTRIM$(A$)

The string of characters resulting from the value associated with A$ by deleting all leading space characters.

MAXLEN(V$)

The maximum length associated with the simple-string-variable or string-array (see 6.6). If there is no effective limit on string length, the value returned shall be MAXNUM.

ORD(A$)

The ordinal position of the character named by the string associated with A$ in the collating sequence of the declared character set, where the first member of the character set is in ordinal position zero. The acceptable values of A$ are single characters in the character set and two-character or three-character mnemonics for characters in the character set. Values of A$ with two or more characters shall be treated with upper-case-letters and lower-case-letters equivalent. The acceptable values for the standard character set are shown in Table 1. The acceptable values for the native character set are implementation-defined. For example, for the standard character set, ORD("BS") = 8, ORD("A") = 65, ORD("a") = 97, ORD("5") = 53, ORD("SOH") = 1, ORD("Soh") = 1, and ORD("ABC") causes an exception.

POS(A$,B$)

The character position, within the value associated with A$, of the first character of the first occurrence of the value associated with B$. If there is no such ocurence, then POS(A$,B$) shall be zero. POS(A$,"") shall be one, for all values of A$.

POS(A$,B$,M)

The character position, within the value associated with A, of the first character of the first ocurence of the value associated with B$, starting at the Mth character of A$. If the value associated with B$ does not occur within the designated portion of the value associated with A$, or if M is greater than LEN(A$), the value returned is zero. Otherwise, the value returned is equivalent to

```
LET temp1   = MAX(1, MIN(M, LEN(A$) + 1))
LET temp2$  = A$(temp1: LEN(A$))
LET temp3   = POS(temp2$, B$)
   IF temp3 = 0 THEN
   LET POS  = 0
   ELSE
   LET POS  = temp3 + temp1 - 1
END IF
```

For example, if A$ has the value "GRANSTANDING", then POS(A$,"AN",1) = 3, POS(A$,"AN",4) = 8, and POS(A$,"AN",9) = 0. POS(A$,"",M) shall be MAX(M,1), as long as M <= LEN(A$).

REPEAT$(A$,M)

The string consisting of M copies of A$; M > 0.

RTRIM$(A$)

The string of characters resulting from the value associated with A$ by deleting all trailing space characters.

STR$(X)

The string generated by the print-statement as the numeric-representation of the value associated with X. No leading or triling spaces shall be included in this numeric-representation. For example, STR$(123.5) = "123.5" and STR$(-3.14) = "-3.14".

TIME$

The time of day in 24-hour notation according to ISO 3307. For example, the value of TIME$ at 11:15 AM is "11:15:00". If there is no clock available, then the value of TIME$ shall be "99:99:99". The value of TIME$ at midnight is "00:00:00".

UCASE$(A$)

The string of characters resulting from the value associated with A$ by replacing each lower-case-letter in the string by its upper-case version.

USING$(A$,X)

The string consisting of the formatted representation of X, using A$ as a format-item, according to the semantics of 10.4. The exceptions defined in 10.4.5 for formatted output also apply to the USING$ function.

VAL(A$)

The value of the numeric-constant associated with A$, if the string associated with A$ is a numeric-constant. Leading and trailing spaces in the string are ignored. If the evaluation of the numeric-constant would result in a value which causes an underflow, then the value returned shall be zero. For example, VAL(" 123.5 ") = 123.5, VAL("2.E-99") could be zero, and VAL("MCMXVII") causes an exception.

6.4.5 Exceptions

- The value of the argument of VAL is not a valid numeric-constant (4001, fatal).
- The value of the argument of VAL is a valid numeric-constant, but evaluating this constant results in an overflow (1004, fatal).

- The value of the argument of CHR$ is not in the appropriate range (4002, fatal).
- The value of the argument of ORD is neither a valid single character nor a valid mnemonic (4003, fatal).
- The value of the second argument of REPEAT$ is not > 0 (4010, fatal).

6.4.6 Remarks

It is recommended that if the magnitude of the value of the VAL function is less than machine infinitesimal, implementations report this as an exception (1504, nonfatal: replace with zero and continue). In BASIC-2 implementations, this permits interception by exception handlers.

The time zone used for DATE$ and TIME$ is implementation-defined.

The effect of the functions UCASE$, and LCASE$ is fully defined only for the ECMA character set as defined in 4.1.4. For other-characters, such as accented letters, the effect is implementation-defined, and may be specified in other national version of this Standard to accommodate the needs of local alphabets.

6.5 String Assignment Statements

6.5.1 General Description

A let-statement provides for the simultaneous assignment of the computed value of a string-expression to a list of string-variables.

6.5.2 Syntax

```
1. let-statement            > string-let-statement
2. string-let-statement     = LET string-variable-list equals-sign
                              string-expression
3. string-variable-list     = string-variable (comma string-variable)*
```

6.5.3 Examples

```
2. LET A$ = "ABC"
   LET A$(I) = B$(3:4)
   LET A$, B$ = "NEGATIVE DISCRIMINANT"
   LET C$(7:10) = "wxyz"
   LET A$ = "ABCD" &&
   & "XYZ"
```

6.5.4 Semantics

The subscripts and substring-qualifiers, if any, of variables in the string-variable-list shall be evaluated in sequence from left to right. Next the string-expression on the right of the equals-sign shall be evaluated (see 6.3). Finally, the value of that string-expression shall be assigned to the string-variables in the string-variable-list in order from left to right.

When a value is assigned to a string-variable with a substring-qualifier, it shall replace the substring of the value of the string-variable specified by the substring-qualifier. The length of the value of the string-variable may change as a result of this replacement. For example, if A$ = "1234", then assigning "32" to A$(2:3) results in "1324", assigning "" to A$(2:3) results in "14", assigning A$(1:2) to A$(2:3) results in "1124", and assigning "5" to A$(2:1) results in "15234".

6.5.5 Exceptions

- The assignment of a value to a string-variable causes a string overflow (1106, fatal).

6.5.6 Remarks

The order of assignment of values to string-variables in the string-variable-list is important in statements such as

LET A$(1:2), A$(2:3) = "X"

where different order of assignment may produce different results.

6.6 String Declarations

6.6.1 General Description

An option-statement may be used to define an ordering on the set of all string characters.

A declare-statement may be used to set a maximum length for specified string-variables in a program-unit.

6.6.2 Syntax

1. option	>	COLLATE (NATIVE / STANDARD)
2. type-declaration	>	string-type
3. string-type	=	STRING length-max? string-declaration (comma string-declaration)*
4. length-max	=	asterisk integer
5. string-declaration	>	simple-string-declaration
6. simple-string-declaration	=	simple-string-variable length-max?

An option-statement with a COLLATE option, if present at all, shall occur in a lower-numbered line than any string-expression, or a dimension-statement or declare-statement referencing a string-array or string-variable within the same program-unit. A program-unit shall contain at most one COLLATE option.

No simple-string-variable shall be declared more than once in a program-unit. A simple-string-variable which is a formal-parameter or a parameter shall not occur in a declare-statement.

6.6.3 Examples

1. COLLATE NATIVE
3. STRING*8 last_name$*20, first_name$, middle_name$

6.6.4 Semantics

The COLLATE option identifies the collating sequence to be used within a program-unit for comparing strings (see 8.1) and for computing values of the CHR$ and ORD functions (see 6.4). OPTION COLLATE NATIVE specifies that the native collating sequence of the host system shall be used. OPTION COLLATE STANDARD specifies that the collating sequence shall correspond to the order of the characters in Table 1. If no COLLATE option appears in a program-unit then the STANDARD collating sequence shall be used within that program-unit.

Simple-string-variables whose string-identifiers appear in string-types may have a maximum length less than or equal to the implementation-defined default value. The maximum is determined, in descending order of precedence, from:

- the length-max in the string-declaration for that variable;
- the length-max in the string-type of the declare-statement containing that variable, or
- the implementation-defined default.

The length-max guarantees that string values up to that length may be stored in the variable and that an attempt to store a longer value will cause a string overflow ex-

ception. The implementation-defined maximum string length default shall be at least 13 characters.

A length-max of 0 in a string-type shall establish the associated string-variable as having a maximum length of zero; i.e., the null string.

6.6.5 Exceptions

None.

6.6.6 Remarks

The native collating sequence may be the standard collating sequence.

The COLLATE option may be extended, on national versions of this Standard, to accommodate specific needs of local alphabets.

7. ARRAYS

7. ARRAYS

Arrays are indexed collections of numbers or strings. Array elements can be manipulated by scalar numeric and string operations (see 5 and 6). In addition, entire arrays may be manipulated by matrix statements.

7.1 Array Declarations

7.1.1 General Description

An option in the option-statement may be used to define the lower bound for all array subscripts within a program-unit which are not explicitly stated. By use of an option-statement the subscripts of all such arrays may be declared to have a lower bound of zero or one; if no such declaration occurs, the lower bound shall be one.

Arrays may have one, two, or three dimensions. The number of dimensions and subscript bounds for each dimension are declared in the declare-statement or dimension-statement. All array-names, except those appearing in a function-parm-list or a procedure-parm-list, must be declared in one and only one such statement. If not explicitly declared, the lower subscript bound for a given dimension is one or zero, depending on the BASE option. Upper bounds must always be explicitly declared.

A one-dimensional array with subscripts 1 to 10 or 1980 to 1989 or -9 to 0 contains 10 elements. A two-dimensional array with subscript bounds 1 to 10 for each dimension contains 100 elements. Similarly, a three-dimensional array with subscript-bounds 1 to 10 for each dimension contains 1000 elements.

A declare-statement can be used to dimension numeric-arrays as well as to declare maximum lengths for string-variables and string-arrays, and to dimension string-arrays. A dimension-statement can be used to dimension arrays, but not to declare the maximum length of strings in string-arrays.

7.1.2 Syntax

```
 1. dimension-statement        = DIM dimension-list
 2. dimension-list             = array-declaration (comma array-declaration)*
 3. array-declaration          = numeric-array-declaration / string-array-declaration
 4. numeric-array-declaration  = numeric-array bounds
 5. bounds                     = left-parenthesis bounds-range (comma bounds-range)*
                                 right-parenthesis
 6. bounds-range               = signed-integer TO signed-integer / signed-integer
 7. signed-integer             = sign? integer
 8. string-array-declaration   = string-array bounds
 9. option                     > BASE ( 0 / 1 )
10. string-declaration         > string-array-declaration length-max?
11. numeric-declaration        > numeric-array-declaration
12. numeric-function-ref       > MAXSIZE maxsize-argument / SIZE bound-argument /
                                 LBOUND bound-argument / UBOUND bound-argument
13. maxsize-argument           = left-parenthesis actual-array right-parenthesis
14. bound-argument             = left-parenthesis actual-array (comma index)?
                                 right-parenthesis
```

The number of bounds-ranges in "bounds" shall be one, two or three.

An array which is named as a formal-array of a defined-function, a subprogram or a program shall not be declared in a declare-statement or dimension-statement (since the formal-array in the function-parm-list or procedure-parm-list serves as its declaration). Any other array shall be declared in a lower numbered line than any reference to that array or one of its elements. Any reference to an array and its elements must agree in dimensionality with the declaration of that array in a declare-statement, a dimension-statement, or as a function-parameter or procedure-parameter.

No numeric-array or string-array shall be dimensioned or declared more than once in a program-unit.

If the optional lower bound (the first signed-integer) is included in the bounds-range, it shall be less than or equal to the upper bound (the second signed-integer).

If the lower bound is not specified, then the upper bound must not be less than the default lower bound, which may be zero or one, depending on the BASE option.

An option-statement with a BASE option, if present at all, shall occur in a lower-numbered line than any declare-statement or dimension-statement or any MAT statement that uses a numeric-array-value in the same program-unit. A program-unit shall contain at most one BASE option.

If a bound-argument does not specify an index, the actual-array must be declared as one-dimensional.

7.1.3 Examples

```
 1. DIM A(6), B(10,10), B$(100), D(1 TO 5, 1980 TO 1989)
    DIM A$(4,4), C(-5 TO 10)
10. A$(3 TO 21) * 8
12. SIZE(A,1)
    SIZE(B$,2)
    SIZE(X)
    LBOUND(A)
    UBOUND(C$,2)
```

7.1.4 Semantics

Each array-declaration declares the named array to be either one-dimensional, two-dimensional, or three-dimensional, according to whether one, two, or three bounds-ranges are specified in the bounds for the array. In addition, the bounds specify the maximum and optionally minimum values that subscripts for the array shall have. If a minimum subscript is not explicitly declared and no BASE option occurs within the program-unit, then it shall be implicitly declared to be one.

The BASE option in an option-statement is local to the program-unit in which it occurs and declares the minimum value for all array subscripts in that program-unit which are not explicitly declared.

If the execution of a program reaches a line containing a dimension-statement, then it shall proceed to the next line with no further effect.

String-array-declarations appearing in a string-declaration may include a length-max, which sets the maximum length of each element of the string-array. As with simple-string-variables, if there is no length-max in the string-declaration, then the length-max, if any, of the string-type takes effect. If there is no length-max in either, then the implementation-defined length-max, if any, shall take effect.

The value of SIZE(A,N) where A is an actual-array and N is an index, shall be the current number or permissible values for the Nth subscript of the array named by A (the value of N is rounded to the nearest integer, and the subscripts of A are indexed from left to right, starting at one). The value of SIZE(A) shall be the current number of elements in the entire array A.

The value of MAXSIZE(A) shall be the total number of elements of the entire array named by A permitted by the array-declaration.

The value of LBOUND(A,N), where A is an actual-array and N is an index, shall be the current minimum value allowed for the Nth subscript of the array named by A. The value of UBOUND(A,N) shall be the current maximum value allowed for the Nth subscript of array A. As in the SIZE function, the value of N is rounded to the nearest inte-

ger, and the subscripts of array A are indexed from left to right, starting at one. The LBOUND and UBOUND functions may be called with a single arguments provided that arguments is a vector, in which case the value of LBOUND and UBOUND are the current minimum and maximum values allowed for the subscript of the vector. (Here, and in the following sections, the word "vector" shall mean a "one-dimensional array" and the word "matrix" shall mean a "two-dimensional array").

7.1.5 Exceptions

- The value of the index in a SIZE reference is less than one or greater than the number of dimensions in the array (4004, fatal).
- The value of the index in an LBOUND reference is less than one or greater than the number of dimensions in the array (4008, fatal).
- The value of the index in a UBOUND reference is less than one or greater than the number of dimensions in the array (4009, fatal).

7.1.6 Remarks

The dimension statement is retained for compatibility with Minimal BASIC. All its capabilities are included within the declare-statement.

If an implementation supports more than three dimensions, SIZE, LBOUND, and UBOUND should work for those extra dimensions, and an exception should be generated only when an attempt is made to inquire about a dimension beyond those declared.

7.2 Numeric Arrays

7.2.1 General Description

Numeric-arrays in BASIC may be manipulated element by element. However, it is often more convenient to regard numeric-arrays as entities rather than as indexed collections of entities, and to manipulate the entire entity at once. BASIC provides a number of standard operations to facilitate such manipulations.

7.2.2 Syntax

```
1. array-assignment           > numeric-array-assignment
2. numeric-array-assignment   = MAT numeric-array equals-sign
                                numeric-array-expression
3. numeric-array-expression   = (numeric-array numeric-array-operator)? numeric-array
                                / scalar-multiplier numeric-array /
                                numeric-array-value /
                                numeric-array-function-ref
4. numeric-array-operator     = sign / asterisk
5. scalar-multiplier          = primary asterisk
6  numeric-array-value        > scalar-multiplier? (CON / IDN / ZER) redim?
7. redim                      = left-parenthesis redim-bounds (comma redim-bounds)*
                                right-parenthesis
8. redim-bounds               = (index TO)? index
9  numeric-array-function-ref= (TRN / INV) left-parenthesis numeric-array
                                right-parenthesis
10. numeric-function-ref      > DET (left-parenthesis numeric-array
                                right-parenthesis) / DOT left-parenthesis
                                numeric-array comma numeric-array
                                right-parenthesis
```

The number of redim-bounds in a redim shall be one, two, or three.

A numeric-array being assigned a value by a numeric-array-assignment shall have the same number of dimensions as the value of the numeric-array-expression.

The numeric-arrays in a numeric-function-ref involving DOT shall be one-dimensional.

There must be no more than two redim-bounds following IDN.

The numeric-arrays in a sum or difference shall have the same number of dimensions. The numeric-array serving as the argument of DET, INV or TRN shall be two-dimensional.

The numeric-arrays serving as operands for the numeric-array-operator asterisk (matrix multiply) shall be either one-dimensional or two-dimensional, and at least one of them shall be two-dimensional.

7.2.3 Examples

In the following examples A, B and C are doubly-subscripted numeric-arrays, X, Y, and Z are singly-subscripted numeric-arrays, and W is a numeric-expression.

```
 2. MAT A = B          MAT X = Y
    MAT A = B + C      MAT X = Y - Z
    MAT A = B*C        MAT X = A*Y          MAT X = Y*A
    MAT A = W * B      MAT X = W * CON
    MAT A = ZER(4,3)   MAT X = ZER
    MAT A = INV(B)     MAT A = TRN(B)
10. DET(B)             DOT(X, Y)
```

7.2.4 Semantics

Array Assignments and Redimensioning

Execution of a numeric-array-assignment shall cause the numeric-array-expression to be evaluated and its value assigned to the array named to the left of the equals-sign. If necessary, this array shall have its size changed dynamically; i.e., its number of dimensions shall be unchanged, but its size in each dimension shall be changed to conform to the size of the array which is the value of the numeric-array-expression.

When the size of a numeric-array is changed dynamically, the current upper bounds for its subscripts shall be changed to conform to the new sizes. That is,

```
new_lower_bound = old_lower_bound
new_upper_bound = old_lower_bound + new_size - 1
```

The new sizes need not individually be less than or equal to the sizes determined in the array-declaration for that numeric-array, as long as the new total number of elements for the numeric-array does not exceed the total number of elements determined by the array-declaration for that array.

Array Expression

The evaluation of numeric-array-expressions shall follow the normal rules of matrix algebra. The symbols asterisk (*), plus (+), and minus (-) shall represent the operations of multiplication, addition, and subtraction respectively.

The dimensions of numeric-arrays in numeric-array-expressions shall conform to the rules of matrix algebra. The numeric-arrays in a sum or difference shall have the same sizes in each dimension. The numeric-arrays in a product shall have sizes L x M and M x N for some L, M and N (in which case the product shall have size L x N), or an M element vector and a size M x N matrix (in which case the product shall be an N element vector), or a size L x M matrix and an M element vector (in which case the product shall be an L element vector). All elements in a numeric-array shall be used when evaluating a numeric-array-expression; i.e., each numeric-array shall be treated as an entity.

When a scalar-multiplier is present in a numeric-array-expression, the primary shall be evaluated, and then each element of the numeric-array shall be multiplied by this value.

If an underflow occurs in the evaluation of a numeric-array-expression, then the value generated by the operation which resulted in the underflow shall be replaced by zero.

Array Values

Numeric-array-values shall be assigned to the numeric-array on the left of the equals sign. If no redim is present, the size of the numeric-array generated shall be the same as the size of the numeric-array to which it is to be assigned. If a redim is present, a numeric-array of the dimensions specified shall be generated, and the numeric-array to which it is assigned shall be redimensioned as described above. In a redim-bounds, the values of the indices are the lower and upper bounds of the corresponding dimension in the associated array-value. If the redim-bounds consists of a single index, its value shall be the upper bound, and the lower bound shall be the current default lower bound in effect. If a redim is used with the IDN constant, then it shall produce a square matrix; i.e., the number of rows shall equal the number of columns. If a redim is not used with the IDN constant, the numeric-array being assigned to shall be square.

The ZER constant shall generate a numeric-array, all of whose elements are zero. The CON constant shall generate a numeric-array, all of whose elements are one. The IDN constant shall generate an identity matrix, i.e., a square matrix with ones on the main diagonal and zeros elsewhere. If only one redim-bounds is used with IDN, then the effect is just as if that redim-bounds had been specified twice.

If a scalar-multiplier is used with an IDN, ZER or CON constant, then the primary (see 5.3) is evaluated and each non-zero element of the IDN, ZER or CON constant is replaced by the value of the primary.

Array Functions

The function TRN shall produce the transpose of its argument. An N x M matrix is returned for an M x N argument.

The function INV shall produce the inverse of its argument. The argument must be a square matrix.

The function DET shall return the determinant of its argument. The argument must be a square matrix.

The value of DOT(X, Y) shall result in a scalar value, which is the result of the inner product multiplication of the one-dimensional numeric-vectors X and Y.

7.2.5 Exceptions

- The sizes of numeric-arrays in a numeric-array-expression do not conform to the rules of matrix algebra (6001, fatal).
- The total number of elements required for a redimensioned array exceeds the number of elements reserved by the array's original dimensions (5001, fatal).
- The first index in a redim-bounds is greater than the second (6005, fatal).
- A redim-bounds consists of a single index which is less than the default lower bound in effect (6005, fatal).
- The redim following IDN does not specify a square matrix, or no redim is present and the receiving matrix is not square (6004,fatal).
- The argument of the DET function is not a square numeric matrix (6002, fatal).

- The argument of the INV function is not a square numeric matrix (6003, fatal).
- Evaluation of a numeric-array-expression results in an overflow (1005, fatal).
- Evaluation of DET or DOT results in an overflow (1009, fatal).
- Application of INV to a singular matrix, or loss of all significant digits (3009, fatal).

7.2.6 Remarks

It is recommended that implementations report underflow as an exception (1505, nonfatal: replace by zero and continue). In BASIC-2 implementation, this permits interception by exception handlers.

7.3 String Arrays

7.3.1 General Description

As with numeric-arrays, string-arrays may be regarded as entities rather than as indexed collections of entities. BASIC provides the ability to concatenate and assign entire arrays of strings.

7.3.2 Syntax

```
1. array-assignment          > string-array-assignment
2. string-array-assignment   = MAT string-array substring-qualifier? equals-sign
                               string-array-expression
3. String-array-expression   = string-array-primary (concatenation
                               string-array-primary)? / string-primary
                               concatenation string-array-primary /
                               string-array-primary concatena-tion
                               string-primary / string-array-value
4. string-array-primary      = string-array substring-qualifier?
5. string-array-value        = (string-primary concatenation)? NUL dollar-sign
                               redim?
```

A string-array being assigned a value by a string-array-assignment shall have the same number of dimensions as the value of the string-array-expression.

Two string-arrays being concatenated shall have the same number of dimensions.

7.3.3 Examples

```
2. MAT A$ = A$ & B$
   MAT A$ = NUL$(5,6)
   MAT A$ = ("Number") & B$
   MAT A$(4:6) = (" ") & B$
```

7.3.4 Semantics

Execution of a string-array-assignment shall cause the string-array-expression to be evaluated and its value assigned to the array named to the left of the equals-sign. If appropriate, this array shall have its size changed dynamically; i.e., its number of dimensions shall be unchanged, but its size in each dimension shall be changed to conform to the size of the array which is the value of the string-array-expression.

When the size of a string-array is changed dynamically, the current upper bounds for its subscripts shall be changed to conform to the new sizes. That is,

```
new_lower_bound = old_lower_bound
new_upper_bound = old_lower_bound + new_size - 1
```

The new sizes need not individually be less than or equal to the sizes determined in the string-array-declaration for that string-array, as long as the new total number

of elements for the string-array does not exceed the total number of elements determined by the array-declaration for that array.

When a string-array on the left of a string-array-assignment has a substring-qualifier, the assignment to each element of the string-array shall replace the substring of the value of each element specified by the substring-qualifier. The substring-qualifier on the left shall be evaluated before the string-array-expression.

String-array-expressions involve the operations of concatenation and substring extraction. Two string-arrays being concatenated shall have the same size in each dimension; the concatenation shall be performed element by element. When concatenation is by scalar, this scalar shall be prefixed or suffixed, as appropriate, to every element of the string-array. When a substring-qualifier is applied to a string-array, then the specified substring shall be extracted from each element in the array.

The order of evaluation and assignment shall be as follows:

- evaluate the substring-qualifiers in the string-array on the left;
- evaluate the string-array-expression from left to right, by evaluating each string-primary or string-array-primary as follows: evaluate first the subscripts, if any, then the substring qualifiers, and then the value of the primary itself;
- concatenate;
- make the assignment.

The string-array-value NUL$ is an array all of whose elements are the null string. If a redim is not present, the size of the string-array generated shall be the same as the size of the string-array to which it is to be assigned. If a redim is present, a string-array of the dimensions specified shall be generated and the string-array to which it is assigned shall be redimensioned as described above. The rules in 7.2.4 for redims with numeric-array-values apply to NUL$ as well.

7.3.5 Exceptions

- The arrays in a string-array-expression have different sizes (6101, fatal).
- The first index in a redim-bounds is greater than the second (6005, fatal).
- A redim-bounds consists of a single index which is less than the default lower bound in effect (6005, fatal).
- The total number of elements required for a redimensioned array exceeds the number of elements reserved by the array's original dimensions (5001, fatal).
- Evaluation of a string-array-expression results in a string overflow (1052, fatal).
- Assignment of a value to a string-array causes a string overflow (1106, fatal).

7.3.6 Remarks

None.

8. CONTROL STRUCTURES

8. CONTROL STRUCTURES

Control structures govern the order of execution of lines in a program, both by statements which make explicit reference to line-numbers and also by explicitly-constructed loops and decision mechanisms which make no reference to line-numbers.

8.1 Relational Expressions

8.1.1 General Description

Relational-expressions enable the values of expressions to be compared in order to influence the flow of control in a program.

8.1.2 Syntax

```
 1. relational-expression    = disjunction
 2. disjunction              = conjunction (OR conjunction)*
 3. conjunction              = relational-term (AND relational-term)*
 4. relational-term          = NOT? relational-primary
 5. relational-primary       = comparison / left-parenthesis relational-expression
                               right-parenthesis
 6. comparison               = numeric-expression relation numeric-expression /
                               string-expression relation string-expression
 7. relation                 = equality-relation / greater-than-sign /
                               less-than-sign / not-greater / not-less
 8. equality-relation        = equals-sign / not-equals
 9. not-equals               = less-than-sign greater-than-sign / greater-than-sign
                               less-than-sign
10. not-less                 = greater-than-sign equals-sign / equals-sign
                               greater-than-sign
11. not-greater              = less-than-sign equals-sign / equals-sign
                               less-than-sign
```

8.1.3 Examples

```
2. NOT X < Y OR A$ = B$ AND B$ = C$
3. A <= X AND X <= B
   1 <= I AND I <= 10 AND A(I) = X
   I < N AND (J > M OR A(I) < B(J))
```

8.1.4 Semantics

The relation "less than or equal to" is denoted by not-greater. The relation "greater than or equal to" is denoted by not-less. The relation "not equal to" is denoted by not-equals. The relations "greater than", "less than", and "equals" are denoted by the corresponding syntactic sign.

The relation of equality shall hold between two numeric-expressions if and only if the two numeric-expressions have the same value.

The relation of equality shall hold between two string-expressions if and only if the values of the two string-expressions have the same length and contain identical sequences of characters.

In the evaluation of relational-expressions involving string-expressions, the relation "less than" shall be interpreted to mean "earlier in the collating sequence than", and the other relations shall be defined in a corresponding manner. More precisely, if two unequal strings in a relational-expression have the same length, then one shall be "less than" the other if, in the leftmost character position in which they differ, the character in that string precedes the character in the other according to the established collating sequence (see 6.6). If the two strings in a relational-expression have different lengths and one has zero length or is an initial

leftmost segment of the other, then the shorter string shall be "less than" the other. Otherwise the relationship between two strings of unequal length shall be determined by the contents of the shorter string and the leftmost portion of the longer string which is of the same length as the shorter string.

The precedence of the operators AND, OR, and NOT shall be as implied by the formal syntax. That is, NOT operates only on the relational-primary immediately following it, AND applies to the relational-terms immediately preceding and following it, and OR applies to the conjunctions immediately preceding and following it.

The order of evaluation of relational-expressions shall be as follows. The relational-expression shall take on the truth-value of the disjunction which constitutes it. The conjunctions immediately contained in the disjunction shall be evaluated from left to right until a true conjunction is found or none are left. As soon as a true conjunction is found, the whole disjunction is evaluated as true, and any remaining conjunctions are not evaluated. If no true conjunctions are found, the disjunction is false. For each conjunction, the relational-terms immediately contained in it are evaluated from left to right until a false relational-term is found or none are left. As soon as a false relational-term is found, the whole conjunction is evaluated as false and any remaining relational-terms are not evaluated. If all the relational-terms are true, then the conjunction is true. For each relational-term, the relational-primary immediately contained in it is evaluated, its truth value reversed if and only if NOT is also immediately contained in the term, and the resulting value assigned to the relational-term. A relational-primary shall be evaluated according to the description above of the various relations, if it is a comparison. Otherwise, it shall take on the value of the relational-expression immediately contained within it. This relational-expression shall be evaluated by re-applying the rules of this paragraph to it.

8.1.5 Exceptions

None.

8.1.6 Remarks

The specification for evaluation of relational-expressions guarantees that certain parts of the expression will not be evaluated if not necessary. For instance, if an array A has subscripts from 1 to 10:

```
1 < X AND X < 10 AND A(X) = KEY
```

will never cause an exception for subscript out of range.

8.2 Control Statements

8.2.1 General Description

Control statements allow for the interruption of the normal sequence of execution of statements by causing execution to continue at a specified line, rather than at the one with the next higher line-number.

The goto-statement allows for an unconditional transfer. The on-goto-statement allows control to be transferred to a selected line. The gosub-statement and return-statement allow for subroutine calls. The on-gosub-statement and return-statement allow for selected subroutine calls.

8.2.2 Syntax

```
1. control-transfer     = gosub-statement / goto-statement / if-statement /
                          io-recovery / on-gosub-statement /
                          on-goto-statement
2. goto-statement       = (GOTO / GO TO) line-number
```

3. on-goto-statement = ON index (GOTO / GO TO) line-number (comma line-number)* (ELSE imperative-statement)?
4. gosub-statement = (GOSUB / GO SUB) line-number
5. return-statement = RETURN
6. on-gosub-statement = ON index (GOSUB / GO SUB) line-number (comma line-number)* (ELSE imperative-statement)?

8.2.3 Examples

2. GO TO 999
   GOTO 999
3. ON L+1 GO TO 400, 400, 500
   ON X GO TO 100, 200, 150, 9999 ELSE LET A = 1
4. GO SUB 5000
   GOSUB 5160
6. ON A+7 GOSUB 1000, 2000, 7000, 4000
   ON F1-2 GOSUB 4360, 4460, 4660 ELSE PRINT F$

8.2.4 Semantics

Execution of a goto-statement shall cause execution of the program to be continued at the line with the specified line-number.

The index in an on-goto-statement shall be evaluated and its value rounded to obtain an integer, whose value shall be used to select a line-number from the list following the GOTO (the line-numbers in the list are indexed from left to right, starting with 1). Execution of the program shall continue at the line with the selected line-number. If the on-goto-statement contains an ELSE clause, and the value of the index in the on-goto-statement is less than one or greater than the number of line-numbers in the list, then the imperative-statement following the ELSE shall be executed; if the imperative-statement in the ELSE part does not transfer control to another line, then execution shall be continued in sequence, i.e., with the line following that containing the on-goto-statement.

The execution of the gosub-statement or on-gosub-statement and the return-statement can be described in terms of stacks of line-numbers, one associated with each invocation of a program-unit or internal-proc-def (but may be implemented in some other fashion). (The stack is conceptual; the Standard does not require that this method be used). Prior to execution of the first gosub-statement or on-gosub-statement in the invocation of a program-unit or internal-proc-def, the stack in that entity shall be empty. Each time a gosub-statement is executed, the line-number of the gosub-statement shall be placed on top of this stack and execution of the program-unit or internal-proc-def shall be continued at the line specified in the gosub-statement.

The index in a on-gosub-statement shall be evaluated by rounding to obtain an integer, whose value shall be used to select a line-number from the list following the GOSUB (the numbers in the list are indexed from left to right, starting with 1). The line-number of the on-gosub statement shall be placed on top of the stack for the appropriate program-unit or internal-proc-def, and execution shall continue at the line with the line-number selected by the index. If the on-gosub-statement contains an ELSE clause, and the value of the index in the on-gosub-statement is less than one or greater than the number of line-numbers in the list, then the imperative-statement following the ELSE shall be executed and the stack of line-numbers shall not be changed; if the imperative-statement in the ELSE part does not transfer control to another line, execution shall then continue in sequence, i.e., with the line following that containing the on-gosub-statement.

Each time a return-statement is executed, the line-number on top of the stack shall be removed from the stack and execution of the program-unit or internal-proc-def shall continue at the line following the one with that line-number.

A return-statement, gosub-statement and on-gosub-statement within an internal-proc-def shall interact only with the stack for that internal-proc-def. All other such statements interact only with the stack for the program-unit containing the statement.

It is not necessary that equal numbers of gosub-statements or on-gosub-statements and return-statements be executed before termination of a program-unit or internal-proc-def; the stack of line-numbers associated with the current invocation of a program-unit or internal-proc-def shall be emptied upon termination of that program-unit or internal-proc-def.

8.2.5 Exceptions

- The value of the index in an on-goto-statement or an on-gosub-statement without an ELSE clause is less than one or greater than the number of line-numbers in the list (10001, fatal).
- An attempt is made to execute a return-statement without having executed a corresponding gosub-statement or on-gosub-statement within the same program-unit or internal-proc-def (10002, fatal).

8.2.6 Remarks

The syntactic element control-transfer is defined solely to permit describing limitations on transfers to line numbers. It is not generated by other productions.

References to nonexistent line-numbers in a program-unit, including those in control-transfers, are syntax errors (see 4.2). There is, therefore, no exception defined in this Standard for such references. Implementations may, however, choose to treat them as exceptions, if they are so documented, since the effect of non-standard programs is implementation-defined.

8.3 Loop Structures

8.3.1 General Description

Loops provide for the repeated execution of a sequence of statements. Do-loops provide for the construction of loops with arbitrary exit conditions. The for-statement and next-statement provide for the construction of counter-controlled loops.

8.3.2 Syntax

1. loop = do-loop / for-loop
2. do-loop = do-line do-body
3. do-line = line-number do-statement tail
4. do-statement = DO exit-condition ?
5. exit-condition = (WHILE / UNTIL) relational-expression
6. do-body = block* loop-line
7. exit-do-statement = EXIT DO
8. loop-line = line-number loop-statement tail
9. loop-statement = LOOP exit-condition?
10. for-loop = for-line for-body
11. for-line = line-number for-statement tail
12. for-statement = FOR control-variable equals-sign initial-value TO limit (STEP increment) ?
13. control-variable = simple-numeric-variable
14. initial-value = numeric-expression
15. limit = numeric-expression
16. increment = numeric-expression
17. for-body = block* next-line
18. exit-for-statement = EXIT FOR
19. next-line = line-number next-statement tail

20. next-statement = NEXT control-variable

The control-variable in the next-statement which terminates a for-loop shall be the same as the control-variable in the for-statement which begins the for-loop.

A for-loop contained in the for-body of another for-loop shall not employ the same control-variable as that other for-loop. No line-numbers in a control-transfer outside a for-loop or do-loop shall refer to a line in the for-body of that for-loop or in the do-body of that do-loop.

An exit-do-statement may only occur in a do-loop. An exit-for-statement may only occur in a for-loop.

8.3.3 Examples

```
2.   10  DO WHILE I <= N AND A(I) <> 0
     20     LET I = I + 1
     30  LOOP
2.   100 DO
     110    LET I = I + 1
     120    PRINT "MORE ENTRIES (ENTER 'NO' IF NONE)"
     130    INPUT A$(I)
     140 LOOP UNTIL A$(I) = "NO"
2.   10  DO
     20     INPUT X
     30  IF 0 < X AND X <= 7 AND X = INT(X) THEN EXIT DO
     40     PRINT "INPUT AN INTEGER BETWEEN 1 AND 7"
     50  LOOP
10.  100 FOR I = 1 TO 10
     150     LET A(I) = I
     200 NEXT I
12.  FOR I = A TO B STEP -1
20.  NEXT C7
```

8.3.4 Semantics

An exit-condition shall be said to require exit from a loop if the value of the relational-expression following the keyword WHILE is false or if the value of the relational expression following the keyword UNTIL is true.

If execution of a program reaches a do-line, then the exit-condition, if any, in that do-line shall be evaluated. If there is no exit-condition, or if it does not require exit from the loop, then execution shall proceed to the next line. If the condition requires exit from the loop, then execution shall continue at the line following the associated loop-line. If execution of a program reaches a loop-line, then the exit-condition in that loop-line, if any, shall be evaluated. If there is no exit condition, or if it does not require exit from the loop, then execution shall resume at the associated do-line; if the condition requires exit from the loop, then execution shall continue at the line following the loop-line.

The action of the for-statement and the next-statement is defined in terms of other statements, as follows.

```
110 FOR v = initial-value TO limit STEP increment (lines)
150 NEXT v
```

shall be equivalent to

```
110 LET own1 = limit
120 LET own2 = increment
130 LET v = initial-value
140 DO UNTIL (v-own1) * SGN(wn2) > 0 (lines)
150 LET v = v + own2
160 LOOP
```

Here v is any simple-numeric-variable, and own1 and own2 are variables associated with the particular for-loop and not accessible to the programmer. The variables own1 and own2 shall be distinct from similar variables associated with other for-loops. In the above equivalence, a control-transfer to the for-line shall be interpreted as a control-transfer to the first let-statement, and a control-transfer to the next-line shall be interpreted as a control-transfer to the last let-statement.

In the absence of a STEP clause in a for-statement, the value of the increment shall be +1.

Execution of an exit-do-statement shall cause execution to continue the line following the loop-line of the smallest do-loop in which the exit-do-statement occurs. Execution of the exit-for-statement shall cause execution to continue at the line following the next-line of the smallest for-loop in which the exit-for-statement occurs.

8.3.5 Exceptions

None.

8.3.6 Remarks

On exit from a for-loop through the next-statement, the value of the control-variable is the first value not used; on all other exits from a for-loop the control-variable retains its current value.

8.4 Decision Structures

8.4.1 General Description

An if-statement allows for conditional transfers, for the conditional execution of a single imperative-statement, or for the execution of one of two alternative imperative-statements.

An if-block allows for the conditional execution of a sequence of lines or for the execution of one of several alternative sequences of lines.

A select-block allows for the conditional execution of any one of a number of alternative sequences of lines, based on the value of an expression.

8.4.2 Syntax

```
 2. if-clause          = imperative-statement / line-number
 3. if-block           = if-then-line then-block elseif-block* else-block?
                         end-if-line
 4. if-then-line       = line-number IF relational-expression THEN tail
 5. then-block         = block*
 6. elseif-block       = elseif-then-line block*
 7. elseif-then-line   = line-number ELSEIF relational-expression THEN tail
 8. else-block         = else-line block*
 9. else-line          = line-number ELSE tail
10. end-if-line        = line-number END IF tail
```

```
11. select-block            = select-line remark-line* case-block case-block*
                              case-else-block? end-select-line
12. select-line             = line-number select-statement tail
13. select-statement        = SELECT CASE expression
14. case-block              = case-line block*
15. case-line               = line-number case-statement tail
16. case-statement          = CASE case-list
17. case-list               = case-item (comma case-item)*
18. case-item               = constant / range
19. range                   = (constant TO / IS relation) constant
20. case-else-block         = case-else-line block*
21. case-else-line          = line-number CASE ELSE tail
22. end-select-line         = line-number END SELECT tail
```

The constants appearing in case-statements in a select-block shall be the same type (i.e., either numeric or string) as the expression in the select-statement. The ranges and constants specified in case-lists in a select-block shall not overlap.

No line-number in a control-transfer outside an if-block, then-block, elseif-block, else-block, select-block, case-block, or case-else-block shall refer to a line inside that if-block, then-block, elseif-block, else-block, select-block, case-block, or case-else-block, respectively, other than to the if-then-line of that if-block or the select-line of that select-block.

A line-number in a control-transfer inside an elseif-block, else-block, case-block, or case-else-block may not refer to the associated elseif-then-line, else-line, case-line or case-else-line.

8.4.3 Examples

```
1. IF X => Y2 THEN GOSUB 900 ELSE GOSUB 2000
   IF X$ = "NO" OR X$ = "STOP" THEN LET A = 1
   IF A = B THEN 100
   IF A$ = B$ THEN 200 ELSE 300
3. 10  IF X = INT(X) THEN
   20      PRINT X; "IS AN INTEGER"
   30  ELSE
   40      PRINT X; "IS NOT AN INTEGER"
   50  END IF
   100 IF A = 0 THEN
   110     PRINT "ONE ROOT"
   120 ELSEIF DISC < 0 THEN
   130     PRINT "COMPLEX ROOTS"
   140 ELSE
   150     PRINT "REAL ROOTS"
   160 END IF
11. 10  SELECT CASE A$(1:1)
    20 CASE "A" TO "Z", "a" TO "z"
    30      PRINT A$; "starts with a letter"
    40  CASE "0" TO "9"
    50      PRINT A$; "starts with a digit"
    60  CASE ELSE
    70      PRINT A$; "doesn't start with a letter or a digit"
    80  END SELECT
```

```
10  SELECT CASE X
20  CASE IS < 0
30      PRINT X; "is negative"
40  CASE IS > 0
50      PRINT X; "is positive"
60  CASE ELSE
70      PRINT X; "is zero"
80  END SELECT
```

8.4.4 Semantics

If the value of the relational-expression in an if-statement is true and an imperative-statement follows the keyword THEN, then this imperative-statement shall be executed; if a line-number follows the keywork THEN, then execution of the program shall be continued at the line with that line-number. If the value of the relational-expression is false and an imperative-statement follow the keyword ELSE, then this imperative-statement shall be executed; if a line-number follows the keyword ELSE, then execution of the program shall be continued at the line with that line-number, if no ELSE is present, then execution shall be continued in sequence, i.e., with the line following that containing the if-statement.

If-blocks shall be executed as follows. If a then-block, elseif-block, or else-block does not contain a block, the effect is as if it did contain a block consisting of a remark-line. If the value of the relational-expression in the if-then-line is true, then execution shall continue at the first line of the corresponding then-block. If false, then the relational-expressions of each corresponding elseif-then-line, if any, shall be evaluated in order. As soon as a true relational-expression is found, execution shall continue at the first line of the blocks of that elseif-block. If no true relational-expression is found in the elseif-then-lines, then, if an else-block is present, execution shall continue at the first line of the block of that else-block. If there is no else-block, execution shall continue at the line following the end-if-line. When execution reaches the end of a then-block, an elseif-block, or an else-block, it shall continue at the line following the corresponding end-if-line.

The expression in a select-statement in a select-block shall be evaluated and its value compared with the case-items in the case statements until a match is found. A match shall occur when

- the value of the expression equals that of a constant appearing as a case-item, or
- the value is greater than or equal to that of the first constant appearing in a range containing the word TO, but less than or equal to the second, or
- the value satisfies the relationship indicated by the relation appearing before the constant in a range.

If and when a match is found, the rest of the case-block headed by the case-statement in which the match was found shall be executed. If no case-item is matched, then the case-else-block, if it is present, shall be executed. When execution reaches the end of a case-block or case-else-block, it shall continue at the line following the end-select-line.

Nesting of blocks is permitted subject to the same nesting constraints as for-loops (i.e. no overlapping blocks).

8.4.5 Exception

- A select-block without a case-else-block is executed and no case-block is selected (10004, fatal).

8.4.6 Remarks

None.

9. PROGRAM SEGMENTATION

9. PROGRAM SEGMENTATION

BASIC provides three mechanisms for the segmentation of programs. The first provides for user-defined functions, whose values may be used in numeric-expressions and string-expressions. The second enables subprograms to be defined, which communicate via parameters and which can be invoked via a call-statement. The third enables separate programs to be executed sequentially without user intervention.

Functions and subprograms (which we refer to collectively as "routines") are of two types: internal and external. External routines are independent program-units lexically following the main-program. Internal routines are contained within a program-unit (the main-program or an external routine) and are considered to be part of that program-unit. An internal routine cannot contain another internal routine.

In general, an external routine does not share anything (including, but not limited to, variables, DATA statements, internal routines, OPTIONs, and DEBUG status) with other program-units. Information is exchanged between external routines and other program-units by means of parameters and, in the case of external functions, returned values. In general, an internal routine shares everything with its surrounding program-unit, with the exception of its parameters. There are no local variables for internal routines. See Appendix 2 for more detail on scope rules.

Within a program-unit, a routine must always be defined or declared in a line lexically preceding its first invocation in that program-unit. It is not an error for a routine to be defined or declared without being invoked. An external routine may be invoked throughout the program; an internal routine may be invoked only from within its containing program-unit.

No control-transfer within an internal or external routine may refer to a line-number outside that routine, nor may a control-transfer outside a routine refer to a line-number within it.

9.1 User-Defined Functions

9.1.1 General Description

In addition to the implementation-supplied functions provided for the convenience of the programmer (see 5.4, 6.4 and elsewhere), BASIC allows the programmer to define new functions within a program-unit or program.

9.1.2 Syntax

```
 1. function-def               = internal-function-def / external-function-def
 2. internal-function-def      = internal-def-line / internal-function-line block*
                                 end-function-line
 3. internal-def-line          = line-number def-statement tail
 4. def-statement              = numeric-def-statement  string-def-statement
 5. numeric-def-statement      > DEF numeric-defined-function function-parm-list?
                                 equals-sign numeric-expression
 6. numeric-defined-function   = numeric-identifier
 7. string-def-statement       = DEF string-defined-function length-max?
                                 function-parm-list? equals-sign
                                 string-expression
 8. string-defined-function    = string-identifier
 9. function-parm-list         = left-parenthesis function-parameter (comma
                                 function-parameter)* right-parenthesis
10. function-parameter         > simple-variable / formal-array
11. formal-array               = array-name left-parenthesis comma* right-parenthesis
12. internal-function-line     > line-number FUNCTION (numeric-defined-function /
                                 (string-defined-function length-max?))
                                 function-parm-list? tail
```

```
13. end-function-line          = line-number END FUNCTION tail
14. external-function-def      = external-function-line unit-block* end-function-line
15. external-function-line     > line-number EXTERNAL FUNCTION
                                 (numeric-defined-function /
                                 (string-defined-function length-max?))
                                 function-parm-list? tail
16. numeric-function-let-statement = LET numeric-defined-function equals-sign
                                 numeric-expression
17. string-function-let-statement  = LET string-defined-function equals-sign
                                 string-expression
18. exit-function-statement    = EXIT FUNCTION
19. type-declaration           > def-type / internal-function-type /
                                 external-function-type
20. def-type                   = DEF function-list
21. internal-function-type     = FUNCTION function-list
22. external-function-type     = EXTERNAL FUNCTION function-list
23. function-list              = defined-function (comma defined-function)*
24. defined-function           > numeric-defined-function / string-defined-function
```

No line-number in a control-transfer outside an internal-function-def shall refer to a line in an internal-function-def other than to an internal-function-line, nor shall a line-number in a control-transfer inside an internal-function-def refer either to a line outside that internal-function-def or to the associated internal-function-line.

A line-number in a control-transfer inside an external-function-def shall not refer to the associated external-function-line.

If a defined-function is defined by an external-function-def, it shall not be defined more then once in the program. If a defined-function is defined by an internal-function-def, it shall not be defined more than once in the containing program-unit.

Within a program-unit, no more than one function (internal or external) of a given name shall be declared or defined.

If a defined-function is defined by an external-function-def, then a declare-statement with external-function-type containing that defined-function shall occur in a lower-numbered line than the first reference to that defined-function in the same program-unit.

If a defined-function is defined by an internal-function-def other than an internal-def-line, then either the internal-function-def, or a declare-statement with internal-function-type naming that defined-function, shall occur in a lower-numbered line than the first reference to that defined-function in the same program-unit.

If a defined-function is defined by an internal-def-line, then either the internal-def-line, or a declare-statement with def-type naming that defined-function, shall occur in a lower-numbered line than the first reference to that defined-function in the same program-unit.

Self-recursive functions need not declare themselves; that is, if a function-def contains a reference to itself, that reference does not require a type-declaration containing the defined-function in a lower-numbered line. An exit-function statement shall occur only within a function-def.

Within each function-def (other than an internal-def-line) shall occur at least one numeric-function-let-statement or string-function-let-statement with defined-function the same as the defined-function in the internal-function-line or external-function-line of the function-def.

The number and type of function-arguments in a numeric-function-ref or string-function-ref shall agree with the number and type of function-parameters in the corresponding function-def. That is,

- The number of function-arguments shall be the same as the number of function-parameters.
- The function-arguments in the function-arg-list shall be associated with the corresponding function-parameters in the function-parm-list (i.e., the first with the first, the second with the second, etc.), and the types shall correspond as follows:

Parameter	Argument
simple-numeric-variable	numeric-expression
simple-string-variable	string-expression
formal-array (numeric)	actual-array (numeric)
formal-array (string)	actual-array (string)

The number of dimensions of an actual-array shall be one more than the number of commas in the corresponding formal-array. A formal-array shall have no more than three dimensions (two commas).

Whenever a numeric argument is passed to a corresponding numeric parameter in a different program-unit, the ARITHMETIC options in effect for the two program-units must agree.

The ARITHMETIC option external-function-def of numeric type must agree with that of the invoking program-unit.

A given function-parameter shall occur only once in function-parm-list. Function-parameters shall not be explicitly declared or dimensioned within the internal-function-def or external-function-def.

A defined-function appearing in a def-type or internal-function-type shall be defined elsewhere in the same program-unit by an internal-def-line or internal-function-def (other than an internal-def-line), respectively.

A defined-function appearing in an external-function-type shall be defined elsewhere in the program by an external-function-def.

9.1.3 Examples

```
 5. DEF E = 2.7182818
    DEF AVERAGE(X, Y) = (X+Y)/2
 7. DEF FNA$(S$, T$) = S$ & T$
    DEF Right$(A$, n) = A$( Len(A$)-n+1 : Len(A$) )
14. 100 EXTERNAL FUNCTION ANSWER(A$)
    120   SELECT CASE UCASE$(A$)
    130   CASE "YES"
    140         LET ANSWER=1
    150   CASE "NO"
    160         LET ANSWER=2
    170   CASE ELSE
    180         LET ANSWER=3
    190   END SELECT
    200 END FUNCTION
21. FUNCTION AVERAGE, REVERSE$
```

9.1.4 Semantics

A function-def specifies the means of evaluating a function based on the values of the parameters appearing in the function-parm-list and possibly other variables or constants.

Function Parameters

When a defined-function is referenced (i.e., when an expression involving the function is evaluated), then the arguments in the function reference, if any, shall be evaluated from left to right and their values shall be assigned to the parameters in the function-parm-list for the function-def (i.e., arguments shall be passed by value to the parameters of the function). The number of dimensions in a formal-array is one more than the number of commas in the formal-array. Upon invocation of a function-def, a formal-array has the same bounds as the corresponding actual-array. A simple-string-variable or string-array which is a function-parameter shall have the implementation-defined default as its maximum length.

Function Evaluation

If a function is defined in a def-statement, then the expression in that statement shall be evaluated and its value assigned as the value of the function. If a function is defined in an internal-function-def or external-function-def, then the lines following the internal-function-line or external-function-line shall be executed in sequential order until

- some other action is dictated by execution of a line, or
- a fatal exception occurs, or
- a chain-statement or stop-statement is executed, or
- an exit-function-statement is executed, or
- an end-function-line is reached.

The value of the defined-function shall be set by execution of one or more numeric-function-let-statements or string-function-let-statements. Upon exit from the function-def, the value shall be that most recently assigned to the defined-function in that invocation. If, upon exit, no such value has been assigned, then the result shall be consistent with the implementation-defined policies for uninitialized variables. A length-max following a string-defined-function establishes the maximum length of the string value to be returned by that function-def. If no length-max is specified, then the maximum length shall be the same as for a string-variable without a length-max.

An exit-function-statement, when executed, shall terminate the execution of the function-def in which it is immediately contained. An end-function-line marks the textual end of a function-block, and also shall terminate execution of the function-block. Execution of a stop-statement in a function-block shall terminate execution of the entire program.

A function-def may refer, directly or indirectly, to the function being defined; i.e., recursive function invocations are permitted.

Lines in a function-def shall not be executed unless the function it defines is referenced. If the execution of a program reaches an internal-def-line, it shall proceed to the next line without further effect. If execution reaches an internal-function-line, it shall proceed to the line following the associated end-function-line without further effect.

Scopes of Variables, Arrays, Channel Numbers, and Data

A function-parameter appearing in the function-parm-list of a function-def shall be local to each invocation of that function-def; i.e., it shall name a variable or array distinct from any variable or array with the same name outside the function-ref.

The treatment of variables and arrays which are not named as function-parameters in a function-def shall depend upon whether the function-def is internal or external. If the function-def is external, then such variables and arrays shall be local to each invocation of that program-unit, i.e., they shall be distinct from objects with the same names outside that function-def or within other invocations of that function-def; in addition, they shall be initialized or not initialized in a manner consistent with the implementation-defined policies for the main-program each time the function-def is invoked. If the function-def is internal, then those variables and arrays shall be global to the containing program-unit and shall retain their assigned values each time the function-def is invoked; if these values are changed during the course of executing the internal-function-def, the changes remain in effect when execution is returned to the surrounding program-unit.

With one exception, the scope of channel-numbers (see 9.2) is always the program-unit. Nonzero channel-numbers within a function-def shall be local to each invocation of that function-def if it is external, and shall be global to the containing program-unit in which it occurs if it is internal. Channel zero shall be global to the entire program. Files shall be assigned to nonzero channels within a program-unit by means of an open-statement before use. Files assigned to channels local to a function-def shall be closed upon exit from that function-def.

The scope of internal data is always the program-unit. Thus, data within an external-function-def shall be local to each invocation of that program-unit. Hence read-statements and restore-statements within such a function-def shall refer only to data in data-statements within that function-def and not to data in other program-units. Upon invocation of such a function-def, the pointer for the data within that function-def shall be reset to the beginning of the data (see 10.1). Data within an internal-function-def shall be part of the data sequence for the containing program-unit, and read-statements and restore-statements within such a function-def shall refer to the entire sequence of data in that program-unit.

9.1.5 Exceptions

- A string-function-let-statement attempts to assign a value whose length exceeds the maximum for the string-defined-function (1106, fatal).

9.1.6 Remarks

Incompatible COLLATE options are allowed between an invoking and invoked program-unit (even if they communicate via string parameters) because COLLATE does not dictate the internal representation of strings, but only their order in a string comparisons and the values of the CHR$ and ORD functions.

It is not an error for an internal-function-def to appear before a declare-statement with def-type or internal-function-type containing the name of that internal function. It is not an error for a function to be defined by an internal-function-def or to appear in a declare-statement, but not to be referred to in that program-unit.

An internal-function-type or def-type may be omitted if the corresponding definition appears before first reference. An external-function-type is always required when an external-function is referenced in a program-unit.

It is not an error for a function to be defined by an internal-function-def or to appear in a declare-statement, but not to be referred to in that program-unit.

It is not an error for an internal-function-def to appear before a declare-statement with def-type or internal-function-type containing the name of that internal function.

An internal-function-type or def-type may be omitted if the corresponding definition appears before the first reference to that function. An external-function-type is always required when an external-function is referenced in a program-unit other than its own.

The requirement that both internal and external functions be declared or defined before they are used allows several program-units within a program each to contain an internal function with the same name as an external function. This facilitates the use of function libraries where the programmer may not know the names of all the external-function-defs in the library.

9.2 Subprograms

9.2.1 General Description

Subprograms provide a mechanism for the logical segmentation of programs, allowing parameters to be passed between program segments. Subprograms, like defined-functions, may be internal or external to a program-unit.

9.2.2 Syntax

```
 1. subprogram-def            = internal-sub-def / external-sub-def
 2. internal-sub-def          = internal-sub-line block* end-sub-line
 3. internal-sub-line         = line-number sub-statement tail
 4. sub-statement             = SUB subprogram-name procedure-parm-list?
 5. subprogram-name           = routine-identifier
 6. procedure-parm-list       = left-parenthesis procedure-parameter (comma
                                procedure-parameter)* right-parenthesis
 7. procedure-parameter       > simple-variable / formal-array / channel-number
 8. channel-number            = number-sign integer
 9. end-sub-line              = line-number end-sub-statement tail
10. end-sub-statement         = END SUB
11. exit-sub-statement        = EXIT SUB
12. external-sub-def          = external-sub-line unit-block* end-sub-line
13. external-sub-line         = line-number EXTERNAL sub-statement tail
14. call-statement            = CALL subprogram-name procedure-argument-list?
15. procedure-argument-list   = left-parenthesis procedure-argument (comma
                                procedure-argument)* right-parenthesis
16. procedure-argument        = expression / actual-array / channel-expression
17. type-declaration          > internal-sub-type / external-sub-type
18. internal-sub-type         = SUB sub-list
19. external-sub-type         = EXTERNAL SUB sub-list
20. sub-list                  = subprogram-name (comma subprogram-name)*
```

No line-number in a control-transfer outside an internal-sub-def shall refer to a line in an internal-sub-def other than to an internal-sub-line, nor shall a line-number in a control-transfer inside an internal-sub-def refer either to a line outside that internal-sub-def or to the associated internal-sub-line.

A line-number in a control-transfer inside an external-sub-def shall not refer to the associated external-sub-line.

If a subprogram-name is defined by an external-sub-def, it shall not be defined more than once in the program. If a subprogram-name is defined by an internal-sub-def, it shall not be defined more than once in the containing program-unit.

Within a program-unit, no more than one subprogram (internal or external) of a given name shall be declared or defined.

If a subprogram-name is defined by an external-sub-def, then a declare-statement with external-sub-type containing that subprogram-name shall occur in a lower-numbered line than the first reference to that subprogram-name in a call-statement in the same program-unit.

If a subprogram-name is defined by an internal-sub-def, then either the internal-sub-def, or a declare-statement with internal-sub-type containing that subprogram-name, shall occur in a lower-numbered line than the first reference to that subprogram-name in the same program-unit.

Self-recursive subprograms need not declare themselves; that is, if a subprogram-def contains a reference to itself in a call-statement, that reference does not require a type-declaration containing that subprogram-name in a lower-numbered line.

An exit-sub-statement shall occur only within a subprogram-def.

The number and type of procedure-arguments in a call-statement shall agree with the number and type of procedure-parameters in the corresponding subprogram-def. That is,

- The number of procedure-arguments shall be the same as the number of procedure-parameters.
- The procedure-arguments in the procedure-arg-list shall be associated with the corresponding procedure-parameters in the procedure-parm-list (i.e., the first with the first, the second with the second, etc.), and the types shall correspond as follows:

Parameter	Argument
simple-numeric-variable	numeric-expression
simple-string-variable	string-expression
formal-array (numeric)	actual-array (numeric)
formal-array (string)	actual-array (string)
channel-number	channel-expression

An actual-array shall have the same number of dimensions as the corresponding formal-array. The number of dimensions in a formal-array is one more than the number of commas in the formal-array.

Whenever a numeric argument is passed to a corresponding numeric parameter in a different program-unit, the ARITHMETIC option in effect for the two program-units must agree.

A given procedure-parameter shall occur only once in a procedure-parm-list. Procedure-parameters shall not be explicitly declared or dimensioned within the internal-sub-def or external-sub-def.

The channel-number zero shall not be used as a procedure-parameter.

A subprogram-name appearing in an internal-sub-type shall be defined elsewhere in the same program-unit by an internal-sub-def.

A subprogram-name appearing in an external-sub-type shall be defined elsewhere in the program by an external-sub-def.

9.2.3 Examples

```
2. 100 SUB exchange(a,b)
   110    LET t = a
   120    LET a = b
   130    LET b = t
   140 END SUB
 4. SUB CALC(X, Y, Z$)
    SUB SORT(A(), B(,), A$, #3)
```

```
13. 2000 EXTERNAL SUB OPEN (#1, fnames$, result)
14. CALL CALC (3*A+2, 7715, "NO")
    CALL SORT (Zvect, Ymat), (L$), #N)
```

9.2.4 Semantics

When a call-statement is executed, control shall be transferred to the subprogram named in to call-statement. Execution of the subprogram shall begin at the line following the sub-line and shall continue in sequential order until

- some other action is dictated by execution of a line, or
- a fatal exception occurs, or
- a chain-statement is executed, or
- a stop-statement or exit-sub-statement is executed, or
- an end-sub-line is reached.

The end-sub-line serves both to mark the textual end of a subprogram and, when executed, to terminate execution of the subprogram. The exit-sub-statement, when executed, shall terminate the execution of the innermost subprogram in which it is contained. When execution of a subprogram terminates, execution shall continue at the line following the call-statement which initiated execution of the subprogram.

Execution of a stop-statement in a subprogram shall terminate execution of the entire program.

A subprogram may call itself, either directly or indirectly through another procedure; i.e., recursive subprogram invocations are permitted.

Lines in a subprogram-def shall not be executed unless the subprogram it defines is referenced through a call-statement. If execution reaches an internal-sub-line, it shall proceed to the line following the associated end-sub-line without further effect.

Subprogram parameters

When a call-statement is executed, its procedure-arguments shall be identified, from left to right, with the corresponding procedure-parameters in the sub-statement for the subprogram.

Procedure-arguments which are numeric-variables or string-variables without substring-qualifiers shall be passed by reference, i.e., any reference to the corresponding procedure-parameter within the subprogram shall result in a reference to the procedure-argument, and any assignment to the procedure-parameter shall result in an assignment to the corresponding procedure-argument.

If a procedure-argument is an array element, its subscripts shall be evaluated once at each entry to the subprogram.

A procedure-argument which is an expression, but not a numeric-variable or a string-variable without a substring-qualifier, shall be evaluated once at each entry to the subprogram and the value so obtained shall be assigned to a location local to the subprogram. This local value shall be used in any reference to the corresponding procedure-parameter, and this local location shall be used as the destination of any assignment to the procedure-parameter. Any necessary evaluation of procedure-arguments shall take place from left to right.

References within a subprogram to the procedure-parameters which are formal-arrays shall result in interferences to the corresponding arrays in the procedure-argument-list; assignments to or redimensioning of such arrays shall result in assignments to or redimensioning of the corresponding arrays in the procedure-argument-list. Upon entry to the subprogram, a formal-array as a procedure-parameter has the same bounds as the corresponding procedure-argument.

For a procedure-parameter which is a simple-string-variable or string-array, the associated maximum length shall be the implementation-defined default, in the case of passing by value; when passing by reference, the maximum length shall be that of the corresponding procedure-argument.

If both an array and one of its elements are named as procedure-arguments in a call-statement and the array is redimensioned during execution of the subprogram, then any subsequent reference within the subprogram to the procedure-parameter associated with the array-element shall produce implementation-defined results.

A procedure-argument which is a channel-expression shall be evaluated once on entry to the subprogram and the resulting channel shall be used whenever the value of the corresponding procedure-parameter is referenced in the subprogram.

The attributes of the file (see 11.1.4) assigned to this channel shall be passed unchanged to the subprogram, and changes to attributes and contents of the file within the subprogram must be immediately effective, regardless of which of the channel-numbers is used in the subsequent reference, and shall remain in effect upon exit from the subprogram.

A file need not be assigned to a channel designated by a procedure-argument when a call-statement is executed. If an open-statement within a subprogram assigns a file to that channel, then that assignment shall remain in effect upon exit from the subprogram.

Scopes of variables, arrays, channel numbers, and data

A procedure-parameter appearing in the procedure-parm-list of a subprogram-def which has been passed by value shall be local to each invocation of the subprogram-def; i.e., it shall name a variable or array distinct from an variable or array with the same name outside the subprogram-def.

For a procedure-parameter which has been passed by reference, its name shall be local to each invocation of the subprogram-def, but that name refers to the same object as the corresponding procedure-argument see Subprogram parameters, above).

The treatment of variables and arrays which are not named as parameters in a subprogram-def shall depend upon whether the subprogram-def is internal or external. If the subprogram-def is external, then such variables and arrays shall be local to each invocation of that program-unit, i.e., they shall be distinct from objects with the same names outside that subprogram-def or within other invocations of that subprogram-def; in addition, they shall be initialized or not initialized in a manner consistent with the implementation-defined policies for the main-program each time the subprogram-def is invoked. If the subprogram-def is internal, then those variables and arrays shall be global to the containing program-unit and shall retain their assigned values each time the subprogram-def is invoked; if these values are hanged during the course of executing the subprogram-def, the changes remain in effect when execution is returned to the surrounding program-unit.

With one exception, the scope of channel-numbers which are not procedure-parameters is always the program-unit. Nonzero channel-numbers within a subprogram-def shall be local to each invocation of that subprogram-def if it is external, and shall be global to the program-unit in which it occurs if it is internal. Channel zero shall be global to the entire program. Files shall be assigned to nonzero channels within a program-unit by means of an open-statement before use. Files assigned to channels local to a subprogram-def shall be closed upon exit from that subprogram-def.

The scope of internal data is always the program-unit. Thus, data within an external-sub-def shall be local to each invocation of that program-unit. Hence read-statements and restore-statements within such a subprogram-def shall refer only to data in data-statements within that subprogram-def and not to data in other program-units. Upon

invocation of such a subprogram-def, the pointer for the data within that subprogram-def shall be reset to the beginning of the data (see 10.1). Data within an internal-sub-def shall be part of the data sequence for that program-unit, and read-statements and restore-statements within such a subprogram-def shall refer to the entire sequence of data in that program-unit.

9.2.5 Exceptions

None.

9.2.6 Remarks

Implementations may extend the language by making the use of an internal-sub-type optional, even when the internal-sub-defs occur after the call-statements referring to them.

An alias is said to exist for an object whenever two or more distinct names exist for the object within the same scope. When parameters are passed by reference, aliases may be created in certain circumstances. Parameter passing by value does not create aliases, since distinct objects are created for each parameter.

Any call-statement creates aliases whenever :

- channel-expressions which round to the same integer value are passed to different formal channel-numbers,
- the same actual-array is passed to different formal-arrays,
- the same simple variable or array element is passed to different formal simple-variables,
- an array is passed to a formal-array and an element of that array is passed to a formal simple-variable,
- a channel-expression is passed to an internal subprogram, or
- an argument which is not a channel-expression is passed by reference to an internal subprogram.

In the first four cases, the alias arises because two or more formal parameters name the same object, or parts of the same object. In the latter two cases, the alias arises because an object is "visible" to an internal subprogram, both as a parameter and as an object global to the entire program-unit.

When the state of an object referred to by an aliased procedure-parameter is changed, that change must be immediately effective in every subsequent reference to the object, regardless of which of the object's names is used in the reference. Events which potentially affect the state of the object referred to by a procedure-parameter include assignment, input/output operations, and array redimensioning.

Thus, the program :

```
100 DECLARE INTERNAL SUB S
110 LET A = 0
120 CALL S(A,A)
130 SUB S(B,C)
140       LET A = 1
150       LET B = 2
160       LET C = 3
170       IF A <> B OR B <> C OR A <> C THEN
180             PRINT "This shouldn't happen."
190       END IF
200 END SUB
210 END
```

would never print the error message in a conforming implementation.

Remarks about the following topics in 9.1.6 apply analogously to subprograms (9.2.6):

- Program-units with different COLLATE options;
- Functions which are defined or declared, but not referenced;
- Functions which are defined before they are declared;
- The requirement that external, but not internal, functions always be declared (rather than defined);
- Internal functions with the same name in different program-units.

9.3 Chaining

9.3.1 General Description

The chain-statement allows separate programs to be executed serially without programmer intervention. Such a facility is useful for segmenting large programs.

9.3.2 Syntax

1. chain-statement = CHAIN program-designator (WITH function-arg-list)?
2. program-designator = string-expression

The association of the function-arguments in the function-arg-list in the chain-statement with the function parameters in the function-parm-list in the program-name-line shall follow the same rules set down for defined-functions (see 9.1).

9.3.3 Examples

1. CHAIN "PROG2"
   CHAIN A$ WITH (X, FILENAMES$)

9.3.4 Semantics

A chain-statement shall terminate execution of the current program, close all files, and initiate execution of the program designated by the program-designator. The way in which a program is associated with its program-designator is implementation-defined.

If the program being chained to contains a program-name-line, then the arguments of the chain-statement are evaluated and assigned to the corresponding parameters in the program-name-line (i.e., parameters are passed by value). The bounds of a formal-array shall therefore be adjusted to equal those of the corresponding actual-array, in accordance with the rules for passing array parameters to functions (see 9.1).

It is implementation-defined whether upper-case-letters and lower-case-letters are treated as equivalent in a program-designator.

The initial values of variables in a chained-to program are implementation-defined.

9.3.5 Exceptions

- The program identified by the program-designator is not available (10005, fatal).
- The number and type of arguments in a chain-statement do not agree with the number and type of the corresponding parameters in the program-name-line of the program being chained to, or a program-name-line with a function-parm-list is not present (4301, fatal).
- An actual-array does not have the same number of dimensions as the corresponding formal-array (4302, fatal).
- Numeric parameters are passed between programs with a chain-statement and the ARITHMETIC options of the program-units disagree (4303, fatal).

9.3.6 Remarks

In a typical implementation a program-designator will be the name of a file containing that program. The program chained to need not be a BASIC program.

If exception 4301, 4302, or 4303 occurs, it may be reported by the chained-from program, the chained-to program, or some intermediate system program.

10. INPUT AND OUTPUT

10. INPUT AND OUTPUT

Input and output facilities are provided for the interaction of a BASIC program with collections of data. Data may be obtained by a program from statements within that program, from a standard source external to that program, or from a named source external to that program (see 11.4). Output data may be directed to a standard destination external to that program or to named destination external to that program (see 11.3 and, for BASIC-2 only, 11.5).

10.1 Internal Data

10.1.1 General Description

The read-statement provides for the assignment of values to variables from a sequence of data created from one or more data-statements. The restore-statement allows data in a program to be reread.

10.1.2 Syntax

```
1. read-statement          > READ (missing-recovery colon)? variable-list
2. variable-list           = variable (comma variable)*
3. missing-recovery        = IF MISSING THEN io-recovery-action
4. io-recovery-action      = exit-do-statement / exit-for-statement / line-number
5. restore-statement       = RESTORE line-number?
6. data-statement          = DATA data-list
7. data-list               = datum (comma datum)*
8. datum                   = constant / unquoted-string
9. unquoted-string         = plain-string-character / plain-string-character
                             unquoted-string-character*
                             plain-string-character
```

An io-recovery-action containing an exit-for-statement shall occur only within a for-body. An io-recovery-action containing an exit-do-statement shall occur only within a do-body.

If a line-number occurs in a restore-statement, the line-number shall refer to a line containing a data-statement.

10.1.3 Examples

```
1. READ X,  , Z
   READ IF MISSING THEN 1350: X(1), A$
5. RESTORE
   RESTORE 1000
6. DATA 3.14159, PI, 5E-30, ", "
9. COMMAS CANNOT OCCUR IN UNQUOTED STRINGS.
```

10.1.4 Semantics

Data from the totality of data-statements in each program-unit shall behave as if collected into a single data sequence. The order in which data appear textually in the totality of all data-statements determines the order of the data in the data sequence.

If the execution of a program reaches a line containing a data-statement, then it shall proceed to the next line with no further effect.

Execution of a read-statement shall cause variables in the variable-list to be assigned values, in order, from the sequence of data in the program-unit containing the read-statement. A conceptual pointer is associated with this data sequence. At the initiation of execution of the program-unit, this conceptual pointer points to the

first datum in the data sequence. Each time a read-statement is executed, each variable in the variable-list in sequence is assigned the value of the datum indicated by the pointer and the pointer advanced to point beyond that datum.

If an attempt is made to read data beyond the end of the data sequence, an exception shall occur unless a missing-recovery is present in the read-statement. In that case, the specified io-recovery-action shall be taken. If the io-recovery-action is an exit-do-statement or exit-for-statement, that statement shall have its normal effect (see 8.3). If the io-recovery-action is a line-number, then execution shall continue at the line having that line-number.

The type of a datum in the data sequence shall correspond to the type of the variable to which it is to be assigned; i.e., numeric-variables require numeric-constants as data and string-variables require string-constants or unquoted-strings as data. An unquoted-string which is also a numeric-constant may be assigned to either a string-variable or a numeric-variable by a read-statement.

If the evaluation of a numeric datum causes an underflow, then its value shall be replaced by zero.

Subscripts and substring-qualifiers in the variable-list shall be evaluated after values have been assigned to the variables preceding them (i.e., to the left of them) in the variable-list.

Execution of a restore-statement resets the pointer for the data sequence in the program-unit containing the restore-statement to the beginning of the sequence, so that the next read-statement executed will read data from the beginning of the sequence. If a line-number is present, then the pointer for the data sequence in the program-unit containing the restore-statement is set to the first datum in the data-statement with the given line-number, so that the next read-statement executed will read data from the beginning of the designated data-statement.

10.1.5 Exceptions

- The variable-list in a read-statement requires more data than are present in the remainder of the data-list and a missing-recovery has not been specified (8001, fatal).
- An attempt is made to assign a value to a numeric-variable from a datum which is not a numeric-constant (8101, fatal).
- The evaluation of a numeric datum causes an overflow (1006, fatal).
- The assignment of a datum to a string-variable results in a string overflow (1053, fatal).

10.1.6 Remarks

Implementations may choose to treat underflows as exceptions (1506, nonfatal: supply zero and continue). In BASIC-2 implementations, this permits interception by exception handlers.

10.2 Input

10.2.1 General Description

Input-statements provide for user interaction with a program by allowing variables to be assigned values supplied from a source external to the program. The input-statement enables the entry of mixed string and numeric data, with data items being separated by commas.

A prompt for input may be specified to replace the usual prompt supplied by the implementation.

The line-input-statement enables an entire line of input, including embedded spaces and commas, to be assigned as the value of a string-variable.

10.2.2 Syntax

```
 1. input-statement           > INPUT input-modifier-list? variable-list
 2. input-modifier-list       = input-modifier (comma input-modifier)* colon
 3. input-modifier            = prompt-specifier / timeout-expression / time-inquiry
 4. prompt-specifier          = PROMPT string-expression
 5. timeout-expression        = TIMEOUT numeric-time-expression
 6. numeric-time-expression   = numeric-expression
 7. time-inquiry              = ELAPSED numeric-variable
 8. line-input-statement      > LINE INPUT input-modifier-list? string-variable-list
 9. input-prompt              = (implementation-defined)
10. input-reply               = data-list comma? end-of-line
11. line-input-reply          = character* end-of-line
```

At most one prompt-specifier, one timeout-expression, and one time-inquiry shall occur in an input-modifier-list. These may occur in any sequence.

10.2.3 Examples

```
 1. INPUT X
    INPUTA$ Y(2)
    INPUT PROMPT "What is your name? ": N$
    INPUT TIMEOUT 3*N, ELAPSED T, PROMPT Pstring$: N$
 8. LINE INPUT A$
    LINE INPUT PROMPT "": A$, B$
10. 2, SMITH, -3
    25, 0, -10.2
11. He said, "Don't".
```

10.2.4 Semantics

Execution of input-statement shall cause execution of the program to be suspended until a valid input-reply, as specified below, has been supplied. An input-statement shall cause variables in the variable-list to be assigned, in order, values from the input-reply.

In interactive mode,the user of the program shall be informed of the need to supply data by the output of an input-prompt.

Input modifier list

If a prompt-specifier is present in the input-statement, then the implementation-defined input-prompt shall not be output; instead, the value of the string-expression in the prompt-specifier shall be output (unless the input-reply is terminated by a comma, see below). In batch mode, the input-reply shall be requested from the external source by an implementation-defined means.

If a timeout-expression is present in an input-modifier-list, then the numeric-time-expression contained therein shall be evaluated to obtain a (possibly fractional) number S of seconds. If no valid input-reply or line-input-reply has been supplied within S seconds, then an exception shall occur. A time-inquiry returns the (possibly fractional) number of seconds elapsed between the issuance of the input-prompt and the reception of the end-of-line of the last input-reply for this input-statement. This value is assigned to the numeric-variable in the time-inquiry. If no clock is provided by an implementation, then a timeout-expression shall have no effect. If a

clock is provided, a time-inquiry result shall always be positive. If no clock is provided, a time-inquiry result shall be -1. The values (minimum and maximum) and resolution of both timeout expressions and time-inquiries are implementation-defined.

Assignment of Values

The assignment of a value from the input-reply to the corresponding variable shall take place as soon as an item of data in the input-reply has been validated with respect to the type of the datum and the allowable range of values for that datum.

Subscripts and substring-qualifiers in a variable-list or string-variable-list shall be evaluated after values have been assigned to the variables preceding them (i.e., to the left of them) in the variable-list or string-variable-list.

The type of each datum in the input-reply shall correspond to the type of the variable to which it is to be assigned; i.e., numeric-constants shall be supplied as input for numeric-variables, and either string-constants or unquoted-strings shall be supplied as input for string-variables. An unquoted-string which is also a numeric-constant may be assigned to either a string-variable or a numeric-variable by an input-statement.

If the evaluation of a numeric datum causes an underflow, then its value shall be replaced by zero.

If an input-reply supplied in response to a request for input does not end with a comma, then the number of data in all the input-replies submitted shall equal the number of variables requiring values.

If the last character other than a space before the end-of-line in an input-reply is a comma, then this shall be taken to signify that further data are to be supplied. As many values as are contained in that input-reply shall be assigned to variables in the variable-list. The input-prompt (but not the string-expression of the prompt-specifier, if there is one) shall then be reissued, and execution of the program shall remain suspended until another valid input-reply has been supplied, from which further data shall be obtained.

When a line-input-statement is executed, a line-input-reply shall be requested for each string-variable in the string-variable-list in the same fashion as an input-reply is requested. That is, the value of the first line-input-reply shall be assigned to the first variable in the variable-list. If there are further variables in the variable-list, the input-prompt (but not the string-expression of the prompt-specifier, if there is one) shall then be reissued, and execution of the program shall remain suspended until a second valid line-input-reply has been supplied and assigned to the second variable in the variable-list. This process continues until a valid line-input-reply has been supplied for each variable in the variable-list. The characters of each line-input-reply, including any leading and trailing spaces, shall be concatenated to form a single string, which shall become the value of the corresponding string-variable, except that the end-of-line, which terminates a line-input-reply, shall not be included. Quotation marks within a line-input-reply are treated as actual characters. Thus, two adjacent quotation-marks are taken as two characters, not as one.

10.2.5 Exceptions

- The line supplied in response to a request for an input-reply is not a syntactically correct input-reply (8102, nonfatal: request that a new input-reply be supplied).
- A datum supplied as input for a numeric-variable is not a numeric-constant (8103, nonfatal: request that the current input-reply be resupplied).

- There are insufficient data in an input-reply not containing a final comma (8002, nonfatal: request that the current input-reply be resupplied).
- There are too many data in an input-reply or there are just enough data and the input-reply ends with a comma (8003, nonfatal: request that the current input-reply be resupplied).
- The evaluation of a numeric datum causes an overflow (1007, nonfatal: request that the current input-reply be resupplied).
- The assignment of a datum or a line-input-reply to a string-variable results in a string overflow (1054, nonfatal: request that the current input-reply or line-input-reply be resupplied).
- The value of a numeric-time-expression is less than zero (8402, fatal).
- A valid input-reply or line-input-reply has not been supplied within the number of seconds specified by a timeout-expression in an input-modifier-list (8401, fatal).

10.2.6 Remarks

This Standard requires that users in the interactive mode always be given the option of resupplying erroneous input-replies; in batch mode this may be treated as a fatal exception. This Standard does not require an implementation to provide facilities for correcting erroneous input-replies, though such facilities may be provided.

It is recommended tat the default input-prompt consist of a question-mark followed by a single space.

This Standard does not require an implementation to output (i.e. echo) an input-reply or line-input-reply.

Implementations may choose to treat underflows as exceptions (1507, nonfatal: supply zero and continue). In BASIC-2 implementation, this permits interception by exception handlers.

If an input datum is an unquoted-string, leading and trailing spaces are ignored (see 4.1). If it is a quoted-string, then all spaces between the quotation-marks are significant (see 6.1).

10.3 Output

10.3.1 General Description

The print-statement is designed for generation of tabular output in a consistent format. The set-statement with MARGIN can be used to specify the width of output-lines. The set-statement with ZONEWIDTH can be used to specify the width of print zones within a print-line. The ask-statement is used to inquire about the current MARGIN and ZONEWIDTH. Generalizations of the print-statement are described in 10.4, 10.5, and 11.3.

10.3.2 Syntax

```
 1. print-statement          > PRINT print-list
 2. print-list               = (print-item? print-separator)* print-item?
 3. print-item               = expression / tab-call
 4. tab-call                 = TAB left-parenthesis index right-parenthesis
 5. print-separator          = comma / semicolon
 6. set-statement            = SET set-object
 7. set-object               > (MARGIN / ZONEWIDTH) index
 8. ask-statement            > ASK ask-io-list
 9. ask-io-list              = ask-io-item comma ask-io-item)*
10. ask-io-item              = (MARGIN / ZONEWIDTH) numeric-variable
```

A given ask-io-item must appear at most once in an ask-statement.

10.3.3 Examples

```
1. PRINT X
   PRINT X, Y
   PRINT X, Y, Z,
   PRINT ,,, X
   PRINT
   PRINT "X EQUALS", 10
   PRINT X, (Y+Z)/2
   PRINT TAB(10); A$ "IS DONE."
6. SET MARGIN 120
   SET ZONEWIDTH 20
```

10.3.4 Semantics

The execution of a print-statement shall generate a string of characters and end-of-lines for transmission to an external device. This string of characters shall be determined by the successive evaluation of each print-item and print-separator in the print-list.

If an expression in a print-list invokes a function which causes a print-statement to be executed which transmits characters to the same device as the original print-statement, then the effect is implementation-defined.

Printing numeric values

Numeric-expressions shall be evaluated to produce a string of characters consisting of a leading space if the number is positive, or a leading minus-sign if the number is negative, followed by the decimal representation of the absolute value of the number and a trailing space. The possible decimal representations of a number are the same as those described for numeric-constants in 5.1 and shall be used as follows.

Each implementation shall define two quantities, a significance-width d to control the number of significant decimal digits printed in numeric representations, and an exrad-width e to control the number of digits printed in the exrad component of a numeric representation. The value of d shall be at least six and the value of e shall be at least two.

Each expression whose value is exactly an integer and which can be represented with d or fewer decimal digits shall be output using the implicit point unscaled representation.

All other values shall be output using either explicit point unscaled representation or explicit point scaled representation. Values which can be represented with d or fewer digits in the unscaled representation no less accurately than they can in the scaled representation shall be output using the unscaled representation. For example, if d = 6, then 10^(-6) is output as .000001 and 10^(-7) is output as 1.E-7.

Values represented in the explicit point unscaled representation shall be output with up to d significant decimal digits and a period; trailing zeros in the fractional part may be omitted. A number with a magnitude less than 1 shall be represented with no digits to the left of the period. This form requires up to d+3 characters counting the sign, the period and the trailing space. Values represented in the explicit point scaled representation shall be output in the format

significand E sign integer

where the value x of the significand is in the range $1 < x < 10$ and is to be represented with exactly d digits of precision, and where the exrad component has one to e digits. Trailing zeros may be omitted in the fractional part of the significand and

leading zeros may be omitted from the exrad. A period shall be printed as part of the significand. This form requires up to d+e+5 characters counting the two signs, the period, the "E" and a trailing space.

Printing string values

String-expressions shall be evaluated to generate the corresponding string of characters.

Print separators and tabs

The evaluation of the semicolon separator shall generate the null string, i.e., string of zero length.

The evaluation of a tab-call or a comma separator depends upon the string of characters already generated by the current or previous print-statements. The "current line" is the (possibly empty) string of characters generated since the beginning of execution or since the last end-of-line was generated.

The "columnar position" of the current line is the print position that will be occupied by the next character output to that line. Print positions shall be numbered consecutively from the left, starting with position one. Each time a character in positions 2/0 through 7/14 of the standard character set is generated, the columnar position shall be increased by one. Each time an end-of-line is generated, the columnar position shall be reset to one. The effect of other characters on the columnar position is implementation-defined.

The "margin" is the maximum columnar position in which a character may appear. Prior to execution of a set-statement with MARGIN, the margin shall be implementation-defined, but must be not less than the default zone width. A margin of MAXNUM shall indicate that the columnar position may be arbitrarily large.

Each print-line is divided into a fixed number of print zones where the number of zones and the length of each zone is implementation-defined. All print zones, except possibly the last one on a line, which may be shorter, shall have the same width. The default width of a zone shall be at least d+e+6 print positions. The zone width may be changed by the execution of a set-statement with ZONEWIDTH. ZONEWIDTH may be set to any value greater than zero, but not greater than the current margin.

The purpose of the tab-call is to set the columnar position of the current line to the specified value prior to printing the next print-item. More precisely, the argument of the tab-call shall be evaluated and rounded to the nearest integer n. If n is less than one, an exception shall occur. If n is greater than the margin m, then n shall be reduced by an integral multiple of m so that it is in the range $1 < n < m$; i.e., n shall be set equal to MOD(n-1,m) + 1.

If the columnar position of the current line is less than or equal to n, then spaces shall be generated, if necessary, to set the columnar position to n; if the columnar position of the current line is greater than n, then an end-of-line shall be generated followed by n-1 spaces to set the columnar position of the new current line to n.

The evaluation of the comma print-separator depends upon the columnar position. If this position is neither in the last print zone on a line nor beyond the margin, then one or more spaces shall be generated to set the columnar position to the beginning of the next print zone on the line. If the initial columnar position is in the last print zone on a line, then an end-of-line shall be generated. Finally, if the initial columnar position is beyond the margin (as it would be if evaluation of the last print-item exactly filled the line), then an end-of-line shall be generated.

Overlength output lines

Whenever the columnar position is greater than one and the generation of the next print-item would cause a character to appear beyond the margin, then an end-of-line shall be generated prior to the characters generated by that print-item.

During the generation of a print-item, whenever that generation would cause a character to appear beyond the margin, an end-of-line shall be generated prior to that character, resetting the columnar position to one.

End of print-list

When evaluation of a print-list is completed, if that print-list did not end with a print-separator, then a final end-of-line shall be generated; otherwise, no such final end-of-line shall be generated.

A completely empty print-list shall generate an end-of-line, thereby completing the current line of output. If this line contained no characters, then a blank line shall result.

Setting the margin

Execution of a set-statement with a MARGIN shall cause its index to be evaluated and to become the new margin. The change in the margin shall take effect immediately, even if a line of output is partially filled. The set-statement with a MARGIN affects only unformatted output.

Setting the zone width

Execution of a set-statement with a ZONEWIDTH shall cause its index to be evaluated and to become the new zone width. The change in the zone width shall take effect immediately, even if a line of output is partially filled. The set-statement with a ZONEWIDTH affects only unformatted output.

Ask-statement

Execution of an ask-statement shall cause the variables in the ask-io-list to be assigned values corresponding to the current margin, if MARGIN is present, or current zonewidth, if ZONEWIDTH is present. If the columnar position may be arbitrarily large, then the value MAXNUM shall be returned to the numeric-variable in the ask-statement with MARGIN.

10.3.5 Exceptions

- The value of the index in a tab-call is less than one (4005, nonfatal: supply one and continue).
- The value of the index in a set-statement with a MARGIN is less than the current zonewidth (4006, fatal).
- The value of the index in a set-statement with a ZONEWIDTH is less than one or greater than the current margin (4007, fatal).

10.3.6 Remarks

The character string generated by printing the value of a numeric-expression contains a single trailing space. If the generation of that space would cause the columnar position to exceed the margin by more than one, then implementations may choose not to generate that space, thereby allowing the number to be printed in the final print zone on a line.

Implementations may choose to use a lower-case "e" in printing numerical values using the explicit point scaled representation.

The print-separator following a tab-call is significant in the same manner that it is significant following an expression.

10.4 Formatted Output

10.4.1 General Description

A print-statement may control the format of output by specifying an image to which that output must conform. The image is specified either within the print-statement or in a separate image-line.

10.4.2 Syntax

```
 1. print-statement          > PRINT formatted-print-list
 2. formatted-print-list     = USING image (colon output-list)?
 3. image                    = line-number / string-expression
 4. output-list              = expression (comma expression)* semicolon?
 5. image-line               = line-number IMAGE colon format-string end-of-line
 6. format-string            = literal-string (format-item literal-string)*
 7. literal-string           = literal-item*
 8. literal-item             = letter / digit / apostrophe / colon / equals-sign /
                               exclamation-mark / left-parenthesis /
                               question-mark / right-parenthesis /
                               semicolon / slant / space / underline
 9. format-item              = (justifier? floating-characters (i-format-item /
                               f-format-item / e-format-item)) / justifier
10. justifier                = greater-than-sign / less-than-sign
11. floating-characters      = (plus-sign* / minus-sign) dollar-sign? / dollar-sign*
                               (plus-sign / minus-sign)?
12. i-format-item            = digit-place digit-place* (comma digit-place
                               digit-place*)*
13. digit-place              = asterisk / number-sign / percent-sign
14. f-format-item            = period number-sign number-sign* / i-format-item
                               period number-sign*
15. e-format-item            = (i-format-item / f-format-item) circumflex-accent
                               circumflex-accent circumflex-accent
                               circumflex-accent*
```

An image which is a line-number shall refer to an image-line in the same program-unit. Any leading spaces following the colon in an image-line are part of the format-string.

All digit-places in an i-format-item shall be the same character, i.e., all shall be number-signs, all shall be percent-signs, or all shall be asterisks.

10.4.3 Examples

```
10 LET sum = 20
20 PRINT USING "The answer is ###.#": sum
produces       "The answer is  20.0".

30 PRINT USING 40: 342, 42.021
40 IMAGE : RATE OF LOSS #### EQUALS ####.## POUNDS
produces  "RATE OF LOSS  342 EQUALS   42.02 POUNDS".

10 LET A$ = "<##### ####.#### ####. ####^^^^"
20 PRINT USING A$: 1, 1, 1
produces    "     1    1.0000 1000. 0000E-03".
```

```
60 PRINT USING 70: "ONE", "TWO", "THREE"
70 IMAGE : Z<####>#### ########Z
produces  "ZONE    TWO   THREE Z".

80 LET A$ = "Pay $**.## on ### %% 19%%"
90 PRINT USING A$: 1, "May", 2, 83
produces    "Pay $*1.00 on May 02 1983".

10 PRINT USING "<%%.## >---$##.## $$$+****": 3.1, -1234.567, 2
produces       "003.10  -$1234.57   $+**2".

10 PRINT USING "<$$$$.## $$$$.###^^^^^": -.02, -.02
produces       "   $-.02   $-.200E-001".

10 PRINT USING "$***,***.##": 1234.7777
produces       "$**1,234.78".
```

10.4.4 Semantics

A print-statement with a formatted-print-list identifies a format-string to be used to control the output generated by the evaluation of the output-list. If the image is specified via a line-number, then the format-string is contained in the image-line with the indicated line-number; otherwise, it is the value of the string-expression.

Format string analysis

The selected format-string shall be analyzed as a number of format-items separated by possibly zero-length literal-strings.

Format-items shall be found within the format-string by scanning the latter from left to right. A search shall be made for the first character which is the start of a syntactically correct format-item, and the longest such format-item starting at that character identified. The scan for format-items shall continue in this way up to the end of the format-string, the search for the start of each new format-item beginning at the character immediately beyond the previously identified format-item. Corresponding to each format-item shall be an output field whose length equals the number of characters in the format-item (including the justifier, floating-characters, digit-places, commas, period, number-signs, and circumflex-accents). Characters which are not part of any format-item shall be literal-items.

Format-strings which are defined in image-lines shall be interpreted as ending with the last character in the line which is not a space or end-of-line.

Literal strings and output fields

A sequence of values to be output shall be generated by evaluating each expression in the output-list in sequence. As each value is generated, the literal-string preceding the next format-item in the format-string shall first be copied unchanged into the string of characters being generated. Then a number of characters equal to the length of the output field determined by that format-item shall be generated, as follows.

Formatted numeric output

Numeric values shall be rounded and represented in a manner corresponding to the format-item used. If a justifier is present in the format-item, it shall be replaced by the character immediately to its right. If, however, the character to its right is a period, or if there is no character to its right, then the justifier shall be replaced by a number-sign.

First, a representation for the magnitude of the value shall be generated.

- For an i-format-item, the value shall be rounded to the nearest integer and represented using implicit point unscaled notation.

- For an f-format-item, the value shall be represented using explicit point unscaled notation, rounding the representation or extending it on the right with zeros in accordance with the number of number-signs following the period in the format-item.

- For both i-format-items and f-format-items, leading zeros to the left of the implicit or explicit decimal point shall not be generated, unless this results in no digits being generated. In that case, the character "0" shall be generated immediately to the left of the explicit or implicit decimal point. After this, if there remain unfilled digit-places, then leading zeros shall be generated in the integer or to the left of the period when a percent-sign is used as a digit-place, leading asterisks when an asterisk is used as a digit-place, and leading spaces when a number-sign is used as a digit-place, such that the number of characters to the left of the implicit or explicit decimal point is equal to the number of digit-places in the format-item.

- For an e-format-item, the value shall be represented using explicit or implicit point scaled notation, corresponding to the use of an f-format-item or i-format-item, respectively, within the e-format-item. The significand for nonzero values shall be scaled by powers of ten such that the leftmost digit-place or number-sign position is occupied by a nonzero digit. In all other respects, the significand shall be generated according to the above rules for i-format-items and f-format-items. The number of circumflex-accents in an e-format-item shall determine the number of characters in the exrad. The first of these characters shall be the letter E, the next a mandatory sign, and the remaining characters the representation of the magnitude of the exrad, with leading zeros being generated so that the number of characters in the exrad equals the number of circumflex-accents in the format-item. If the exponent is zero, the mandatory sign is positive; the exponent of zero is zero.

Second, commas shall be inserted in the numeric representation wherever a comma occurs in the format-item, provided at least one digit has been generated to the left of the point of insertion; if no digit has been generated to the left of this point, then an asterisk shall be inserted if the digit-place immediately to the left is an asterisk, and a space inserted if the digit-place immediately to the left is a number-sign.

Third, leading characters composed of sign, dollar-sign, and space shall be generated according to the following table:

Floating-characters		Leading Characters Generated	
First*	Last	Non-negative	Negative
-	$	" $"	"-$"
$	-	"$ "	"$-"
-	none	" "	"-"
+	$	"+$"	"-$"
$	+	"$+"	"$-"
+	none	"+"	"-"
$	none	"$"	"$-"
none	none	""	"-"

* may be several occurrences

Finally, the representation of the numeric value so generated shall be extended by spaces on the left so that its length equals that of the format-item. This has the effect of right-justifying a numeric-representation in an output field.

Formatted string output

A string value may be output using any type of format-item. The string shall be extended by spaces so that its length equals that of the format-item. These space shall be added on the left (for right-justification) if the format-item begins with a greater-than-sign, on the right (for left-justification) if it begins with a less-than-sign, and equally on either side (for centering) otherwise; if the number of spaces required in the last case is odd, the extra space shall be added on the right.

Formatted Output Completion

If the number of values to be output exceeds the number of format-items in the format-string, an end-of-line shall be generated each time the end of the format-string is reached and the format-string reused for the remaining expressions. If format-items remain in the format-string after all values have been output, then the next literal-string, if any, shall be output. Generation of characters is always terminated beginning at the first unused format-item. Finally, an end-of-line shall be generated after all other character generation is completed, unless the output-list ends with a semicolon, in which case no such end-of-line shall be generated.

The current margin shall not affect the output; in particular, no end-of-line shall be generated upon formatted output just because the margin is exceeded. If the execution of a program reaches an image-line, it shall proceed to the next line with no further effect.

10.4.5 Exceptions

- An invalid format-string is specified in a formatted-print-list (8201, fatal).
- A formatted-print-list contains an output-list, but there is no format-item in the format-string (8202, fatal).
- An output string, whether generated from a string-expression or a numeric-expression, is longer than its corresponding format-item (8203, nonfatal: fill the output field with asterisks, report the unformatted representation of the value on the next line, and continue printing on the following line in a position identical to the position which would have resulted if no exception had occurred).
- The exrad for numeric output exceeds the space allocated by circumflex-accents in a format-item (8204, nonfatal: fill the output field with asterisks, report the unformatted representation of the value, and continue).

10.4.6 Remarks

Since format-strings may be evaluated dynamically, errors in them (even if occurring in an image-line and therefore statically determined) may be treated as exceptions.

Implementations may choose to use a lower case "e" in printing numerical values using the explicit point scaled representation.

The integer part of a number generated with an i-format-item or f-format-item may validly contain more digits than there are digit-places in the format-item, as long as the floating-characters provide sufficient room.

Negative numeric values always generate a minus-sign. The corresponding format-item must provide room for this minus-sign with floating-characters, since digit-places are completely filled by digits, or by leading spaces, zeros, or asterisks. In particular, a format-item with no floating-characters, or with only a single dollar-sign as a floating-character, will cause exception 8203 if an attempt is made to fill that field with a negative value.

10.5 Array Input and Output

10.5.1 General Description

Statements are provided which enable entire arrays to be input or output. These statements generalize the input and output statements which manipulate single values (see 10.1 to 10.4).

10.5.2 Syntax

```
 1. array-read-statement       > MAT READ (missing-recovery colon)? redim-array-list
 2. redim-array-list           = redim-array (comma redim-array)*
 3. redim-array                = array-name redim?
 4. array-input-statement      > MAT INPUT input-modifier-list? (redim-array-list /
                                 variable-length-vector)
 5. variable-length-vector     = array-name left-parenthesis question-mark
                                 right-parenthesis
 6. array-line-input-statement> MAT LINE INPUT input-modifier-list?
                                 redim-string-array-list
 7. redim-string-array-list    = redim-string-array (comma redim-string-array)*
 8. redim-string-array         = string-array redim?
 9. array-print-statement      > MAT PRINT (array-print-list / (USING image colon
                                 array-output-list))
10. array-print-list           = array-name (print-separator array-name)*
                                 print-separator?
11. array-output-list          = array-name (comma array-name)* semicolon?
```

A redim and the array in its redim-array shall have the same number of dimensions.

A variable-length-vector must be one-dimensional.

10.5.3 Examples

```
1. MAT READ A
   MAT READ A(M,N), B
4. MAT INPUT A$(3,4)
   MAT INPUT X(?)
   MAT INPUT PROMPT "Enter data: ": X(?)
8. MAT LINE INPUT A$
9. MAT PRINT A; B, C;
```

10.5.4 Semantics

The array read statement

Execution of an array-read-statement shall cause arrays in the redim-array-list to be assigned, in order, values from the data sequence created by data-statements in the program-unit containing that statement. Values shall be assigned to all elements in each array in row major order, (i.e., the last subscript varying most rapidly, then the next to last subscript, if any, etc.) with each successive value being obtained from the datum in the data sequence indicated by the pointer for the sequence and the pointer being advanced beyond that datum.

The type of each datum in the data sequence shall correspond to the type of the array-element to which it is to be assigned (see 10.1).

If a redim is present then dynamic redimensioning shall take place before values are assigned to the redimensioned array. The redimensioning shall be done according to the rules for bounds in array-declarations. The values of the indices shall be used as the new lower and upper bounds for the array. If an exception occurs when attempting to redimension an array, it shall retain its old dimensions. Redims in the redim-

array-list shall be evaluated after values have been assigned to the arrays preceding them (i.e., to the left of them) in the redim-array-list.

The handling of insufficient data with or without a missing-recovery shall work as described in 10.1.

If the evaluation of a numeric datum causes an underflow then its value shall be replaced by zero.

The array input statement

Execution of an array-input-statement shall cause execution of the program to be suspended until a valid input-reply, as specified below, has been supplied. An array-input-statement shall cause arrays in the redim-array-list to be assigned, in order, values from the input-reply. Values shall be assigned to all elements in each array in row major order.

In the interactive mode, the user of the program shall be informed of the need to supply data by the output of an input-prompt. The prompt is identical to that of the input-prompt of the input-statement.

The input-modifier-list, if present, shall work as described in 10.2.

The type of each datum in the input-reply shall correspond to the type of the array-element to which it is to be assigned.

If a redim is present then dynamic redimensioning shall take place as described above for the array-read-statement before values are assigned to the redimensioned array. Redims in the redim-array-list shall be evaluated after values have been assigned to the redim-arrays preceding them (i.e., to the left of them) in the redim-array-list.

If the recovery procedure for an input exception causes input data to be re-supplied to an array which was redimensioned after the original assignment of data to it, but before the exception occurred, the effect is implementation-defined. Data in response to a request for array input need not be supplied in a single input-reply. If the array-list has not been completely supplied with data and the input-reply contains a final comma, then the input-prompt shall be issued and a further input-reply shall be requested to obtain more data.

If the evaluation of a numeric datum causes an underflow then its value shall be replaced by zero.

Input of variable length vectors

If a variable-length-vector occurs in an array-input-statement, then as many data as are present in the input-reply (or sequence of input-replies up to and including the first which does not end with a comma) shall be supplied as input for that vector. Assignment of data shall begin with the current lower bound for the vector. After assignment, the vector shall be redimensioned dynamically by setting the upper bound for its subscript equal to the subscript of the element receiving the last datum. The number of data values assigned to the variable-length-vector shall not exceed the original size for that vector as specified in its array-declaration.

The type of each datum in the input-reply shall correspond to the type of the array.

The array-line-input-statement

When an array-line-input-statement is executed, a line-input-reply shall be requested for each element of each string-array in the string-array-list in the same fashion that an input reply is requested and shall assign the entire contents of successive line-input-replies (excluding their end-of-lines) in row major order to elements of the string-arrays in the string-array-list. The number of line-input-replies requested shall equal the number of elements requiring values.

In the interactive mode, the user of the program shall be informed of the need to supply data by the output of an input-prompt.

The input-modifier-list, if present, shall work as described in 10.2.

If a redim is present then dynamic redimensioning shall take place as described above for the array-read-statement before values are assigned to the redimensioned array. Redims in the redim-string-array-list shall be evaluated after values have been assigned to the redim-string-arrays preceding them (i.e., to the left of them) in the redim-string-array-list.

The array print statement

Execution of an array-print-statement shall cause the values of all elements in all arrays in the array-print-list to be printed. An end-of-line shall be generated prior to any characters generated by an array-print-statement if the current line of output is nonempty.

For an array-print-statement with an array-print-list, the characters generated for transmission to an external device by the printing of a two-dimensional array are almost precisely those that would be generated if the elements in that array had been listed, row by row, in the print-list of a print-statement, separated by the separator which follows the array-name in the array-print-list (or separated by a comma if no separator follows the array name). The only additional characters generated shall be an end-of-line each time a row of the array has been printed (if such an end-of-line has not already been generated). A three-dimensional array shall be printed like a series of two-dimensional arrays, one for each value of the first subscript, with an extra end-of-line generated between each value of the first subscript. When a one-dimensional array is printed, it shall be treated like a row-vector, and printed as if it were a 1 x N array.

Finally, an extra end-of-line shall be generated between the output for successive arrays in an array-print-list.

For an array-print-statement with an array-output-list, the characters generated for transmission to an external device are exactly those that would be generated if the elements of each array had been listed array by array, in row-major order, in the output-list of a print-statement, using the same image as that in the array-print-statement. No additional end-of-lines shall be generated. As with a print-statement using an image, if there is no trailing semicolon in the array-output-list, a final end-of-line shall be generated after all other output from the array-print-statement. If there is such a semicolon, then this final end-of-line shall not be generated.

10.5.5 Exceptions

- The redim-array-list in an array-read-statement requires more data than are present in the remainder of the data sequence and no missing-recovery has been specified (8001, fatal).
- An attempt is made to assign a value to an element of a numeric-array from a datum in the data sequence which is not a numeric-constant (8101, fatal).
- The assignment of a datum during execution of an array-read-statement results in a string overflow (1053, fatal).
- The evaluation of a numeric datum in a data-list causes an overflow (1006, fatal).
- The line supplied in response to a request for array input is not a syntactically correct input-reply (8102, nonfatal: request that a new input-reply be supplied).
- A datum supplied as input for a numeric-array is not a numeric-constant (8103, nonfatal: request that the current input-reply be resupplied).

- There are insufficient data in an input-reply not containing a final comma (8002, nonfatal: request that the current input-reply be resupplied).
- There are too many data in an input-reply or there are just enough data and the input-reply ends with a comma (8003, nonfatal request that the current input-reply be resupplied).
- The evaluation of a numeric datum in an input-reply causes an overflow (1007, nonfatal: request that the current input-reply be resupplied).
- The assignment of a string datum during execution of an array-input-statement or an array-line-input-statement causes a string overflow (1054, nonfatal: request that the current input-reply or line-input-reply be resupplied).
- The total number of elements required for a redimensioned array exceeds the number of elements reserved by the array's original dimensions (5001, fatal).
- The first index in a redim-bounds is greater than the second index (6005, fatal).
- A redim-bounds consists of a single index which is less than the default lower bound in effect (6005, fatal).
- A valid input-reply or line-input-reply has not been supplied within the number of seconds specified by a timeout-expression in an input-modifier-list (8401, fatal).
- The value of numeric-expression used as a time-expression is less than zero (8402, fatal).
- An invalid format-string is specified in an array-print-statement (8201, fatal).
- An array-print-statement contains an array-output-list, but there is no format-item in the format-string (8202, fatal).

10.5.6 Remarks

This Standard does not require an implementation to output (i.e., echo) the input-reply or line-input-reply.

This Standard does not require an implementation to provide facilities for correcting erroneous input-replies, though such facilities may be provided.

Implementations may choose to treat underflows as exceptions (1507, nonfatal: supply zero and continue). In BASIC-2 implementations, this permits interception by exception handlers.

11. FILES

11. FILES

Two different levels of file processing are defined for BASIC-1 and BASIC-2. The different combinations of file organization and record types permitted for the two levels are detailed below.

The production rules permitted in BASIC-2 only are so identified. In the text, the usage of indentation permits to distinguish the parts of the text valid for BASIC-1 only or for BASIC-2 only from the parts of text valid for both levels. Although the features permitted in BASIC-1 are a true subset of those permitted in BASIC-2, when the identification of these features would be too difficult to present in a single text, this text is repeated for each of the two levels and so identified.

By convention, production rules referring to BASIC-1 and BASIC-2 are called core rules and production rules referring only to BASIC-2 are called enhanced rules.

Files are organized collections of data external to BASIC programs. They provide the user with a means of saving data developed during execution of a program and then retrieving and modifying that data during subsequent execution of BASIC programs. The process by which external data is transferred to or from a program is called input or output, respectively. An implementation-defined means must be provided for the creation, preservation and retrieval of files. Input and output operations to these files must perform as specified in this section.

This section describes the logical appearance of files and devices to a BASIC program. In some cases, these attributes may reflect physical characteristics, but in general this Standard makes no presumptions concerning the physical representation or organization of files or devices.

The meaning of certain terms used throughout this section is as follows. A "file element" is an entity, a sequence of which constitutes a file. Thus, for keyed and sequential files, a file element is a record, for relative files it is a record area, for stream files, it is a value. Associated with each file during execution is a "file pointer", which always uniquely identifies a particular file element upon completion of any statement, or points to the end of file. If the pointer is at the beginning of the file, then it identifies the first file element, if any. If a file is an empty sequence, then the beginning and end of file are the same, and the pointer identifies this location. Whenever reference is made to the "next" file element, it is understood that if none such exists, the end of file is substituted. For sequential, stream and keyed files, the "end of file" is the location immediately following the last file element. For relative files, the "end of file" immediately follows the last existing record, and thus identifies an empty record area.

BASIC-1

There are two kinds of file-organization: sequential and stream. A sequential file is a sequence of records. A stream file is a sequence of values.

There are two kinds of record-type: display and internal. A display record is a sequence of characters. An internal record is a sequence of typed values. Display records provide for the exchange of data between systems employing different internal representations for numeric and string values, and also manipulate data in human-readable form. Internal records provide for efficient manipulation of data within a single system.

The following combinations of file-organization and record-type are supported:

- sequential display
- sequential internal
- stream internal

All other combinations of file-organization and record-type are implementation-defined.

There are five statements which operate on the file as a whole and are thus called "file operations": OPEN, CLOSE, ERASE, SET and ASK. There are five statements which apply to individual file elements and are known as "record operations": INPUT, PRINT, READ, WRITE and SET with pointer-control, including the variations using MAT and LINE. References to "INPUT operations", "WRITE operations", and so forth should be understood to include any of the statements using the keyword in question, e.g. "WRITE operations" includes WRITE and MAT WRITE. The five record operations can affect data within a file, variables within the program and the file pointer.

PRINT and WRITE affect file data and the pointer, READ and INPUT affect program variables and the pointer. SET with pointer-items obviously affects only the pointer.

BASIC-2

There are four kinds of file-organization: sequential, stream, relative and keyed. Sequential and keyed files are sequences of records. A relative file is a sequence of record areas, each of which may or may not contain a record. A stream file is a sequence of values.

There are three kinds of record-type: display, internal and native. An internal record is a sequence of typed values. A native record is a sequence of fields, as described by a programme-specified template. Display records provide for the exchange of data between systems employing different internal representations for numeric and string values, and also manipulate data in human-readable form. Internal records provide for efficient manipulation of data within a single system. Native records provide for the exchange of data among different language processors within a single system.

The following combinations of file-organization and record-type are supported:

- sequential display
- sequential internal
- stream internal
- relative internal (enhanced internal)
- keyed internal (enhanced internal)
- sequential native (enhanced native)
- relative native (enhanced native)
- keyed relative (enhanced native)

All other combinations of file-organization and record-type are implementation-defined.

Within each subsection, the syntax rules for sequential display, sequential internal and stream internal are presented first, followed by additional syntax productions which pertain to enhanced files. Some of the enhanced productions apply only to enhanced native files: these are preceded by an "N".

There are five statements which operate on the file as a whole and are thus called "file operations": OPEN, CLOSE, ERASE, SET and ASK. There are seven statements which apply to individual file elements and are known as "record operations": INPUT, PRINT, READ, WRITE, REWRITE, DELETE and SET with pointer-control, including the variations using MAT and LINE. References to "INPUT operations", "WRITE operations", and so forth should be understood to include any of the statements using the keyword in question, e.g. "WRITE operations" includes WRITE and MAT WRITE. The seven record operations can affect data within a file, variables within the program and the file pointer. PRINT, WRITE, REWRITE and DELETE affect file data and the pointer, READ and INPUT affect program variables and the pointer. SET with pointer-items affects only the pointer.

Devices

Not all input or output is to or from a file, as defined above. An implementation may allow file processing statements to apply as well to devices, such as a terminal, a line printer or communications line.

When the term "file" is used throughout chapter 11, it should generally be understood to mean any source or destination of external data, i.e. either a true file or a device. In certain contexts where it is necessary to distinguish between the two, the terms "true file" and "Device"will be used for emphasis.

Devices differ from files in the following ways:

- It is implementation-defined whether data written to any given device is stored there and may later be retrieved by input operations (see 11.1).
- It is implementation-defined whether a given device is erasable (see 11.1).
- RELATIVE and KEYED file-organizations are not allowed for devices (see 11.1). (not relevant to BASIC-1)
- A device need not support all access modes (see 11.1).
- A device need not support the minimum record size of 132 (see 11.1). However, the implementation must document the minimum record-size for each device supported.
- It is implementation-defined whether a given device has record-setter capability (see 11.2).
- It is implementation-defined what condition causes the data-found condition to be set true or false for a given device (see 11.2).
- For interactive terminal devices only, the semantics of the input-control-items prompt-specifier, timeout-expression, and time enquiry must be supported. The implementation must define which devices, if any, are interactive terminal devices. The effect of these input-control-items on other devices and on true files is implementation-defined (see 11.4).
- It is implementation-defined whether the following conditions are treated as fatal exceptions, as defined in 11, or as nonfatal, as defined in 10 (in which case the recovery procedure is applied), when these conditions occur within INPUT operations on a device (see 11.4).

Section 11	Section 10	Condition
8105	8102	Syntax error in input-reply
8101	8103	Datum from a numeric-variable not a numeric-constant
8012	8002	Too few data in input-reply
8013	8003	Too many data in input-reply
1008	1007	Numeric overflow on input
1105	1054	String overflow on input

The following tables provide an overview of the various file facilities. For the full specifications, see 11.1 through 11.4.

- TABLE 1 FILE-ORGANIZATION VERSUS OPERATIONS AND RECORD-SETTERS.

  This table illustrates which combination of record operations and record-setter are legal under a given file-organization, thus the organization is defined by the capabilities of record manipulation it allows. Combinations of operations and record-setters which do not appear in the table are syntax errors. Organizations permitted in BASIC-1 and BASIC-2 are identified by *, those permitted only in BASIC-2 are identified by **.

File Organization

Operation record-setter	SEQUENTIAL	STREAM	RELATIVE	KEYED
INPUT				
absent	*OK	*ID 2	**ID 2	**ID 2
NEXT	*OK	*ID 2	**ID 2	**ID 2
BEGIN	*OK	*ID 2	**ID 2	**ID 2
END	*OK 4	*ID 2	**ID 2	**ID 2
SAME	*OK	*ID 2	**ID 2	**ID 2
PRINT				
absent	*OK	*ID 2	**ID 2	**ID 2
NEXT	*OK	*ID 2	**ID 2	**ID 2
BEGIN	*OK	*ID 2	**ID 2	**ID 2
END	*OK	*ID 2	**ID 2	**ID 2
SAME	*OK	*ID 2	**ID 2	**ID 2
READ				
absent	*OK	*OK	**OK	**OK
NEXT	*OK	*OK	**OK	**OK
BEGIN	*OK	*OK	**OK	**OK
END	*OK 4	*OK 4	**OK	**OK
SAME	*OK	*OK	**OK	**OK
RECORD	**EX 1	**EX 1	**OK	**EX 1
KEY	**EX 1	**EX 1	**EX 1	**OK
WRITE				
absent	*OK	*OK	**OK	**EX 3
NEXT	*OK	*OK	**OK	**EX 3
BEGIN	*OK	*OK	**OK	**EX 3
END	*OK	*OK	**OK	**EX 3
SAME	*OK	*OK	**OK	**EX 3
RECORD	**EX 1	**EX 1	**OK	**EX 1,3
KEY (exact)	**EX 1	**EX 1	**EX 1	**OK
REWRITE and DELETE				
absent	**ID 5	**ID 5	**OK	**OK
NEXT	**ID 5	**ID 5	**OK	**OK
BEGIN	**ID 5	**ID 5	**OK	**OK
END	**ID 5	**ID 5	**OK 4	**OK 4
SAME	**ID 5	**ID 5	**OK	**OK
RECORD	**ID 5	**ID 5	**OK	**EX 1
KEY	**ID 5	**ID 5	**EX 1	**OK
SET with pointer-items				
absent	*OK	*OK	**OK	**OK
NEXT	*OK	*OK	**OK	**OK
BEGIN	*OK	*OK	**OK	**OK
END	*OK	*OK	**OK	**OK
SAME	*OK	*OK	**OK	**OK
RECORD	**EX 1	**EX 1	**OK	**EX 1
KEY	**EX 1	**EX 1	**EX 1	**OK

OK - Semantics defined by Standard
EX - Exception
ID - Implementation-defined
* - BASIC-1 and BASIC-2
** - BASIC-2 only

Notes to the Table 1

1. RECORD is valid only with RELATIVE files and KEY with KEYED files. (BASIC-2 only)
2. INPUT and PRINT are defined for record-type DISPLAY, and DISPLAY is defined only for SEQUENTIAL.
3. WRITE to a KEYED file must specify an exact key search. (BASIC-2 only)
4. END implies that data-found will be false.
5. REWRITE and DELETE are implementation-defined for file-organizations other then RELATIVE and KEYED. (BASIC-2 only)

- TABLE 2 RECORD OPERATIONS VS CONTROLS

This table illustrates which control features are allowed syntactically with the various operations. SET is only allowed with pointer-items. The permitted record setting are NEXT, BEGIN, END, SAME.

	CONTROLS				
	record-setter	io-recovery		interpretation	
		missing	not missing	image	template
INPUT	*A	*A			
PRINT	*A		*A	*A	
READ	*A	*A			**A
WRITE	*A		*A		**A
REWRITE	**A	**A			**A
DELETE	**A	**A			
SET	*A	*A	*A		

A = allowed
* = BASIC-1 and BASIC-2
** = BASIC-2 only

- TABLE 3 FILE-ORGANIZATION VS RECORD-TYPE

This table illustrates which combination of file-organization and record-type are defined by this standard.

	Record-type		
ORGANIZATION	DISPLAY	INTERNAL	NATIVE
SEQUENTIAL	*A	*A	**A
STREAM		*A	
RELATIVE		**A	**A
KEYED		**A	**A

A = allowed
* = BASIC-1 and BASIC-2
** = BASIC-2 only

11.1 File Operations

11.1.1 General Description

There are four statements which affect a file as an entity. The open-statement makes a file accessible to the program, establishing the connection between the file and the program. Since the format for identifying files may vary with the operating system, it is assumed only that with each file is associated a string of characters, called its name, which identifies the file to the operating system. A file is identified within a program by the number of a channel through which it is accessed. The close-statement terminates the accessibility effected by they open-statement. The erase-statement deletes all or part of the data within a true file, but may have no effect on a device. The ask-statement is used to inquire about the current status of the file.

11.1.2 Syntax

BASIC-1 and BASIC-2

```
 1. open-statement            = OPEN channel-setter NAME file-name
                                file-attribute-list
 2. channel-setter            = channel-expression colon
 3. channel-expression        = number-sign index
 4. file-name                 = string-expression
 5. file-attribute-list       = (comma file-attribute)*
 6. file-attribute            > core-file-attribute
 7. core-file-attribute       = access-mode / file-organization / record-type /
                                record-size
 8. access-mode               = ACCESS (INPUT / OUTPUT / OUTIN / string-expression)
 9. file-organization         = ORGANIZATION (file-organization-value
                                /string-expression)
10. file-organization-value   > core-file-org-value
11. core-file-org-value       = SEQUENTIAL / STREAM
12. record-type               = RECTYPE (record-type-value / string-expression)
13. record-type-value         > core-record-type-value
14. core-record-type-value    = DISPLAY / INTERNAL
15. record-size               = RECSIZE (VARIABLE / string-expression) (LENGTH
                                index)?
16. close-statement           = CLOSE channel-expression
17. erase-statement           = ERASE REST ? channel-expression
18. ask-statement             > ASK channel-setter ask-item-list
19. ask-item-list             = ask-item (comma ask-item)*
20. ask-item                  = ask-attribute-name variable variable*
21. ask-attribute-name        > core-attribute-name
22. core-attribute-name       = ACCESS / DATUM / ERASABLE / FILETYPE / MARGIN / NAME
                                / ORGANIZATION / POINTER / RECSIZE / RECTYPE /
                                SETTER / ZONEWIDTH
```

BASIC-2 only

```
 23. file-organization-value   > enhanced-file-org-value
 24. enhanced-file-org-value   = RELATIVE / KEYED
N25. record-type-value         > enhanced-record-type-value
N26. enhanced-record-type-value= NATIVE
 27. file-attribute            > enhanced-file-attribute
 28. enhanced-file-attribute   = collate-sequence
 29. collate-sequence          = COLLATE ( STANDARD / NATIVE / string-expression)
 30. ask-attribute-name        > enhanced-attribute-name
 31. enhanced-attribute-name   = RECORD / KEY / COLLATE
```

A given file-attribute must appear at most once in a file-attribute-list.

A given ask-attribute-name must appear at most once in a ask-item-list.

The number and types of variables in an ask-item must agree with the table below in Semantics.

11.1.3 Examples

1. OPEN #3: NAME "myfile"
   OPEN #N: NAME A$, ACCESS OUTIN, ORGANIZATION STREAM, RECTYPE INTERNAL, RECSIZE VARIABLE LENGTH N
   OPEN #N+1: NAME "MY" & F$, ORGANIZATION ORG$

16. CLOSE #N

17. ERASE #3
    ERASE REST #4

18. ASK #3: ACCESS AC$, DATUM DT$, NAME NM$, ORGANIZATION ORG$, POINTER P$, RECSIZE RS$ NUMCHARS, RECTYP RT$

    ASK #N: KEY K$

11.1.4 Semantics

Files are accessed through channels to which they may be assigned during execution of a program-unit. A channel is a logical path through which external data may be transferred to or from a BASIC program. Within a program-unit, a channel is identified by a channel number local to that program-unit. The channel number is an integer from 0 up to and including some implementation-defined maximum. This maximum must be at least 99. A file, identified by its file-name, is open if it is currently assigned to a channel and closed otherwise. A channel is active if it currently has some file assigned to it and inactive otherwise. At the initiation of execution of a program, all channels except channel zero shall be inactive. Channel zero shall always be active. Execution of the open-statement, close-statement, or erase-statement (see below) for channel zero shall cause a nonfatal exception.

Input and output from and to channel zero shall have the same source and destination as input-statements and print-statements which do not contain channel-expressions. Channel zero shall behave as a device with the file-attributes sequential, display, and outin, and without record-setter or erase capability.

Open-statement

The open-statement makes the file identified by the file-name accessible to the program through the channel number specified in the channel-expression. It is implementation-defined whether file names differing only in the case of the letters (upper or lower) denote the same file or different files. Following a successful open-statement, the associated channel shall be active and the file open. An attempt to open a file on a channel which is already active causes an exception. The effect of attempting to open a file which is already open is implementation-defined. The number of channels other than channel zero which may be active simultaneously is at least one.

After a successful open, a true file shall be accessible in accordance with the associated file-attributes, whether explicitly specified or in effect by default. This accessibility consists of the ability to perform certain operations and manipulate the file pointer in certain ways. See the preceding section for an overview of which statements are allowed under which attributes. If an attempt is made to OPEN a file which cannot be made accessible with the requested attributes (i.e., if not all the associated operations can be successfully executed for this file), then an exception results.

For a device, a successful open guarantees that, with two exceptions, all the file processing statements will have the same effects as for a true file. In particular, on output, the same data will be generated, and on input, values and characters will be interpreted and assigned to variables in the same way. A device, however, might not support the semantics associated with the recorder-setter (see Section 11.2) or the erase-statement (below). The ask-statement may be used to determine whether a particular device supports these capabilities.

BASIC-1 only

If a file is opened successfully with a given file-organization, record-type, and record-size, then closed, and then opened at a later time with a different value for one of these file-attributes, then it is implementation-defined whether the file is thus accessible. Also, for files with record-type INTERNAL, if a different ARITHMETIC option is in effect for the two executions, it is implementation-defined whether the file is thus accessible. Conversely, if a true file is reopened at a later time with the same values for the file-attributes mentioned and, for files with record-type INTERNAL, the same ARITHMETIC option is in effect, and the user has employed the implementation-defined means to preserve the file unchanged in the interim, then the file must be accessible and the contents of the file faithfully preserved. Devices are not required to preserve data. In the foregoing, "same ARITHMETIC option" refers to DECIMAL or NATIVE.

If a file with record-type INTERNAL opened in one program-unit is accessed by another program-unit with a different ARITHMETIC option, the results are implementation-defined.

Implementations must provide true files for which all access-modes are available. Implementations may also support true files for which some access-modes are not available. A device need not support all access-modes.

Implementations conforming to this standard need only to accept and process the following combinations of file-organization-value and record-type-value:

- sequential display,
- sequential internal,
- stream internal.

The effect of the other combination is implementation-defined.

When a string-expression is used as an attribute value, its value must be one of the associated keywords for that attribute. Upper-case-characters and lower-case-characters shall be treated as equivalent within such string values. Implementations may define additional file attribute values.

BASIC-2 only

If a file is opened successfully with a given file-organization, record-type, and record-size, then closed, and then opened at a later time with a different value for one of these file-attributes, then it is implementation-defined whether the file is thus accessible. Also, for files with record-type INTERNAL or NATIVE, if a different ARITHMETIC option is in effect for the two executions, it is implementation-defined whether the file is thus accessible. Conversely, if a true file is re-opened at a later time with the same values for the file-attributes mentioned and, for files with record-type INTERNAL or NATIVE, the same ARITHMETIC option is in effect, and the user has employed the implementation-defined means to preserve the file unchanged in the interim, then the file must be accessible and the contents of the file faithfully preserved. Devices are not required to preserve data. In the foregoing, "same ARITHMETIC

option" refers to DECIMAL, NATIVE or FIXED (see 15.1), not to the default specification in the FIXED option. If a KEYED file is re-opened with a different collate-sequence, an exception results.

If a file with record-type INTERNAL or NATIVE opened in one program-unit is accessed by another program-unit with a different ARITHMETIC option, the results are implementation-defined.

Implementations must provide true files for which all access-modes are available. Implementations may also support true files for which some access-modes are not available. A device need not support all access-modes.

Implementations conforming to this standard need only to accept and process the following combinations of file-organization-value and record-type-value:

- sequential display
- sequential internal
- stream internal
- relative internal
- keyed internal
- sequential native
- relative native
- keyed relative

The effect of the other combinations is implementation-defined.

When a string-expression is used as an attribute value, its value must be one of the associated keywords for that attribute. Upper-case-characters and lower-case-characters shall be treated as equivalent within such string values. Implementations may define additional file attribute values.

Access-mode

An access-mode specifies the direction in which data may be transferred from and to a file, either by one of the keywords INPUT, OUTPUT, or OUTIN, or by a string-expression whose value is one of these keywords.

If access-mode is INPUT, then it shall be possible to read data from the file, but not to change the file. In particular, READ, SET with pointer-items, and INPUT statements (including variations with MAT and LINE) are allowed, but not PRINT, WRITE, REWRITE or DELETE. REWRITE and DELETE apply only to BASIC-2.

If the access-mode is OUTPUT, then it shall be possible to add new data to the file, but not to change existing data in it, nor to retrieve data from it. In particular, PRINT, SET with pointer-items, and WRITE are allowed, but not READ, INPUT , REWRITE or DELETE. REWRITE or DELETE apply only to BASIC-2.

If the access-mode is OUTIN, then all record-operations (including REWRITE and DELETE for BASIC-2) are allowed for the file.

The erase-statement shall be allowed only for a file with an access-mode of OUTIN.

If no access-mode is specified explicitly in the file-attribute-list, then the access-mode shall be OUTIN if the file can be both read and written INPUT if it can only be read, and OUTPUT if it can only be written. Channel zero shall behave as if opened with OUTIN.

For a file opened with access-mode OUTPUT, the pointer shall be set to the end of the file following the OPEN, otherwise, it shall be set to the beginning of file.

File-organization

The file-organization specifies the logical relationship between file elements, and the means by which the file pointer can be manipulated to identify the elements. The organization is specified with one of the keywords SEQUENTIAL, STREAM, RELATIVE or KEYED, or with a string-expression whose value is one of these keywords. Devices are accessed as either SEQUENTIAL or STREAM, RELATIVE and KEYED are allowed only for true files. RELATIVE and KEYED apply only to BASIC-2.

If no file-organization is explicitly specified in the open-statement, then the organization shall be determined from available system information about the file. If such information is insufficient, the system shall attempt to open the file as SEQUENTIAL. Channel zero shall behave as if opened with SEQUENTIAL.

- A sequential file is a sequence of records. The order of the records is established by the order in which they were written. Records can be added only to the end of the file. The only means for identifying records with the file pointer is relative to the current position of the pointer, and the two special locations BEGIN (which identifies the first record in the sequence, if any), and END, immediately following the last record (the only location where it is possible to add records). A single record operation may affect several DISPLAY records, but only one INTERNAL or, for BASIC-2, NATIVE record.

- A stream file is much like a sequential file, except that it is a sequence of individual values, rather than of records. The order of values is established by the order in which they were written. Values can be added only to the end of the file. The only means for identifying values is relative to the current pointer position, or BEGIN and END (specifying respectively, the first value, if any, in the sequence, and the location immediately following the last value). One record operation may typically read or write a contiguous series of values within a stream file.

  BASIC-2 only

  - A relative file is a sequence of record-areas, each of which may or may not contain a record. The record-areas are numbered sequentially beginning with 1. Thus the order of the record-areas and the records within them is established by the identifying integer associated with each. The file pointer may be manipulated with the use of this record number as well as by those means provided for sequential files. For relative files, the beginning of file is the first record-area, regardless of whether it contains a record. The end of file immediately follows the last existing record. Thus if the highest existing record number is 44, end of file refers to record-area 45. If there are no records in the file, end of file refers to record-area number 1. Records within a relative file may not only be read and written, but also changed (with REWRITE) and deleted (with DELETE). Moreover, records may be added, not only at the end of file, but also at any empty record-area, including those past the end of file. A record operation processes at most one record.

  - A keyed file is a sequence of records, each of which is identified by a string called a key. The logical sequence of records is established by the collating order of their keys. (See collate-sequence, below.) The file pointer may be manipulated with respect to the keys, as well as by the means provided for sequential files. As with sequential files, beginning of file refers to the first existing record in the sequence (if any), and end of file refers to the location immediately following the last record. Records may be added anywhere within the sequence. An exact key, however, must always be specified for record creation, and no duplicate keys are allowed. Records may also be read, changed or deleted. A record operation processes at most one record.

Record-types

A record-type specifies the logical representation of data within a record or as an individual file element. The record-type affects how data is interpreted and transformed when being transferred between a program and a file. A record-type is specified with one of the keywords DISPLAY, INTERNAL or NATIVE or with a string-expression whose value is one of these keywords. NATIVE apply only for BASIC-2.

If no record-type is explicitly specified on the OPEN, the record-type is determined from available system information about the file. If such information is insufficient, then the file shall be opened as DISPLAY. Channel zero behaves as if opened with DISPLAY.

- The display type specifies that a record is a sequence of characters. On output, the characters are processed in accordance with the semantics of the PRINT statement, and on input with those of the INPUT statement (see 10). READ and WRITE are also allowed for display records; they follow the semantic rules for INPUT and PRINT, respectively.

- The internal type specifies that a record is a sequence of typed values (or that each file element is a value), in the same sense that a program variable contains a value. The essential aspect of internal format is that (for a true file) values are preserved and retrievable. Thus, if a numeric or string value is written from a program variable, and later read into another variable, the two variables must be strictly equal (assuming the original variable to be unchanged). Since INPUT and PRINT statements are essentially character-oriented, they cause an exception when used on a file opened as internal.

  BASIC-2 only

  - The native type specifies that a record is a sequence of fields, as described by a program-specified TEMPLATE. This TEMPLATE, in conjunction with the list of operands of the associated record operation, specifies the size, type, number, and order of fields within the record. This allows data in a file to be put in a form suitable for exchange with other language processors which have similar record specification capabilities. Values are preserved subject to certain restrictions regarding the size of the fields in the record. As with the internal type, INPUT and PRINT cause an exception when used on a file opened as native.

Record-size

A record-size specifies the maximum length of records in a file. It is specified explicitly with the keyword LENGTH.

Unless an enhancement to this Standard provides for fixed-length records, all files shall be composed of variable-length records, i.e., of records whose lengths are independent of each other. The length of a record of type DISPLAY shall be the number of characters in that record. The length of records of other types (INTERNAL or, for BASIC-2 only, NATIVE) shall be implementation-defined. An attempt to perform a record operation for a record whose length exceeds the maximum set (either explicitly or by default) in the OPEN operation shall use an exception. A specified LENGTH index must be greater than zero.

If no record-size is explicitly specified in the open-statement, then the record-size is determined from available system information about the file. If such information is insufficient, then the file shall be opened as VARIABLE. If the index is omitted, then the maximum length of records shall be implementation-defined. Channel zero shall behave as if opened with VARIABLE and the length index omitted.

Implementations must support record-sizes of at least 132 for true files.

Collate-sequence (BASIC-2 only)

The collate-sequence specifies, for a KEYED file, the collating sequence of the record keys. A collate-sequence is specified with one of the keywords STANDARD or NATIVE, or with a string-expression whose value is one of these keywords. Collate-sequence has meaning only for a KEYED file. For other file-organizations, it has no effect.

The collate-sequence of a file governs all record operations for that file and the file-operation ERASE. Thus, the logical appearance of the file, when operated on by READ, WRITE, REWRITE, DELETE, SET with pointer-control, ERASE and ASK must be in accordance with the specified collate-sequence (see file-organization, above and 11.2).

The collate-sequences STANDARD and NATIVE imply exactly the same ordering as in the option-statement (see 6.6). Thus, if the collate-sequence associated with a file and a program-unit agree, it follows that an earlier key in the file will always compare as less than a later key. When the sequences disagree, this relationship may not hold. Nonetheless, it must be possible for a program-unit with a different collate-sequence to access a KEYED file; the collate-sequence affects only the logical order of the records, not their contents. Implementations with KEYED files must support both collate-sequences.

If no collate-sequence is specified in the open-statement, then the collate-sequence shall be determined from available system information about the file. If such information is insufficient, the system shall attempt to open the file with the same collate-sequence as that in effect for the program-unit containing the open-statement. Since channel zero has file-organization SEQUENTIAL (not KEYED), it has no associated collate-sequence.

Close-statement

Execution of a close-statement shall close the file assigned to the specified channel, causing the channel to become inactive. If no file is assigned to the channel, no action occurs. Upon exit from an external-sub-def or external-function-def, any files opened by such a procedure whose channels are not formal parameters shall be closed. Upon program termination, any files still open shall be closed.

Erase-statement

For a true file, execution of an erase-statement shall delete all or part of the data within the file assigned to the specified channel. The file-attributes associated with the file are not changed. If the REST option is omitted, then all file elements are deleted, the file becomes empty, and the file pointer points to the end of file (which is the same as the beginning file).

If the REST option is specified, then all file elements at or beyond the current location of the file pointer are deleted. All file elements preceding it are left unchanged. The file pointer is then set to end of file.

The erase-statement may not be effective for a device. The ask-statement can be used to determine if a device supports this capability.

An erase-statement executed for channel zero shall cause an exception, but no other effect shall occur.

An erase-statement is allowed only for a file opened with access-mode OUTIN. For other access-modes, there is no effect on the file and an exception results.

Ask-statement

Execution of an ask-statement shall cause the variables in the ask-item-list to be assigned values corresponding to the attributes of the file currently assigned to the specified channel, as indicated in the following table. If the channel is inactive,

then all such string-variables shall be assigned the null string, and all such numeric variables shall be assigned 0. In all cases below, A$ represents a string-variable and N represents a numeric-variable.

In BASIC-2 the following responses can be expected:

Ask-item

Values

ACCESS A$

The access-mode of the file, i.e., "INPUT", "OUTPUT", or "OUTIN".

COLLATE A$

The collate-sequence associated with a KEYED file, i.e. "STANDARD" or "NATIVE". For file-organizations other than KEYED, the null string is assigned.

DATUM A$

The type of the next datum in the file following the current pointer position, i.e., "NUMERIC", "STRING", "NONE" (if no data follow), or "UNKNOWN" (if it is impossible to determine the type or whether more data follow). DATUM is well-defined only for STREAM INTERNAL files. For other file organizations, it is implementation-defined.

ERASABLE A$

"YES" or "NO" depending on whether or not this file is erasable, i.e., if the ERASE statement can delete file elements.

FILETYPE A$

"FILE" or "DEVICE" depending on whether this is a true file capable of preserving data, or is a device.

KEY A$

The key associated with the record identified by the file pointer in a keyed file. If the pointer is at the end of file or if this is not a keyed file, the null string is assigned.

MARGIN N

The current margin for a display file (MAXNUM if the record may be of arbitrary length). If the file is not DISPLAY, zero is assigned.

NAME A$

The name of the file assigned to the channel.

ORGANIZATION A$

The file-organization of the file, i.e., "SEQUENTIAL", "STREAM", "RELATIVE" or "KEYED".

POINTER A$

The current pointer position for the file, i.e., "BEGIN", "MIDDLE", or "END", where MIDDLE shall mean neither BEGIN nor END, and END shall be the pointer position for an file, or a position beyond the end, in the case of a RELATIVE file. UNKNOWN may be returned in the case of devices for which an implementation cannot determine which of the above values is correct.

RECORD N

The number of the record-area identified by the file-pointer. For non-relative files, zero is assigned.

RECSIZE A$ N

The record-size of the file, i.e. "VARIABLE" and the maximum length for its records (MAXNUM if there is no effective limit on record-length, e.g., a communication line).

RECTYPE A$

The record-type for the file, i.e. "DISPLAY", "INTERNAL" or "NATIVE".

SETTER A$

"YES" or "NO" depending on whether or not this file has record-setter capability.

ZONEWIDTH N

For DISPLAY files, the current zonewidth. For non-DISPLAY files, zero is returned.

In BASIC-1, the following responses can be expected:

ask-attribute	value
ACCESS	as BASIC-2
COLLATE	null string
DATUM	as BASIC-2
ERASABLE	as BASIC-2
FILE TYPE	as BASIC-2
KEY	null string
MARGIN	as BASIC-2
NAME	as BASIC-2
ORGANIZATION	SEQUENTIAL or STREAM
POINTER	as BASIC-2, except that END means an empty file
RECORD	zero
RECSIZE	as BASIC-2
RECTYPE	DISPLAY or INTERNAL
SETTER	as BASIC-2
ZONEWIDTH	as BASIC-2

The effect of executing an ask-statement for channel zero is as follows:

ask-attribute	value
ACCESS	OUTIN
COLLATE	null string
DATUM	UNKNOWN
ERASABLE	NO
FILETYPE	DEVICE
KEY	null string
MARGIN	current margin
NAME	implementation-defined
ORGANIZATION	SEQUENTIAL
POINTER	UNKNOWN
RECORD	zero
RECSIZE	VARIABLE MAXNUM
RECTYPE	DISPLAY
SETTER	NO
ZONEWIDTH	current zonewidth

11.1.5 Exceptions

- The value of a channel-expression is not between 0 and the implementation-defined maximum (7001, fatal).
- Channel zero is specified in an open-statement, a close-statement, or an erase-statement (7002, nonfatal do nothing and continue).
- A nonzero channel specified in an open-statement is already active (7003, fatal).
- A string-expression used to specify a file-attribute does not have a recognizable value (7100, fatal).
- Access to a file in an open-statement is not possible in accordance with the specified or default file-attributes (71xx fatal: the values and meanings for xx are implementation-defined).
- A KEYED file is re-opened with a different collate-sequence from that of an earlier open (7050, fatal). (BASIC-2 only)
- A LENGTH index is not greater than zero (7051, fatal).
- A device is opened as RELATIVE or KEYED (7052, fatal). (BASIC-2 only)
- A nonzero channel specified in an erase-statement is inactive (7004, fatal).
- An erase-statement is used on a file which has not been opened as OUTIN (7301, fatal).
- An erase-statement is used on a device without erase capability which has been opened with OUTIN (7311, nonfatal: do nothing and continue).

11.1.6 Remarks

It is recommended that implementations recognize as file-names at least those strings of characters consisting of an upper-case-letter followed by at most three more upper-case-letters or digits. It is also recommended that information required by the operating system, for the purpose of protecting the security of files be considered part of the file-name.

It is recommended that implementations use the file-name to distinguish between the opening of a true file, and opening of non-file devices, such as a communications line or a line printer.

It is recommended that the number of channels which may be active simultaneously be at least four in addition to channel zero.

It is recommended that the default maximum length of records in a file be infinite, i.e., that records be allowed to be of any length.

It is also recommended that record-size for INTERNAL and, for BASIC-2 only, NATIVE files has a meaning comparable to that for DISPLAY, i.e., that it specifies the maximum number of characters or bytes within the record.

Additional values may be returned by an ASK statement if an implementation supports access-modes, file-organizations, record-types, record-sizes and collate-sequences in addition to those specified in this Standard.

If implementations return a status code following various file operations, it is recommended that this be made accessible through an additional ASK attribute to be called IOSTAT which returns a single string value, e.g., "ASK IOSTAT S$" returns a value in S$ reflecting the status of the file following the last attempted operation.

The maximum length of a KEY is implementation-defined. (BASIC-2 only)

11.2 File Pointer Manipulation

11.2.1 General Description

The pointer for an open file can be altered in certain ways, without also performing any data transfer. The rules for pointer manipulation with the set-statement with pointer-items also apply when used in conjunction with other record operations.

11.2.2 Syntax

BASIC-1 and BASIC-2

```
 1. set-object              > channel-setter pointer-items
 2. pointer-items           = (pointer-control / io-recovery / pointer-control
                              comma io-recovery)
 3. pointer-control         > POINTER core-record-setter
 4. record-setter           > core-record-setter
 5. core-record-setter      = BEGIN / END / SAME
 6. io-recovery             = missing-recovery / not-missing-recovery
 7. not-missing-recovery    = IF THERE THEN io-recovery-action
```

BASIC-2 only (Enhanced Files productions):

```
 8. pointer-control         > enhanced-record-setter
 9. record-setter           > enhanced-record-setter
10. enhanced-record-setter  = RECORD index / KEY (exact-search / inexact-search)
                              string-expression
11. exact-search            = equals-sign?
12. inexact-search          = greater-than-sign / not-less
```

11.2.3 Examples

```
1. SET #N: POINTER BEGIN, IF MISSING THEN EXIT DO
   SET #3: RECORD N+1, IF MISSING THEN 1200
   SET #4: KEY "Jones", IF THERE THEN EXIT DO
```

11.2.4 Semantics

Execution of a set-statement with pointer-items shall set the pointer for the file assigned to the specified channel. After the pointer has been set, an optional io-recovery may take effect. The semantics associated with the record-setter and when the io-recovery takes effect are uniform for all the record operations (see 11.3, 11.4 and, for BASIC-2, 11.5). If any of the exceptions listed below in 11.2.5 occurs, the file pointer remains unchanged from its state before the SET with pointer-control. A device may not be able to achieve the effect of a record-setter. The ask-statement may be used to determine whether a device has record-setter capability.

Record-setters

BASIC-1

An absent record-setter leaves the file pointer unchanged from its previous state. The io-recovery (see below), if present, still has its usual effect.

A record-setter of NEXT indicates that the pointer is to be set to the next record (for SEQUENTIAL files) or value (for STREAM files) at or beyond the current location. For a SEQUENTIAL file, the only case in which NEXT would have some effect is if there were a partial record pending (see 11.3). In this case, an end-of-record shall be generated and the pointer left at end of file.

An absent record-setter leaves the file pointer unchanged from its previous state. The io-recovery (see below), if present, still has its usual effect.

A record-setter of NEXT indicates that the pointer is to be set to the next existing record (for non-STREAM files) or value (for STREAM files) at or beyond the current location. In the case of a RELATIVE file, NEXT shall therefore cause the pointer to skip over any empty record areas to the next existing record. If the pointer is already at or beyond the end of file, or is pointing to an existing record, NEXT shall leave the pointer unchanged. This capability allows RELATIVE files to be processed as if they were SEQUENTIAL. In the case of STREAM and KEYED files, the pointer is always pointing to an existing file element or end of file and so is left unchanged. For a SEQUENTIAL file, the only case in which NEXT would have some effect is if there were a partial record pending (see Section 11.3). In this case, an end-of-record shall be generated and the pointer left at end of file.

A record-setter of BEGIN causes the pointer to be set to the beginning of file, i.e., to the first file element. If the file is empty, the location is also the end of file.

A record-setter of END causes the pointer to be set to end of file, defined as immediately beyond the last file element (if any) in the case of SEQUENTIAL, STREAM, and KEYED files, and as immediately beyond the last existing record in the case of a RELATIVE file (or at record-area number 1, if no records exist).

A record-setter of SAME allows the user to access the same file-element(s) that have most recently been processed since the OPEN for that channel. Its use is valid only if the most recently executed record operation which accessed the channel meets these conditions : it was not a delete-statement, and no exception occurred during its execution at least until after the file pointer had been set.

If these conditions are not met, no pointer manipulation takes place and an exception results. If they are met and the most recent operation was a READ, INPUT, SET with pointer-items, or REWRITE, then the file pointer is reset to the same file element it was just set to by the record-setter of that operation. If this operation had no record-setter, then SAME resets the pointer to the same location it had at the beginning of that operation. If the most recent operation was a WRITE or PRINT, then SAME sets the pointer to the first file element created by that operation.

A record-setter with RECORD is valid only for use with RELATIVE files. If an attempt is made to use this record-setter on a file not opened as RELATIVE, the pointer is left unchanged and an exception results. The index is evaluated by rounding to an integer, and the pointer set to the corresponding record-area, whether or not it contains a record. If the index evaluates to an integer less than one, the pointer is left unchanged and an exception is generated.

A record-setter with KEY is valid only for use with a KEYED file. If an attempt is made to use this record-setter on a file not opened as KEYED, the pointer is left unchanged and an exception results. For an exact-search the pointer is set to the record whose key equals that of the string-expression; if none such exists, the pointer is set to the first record whose key is greater than the ring-expression. If there is no such record, the pointer is set to end of file. For an inexact-search with not-less, the pointer is set exactly as for an exact-search, except for the setting of the data-found condition (see below). For an inexact-search with greater-than-sign, the pointer is set to the first record whose key is strictly greater than the string-expression; if none exists, it is set to end of file.

Io-recovery

At the completion of pointer manipulation there shall be set a condition called data-found, which is either true or false. If data-found is true, and if a not-missing-recovery has been specified, then the io-recovery-action takes effect. If the data-found condition is false and a missing-recovery has been specified, then the io-recovery-action also takes effect. Except for these two cases, the io-recovery-action, if any, is ignored. The data-found condition is false if:

- in BASIC-2 only, an exact-search has been specified, but no record was found whose key was equal to the string-expression, or
- after the pointer is set, it points to end of file, or
- in BASIC-2 only, after the pointer is set, it points to an empty record-area, or
- for a device, there is an implementation-defined condition signifying that no data is available for input; otherwise, the data-found condition is true.

If the io-recovery-action is an exit-do-statement or exit-for-statement, the statement shall have its normal effect (see 8.3). If the io-recovery-action is a line-number then execution shall continue at the specified line.

11.2.5 Exceptions

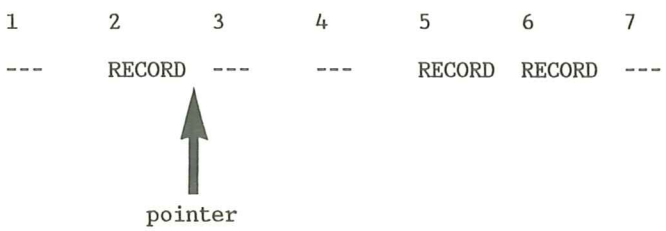
- A set-statement with pointer-items is executed for an inactive channel (7004, fatal).
- A record-setter is used with channel zero (7002, nonfatal: do nothing and continue).
- A record-setter is used on a device without record-setter capability (7205, nonfatal: do nothing and continue).
- The record-setter SAME is used, and the most recently executed operation for the channel was a delete-statement (7204, fatal). (BASIC-2 only)
- The record-setter SAME is used, and the most recently executed operation for the channel caused an exception before pointer manipulation took place (7204, fatal).
- The record-setter SAME is used, and no record operation has been executed on that channel since the OPEN (7204, fatal).
- The record-setter RECORD is used on a file opened with a file-organization other than RELATIVE (7202, fatal). (BASIC-2 only)
- The record-setter KEY is used on a file opened with a file-organization other than KEYED (7203, fatal). (BASIC-2 only)
- The index of a RECORD record-setter evaluates to an integer less than one (7206, fatal). (BASIC-2 only)
- A record-setter specifies an exact-search for the null string (7207, fatal). (BASIC-2 only)

11.2.6 Remarks

For devices, data-found could be set false by such conditions as no more cards in a card reader, control-Z sent from a terminal (which signifies end-of-file for some systems), or that the device is for output only, e.g., a line printer.

BASIC-2

Given a RELATIVE file, with three existing records, numbers 2, 5, and 6:



If READ RECORD 2 has just taken place, then the following record-setters will have the described effect :

record-setter	resulting pointer position in front of
BEGIN	1
END	7
SAME	2
NEXT	5
absent	3
RECORD n	n

11.3 File Data Creation

11.3.1 General Description

Statements are provided to allow the user to send data developed within the program to an external destination. In the case of true files, such data can be retrieved and modified by later programs. The facilities generalize the output capabilities presented in Section 10 to files. New facilities are also defined to allow output to the various record-types. The set-objects MARGIN or ZONEWIDTH are not part of a data creation statement, but are included in this section because of their interaction with display records.

11.3.2 Syntax

BASIC-1 and BASIC-2

```
 1. print-statement          > PRINT channel-expression print-control (colon
                               (print-list / output-list))?
 2. array-print-statement    > MAT PRINT channel-expression print-control colon
                               (array-print-list / array-output-list)
 3. print-control            =(comma print-control-item)*
 4. print-control-item       = core-record-setter / not-missing-recovery / USING
                               image
 5. set-object               > channel-setter (MARGIN / ZONEWIDTH) index
 6. write-statement          = WRITE channel-expression write-control colon
                               expression-list
 7. array-write-statement    = MAT WRITE channel-expression write-control colon
                               array-list
 8. write-control            = (comma write-control-item)*
 9. write-control-item       > record-setter / not-missing-recovery
10. expression-list          = expression (comma expression)*
11. array-list               = array-name (comma array-name)*
```

BASIC-2 only (Enhanced Files productions):

```
N12. write-control-item        > template-identifier
N13. template-identifier       = WITH (line-number / string-expression)
N14. declarative-statement     > template-statement
N15. template-statement        = TEMPLATE colon template-element-list
N16. template-element-list     = template-element (comma template-element)*
N17. template-element          = fixed-field-count (field-specifier / left-parenthesis
                                 template-element-list right-parenthesis) /
                                 variable-field-count field-specifier
N18. fixed-field-count         = SKIP? (integer OF)?
N19. variable-field-count      = question-mark OF
N20. field-specifier           = numeric-specifier / string-specifier
N21. numeric-specifier         = NUMERIC asterisk numeric-field-size
N22. numeric-field-size        = fixed-point-size / E
N23. fixed-point-size          = integer-size period? / integer-size? period
                                 fraction-size
N24. integer-size              = integer
N25. fraction-size             = integer
N26. string-specifier          = STRING asterisk string-field-size
N27. string-field-size         = integer
```

Within a print-statement or array-print-statement, an image must not be used with a print-list, i.e., only an output-list may be used when an image is present as a print-control.

The line-number of a template-identifier must refer to a template-statement in the same program-unit. (BASIC-2 only)

The integer in a fixed-field-count must be greater than zero. (BASIC-2 only)

In a fixed-point-size, the integer-size or fraction-size must be greater than zero.(BASIC-2 only)

String-field-size must be greater than zero. (BASIC-2 only)

The record-setter in a write-control must not specify an inexact-search. (BASIC-2 only)

A given print-control-item must appear at most once in print-control.

A given write-control-item must appear at most once in write-control.

11.3.3 Examples

```
1. PRINT #3: A, B, C
   PRINT #3, END, USING 123: A$, B+C;
2. MAT PRINT #N, SAME, IF THERE THEN EXIT FOR: A$, B$, C
5. #3: MARGIN N+1
6. WRITE #3, RECORD 47, IF THERE THEN 666: A+B, C$ & D$
   WRITE #X+Y WITH TEMPLATES3$: X, Y, Z + W
7. MAT WRITE #3, KEY "Whoever", IF THERE THEN 666,
                                 WITH 111: A, B$
N15. TEMPLATE: STRING*5, 2 OF NUMERIC*3.4
     TEMPLATE: ? OF NUMERIC*5.2, ? OF STRING*5
N16. 5 OF STRING*22, 3 OF NUMERIC*E, ? OF NUMERIC*.6
```

11.3.4 Semantics

All data creation statements follow a general pattern which will be described here. In all cases, the function of a data creation statement is to add one or more new file elements to a file. Previously existing file elements are not affected. Details

on aspects peculiar to each of the various forms are presented below, under the headings of each statement type.

First, the channel to which the data will be sent is determined from the channel-expression. The file-attributes are checked against the intended operations. All data creation statements require an access-mode of OUTPUT or OUTIN. If the channel is active and the file-attributes are compatible with the data creation statement, then the next phase begins. Otherwise, an exception results and the file, the file pointer, and all program variables remain unchanged.

The second phase of processing involves setting the file pointer, based on the record-setter (or its absence). This is done exactly as described in 11.2. The data-found condition is now set, again as described in 11.2. If data-found is true and a not-missing-recovery is present, then the io-recovery-action is taken. If data-found is true, and a not-missing-recovery is absent, then an exception results. In either case, no further change is made to the pointer position or the file.

If data-found is false, then the third phase begins, the actual output of data at the location indicated by the pointer. The operands are evaluated in succession from left to right until enough data to fill a file-element has been generated. Only then is the file-element actually added to the file and the pointer advanced immediately beyond the file-element just created. In particular, this means that an exception during data transfer will never result in a partial file-element being added to the file. However, if a statement can create several file-elements, those which have already been created before the exception occurs continue to exist in the file. Following the completion of data transfer, the file pointer is always left pointing at the next file-element (or end of file if none such exists) beyond the last one created. If an exception prevented the creation of any file elements, the pointer is left as it was set in the second phase.

Print-statement

The transfer of data with the print-statement works just as described in 10.3 and 10.4, except that the sequence of characters generated constitutes a record of a DISPLAY file, rather than current line, and end-of-record is generated in place of end-of-line. Note that it is possible to create records containing zero characters. End-of-record is the implementation-defined means whereby it is indicated that the storage of a file-element in a file is completed, i.e., no change or addition to this record is possible with a data creation statement. Except for the special case discussed below, no data is actually added to the file until a valid end-of-record has been generated, i.e., partial records are not added to the file. The effective margin for the file, which is used to control when end-of-record is generated, is taken from the value of RECSIZE established when the file was opened, or from a set-statement with MARGIN for this channel executed since the open (see below).

In one special case, a partial record is added to a file. If the print-list or output-list contains a trailing print-separator, then upon successful completion of the statement, a partial record has been created at the end of file, with the pointer left at end of file, i.e. just beyond the partial record. Note that if there is an exception before completion of the statement, then the partial record is not added to the file, as would also be true of a complete record. If and only if the next operation for the channel is a print-statement with an absent record-setter, then the sequence of characters it generates is appended to the end of the partial record, in accordance with the usual rules regarding the margin. If the next operation for that channel is anything other than such a print-statement, then before any other processing takes place, an end-of-record is added to complete the partial record, and the pointer left at end of file.

Array-print-statement

The transfer of data with the array-print-statement works just as described in 10.5, except that the sequence of characters generated constitutes a record of a DISPLAY file, rather than the current line, and end-of-record is generated in place of end-of-line. Note that by the rules of 10.5, a partial record is never created by the array-print-statement with an array-print-list, but may be created with an array-output-list containing a trailing semicolon. Since an array-print-statement always starts a new line, it may not be used to complete a partial record. The effective margin is controlled as described under print-statement and "Setting the margin" (below).

Setting the margin

Associated with each open DISPLAY file is a margin, the maximum number of characters which a record can contain. The margin is used by print-statement and array-print-statement to determine when an end-of-record should be generated. Upon open, the effective margin is the LENGTH index in RECSIZE, or the implementation-defined length, which must be not less than the default zone width, if LENGTH is not specified explicitly. The set-statement with a MARGIN changes the margin for the active channel to the specified index. If a partial record exists in the file affected by the margin, the new margin is used when subsequently attempting to complete the partial record. A margin of MAXNUM indicates that a record may be arbitrarily large. The margin index must evaluate to greater than zero. The effect of a set-statement with MARGIN ends when the file is closed.

The maximum margin supported is implementation-defined.

Setting the zone width

Associated with each open DISPLAY file is a zone width, which controls the effect of PRINT as described in 10.3. Upon open, the zone width for a file is set to the implementation-defined default value, which shall be at least d+e+6. The set-statement with ZONEWIDTH changes the zone width for the active channel to the specified index.

All zones are the same width, except possibly the last, which may be shorter. If a partial record exists in the file affected by the set-statement with ZONEWIDTH, the new zone width is used when subsequently attempting to complete the partial record. In a set-statement with ZONEWIDTH the index must evaluate to greater than zero. The effect of the set-statement with ZONEWIDTH ends when the file is closed.

The maximum zone width is implementation-defined.

Display record-type

DISPLAY records are sequences of characters; the characters generated by the PRINT operations are as described in Section 10. The accuracy of numeric values is limited only by the implementation-defined significance-width or length of the format-item, and by the ARITHMETIC option in effect.

Channel zero

PRINT to channel zero works in accordance with the semantics for a device without record-setter or erase capability. The destination of the output data is the same as if the channel-expression had been omitted. Also, if there is an exception for which a different recovery procedure is specified in Section 10 than in 11, the procedure of Section 10 shall be used. A set-statement with MARGIN or ZONEWIDTH specifying channel zero has the same effect as if the channel-setter were omitted.

Write operation

The write-statement and array-write-statement are used to create records of any type. Successive expression values are arranged in corresponding sequences of values or fields or characters, and written out to the file. Partial records are never created.

File organization

For STREAM files, one statement may create several file-elements, specifically one file-element is created for each expression or array-element evaluated. If an exception occurs during internal evaluation, previously created values remain in the file, the pointer is left at end of file, and any remaining values are ignored.

For INTERNAL SEQUENTIAL or NATIVE files, the values or fields generated by the expressions or arrays form one record. Thus, if an exception occurs before the statement is completed, no record is added to the file, and the file pointer is left unchanged from phase two. NATIVE files apply only to BASIC-2.

BASIC-2 only

Since records in a KEYED file are identified by their keys, it is necessary when creating a new record that an explicit key be associated with it; thus when attempting to write to a KEYED file, an exact-search must always be specified in the record-setter. If data-found is false, then a new record is inserted into the file, with a key equal to the string-expression of the exact-search.

Display record-type

A WRITE operation type on a display record generates exactly the same sequence of records and characters as would a PRINT operation with the same expression-list or array-list. Note, however, that not all PRINT facilities are available for WRITE, which is record-oriented, rather than line-oriented.

For DISPLAY files, one statement may create several file-elements in the case of margin overflow. If a fatal exception occurs during generation of an element, any elements previously created by that statement remain in the file, the pointer is left at the end of the file, and any remaining expressions are ignored.

Internal record-type

An internal record (of a STREAM file) is a sequence of values. There are two types of values, numeric and string. The sequence of values and their types are determined by the sequence and types of the expressions and array-elements from which the values are generated. When a value stored in a file is later retrieved, the effect is as if the expression or array-element with which it was created were assigned to the input variable with a let-statement.The length and content of string values are preserved. Numeric values are also preserved consistent with the usual limitations on precision associated with the prevailing ARITHMETIC option.

Native record-type (BASIC-2 only)

The TEMPLATE describes the location, size, and type of fields within a record. When writing to a native file, a TEMPLATE must always be used. It must not be used with any other record-type. A TEMPLATE is associated with a particular data creation statement by means of the template-identifier in the statement which specifies the template-statement to be used or a string-expression whose value must be a syntactically correct template-element-list. The string-expression, is evaluated before the expression-list or array-list of the write-statement or array-write-statement. Several statements may use the same template-statement.

When generating data for a native record, each expression within the expression-list is associated with a numeric-specifier or string-specifier within a TEMPLATE; the specifier is then used to transform the value of the expression into a field within a

record. The association takes place from left to right within the expression-list and the templates-element-list, each expression using the next available field-specifier. If the type of the expression (numeric or string) disagrees with the type of the specifier, an exception results. The number of expressions must not be greater than the number of specifiers. Extra specifiers beyond the last expression are ignored. The contents of the field are determined by the value of the expression and the size characteristics of the specifier.

For string values, the string-field-size is the number of characters in the field. The string value is left-justified within the field. If the value's length exceeds that of the field, an exception results. If shorter, the field is padded on the right with spaces.

Numeric fields are used to retain numeric values (both magnitude and sign). The sign is always stored in the field, but the numeric-field-size explicitly describes only the storage of the number's magnitude. For a numeric-field-size of E, the value is retained with the implementation-defined number of significant digits for the prevailing ARITHMETIC option. For a fixed-point-size, the integer-size describes the number of available digit places to the left of the decimal point, and the fraction-size, to the right of the decimal point. An omitted integer-size or fraction-size is treated as equivalent to zero. The numeric value is stored in accordance with these sizes. If the value contains significant digits to the right of the available field positions, the value is rounded when stored. This may result in a field with a value of zero. If the value contains significant digits to the left of the available field positions, an exception results.

The fixed-field-count in a template-statement indicates skipping and/or repetition for individual specifiers or a series of specifiers. The integer of the fixed-field-count indicates the number of repetitions and the keyword SKIP indicates that the affected specifiers shall generate skipped fields. A field-count applies to the entity (either a field-specifier or a parenthesized template-element-list) in the same template-element. For an integer field-count (indicating repetition) the effect is just as if the entity governed by the field-count had been written out explicitly the equivalent number of times. When SKIP is used within a field-count, it indicates that the specifiers governed by it are not associated with values from the expression-list or array-list. Rather, as the record is being generated, fields within the record are assigned the value zero if numeric and spaces if string, corresponding to the usual size and type of the field-specifier in question. If a field-specifier is governed by several SKIPs (from various levels above it) the effect is just as if it were governed by only one, as described above. For example, given the following expression-lists and templates-element-lists,

```
A, B, C and NUMERIC*4, NUMERIC*5, NUMERIC*6
D, E    and NUMERIC*4, SKIP NUMERIC*5, NUMERIC*6
```

A and D will occupy equivalent field locations, as will C and E. The second field in the second record will be the same size as occupied by B in the first record, with a value of zero.

As an illustration of the preceding description, equivalent pairs of template-element-lists are shown below:

```
1 - STRING*4, STRING*4, STRING*4
2 - 3 OF STRING*4

1 - STRING*5, STRING*4, NUMERIC*2, NUMERIC*2, NUMERIC*2, STRING*4, NUMERIC*2,
    NUMERIC*2, NUMERIC*2
2 - STRING*5, 2 OF (STRING*4, 3 OF NUMERIC*2)
```

1 - SKIP NUMERIC*3, SKIP NUMERIC*3, NUMERIC*4, SKIP STRING*5, SKIP STRING*6
2 - SKIP 2 OF NUMERIC*3, NUMERIC*4, SKIP (STRING*5, SKIP STRING*6)

Note that in 2 of the last example, the SKIP immediately in front of STRING*6 is superfluous. A variable-field-count is used only in conjunction with arrays (see below).

If execution reaches a template-statement, it proceeds to the next line with no further effect.

Array-write-statement

An array-write-statement behaves just like the write-statement would if the arrays were written out explicitly as array-elements in row major order (the last subscript varying most rapidly). Thus, for example, if "DIMA (3), B(2,2)" and OPTION BASE 1 are in effect, the following two statements are equivalent:

```
MAT WRITE #3: A, B
WRITE #3: A(1),A(2),A(3), B(1,1),B(1,2),B(2,1),B(2,2)
```

X.7

BASIC-2 only

When writing to a NATIVE record, arrays in an array-list can use the variable-field-count. If a fixed-field-count is used, then the number and type of the specifiers must match the array-elements as with WRITE. When the first element of an array is to be associated with a field-specifier, and if a template-element has just been completed (or if this is the first array in the list), and if the next template-element has a variable-field-count, then the field-specifier is used for all the elements of the array. When evaluation of the array is complete, the next array, if any, uses the next template-element which may or may not also have a variable-field-count. An array must use either a template-element with a variable-field-count or template-elements with fixed-field-counts, but not both.

11.3.5 Exceptions

- The value of the index in a set-statement with MARGIN is less than the current zonewidth for that file (4006, fatal).
- The value of the index in a set-statement with a ZONEWIDTH is less than one, or greater than the current margin for that file (4007, fatal).
- A set-statement with MARGIN or ZONEWIDTH specifies an inactive channel (7004, fatal).
- A set-statement with MARGIN or ZONEWIDTH specifies a file not opened as DISPLAY (7312, fatal).
- A set-statement with a MARGIN or ZONEWIDTH specifies a file opened as INPUT (7313, fatal).

The following exceptions for data creation statements are grouped according to the phase of processing during which they are detected. Phase 1 exceptions imply no change to the file or file pointer. Phase 2 exceptions imply no change to the file. Phase 3 exceptions imply that some file-elements may have been created.

Phase 1 Exceptions:

- A data creation statement attempts to access an inactive channel (7004, fatal).
- A print-statement or array-print-statement attempts to access a file opened as INTERNAL or, for BASIC-2 only, NATIVE (7317, fatal).

- The record-setter cannot be processed correctly, as described in 11.2.5, exceptions 7002 and 7202-7207 (use the procedure of 11.2.5).
- A data creation statement attempts to access a file opened as INPUT (7302, fatal).
- A write-statement or array-write-statement attempts to access a KEYED file, but does not specify an exact-search in its record-setter (7314, fatal). (BASIC-2 only)
- The string-expression of a template-identifier is not a syntactically correct template-element-list (8251, fatal). (BASIC-2 only)
- A template-identifier is used on a file opened as DISPLAY or INTERNAL (7315, fatal). (BASIC-2 only)
- A write-statement or array-write-statement does not have a template-identifier when attempting to access a file opened as NATIVE (7316, fatal). (BASIC-2 only)

Phase 2 Exceptions:

- For a data creation statement, the condition data-found is true, and a not-missing-recovery has not been specified (7308, fatal).

Phase 3 Exceptions:

- An attempt is made to create a record larger than the value of RECSIZE (8301, fatal).
- An expression or array-element does not agree in type (numeric or string) with its associated TEMPLATE field-specifier (8252, fatal). (BASIC-2 only)
- A template-element with a variable-field-count does not coincide with the first element of an array (8253, fatal). (BASIC-2 only)
- There are not enough field-specifiers in a template-statement for all the expressions or array-elements (8254, fatal). (BASIC-2 only)
- A numeric value has significant digits to the left of the available digit places in the field of a template (8255, fatal). (BASIC-2 only)
- A string value is longer than the length of its field in the template (8256, fatal). (BASIC-2 only)

11.3.6 Remarks (BASIC-2 only)

Implementations may provide syntactic enhancements to template-element-list, e.g., to allow for additional data types. The exception for incorrect syntax then applies to the enhanced definition of template-element-list.

The variable-field-count is especially useful when writing an array whose size may change in the program, since the use of the fixed-field-count implies knowing the exact size in advance.

11.4 File Data Retrieval

11.4.1 General Description

Statements are provided to allow the program to retrieve data from a file to which it has previously been written or from a device. The facilities generalize the input capabilities presented in Section 10 to files. New facilities are also defined to allow input from the various record-types.

11.4.2 Syntax

BASIC-1 and BASIC-2

```
 1. input-statement            > INPUT channel-expression input-control colon
                                 variable-list (comma SKIP REST)?
 2. array-input-statement      > MAT INPUT channel-expression input-control colon
                                 (redim-array-list / variable-length-vector)
 3. line-input-statement       > LINE INPUT channel-expression input-control colon
                                 string-variable-list
 4. array-line-input-statement> MAT LINE INPUT channel-expression input-control colon
                                 redim-string-array-list
 5. input-control              = (comma input-control-item)*
 6. input-control-item         = core-record-setter / missing-recovery /
                                 prompt-specifier / timeout-expression /
                                 time-inquiry
 7. read-statement             > READ channel-expression read-control colon
                                 variable-list (comma SKIP REST)?
 8. array-read-statement       > MAT READ channel-expression read-control colon
                                 redim-array-list
 9. read-control               = (comma read-control-item)*
10. read-control-item          > record-setter / missing-recovery
```

BASIC-2 only (Enhanced Files productions):

```
N11. read-control-item         > template-identifier
```

A given input-control-item must appear at most once in input-control. (BASIC-2 only)

A given read-control-item must appear at most once in read-control. (BASIC-2 only)

A variable-length-vector must be declared as one-dimensional. (BASIC-2 only)

11.4.3 Examples

```
1. INPUT #3: A, B, C, A$
2. MAT INPUT #W, BEGIN, IF MISSING THEN EXIT DO: A, B$
3. LINE INPUT #G, NEXT: A$, B$, C$
   MAT LINE INPUT #4, IF MISSING THEN 1234: A$, B$(N), C$(8)
4. MAT LINE INPUT #4, IF MISSING THEN 1234: A$, B$(N), C$(8)
7. READ #3, SAME, WITH 333: W$, SKIP REST
8. MAT READ #N, RECORD W+2, IF MISSING THEN 111, WITH 222: N, W(Q)
```

11.4.4. Semantics

All data retrieval statements follow a general pattern, which will be described here. Details on the aspects peculiar to each of the various forms are presented below, under the headings for each statement type.

First, the channel from which data will be retrieved is determined from the channel-expression. Then, the file-attributes are checked against the intended operation. All data retrieval statements require an access-mode of INPUT or OUTIN. If the channel is active and the file-attributes are compatible with the data retrieval statement, then the next phase begins. Otherwise, an exception results and the pointer and all program variables remain unchanged.

The second phase of processing involves setting the file pointer, based on the record-setter if present. In the absence of a record-setter the file pointer does not change. This is done exactly as described in 11.2. The data-found condition is now set, again as described in 11.2. If data-found is false and a missing-recovery is present, then the io-recovery-action is taken, otherwise an exception results. In either case, no further change is made to the pointer position.

If data-found is true, then the third phase begins, the actual input of data from the element indicated by the pointer. Data is transferred from the file element(s) to each of the operands (variables or arrays), from left to right, with successive data or values or fields from the file being assigned to successive variables or arrays. Note in particular that evaluation of subscripts, substring-qualifiers, and redims is delayed until after assignment of data to previous operands, but occurs before assignment of data to the operand to which they apply. Note also that assignment of a string value to a string variable with a substring-qualifier takes place in accordance with the usual semantics of string assignment described in 6.5. If an exception occurs during data transfer, variables and array-elements for which a legal assignment has been made retain their new values, but all subsequent variables and array-elements retain their original values. Following a successful data retrieval operation, the pointer is advanced to the next file element, i.e., the next record, record-area, or value in the file.

One data retrieval operation usually affects only one file element. The three cases in which several file elements may be processed are:

- LINE or MAT LINE INPUT,
- READ from a STREAM file, and
- INPUT or READ from a DISPLAY file with records with trailing commas (indicating continuation of data).

The SKIP REST option is allowed only for non-stream files. It causes the remainder of the record from which the last datum or value or field was taken to be ignored. It is still mandatory that the record contain enough data to satisfy the variables or arrays in the list.

During this third phase of processing, a number of exception conditions may arise. Each such exception is associated with a particular file element. In all cases, the pointer is advanced to the file element immediately following the one with which the exception is associated. The following table summarizes these exceptions and which file-element they apply to.

Exception	Associated file-element
File-element larger than RECSIZE	The oversize file-element
Invalid redim, subscript, substring-qualifier, redim too large.	The file-element from which data would have been taken
Bad TEMPLATE: wrong type, field-count of "?" on other than first element of an array, too few specifiers (BASIC-2 only)	The file-element from which data would have been taken
Bad data: wrong type,syntax, overflow	File-element containing the bad data
Insufficient data in file-element	The file-element with insufficient data
Insufficient data in file	End of file (i.e. no associated file-element)
Excess data in file-element	The file-element with excess data

Input-statement

The effect of a prompt-specifier, timeout-expression, and time-enquiry is as described in 10.2. These input-control-items apply only to interactive terminal devices. For other devices and true files, their effect is implementation-defined. The transfer of data with the input-statement also works just as described in 10.2, except that records are treated like input-replies, and end-of-record is treated like end-of-line. Each datum (as defined in 10.1) is assigned in order to a variable in the variable-list. All the INPUT operations (as opposed to the READ operations) are valid only for a file opened as DISPLAY. For any other record-type, an exception results. The input-statement may process several records if the last non-blank character in a record is a comma. If, following a record with a trailing comma, end of file is encountered before all variables have been assigned values, then the remaining variables shall retain their old values, the file pointer shall be positioned to end of file, and an exception shall result.

When any of the INPUT statements is executed for a device and a phase 3 exception occurs, implementations may use the recovery procedures specified for true files in this section, or, if an equivalent exception is specified in Section 10, that recovery procedure may be used instead. This is to allow input from several interactive devices to use the nonfatal recovery procedures.

Array-input-statement

The array-input-statement behaves just like the input-statement would if the arrays were written out explicitly as array-elements in row major order (the last subscript varying most rapidly). The only additional capability is that of allowing a redim to change the dimensions of the array in accordance with the redim rules for the array-input-statement without a channel-expression (see 10.5). Thus, for example, if "DIM A(3)" and OPTION BASE 1 are in effect, the following two statements are equivalent:

```
MAT INPUT #N: A
INPUT #N: A(1), A(2), A(3)
```

The following two statements are also equivalent:

```
MAT INPUT #N: A$(2,2), C(2)
INPUT #N: A$(1,1), A$(1,2), A$(2,1), A$(2,2), C(1), C(2)
```

However, the effect of

```
MAT INPUT #N: A(1), B(A(1))
```

depends on the first datum encountered, since it controls the effective size of array B. Nonetheless, it behaves exactly as would an input-statement for which the appropriate number of array-elements for B had been coded. If an array is encountered whose redim yields a size less than 1 in any dimension, then it, and all subsequent arrays, shall retain their old values, and an exception shall result.

Variable-length-vectors

The transfer of data and consequent redimensioning of the array of a variable-length-vector takes place just as described in 10.5.

Line-input-statement

The line-input-statement behaves exactly as described in 10.2, except that records are treated like input-replies, and end-of-record like end-of-line. The content of each successive record is assigned as the value of successive string-variables, including any leading or trailing spaces. A record may contain a null string, and it

shall be assigned in the normal way. If end of file is encountered before all variables have been assigned values, then the remaining variables shall retain their old values, the file pointer shall be positioned to end of file, and an exception shall result.

Array-line-input-statement

The array-line-input-statement behaves just as would a line-input statement for which the array-elements had been coded out explicitly, instead of as arrays. See semantics above for array-input-statements. Note that here too, the size of a later array may depend on the value assigned to an earlier array, e.g.:

```
MAT LINE INPUT #N: A$(1), B$(VAL(A$(1)))
```

If the first record contained the string " 12 ", then twelve subsequent records would be read into the array B$. If an array is encountered whose redim yields a size less than 1 in either dimension, then it, and all subsequent arrays, shall retain their old values, and an exception results.

Input-statements for channel zero

Input from channel zero works in accordance with the semantics for non-file devices. For those exceptions for which a different recovery procedure is specified in Section 10 than in 11, the procedure of Section 10 shall be used.

Read-operation

The read-statement and array-read-statement are used to retrieve data from files with records of any type. Successive data or values or fields are assigned to successive variables or arrays in the operand list. READ may access several file elements for SEQUENTIAL or STREAM files, but only one for RELATIVE and KEYED files. RELATIVE or KEYED files are provided only in BASIC-2.

File organizations

For non-STREAM files (SEQUENTIAL files in BASIC-1 and RELATIVE and KEYED files in BASIC-2), the variables receive values from the sequence of data or values or fields within a record. There must be just enough data within the record (or records in the case of DISPLAY records with trailing commas) to satisfy the variable-list (except for SKIP REST, see above). For STREAM files, the variables receive their values directly from the sequence that constitutes the file, beginning with the file-element indicated by the pointer, and so file-element boundaries are insignificant. If end of file is encountered before all variables have been assigned values, then the remaining variables shall retain their old values, the file pointer shall be positioned to end of file, and an exception shall result.

Display record-type

Records in DISPLAY files are sequences of characters. The retrieval of string data shall take place as described in 10.2. Note that retrieving data from a record created with PRINT does not necessarily preserve the same value, since, for instance, leading and trailing spaces are not saved in unquoted strings n input. For numeric data, the accuracy shall be consistent with the usual semantics for assignment of a numeric-constant to a numeric-variable, i.e. at least six significant digits for OPTION ARITHMETIC NATIVE and at least ten digits for OPTION ARITHMETIC DECIMAL. For a numeric-constant with no more significant digits than the implementation-defined precision, the exact value is assigned with OPTION ARITHMETIC DECIMAL.

A READ operation on a DISPLAY record assigns values exactly as would an INPUT operation with the same variable-list or redim-array-list. Note, however, that not all the INPUT facilities are available for READ, which is record-oriented.

Internal record-type

An internal record (and a stream file) is a sequence of values. There are two types of value, numeric and string. For INTERNAL file elements, the values must be retrieved with a variable of the same type as that of the value, otherwise an exception results. Thus, the contents of an INTERNAL file element are self-typed. The sequence of values and their types are determined by the record operation which created or modified the file-element(s). When a value is retrieved, the effect is as if the expression with which it was created were assigned to the input variable with a let-statement. The length and content of string values are preserved. Numeric values are also preserved, consistent with the usual limitations on precision and type associated with the prevailing ARITHMETIC option.

Native record-type (BASIC-2 only)

The TEMPLATE describes the location and type of fields within the record. When reading from a native record, a TEMPLATE must always be used. It must not be used with any other record-type. A TEMPLATE is associated with a particular data retrieval statement by means of the template-identifier in the statement, which specifies the template-statement to be used, or a string-expression whose value must be a syntactically correct template-element-list. The string-expression is evaluated before any input takes place and before any redims, substring qualifiers, or subscripts are evaluated. Several statements may use the same template-statement.

When retrieving data from a native record, each variable within the variable-list is associated with a field-specifier within a template; the specifier is then used to return data from a field within a record. This association takes place from left to right, within the variable-list and template-element-list, each variable using the next available field-specifier. A variable is associated with a specifier after a value has been assigned to the previous variable, and any subscripts, substring-qualifiers, or redims for this variable have been evaluated. If the type of the variable (numeric or string) disagrees with the type of the specifier, an exception results. The number of specifiers must not be less than the number of variables. Extra specifiers beyond the variables are ignored. The contents of the next field in the record is interpreted according to the specifier, and the resulting value placed in the variable.

When retrieving data, the specifiers of all fields within a record must be compatible with the specifiers with which they were created, otherwise the results are implementation-defined. In order to be compatible, the creating and retrieving specifiers for a field must both be of type STRING, with equal string-field-sizes, or both NUMERIC with a numeric-field-size of E, or both NUMERIC with equal integer-sizes and fraction-sizes. An omitted integer-size or fraction-size is treated as equivalent to zero.

When the TEMPLATE specifiers are compatible with the record, then the values are retrieved in accordance with the field sizes. For strings, a value is assigned with length equal to the string-field-size, and contents as originally stored in the record, including any spaces used for padding. For numbers, a value is assigned whose accuracy is limited only by the numeric-field-size and ARITHMETIC option. For numbers stored with a field size of E, or with a fixed-point-size and with no more significant digits than the implementation-defined precision, the exact value is retained under OPTION ARITHMETIC DECIMAL. Otherwise, the numbers are rounded according to the OPTION in effect and stored in the variable. Section 11.3.4 describes how values are stored in the fields of native records an the effect of field-counts. The only difference upon retrieval is that SKIP specifiers do not generate fields of zero or spaces, but cause the affected fields simply to be skipped over. As before, such specifiers are not associated with variables.

Array-read-statement

In general, an array-read-statement behaves just like the read-statement would if the arrays were written out explicitly as array-elements. As with INPUT, there is delayed evaluation of redims.

BASIC-2 only

For this reason, when reading from a native record, a variable-field-count is provided. If a fixed-field-count is used, then the number and types of the specifiers must match the array-elements, as with READ. When the first element of an array is to be associated with the next specifier, however, and if a template-element has just been completed (or if this is the first array in the list), and the next template-element is a variable-field-count, then the associated specifier is used for all the elements of the array. When the array has been filled, the next array, if any, uses the next template-element, which may or may not also have a variable-field-count. An array must either use a template-element with a variable-field-count or template-elements with fixed-field-counts, but not both.

11.4.5 Exceptions

The exceptions are grouped according to the phase of processing during which they are detected. Phase 1 exceptions imply no change to the file pointer or variables. Phase 2 exceptions imply no change to the variables. Phase 3 exceptions imply that some variables may have received values from the file.

Phase 1 Exceptions:

- A data retrieval attempts to access an inactive channel (7004, fatal).
- An input-statement, array-input-statement, line-input-statement, or array-line-input-statement attempts to access a file opened as INTERNAL or, in BASIC-2 only, NATIVE (7318, fatal).
- The record-setter cannot be processed correctly, as described in 11.2.5, exceptions 7002 and 7202-7207 (use the procedure of 11.2.5).
- A data retrieval statement attempts to access a file opened as OUTPUT (7303, fatal).
- The string-expression of a template-identifier is not a syntactically correct template-element-list (8251, fatal). (BASIC-2 only)
- A template-identifier is used on a file opened as DISPLAY or INTERNAL (7315, fatal). (BASIC-2 only)
- A read-statement or array-read-statement does not have a template-identifier when attempting to access a file opened as NATIVE (7316, fatal). (BASIC-2 only)
- The SKIP REST option is used on a file opened as STREAM (7321, fatal).

Phase 2 Exceptions:

- For a data retrieval statement, the condition data-found is false and a missing-recovery has not been specified (7305, fatal).

Phase 3 Exceptions:

- An attempt is made to access a record larger than the value of RECSIZE (8302, fatal).
- The first index in a redim-bounds is greater than the second (6005, fatal).
- A single index used in redim bounds is less than the default lower bound in effect for the program unit (6005, fatal).

- The total number of elements required for a redimensioned array exceeds the number of elements reserved by the array's original dimensions (5001, fatal).
- A variable or array-element does not agree in type (numeric or string) with its associated TEMPLATE specifier (8252, fatal). (BASIC-2 only)
- A variable-field-count in a template-element does not coincide with the first element of an array (8253, fatal). (BASIC-2 only)
- There are not enough TEMPLATE specifiers for all the variables or array-elements (8254, fatal). (BASIC-2 only)
- A data retrieval statement, other than a line-input-statement or an array-line-input-statement, attempts to access a DISPLAY record that is not a syntactically legal input-reply (8105, fatal).
- The datum of a DISPLAY record to be assigned to a numeric variable is not a numeric-constant (8101, fatal).
- A value in an INTERNAL record does not agree in type (numeric or string) with the variable to which it is to be assigned (8120, fatal).
- A value, datum, or field (for BASIC-2 only) in a file causes numeric overflow upon assignment to the variable (1008, fatal).
- A value, datum, or field (for BASIC-2 only) in a file causes string overflow upon assignment to a variable (1105, fatal).
- There are not enough data, values, or fields (for BASIC-2 only) within a record of a non-STREAM file for the operands of a data retrieval statement and the record is not DISPLAY with a trailing comma (8012, fatal).
- End of file is encountered while seeking further data for the operands of a data of a data retrieval statement (8011, fatal).
- There are too many data in a record for the operands of a data retrieval statement and SKIP REST is not specified (8013, fatal).
- There is just enough data in a DISPLAY record with a trailing comma to satisfy a request for input, and SKIP REST is not specified (8013, fatal).

11.4.6 Remarks

Implementations may choose to treat underflows as exceptions (1508, nonfatal: supply zero and continue). In BASIC-2, this permits interception by exception handlers.

11.5 File Data Modification (BASIC-2 only)

11.5.1 General Description

Statements are provided to allow the user to modify data previously stored in a file. Such data can either be changed or deleted. The modifications are always done at the record level.

11.5.2 Syntax

Core productions :
None.

BASIC-2 only (Enhanced Files productions):

```
 1. imperative-statement      > rewrite-statement / array-rewrite-statement /
                                delete-statement
 2. rewrite-statement         = REWRITE channel-expression rewrite-control colon
                                expression-list
 3. array-rewrite-statement   = MAT REWRITE channel-expression rewrite-control colon
                                array-list
 4. rewrite-control           = (comma rewrite-control-item)*
 5. rewrite-control-item      > missing-recovery / record-setter
 6. delete-statement          = DELETE channel-expression delete-control
 7. delete-control            = (comma delete-control-item)*
 8. delete-control-item       = missing-recovery / record-setter
N9. rewrite-control-item      > template-identifier
```

The line-number of a template-identifier must refer to a template-statement in the same program-unit.

A given rewrite-control-item must appear at most once in rewrite-control.

A given delete-control-item must appear at most once in delete-control.

11.5.3 Examples

```
2. REWRITE #N, KEY = B$, IF MISSING THEN 666: A,B,C$
3. MAT REWRITE #3, RECORD N-1, WITH 111: X,Y,Z
6. DELETE #3, KEY "JONES"
```

11.5.4 Semantics

The data modification statements are modeled closely on certain aspects of data retrieval statements and data creation statements. Like the data retrieval statements, they operate on existing records. Like the data creation statements, they can alter the state of a file. The data modification statements are specified only for file-organizations RELATIVE and KEYED. For other file-organizations, their effect is implementation-defined. The data modification statements may be used only with access-mode OUTIN. Except for access-mode, the first and second phase of processing (i.e. checking of file attributes and setting the file pointer) for these statements is exactly like that for the data retrieval statements (see 11.4.4), because they operate on existing records. The third phase of processing, undertaken only if the operation is legal, the file pointer successfully set, and data-found is true, is described below under the individual headings.

Rewrite-statement

The rewrite-statement generates exactly one record, and that record is identical to the one that would be generated by a write-statement with the same expression-list or array-list and template-identifier, if any (see 11.3.4), with one exception : for a NATIVE record, fields governed by SKIP are not filled with zero or spaces, but rather the previous contents of the fields are left unchanged. This effect of SKIP occurs only if the TEMPLATE used by the REWRITE is compatible with TEMPLATE last used to alter the record (see 11.4.4 for the definition of "compatible"). The result of using an incompatible TEMPLATE containing SKIP is implementation-defined. The use of an incompatible TEMPLATE without SKIP is defined above since the entire record is replaced.

If no exceptions occur during the generation of data to be used for modification of existing data, then the record pointed to by the file pointer is replaced by the record just generated, and the file pointer advanced to the next file-element. This

implies that the identifying record-number in a RELATIVE file, or identifying key in a KEYED file is not changed. If there is an exception, the pointer is left as it was set in the second phase (see 11.3.4 and 11.4.4) and the data in the file is unchanged.

Array-rewrite-statement

An array-rewrite-statement behaves just like rewrite-statement would if the array-elements were written out explicitly. The rules for matching arrays and specifiers in a TEMPLATE are exactly the same as for the array-write-statement (see 11.3.4).

Delete-statement

The delete-statement causes the record indicated by the file pointer to be deleted, and the file pointer advanced to the next file-element. This implies that for a RELATIVE file, the affected record-area no longer contains a record, and for a KEYED file, the affected record is eliminated from the sequence of records constituting the file.

11.5.5 Exceptions

The following exceptions are grouped according to the phase of processing during which they are detected. Phase 1 exceptions imply no change to the file or file pointer. Phase 2 exceptions imply no change to the file. Phase 3 exceptions also imply no change to the file.

Phase 1 Exceptions:

- A data modification statement attempts to access an inactive channel (7004, fatal).
- A data modification statement attempts to access channel zero (7320, fatal).
- The record-setter cannot be processed correctly, as described in 11.2.5, exceptions 7002 and 7202-7207 (use the procedure of 11.2.5).
- A data modification statement attempts to access a file opened as INPUT or as OUTPUT (7322, fatal).
- The string-expression of a template-identifier is not a syntactically correct template-element-list (8251, fatal).
- A template-identifier is used on a file opened as INTERNAL or DISPLAY (7315, fatal).
- A rewrite-statement or array-rewrite-statement does not have a template-identifier when attempting to access a file opened as NATIVE (7316, fatal).

Phase 2 Exceptions:

- For a data modification statement, the condition data-found is false, and a missing-recovery has not been specified (7305, fatal).

Phase 3 Exceptions:

- An attempt is made to rewrite a record larger than the value of RECSIZE (8301, fatal).
- An expression or array-element does not agree in type (numeric or string) with its associated TEMPLATE specifier (8252, fatal).
- A template-element with a variable-field-count does not coincide with the first element of an array (8253, fatal).

- There are not enough TEMPLATE specifiers for all the expressions or array-elements (8254, fatal).
- A numeric value has significant digits to the left of the available digit places in the field of a template (8255, fatal).
- A string value is longer than the length of its field in the template (8256, fatal)

11.5.6 Remarks

Note that the DELETE and REWRITE will affect the record indicated by the file pointer, even if the pointer is set with NEXT or left as is from previous operation (i.e. if the record-setter is absent).

12. EXCEPTION HANDLING AND DEBUGGING

12. EXCEPTION HANDLING AND DEBUGGING

12.1 Exception Handling (BASIC-2 only)

12.1.1 General Description

Exception handling facilities provide a means of regaining control of a program after an exception has occurred.

12.1.2 Syntax

BASIC-2 only

```
 1. protection-block          = when-use-block / when-use-name-block
 2. when-use-block            = when-line when-block use-line exception-handler
                                end-when-line
 3. when-line                 = line-number WHEN EXCEPTION IN tail
 4. when-block                = block*
 5. use-line                  = line-number USE tail
 6. exception-handler         = block*
 7. end-when-line             = line-number END WHEN tail
 8. when-use-name-block       = when-use-name-line when-block end-when-line
 9. when-use-name-line        = line-number WHEN EXCEPTION USE handler-name tail
10. handler-name              = routine-identifier
11. handler-return-statement  = RETRY / CONTINUE
12. exit-handler-statement    = EXIT HANDLER
13. cause-statement           = CAUSE EXCEPTION exception-type
14. exception-type            = index
15. detached-handler          = handler-line exception-handler end-handler-line
16. handler-line              = line-number HANDLER handler-name tail
17. end-handler-line          = line-number END HANDLER tail
18. numeric-supplied-function > EXLINE / EXTYPE
19. string-supplied-function  > EXTEXT dollar-sign
```

Handler-return-statements and exit-handler-statements shall only occur within exception-handlers. The no-argument numeric-supplied-functions EXLINE and EXTYPE shall be invoked only within exception-handlers. EXTEXT$ takes a single numeric argument, which is an index.

No line-number in a control-transfer outside a protection-block shall refer to a line in that protection-block other than its when-line or when-use-name-line. No line-number in a control-transfer inside an exception-handler shall refer to a line outside that exception-handler other than its own end-handler-line or end-when-line, nor shall a line-number in a control-transfer outside an exception-handler refer to a line inside that exception-handler or to its end-handler-line or end-when-line.

A detached-handler referred to in a when-use-name-line within an internal-proc-def must be defined in the same internal-proc-def. A detached-handler referred to in a when-use-name-line that is not within an internal-proc-def must be defined in the same program-unit but not within an internal-proc-def. No two handler-lines in the same program unit shall have the same handler-name. A detached-handler may not appear within a protection-block.

A protection-block may not appear within an exception-handler.

12.1.3 Examples

Example 1 : handling errors in input-replies by allowing the input-reply to be resupplied after issuing a suitable message

```
100 WHEN EXCEPTION IN
110         PRINT "Enter your age and weight"
```

```
120         INPUT a, w
130         IF a > 10 THEN
140              PRINT "What is your height"
150              INPUT h
160        END IF
170 USE
180        PRINT "Please enter numbers only"
190        RETRY
200 END WHEN
```

Example 2 : dynamic file opening

```
100 HANDLER file_trouble
110        LET file_ok$ = "false"
120        IF EXTYPE = 7107 THEN
130              LET message$ = "doesn't exist"
140        ELSEIF EXTYPE = 7102 THEN
150              LET message$ = "is the wrong type"
160        ELSE
170              LET message$ = "couldn't be used"
180        END IF
190        PRINT "file"; filename$; message$; "try again"
200 END HANDLER

500 DO
510        INPUT filename$
520        LET file_ok$ = "true"
530        WHEN EXCEPTION USE file-trouble
540          OPEN #n: NAME filename$ ! other parameters omitted
550        END WHEN
560 LOOP UNTIL file_ok$ = "true"
```

Example 3: Nested handlers

```
100 WHEN EXCEPTION IN
110        DO
120           READ #1, IF MISSING THEN EXIT DO: A
130           LET I = I+1    ! I initialized outside loop
140           WHEN EXCEPTION IN
150              LET B(I) = 1000*A*A
160           USE
170              ! Assume it is numeric overflow
180              LET B(I) = MAXNUM
190              CONTINUE
200           END WHEN
210        LOOP

220 USE
230        IF EXTYPE = 8101 THEN    ! non-numeric data
240           RETRY                 ! get next data item
250        ELSE                     ! give up
260           PRINT "Unable to process file"
270           STOP
280        END IF
290 END WHEN
```

13. CAUSE EXCEPTION I

12.1.4 Semantics

When an exception occurs during the execution of a program-unit, the action taken shall depend upon whether or not the exception occurs within a when-block. If the exception occurs outside a when-block, then the default exception handling procedures specified in this Standard shall be applied (see 2.4). If the exception occurs within a when-block, then the default exception handling procedures, which require that an exception be reported, shall not be applied; instead, control shall be transferred to the exception-handler associated with the inner-most protection-block within which the exception occurred.

When the protection-block is a when-use-block, the associated exception-handler is that which follows the use-line of the protection-block. When the protection-block is a when-use-name-block, the associated exception-handler is the detached-handler named in the when-use-name-line of the protection-block. In all respects, a detached-handler behaves semantically as though it were an exception-handler in the when-use-block of the when-block with the exception.

Within an exception-handler, the type of the exception which caused that handler to be executed shall be obtainable as the value of the parameterless function EXTYPE. The values of EXTYPE for all exceptions defined in this Standard are specified in Table 2, along with the description of each exception in this Standard. The line-number of the line whose execution caused the exception shall be obtainable as the value of the parameterless function EXLINE.

There are four means of exiting from an exception-handler.

- Execution of the handler-return-statement CONTINUE shall cause control to be transferred to the statement lexically following that which caused the exception. If the exception occurred in a line which begins or is part of a structure (such as a do-line, loop-line, for-line, if-then-line, elseif-then-line, select-line, or case-line), then control shall be transferred to the statement lexically following the entire structure of which the line is a part.
- Execution of the handler-return-statement RETRY shall cause control to be transferred to the statement or line which caused the exception, causing the statement or line to be re-executed; if that statement was performing data retrieval, then the previous input-reply or line-input-reply shall be discarded and a new one requested.
- If control reaches an end-when-line which terminates an exception-handler or reaches an end-handler-line, then control shall be transferred to the line following the end-when-line of the protection-block within which the exception occurred with no further effect.
- Execution of an exit-handler-statement shall cause the exception to be propagated to the lexical environment surrounding the innermost protection-block containing the exception (also note the effect of calls and function invocations - see below); i.e. the effect on handling the exception is as if the exception-handler did not exist (except for the effect of any statements already executed in the handler), and the rules for handling the original exception depend upon whether or not the exception occurs within some outer when-block.

If execution reaches a use-line in a when-use-block, or an end-when-line in a when-use-name-block, then control shall be transferred to the line following the protection-block of which the use-line or end-when-line is a part. If execution reaches an end-handler-line of a detached-handler, control shall continue at the line following the end-when-line of the when-use-name-block causing the exception. If execution reaches a handler-line of a detached-handler other than by the occurrence of an exception, control shall then continue at the line immediately following the end-handler-line.

A separate GOSUB stack is associated with each exception-handler (see 8.2) so RETURN never attempts to transfer control into or out of an exception handler.

Execution of a cause-statement shall result in the occurrence of a fatal exception and the setting of EXTYPE to the rounded value of the exception-type.

If an exception is caused by a statement lexically within an exception-handler, then this new exception shall be handled by the default exception-handling procedures.

If a fatal exception occurs in a procedure-part or internal-proc-def and either:

- the line causing the fatal exception is not contained in a when-block and therefore no exception-handler is entered, or
- an exception-handler is entered, an exit-handler-statement is executed with the handler, and there is no lexically surrounding when-block to intercept the exception,

then the fatal exception shall be propagated back to the line that invoked the procedure-part or internal-proc-def. This propagation shall continue to occur until either:

- a user-defined exception-handler resolves the exception by execution of a handler-return-statement o by causing control to pass to an end-handler-line or to an end-when-line which terminates the exception-handler, or
- the main program or a parallel-section is reached, in which case the default exception-handling procedures are applied.

If an exception-handler is invoked as a result of this process, then the value returned by the EXTYPE function shall be 100000 plus the value that would have been returned by EXTYPE in the procedure-part or integral-proc-def in which the exception originally occurred. The value of EXLINE shall be the line-number of the most recent line to which the exception was propagated, i.e., the line lexically within the when-block associated with the exception-handler, not the line of the original exception.

The default exception-handling procedures shall always report the EXTYPE and EXLINE of the original exception.

The value of EXTYPE for exceptions defined by local enhancements to this Standard shall be negative. When negative values of EXTYPE are propagated, the value shall be -100000 plus the value that would have been returned by EXTYPE for the original exception.

Values of EXTYPE from 1 to 999 will not be used by future enhancements to this Standard, nor shall they be used by local enhancements to this Standard.

The value of EXTEXT$ shall be the text part of the error message provided by the system for the exception number obtained by rounding its argument to an integer. If its argument is not the exception number of a standard system exception, the value of EXTEXT$ shall be the null string.

If the main-program is reached and no exception-handler is invoked there as a result of the original exception, then the exception shall be handled by the default exception handling procedures specified in this Standard.

12.1.5 Exceptions

A cause-statement is executed (exception-type, fatal).

12.1.6 Remarks

Users should note that there are two kinds of exception propagation specified in this section. First, there is "lexical" propagation, outward to surrounding protection-blocks within a program-unit or internal-proc-def. If this process propagates the exception outside of any such protection-block, "invocation" propagation takes effect, passing the exception back to invoking statements.

The function EXLINE should be used with caution, as the use of editing facilities which renumber lines in a program (see 16.2) may invalidate computations involving EXLINE. For example, the program fragment

```
1000 SELECT CASE INT(EXLINE/100)
1010 CASE 1, 2
     ...
1100 CASE 3 TO 7
     ...
```

would probably behave differently if lines 100 through 800 were renumbered.

When a fatal exception is propagated back to invoking statements and the default exception-handling procedure is applied as a result, only the original exception's EXTYPE and EXLINE must be reported. Implementations may, however, also report the line-numbers of the lines through which the exception was propagated, or any other information deemed useful.

It is not possible to pass a nonfatal exception back to a calling routine since it will be handled either by an exception-handler in the called routine or by the system handler. An exception handler may, however, cause a fatal exception with a cause-statement.

The cause-statement is not intended actually to simulate any given exception, but rather to raise a fatal exception with a specified value of EXTYPE. In particular, if the specified EXTYPE is the same as for some nonfatal exception, implementations need not apply the recovery procedure as though that nonfatal exception had actually occurred. It is presumed that a program will normally contain an exception-handler to receive and process the exception.

All positive values of EXTYPE are reserved for future versions of this Standard. Exceptions defined by local enhancements to this Standard should be identified by negative values for EXTYPE, following the categories established in Table 2. The value returned by EXTYPE for an exception defined in a local enhancement and occurring in a procedure-part or internal-proc-def should be -100000 plus the negative value identifying that exception. For example, if an implementation chose an EXTYPE value of -4029 for an invalid argument in a new built-in function, and if that exception occurred in a subprogram, but was not handled there, then the value of EXTYPE in an exception-handler in a calling program should be -104029.

It is recommended that implementations use the "zero-th" value in a class of EXTYPE values to represent "other exceptions of this type". For example, an EXTYPE value of 1000 might represent all overflows not defined in this Standard.

Values of EXTYPE from 1 to 999 may only occur from cause-statements in application programs. These values should be encouraged for use, since they will not be assigned standard meanings in future enhancements to this Standard.

CONTINUE should be used with caution. For instance, if an exception occurs within a def-statement, on-gosub-statement, on-goto-statement, or if-statement, CONTINUE will transfer control to the lexically following line. Such action may not be equivalent to resumption of normal flow of control.

The following example illustrates the effect of CONTINUE with control structures:

```
100 WHEN EXCEPTION IN
120       INPUT PROMPT "enter your age and weight": a, w
130       DO WHILE a > 1
140          IF a < 9999999999 THEN
150              INPUT PROMPT "What is your height ": h
160              PRINT "Check the following:"
170              PRINT "Age:"; a, "Weight:"; w, "Height:"; h
200              INPUT PROMPT "Enter your age": a
210          END IF
220          PRINT "Lexically following IF"
230       LOOP
240       PRINT "Lexically following DO WHILE"
```

For exception in line :	CONTINUE transfers control to line:
120	130
130	240
140	220
150	160

The precise format of the values of the EXTEXT$ function is implementation-defined. In particular, implementations may choose to omit, or to mark in a special way, those fields in an error message that are specific to a particular instance of an exception, such as the line number at which the exception occurred or the value of an out-of-range subscript.

12.2 Debugging (BASIC-1 and BASIC-2)

12.2.1 General Description

Debugging facilities are provided by language statements in order to allow test points to be built into a program. These statements allow the user to set break points, to trace the action of the program, and to turn the debugging system on and off within each program-unit.

12.2.2 Syntax

1. debug-statement = DEBUG (ON / OFF)
2. break-statement = BREAK
3. trace-statement = TRACE ON (TO channel-expression)? / TRACE OFF

12.2.3 Examples

3. TRACE ON
   TRACE ON TO #3

12.2.4 Semantics

Each program-unit shall have a debugging status, which is either active or inactive at any given time. The debugging status of a program-unit shall persist between invocations of that program-unit (with the exception of the main program). Changes in the debugging status of one program-unit shall not affect the debugging status of any other program-unit. At the beginning of execution of the program, debugging shall be inactive for all program-units.

Execution of the debug-statement DEBUG ON shall cause debugging to become active for the program-unit in which that debug-statement occurs. Debugging shall remain active for the remainder of that invocation of that program-unit, and for each subsequent invocation of that program-unit, until the debug-statement DEBUG OFF is executed in that program-unit. Execution of the debug-statement DEBUG OFF shall cause debugging to become inactive for the remainder of that invocation of that program-unit, and for

each subsequent invocation of that program unit, until the debug-statement DEBUG ON is executed in that program-unit.

The execution of a break-statement when debugging is active shall cause an exception. The standard recovery procedure from this exception shall be to report the line-number of the break-statement and to signify to the user that interaction with the debugging system is possible. The actions allowed by the debugging system, including the method for continuing execution or terminating execution of the program, are implementation-defined. If the execution of a program reaches a line containing a break-statement, and debugging is inactive, then it shall proceed to the next line with no other effect.

The execution of a trace-statement when debugging is active shall turn tracing on (if ON is specified) or off (if OFF is specified) in the program-unit containing the trace-statement. Prior to the execution of any trace-statement upon each separate entry to a program-unit, tracing shall be off. If the execution of a program reaches a line containing a trace-statement, and debugging is inactive, then it shall proceed to the next line with no other effect.

The execution of a trace-statement shall not affect the debugging status, nor shall the execution of a debug-statement affect the tracing status (ON or OFF).

Whenever tracing is on and debugging is active in a program-unit, the following actions shall occur each time a line of the specified type is executed :

- for any line which interrupts the sequential order of execution of lines in a program, both the line-number of that line and the line-number of the next line to be executed shall be reported; and
- for any line which assigns a value to a variable or to an element of an array, both the line-number of that line and any values assigned by execution of that line shall be reported. Whenever tracing has been turned on via a trace-statement with a channel-expression, trace reports shall be directed to the (display format) file assigned to the specified channel. If no channel-expression has been specified, the trace report shall be directed to the device associated with channel zero.

The contents of the trace report are implementation-defined, but shall include at least the name of the variable traced, as that name lexically appears in the statement causing the TRACE report, and its value; if the variable is an array element, the value(s) of its subscripts shall also be included.

12.2.5 Exceptions

- A break-statement is executed when debugging is active (10007, nonfatal: the recovery procedure is to report the line-number of the statement and to permit interaction with the debugging system).
- An attempt is made to direct a trace report to an inactive channel. (7401, fatal).
- An attempt is made to direct a trace report to a file which is not display format opened with access OUTPUT or OUTIN (7402, fatal).

12.2.6 Remarks

Since an array-assignment assigns a value to each element of an array, tracing an array-assignment causes reporting of all new array element values.

The form of all trace reports is implementation-defined.

Implementations may provide debugging facilities through commands in addition to statements. It is recommended that such commands use the same keywords as the statements.

13. GRAPHICS

13. GRAPHICS

The facilities provided in section 13.1 through 13.3 are a subset of those provided by level 0b of the Graphical Kernel System (GKS) as defined in ISO 7942. The values of the EXTYPE function for exceptions defined in GKS are 11000 plus the value of the GKS error number.

In GKS terms, any BASIC program that includes statements from Section 13 of this Standard has implied calls to the functions OPEN GKS, OPEN WORKSTATION (#0, "Maindev", 1), and ACTIVE WORKSTATION #0 before any graphics statements are executed, and calls to the functions DEACTIVE WORSTATION #0, CLOSE WORKSTATION #0 and CLOSE GKS as the program terminates.

13.1 Coordinate Systems

13.1.1 General Description

The coordinates used to produce graphic output may be chosen to suit the application. The range of this system of "problem coordinates" (world coordinates) is established by a SET WINDOW statement. This range is mapped into a rectangular portion of an abstract viewing surface which can be specified by a SET VIEWPORT statement. It is possible to specify what part of this abstract viewing surface will be presented to the user on the display surface by a SET DEVICE WINDOW statement. This rectangle, in turn, may be located on the display surface by a SET DEVICE VIEWPORT statement.

No output will be produced outside the device viewport. It is possible to guarantee that all graphic output which lies outside the viewport will be eliminated by enabling clipping.

Ask statements are provided to determine the current values for the parameters established by execution of one of the set statements or by default.

13.1.2 Syntax

```
1. set-object              > WINDOW boundaries / VIEWPORT boundaries / DEVICE
                             WINDOW boundaries / DEVICE VIEWPORT boundaries
                             / CLIP string-expression
2. boundaries              = boundary comma boundary comma boundary comma boundary
3. boundary                = numeric-expression
4. ask-statement           > ASK ask-object status-clause?
5. status-clause           = STATUS numeric-variable
6. ask-object              > WINDOW boundary-variables / VIEWPORT
                             boundary-variables / DEVICE WINDOW
                             boundary-variables / DEVICE VIEWPORT
                             boundary-variables / DEVICE SIZE
                             numeric-variable comma numeric-variable comma
                             string-variable / CLIP string-variable
7. boundary-variables      = numeric-variable comma numeric-variable comma
                             numeric-variable comma numeric-variable
```

13.1.3 Examples

```
1. WINDOW 0, PI*2, -1, 1
   VIEWPORT .5*width, width, .5*height, height
   DEVICE WINDOW 0, .8, 0, 1
   DEVICE VIEWPORT .3, .5, .1, 1
   CLIP "Off"
```

4. ASK WINDOW X1, X2, Y1, Y2
   ASK VIEWPORT L, R, B, T
   ASK DEVICE WINDOW XMIN, XMAX, YMIN, YMAX
   ASK DEVICE VIEWPORT LEFT, RIGHT, BOTTOM, TOP
   ASK DEVICE SIZE Width, Height, Unit$
   ASK CLIP CLIP_STATE$

13.1.4 Semantics

Graphic output is specified in problem coordinates. A normalization transformation defines the mapping from the problem coordinate system onto the normalized device coordinate (NDC) space which can be regarded as an abstract viewing surface.

The normalization transformation is specified by defining the limits of a rectangular area, called a window, in problem coordinates. The window is mapped linearly onto a specified rectangular area, called a viewport, in NDC space.

Execution of a set-statement with the keyword WINDOW shall establish the boundaries of the window. The parameters represent the problem coordinates of the left, right, bottom, and top edges, in that order, of the window rectangle. At the start of program execution the window values are (0, 1, 0, 1).

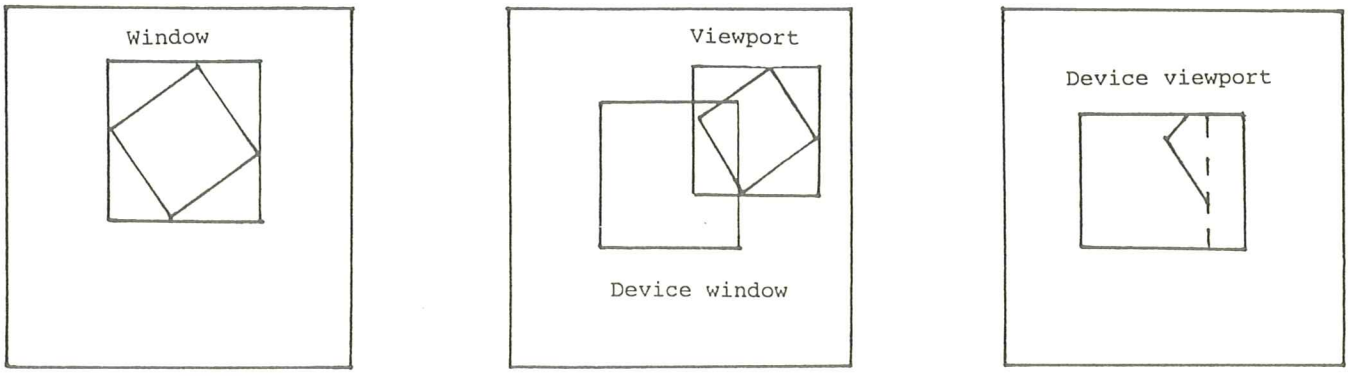
Execution of a set-statement with the keyword VIEWPORT shall establish the viewport boundaries. The parameters represent the normalized device coordinates of the left, right, bottom, and top edges, in that order, of the viewport rectangle. Viewport coordinates must not be less than zero not more than one. The value of the left coordinate shall be less than the right, and the bottom less than the top. At the start of program execution the viewport values are (0, 1, 0, 1).

The viewport may also be used to define a clipping rectangle. Execution of a set-statement with the keyword CLIP shall enable or disable clipping to the viewport boundary (see Section 13.3) depending on whether the value of the string-expression is "ON" or "OFF". The letters in the value of the string-expression may be any combination of upper-case and lower-case. At the start of program execution, clipping shall be enabled.

A device transformation is used to map a rectangle in NDC space called a device window uniformly onto a rectangle on a physical surface called a device viewport. This transformation shall perform equal scaling with a positive scale for both axes. To ensure equal scaling, the device transformation maps the device window onto the largest rectangle that can fit within the device viewport such that the aspect ratio of the device window is preserved and the lower-left corner of the device window is mapped onto the lower-left corner of the device viewport.

Execution of a set-statement with the keyword DEVICE WINDOW shall establish the boundaries of the device window. The parameters represent the normalized device coordinates of the left, right, bottom, and top edges, in that order, of the device widow rectangle. These coordinates shall not be less than zero not greater than one. The value of the left coordinate shall be less than the right, and the bottom less than the top. At the start of program execution, the device window values are (0, 1, 0, 1). To ensure that no output outside the device window is displayed, clipping takes place at the device window boundaries. This clipping may not be disabled. Execution of a set-statement with the keywords DEVICE WINDOW shall cause the display surface to be cleared if it is not already clear.

The figure below illustrates the relationship between the window, the viewport, the device window, and the device viewport; clipping is assumed "ON".



Execution of a set-statement with the keywords DEVICE VIEWPORT shall establish the boundaries of the device viewport. The parameters represent the coordinates of the left, right, bottom, and top edges, in that order of the device viewport rectangle. Units for the device viewport shall be meters on a device capable of producing a precisely scaled image and appropriate device dependent coordinates otherwise. The left and bottom edges of a display surface are represented by the coordinate value zero. At the start of program execution, the device viewport is the entire screen. Execution of a set-statement with the keywords DEVICE VIEWPORT shall cause the display surface to be cleared if it is not already clear.

If a status-clause is included in an ask-statement, a status associated with the execution of the ask-statement shall be returned in the numeric-variable. If the statement returned meaningful values for the ask-object, a value of zero shall be returned in the status-clause. If the ask-statement could not return meaningful values for the ask-object a nonzero value shall be returned in the status-clause that is defined with the semantics of the particular ask-object. If an ask-statement with a particular ask-object is always expected to return meaningful values, the semantics for that ask-object do not specify alternate status values and zero shall always be returned.

Execution of an ask-statement with one of the keywords WINDOW, VIEWPORT, DEVICE WINDOW, or DEVICE VIEWPORT shall provide the current values for the specified rectangle. Values for the left, right, bottom and top sides, respectively, shall be assigned to the boundary-variables equal to the values last established by a set-statement, or, if no appropriate set-statement has been executed, equal to the default value.

Execution of an ask-statement with the keywords DEVICE SIZE shall assign to the first numeric variable the size in the horizontal direction and shall assign to the second numeric variable the size in the vertical direction of the available display surface. The string-variable shall be assigned the value "METERS" if the sizes are in meters or the value "OTHER" if the units of measure are device coordinates of other units. The values "METERS" and "OTHER" shall consist of upper-case-letters.

Execution of an ask-statement with the keyword CLIP shall assign the value "ON" to the string-variable if clipping is enabled and the value "OFF" if it is disabled. The values returned shall be all upper-case-letters.

13.1.5 Exceptions

- The boundaries in a set-statement specify a rectangle of zero width or height (11051, nonfatal: continue with current values).
- The boundaries in a set-statement with the keywords VIEWPORT, DEVICE WINDOW, or DEVICE VIEWPORT specify a rectangle of negative width or height (11051, nonfatal: continue with current values).
- A boundary of the viewport is not in the range [0, 1] (11052 nonfatal: continue with current values).
- A boundary of the device window is not in the range [0, 1] (11053, nonfatal: continue with current values).
- A boundary of the device viewport is not in the display space (11054, nonfatal: continue with current values).
- The value of the string-expression in a set-statement with the keyword CLIP is neither "ON" nor "OFF" after conversion to upper-case (4101, nonfatal: continue with current value).

13.1.6 Remarks

The manner in which a particular graphic display device is selected by a program is implementation-defined.

The meaning of a window with the left edge greater than the right or the bottom edge greater than the top is implementation-defined. If possible, implementations should provide appropriately inverted images. The effect of all graphic output is defined in terms of the abstract problem space, in which lower values are to the left and down, and higher values to the right and up. When this problem space is mapped to NDC, it may be inverted as indicated by the order of the WINDOW boundaries. This relaxes the GKS rule that states that reversal window coordinates causes an error.

SET WINDOW, SET VIEWPORT, SET DEVICE WINDOW, and SET DEVICE VIEWPORT correspond to the GKS functions SET WINDOW, SET VIEWPORT, SET WORKSTATION WINDOW, and SET WORKSTATION VIEWPORT, respectively. The GKS transformation number is one in these statements as defined above. The GKS workstation number is #0 in these statements.

SET CLIP corresponds to the GKS function SET CLIPPING INDICATOR.

ASK WINDOW and ASK VIEWPORT correspond to the GKS function INQUIRE NORMALIZATION TRANSFORMATION for normalization transformation one.

ASK CLIP corresponds to the GKS function INQUIRE CLIPPING INDICATOR.

ASK DEVICE WINDOW and ASK DEVICE VIEWPORT correspond to the current workstation window and current workstation viewport parameters, respectively, of the GKS function INQUIRE WORKSTATION TRANSFORMATION with a workstation identifier of one.

ASK DEVICE VIEWPORT before any SET DEVICE VIEWPORT may be used to find the device coordinates of the full available device surface.

ASK DEVICE SIZE corresponds to the device coordinate units and maximum display surface size in device coordinate units parameters of the GKS function INQUIRE MAXIMUM DISPLAY SURFACE SIZE.

13.2 Attributes and Screen Control

13.2.1 General Description

A graphical display device may possess several styles of lines or points, each with a particular width or texture. A particular style may be selected for graphic output. A

graphic device also may be able to draw lines and/or fill areas in a variety of colors. Particular colors may be selected for line drawing and screen background.

The current style and color of the geometric object may be determined by ask-statements. The number of colors and the number of line or point styles available may also be determined by ask-statements.

The clear-statement clears the entire screen, returning it to its background color. For hard-copy devices, the clear-statement causes the paper to advance, the pen to move aside, or similar action.

This Standard provides text of one style and size that shall be output horizontally with the initial-point at the left.

13.2.2 Syntax

1. imperative-statement	> clear-statement
2. clear-statement	= CLEAR
3. set-object	> primitive-1 STYLE index / primitive-2 COLOR index
4. primitive-2	= primitive-1 /TEXT / AREA
5. primitive-1	= POINT / LINE
6. rgb-list	> [deleted]
7. ask-object	> primitive-1 STYLE numeric-variable / primitive-2 COLOR numeric-variable / MAX primitive-1 STYLE numeric-variable / MAX COLOR numeric-variable
8. mix-list	= [deleted]
9. text-facet	= [deleted]

13.2.3 Examples

3. LINE STYLE 2
   TEXT COLOR 5

7. Max color color_max
   Max point style PtStyles

13.2.4 Semantics

Execution of a clear-statement shall clear the graphic display if not already clear. For soft-copy devices, it shall erase the screen. For hard-copy devices, it shall advance the medium or allow the device operator to change it.

Execution of a set-statement with the keywords LINE STYLE or POINT STYLE shall cause the index to be evaluated by rounding to obtain an integer N and shall establish the style for subsequent lines or points to be the Nth one of the set of available line or point styles. The number of line styles available is implementation-defined, but shall be at least three. A line style of one must correspond to drawing of solid lines. A line style of two shall correspond to drawing of dashed lines. A line style of three shall correspond to dotted lines. All other values for line style are implementation-defined. At the initiation of program execution, the line style shall be one.

Point styles produce centered symbols. The number of point styles is implementation-defined, but shall be at least three. A point style of one must correspond to a dot (.), a point style of two to a plus sign (+), a point style of three to an asterisk (*). All other values for point-style are implementation-defined. At the start of program execution, the point style shall be three.

Execution of an ask-statement with the keywords LINE STYLE or POINT STYLE shall assign the number of the actual current line style or point style to the numeric-variable.

Execution of an ask-statement with the keywords MAX LINE STYLE or MAX POINT STYLE shall assign to the numeric-variable the largest value of LINE STYLE or POINT STYLE, respectively, available.

All values for style shall be valid from one to the number returned by ASK MAX POINT STYLE or ASK MAX LINE STYLE.

Execution of a set-statement with the one of the keyword pairs POINT COLOR, LINE COLOR, TEXT COLOR, or AREA COLOR shall cause the index to be evaluated by rounding to obtain an integer N and shall establish the color index of subsequent points, lines, text, or filled areas to be the Nth one of the set of colors, if possible with the current graphics device. This color is called a foreground color. At the initiation of execution, the color associated with each index is implementation-defined, and the foreground color indices shall all have the value one. The number of colors available is implementation-defined.

Execution of an ask-statement with one of the keyword pairs POINT COLOR, LINE COLOR, TEXT COLOR, or AREA COLOR shall assign to the numeric-variable the current value of the color index for points, lines, text or filled areas, as appropriate.

Execution of an ask-statement with the keywords MAX COLOR shall assign to the numeric-variable the largest distinct value available as an index for SET POINT COLOR, SET LINE COLOR, SET TEXT COLOR, or SET AREA COLOR. All values for color index from zero to this value should be valid.

13.2.5 Exceptions

- A color index in a set-statement with the keywords POINT COLOR, LINE COLOR, TEXT COLOR, or AREA COLOR is less than zero or greater than the maximum color index for the implementation (11085, nonfatal: use the implementation default).
- The value of the numeric-expression in a set-statement with the keywords LINE STYLE is less than or equal to zero or greater than the maximum style available (11062, nonfatal: use the value one).
- The value of the numeric-expression in a set-statement with the keywords POINT STYLE is less than or equal to zero or greater than the maximum style available (11056, nonfatal: use the value three).

13.2.6 Remarks

It is recommended that implementations make the value returned by ASK MAX COLOR the same as the number of colors (not counting background color) available for simultaneous display, not the total number of different colors available on the device.

The CLEAR statement corresponds to the GKS function CLEAR WORKSTATION (#0, CONDITIONALLY). SET LINE STYLE and SET POINT STYLE corresponds to the GKS functions SET LINETYPE and SET MARKER TYPE, respectively. SET LINE COLOR, SET POINT COLOR, SET TEXT COLOR, and SET AREA COLOR correspond to the GKS functions SET POLYLINE COLOUR INDEX, SET POLYMARKER COLOUR INDEX, SET TEXT COLOUR INDEX, and SET FILL AREA COLOUR INDEX, respectively.

The following ask-objects correspond to various parameters of the GKS function INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES: LINESTYLE is linetype, POINSTYLE is marker type, LINE COLOR is polyline colour index, POINT COLOR is polymarker colour index, TEXT COLOR is text colour index and AREA COLOR is fill area colour index.

13.3 Graphic Output

13.3.1 General Description

The statements described in this section are used to generate various kinds of graphic output. The user may cause points, line segments, or filled-in areas to be

drawn on the screen. There is a facility for including text within the drawing. The effect of the graphic output statements depends on the current values of the various set-objects described in section 13.1 and 13.2.

13.3.2 Syntax

```
 1. imperative-statement       > graphic-output-statement
 2. graphic-output-statement   > geometric-statement / graphic-text-statement
 3. geometric-statement        > graphic-verb geometric-object colon point-list
 4. graphic-verb               > GRAPH
 5. geometric-object           = POINTS / LINES / AREA
 6. point-list                 = coordinate-pair (semicolon coordinate-pair)*
 7. coordinate-pair            = numeric-expression comma numeric-expression
 8. array-geometric-statement  = [deleted]
 9. size-select                = [deleted]
10. array-point-list           = [deleted]
11. graphic-text-statement     = graphic-verb TEXT initial-point (comma USING image
                                 colon expression-list / colon
                                 string-expression)
12. initial-point              = comma AT coordinate-pair
13. array-cells-statement      = [deleted]
14. point-pair                 = [deleted]
```

A graphic-output-statement with LINES as the geometric-object must contain at least two coordinate-pairs in its point-list. A graphic-output-statement with AREA as the geometric-object must contain at least three coordinate-pairs in its point-list.

13.3.3 Examples

```
 3. GRAPH LINES: 3,4; 5,6; 66.66,77.77
11. GRAPH TEXT, AT XP, YP: "here is the label: " & TEXT$
    GRAPH TEXT, AT 0,Y_VALUE, USING "##. ##^^^^": Y_VALUE
```

13.3.4 Semantics

The graphic-output-statement

Graphic-output-statements are the means by which the user generates all graphic output. The geometric-statement is used to draw a series of marked points, a contiguous set of line segments, or a filled polygon area. The graphic-text-statement produces alphanumeric labels.

The geometric-statement

The geometric-statement makes use of a sequence of points specified in problem coordinates. That sequence is determined by the coordinate-pairs in the point-list, the first coordinate-pair designating the first point and so on through the end of the point-list.

If the geometric-object is POINTS, then a point marker of the style and color indicated by the current value of POINT STYLE and POINT COLOR shall be drawn at each point in the sequence. If the geometric-object is LINES, then a line segment shall be drawn connecting each successive pair of points in the sequence, the first to the second, the second to the third, and so on. Thus, the number of line segments shall be one fewer than the number of points in the sequence. The style and color of the segments are determined by the current value of LINE STYLE and LINE COLOR. If the geometric-object is AREA, then a filled polygon is drawn whose edges consist of the sequence of line segments as described above for LINES. If the first and last points in the sequence are not coincident, then the line segment joining them completes the outline. The color of the interior and edge is determined by the current value of AREA COLOR. The interior of the polygon is defined as the set of all points (pixels)

such that any line segment beginning at that point and extended indefinitely in any direction will cross the polygon boundary an odd number of times. The fill pattern shall be solid on devices where this is possible.

The graphic-text-statement

The graphic-text-statement draws a label consisting of the string of characters generated by its string-expression, or by its image and expression-list. The characters used for labels shall have an implementation-defined size and style. The effect of clipping on characters which lie partly in and partly out of the viewport on the screen is implementation-defined.

13.3.5 Exceptions

- A graphic-output-statement with LINES as the geometric-object specifies fewer than two points (11100, fatal)
- A graphic-output-statement with AREA as the geometric-object specifies fewer than three points (11100, fatal)

13.3.6 Remarks

The graphic-text-statement is designed to give easy access to a device's hardware-generated character set.

Text is described with respect to problem coordinates and may become distorted when the aspect ratio of the window and viewport differ.

If a device is unable to fill a polygon, it is recommended that the outline of the polygon be drawn and the interior be hashed or shaded in a manner corresponding to the current color number.

It is recommended that the result of filling an area consisting solely of colinear points be a line segment through those points, that filling or drawing a line through a set of coincident points result in a dot being drawn.

GRAPH POINTS correspond to the GKS function POLYMARKER. GRAPH LINES correspond to the GKS function POLYLINE. GRAPH AREA correspond to the GKS function FILL AREA. GRAPH TEXT is an extension of the GKS function TEXT in that it allows formatting of text with USING.

15. FIXED DECIMAL NUMBERS

15. FIXED DECIMAL NUMBERS (BASIC-2 only)

This Section specifies an option in which the values of all numeric variables behave logically as fixed-point decimal numbers with program-defined precisions. Use of this option also implies that numeric-constants and numeric-expressions generally, are represented as fixed-point decimal numbers. Implementation of this Section is mandatory in BASIC-2.

The main intent of this data type is to provide an interface with non-BASIC processors, and as a result, the precision and accuracy requirements for numeric-expressions are not specified.

15.1 Fixed Decimal Precision

15.1.1 General Description

An option is provided which allows definition of all numeric variables in a program-unit as having fixed-point decimal numbers as values. The specification of this option defines a default precision for the values of variables. In addition, other precision attributes can be specified for individual variables.

15.1.2 Syntax

1. option	> ARITHMETIC FIXED fixed-point-type
2. fixed-point-type	= asterisk fixed-point-size
3. numeric-type	> NUMERIC fixed-point-type? fixed-declaration (comma fixed-declaration)*
4. fixed-declaration	= simple-numeric-variable fixed-point-type? / numeric-array-declaration fixed-point-type?

An option-statement with an ARITHMETIC FIXED option, if present at all, shall occur in a lower-numbered line than any numeric-expression, numeric-variable, or any declare-statement with NUMERIC in the same program-unit.

A fixed-declaration, if present at all, shall occur in a lower-numbered line than any reference to the variable or array declared therein.

A fixed-point-size may appear in a declare-statement only if the ARITHMETIC FIXED option has been specified for the program-unit.

Variables and arrays shall not be described more than once, in either a declare-statement, a dimension-statement, or as a function-parameter or procedure-parameter.

15.1.3 Examples

```
1. ARITHMETIC FIXED*8.2
3. NUMERIC*5.2 A, B, C*5.5, D (1 TO 8)*6.6
   NUMERIC     E (1 TO 10, 1961 TO 1981)
```

15.1.4 Semantics

When the ARITHMETIC FIXED option is specified, then the values of numeric constants, variables, and expressions shall behave logically as fixed-point decimal numbers. In the case of variables, this means that the set of values they are capable of assuming are exactly those values which can be expressed with integer-size decimal digits to the left of the decimal point and fraction-size digits to the right, together with the sign. The sign is not counted in the size of the representation. Each implementation shall define a maximum precision, P, which controls the number of decimal digits available for the representation of numeric values. This precision shall not be less than 18.

The semantics for numeric-constants are as specified in Section 5.1, except as follows. Each numeric constant has a precision attribute defined by the number of significant decimal digits. The first significant digit is either the first nonzero digit, or the digit immediately to the right of the decimal point, whichever is far-

ther left. The last significant digit is the last explicitly written or the digit immediately to the left of the decimal point, whichever is farther right. In the special case of zero, there is at least one significant digit, namely immediately to the left of the decimal point. A numeric-constant written in scaled notation is interpreted as if expressed in the equivalent unscaled notation.

For example:

constant as written	significant digits
12.34	12.34
12.300	12.300
12.300E-4	.0012300
12.300E7	123000000.
00.00E-3	.00000
0.0E3	0.

If the number of significant digits exceeds P, the implementation shall round the value to no fewer than P digits. If the number of significant digits to the left of the decimal point exceeds P, an overflow exception results.

Each simple-numeric-variable and numeric-array has a precision attribute defined in terms of the number of digits maintained in the integer part and the fraction part, namely integer-size and fraction-size. The representation of variables and arrays is governed by (in descending order of precedence):

- the fixed-point-size specified in the fixed-declaration of the variable or array, or,
- the fixed-point-size following DECLARE NUMERIC in a declare-statement containing a fixed-declaration for the variable or array, or
- the default fixed-point-size specified in the ARITHMETIC FIXED option.

The precision attribute of a numeric-array applies to each of its elements. The significant digits for a numeric-variable are the same as if the variable were written out with its full precision as a numeric-constant.

The semantics of numeric-expressions and numeric-supplied-functions are as specified in 5.3 and 5.4, except a follows. The precision attribute of the result obtained by evaluating a numeric-supplied-function or numeric-expression is implementation-defined. The accuracy of such evaluation is also implementation-defined.

Assignment of a numeric value to a numeric-variable, whether done by internal assignment (such as with LET), or from an external source (such as with INPUT), proceeds as follows. The integer part and fraction part of the value are moved to the integer part and fraction part of the variable, aligned on the decimal point. If any nonzero digits are truncated on the left of the integer part, an overflow exception results. If any digits are truncated on the right of the fraction part, the resulting value in the variable is rounded to the precision of the variable. If necessary, the value is extended with zeros on the left of the integer part, or the right of the fraction part so as to fill all the digit places of the receiving variable.

The semantics for input and output are as specified in Section 10, except as follows. When a numeric-expression is used as a print-item in a print-statement, its value is always printed in unscaled representation, either implicit point or explicit point. The digits printed are exactly the significant digits, as defined above. Note that for numeric-expressions other than variables and constants, significant digits are implementation-defined. Implicit point representation shall be used when there are no significant digits to the right of the decimal point; otherwise explicit point representation shall be used.

The semantics for file areas are as specified in Section 11, with the following additions. For DISPLAY records, the rules given above for input, output, and

assignment are used. For INTERNAL records, the values are self-typed, and so input and output takes place as defined above. Thus, the result of WRITE A and READ B, where they access the same value in the file, is the same as LET B = A. Note that it is implementation-defined whether an INTERNAL file accessed with one ARITHMETIC option is accessible with another. The ARITHMETIC FIXED option with different default precisions is not considered to be a different option for the purposes of accessibility. For NATIVE records, assignment of values to and from fields of fixed-point-size takes place in accordance with the usual rules for fixed-point assignment. When a value is moved to a field with a size of E (indicating floating-point), at least the first P significant digits must be retained exactly. When a value obtained from such a field is assigned to a variable, the field is treated as a scaled numeric-constant, as described above. Again, note that it is implementation-defined whether a NATIVE file accessed with one ARITHMETIC option is accessible with another. The ask-attribute DATUM returns the type of the next datum in a file. For numeric data in STREAM INTERNAL files written with the FIXED option, the type returned by the ask-attribute DATUM shall be:

"NUMERIC*ii.ff",

where ii is the two digit number for integer-size and ff the two digit number for fraction-size.

15.1.5 Exceptions

- The number of significant digits in the integer part of a numeric-constant exceeds P (1001, fatal).
- In an option-statement or a declare-statement, the sum of integer-size and fraction-size in a fixed-point-size exceeds P (1010, fatal).
- Upon assignment of a numeric value to a variable, the number of significant digits in the integer part exceeds the variable's integer-size (1011, fatal).

15.1.6 Remarks

It is recommended that the accuracy of transcendental functions such as LOG, COSH, ATN, SIN, and EXP be no less than that specified for OPTION ARITHMETIC DECIMAL. It is recommended that for non-transcendental functions, such as ABS INT, and MAX, and for the operations +, -, *, /, and ^, an intermediate result be maintained as floating-point decimal with P+2 significant digits. This would imply that whenever all the intermediate results of a numeric-expression are exact within P+2 decimal digits and the final result is exact within P decimal digits, then the final result is exactly correct.

15.2 Fixed Decimal Program Segmentation

15.2.1 General Description

When the fixed decimal option is specified for a program-unit, it applies to all numeric entities in the scope of that unit, including parameters, formal parameters, and (in the case of an external-function-def) the result of function evaluation.

15.2.2 Syntax

```
1. function-parameter          > numeric-fixed-parameter
2. procedure-parameter         > numeric-fixed-parameter
3. numeric-fixed-parameter     = simple-numeric-variable fixed-point-type /
                                 fixed-formal-array
4. fixed-formal-array          = formal-array fixed-point-type
5. internal-function-line      > line-number FUNCTION fixed-defined-function
                                 function-parm-list? tail
```

6. external-function-line > line-number EXTERNAL FUNCTION fixed-defined-function function-parm-list? tail
7. numeric-def-statement > DEF fixed-defined-function function-parm-list? equals-sign numeric-expression
8. defined-function > fixed-defined-function
9. fixed-defined-function = numeric-defined-function fixed-point-type

A numeric-variable or actual-array appearing in a call-statement shall have the same integer-size and fraction-size as the corresponding procedure-parameter. For all other numeric function-argument or procedure-arguments and their corresponding function-parameters or procedure-parameters, it is necessary only that the ARITHMETIC options of their respective program-units agree, i.e., that both be DECIMAL or NATIVE or FIXED.

An option-statement with an ARITHMETIC FIXED option shall occur in a lower-numbered line within the program-unit than any internal-function-def that declares a numeric-defined-function or specifies numeric parameters.

A fixed-point-type may appear in an internal-function-line or numeric-def-statement only if the ARITHMETIC FIXED option has been specified for the program-unit.

A numeric-fixed-parameter may be used only if the ARITHMETIC FIXED option has been specified for the program-unit.

When a fixed-defined-function is declared in a function-type, the fixed-point-sizes specified either explicitly or by default in the declaration and the corresponding definition must agree.

15.2.3 Examples

```
3. A()*8.2
   B(, )*4.4
5. 123 FUNCTION SUMVECTOR*5.2 (V()*5.2)
6. 234 EXTERNAL FUNCTION ANSWER*1 (A$)
7. DEF AVERAGE*10.3 (X*10.3, Y*10.3) = (X+Y)/2
```

15.2.4 Semantics

When the ARITHMETIC FIXED option is specified for a program-unit, the values of numeric procedure-parameters, numeric function-parameters, and numeric-defined-functions shall be represented and manipulated as fixed-point decimal numbers. If the fixed-point-size of one of these is not explicitly specified in the appropriate procedure-parameter or function-parameter, internal-def-line or internal-function-line or external-function-line, then it is assumed to be the default specified in the ARITHMETIC FIXED option. The fixed-point-size of a normal-array applies to each of its elements.

The evaluation and assignment of the arguments in a function reference to the parameters of the function-def proceed as described in 9.1, with the following addition. In the case where the fixed-point-size of an argument differs from that of the corresponding parameter, the assignment rules given in 15.1.4 apply.

The association of the procedure-arguments in a call-statement with the procedure-parameters in the corresponding sub-statement proceeds as described in Section 9.2, with the following addition. In the case where the fixed-point-size of a procedure-argument which is a numeric-expression, but not a numeric-variable, differs from that of the corresponding procedure-parameter, the assignment rules given in 15.1.4 apply.

15.2.5 Exceptions

- In a numeric-fixed-parameter or fixed-defined-function, the sum of the integer-size and fraction-size in a fixed-point-size exceeds P (1010, fatal).
- Upon assignment of a numeric value to a numeric-fixed-parameter or fixed-defined-function, the number of significant digits in the integer part exceeds the integer-size of the numeric-fixed-parameter of fixed-defined-function (1011, fatal).

15.2.6 Remarks

None.

TABLE 1

Standard BASIC Character Set

The name of the characters indicated in the table correspond to the name of the characters in Standard ECMA-6. Where different names are used in this Standard for the syntax of BASIC, these names are indicated between parentheses.

ORDINAL POSITION	CODE	GRAPHIC	ACRONYM	NAME
0.	0/0		NUL	NULL
1.	0/1		SOH	START OF HEADING
2.	0/2		STX	START OF TEXT
3.	0/3		ETX	END OF TEXT
4.	0/4		EOT	END OF TRANSMISSION
5.	0/5		ENQ	ENQUIRY
6.	0/6		ACK	ACKNOWLEDGE
7.	0/7		BEL	BELL
8.	0/8		BS	BACKSPACE
9.	0/9		HT	HORIZONTAL TABULATION
10.	0/10		LF	LINE FEED
11.	0/11		VT	VERTICAL TABULATION
12.	0/12		FF	FORM FEED
13.	0/13		CR	CARRIAGE RETURN
14.	0/14		SO	SHIFT OUT
15.	0/15		SI	SHIFT IN
16.	1/0		DLE	DATA LINK ESCAPE
17.	1/1		DC1	DEVICE CONTROL ONE
18.	1/2		DC2	DEVICE CONTROL TWO
19.	1/3		DC3	DEVICE CONTROL THREE
20.	1/4		DC4	DEVICE CONTROL FOUR
21.	1/5		NAK	NEGATIVE ACKNOWLEDGE
22.	1/6		SYN	SYNCHRONOUS IDLE
23.	1/7		ETB	END OF TRANSMISSION BLOCK
24.	1/8		CAN	CANCEL
25.	1/9		EM	END OF MEDIUM
26.	1/10		SUB	SUBSTITUTE
27.	1/11		ESC	ESCAPE
28.	1/12		FS	FILE SEPARATOR
29.	1/13		GS	GROUP SEPARATOR
30.	1/14		RS	RECORD SEPARATOR
31.	1/15		US	UNIT SEPARATOR
32.	2/0		SP	SPACE
33.	2/1	!		EXCLAMATION MARK
34.	2/2	"		QUOTATION MARK
35.	2/3	#		NUMBER SIGN
36.	2/4	$		DOLLAR SIGN
37.	2/5	%		PERCENT SIGN
38.	2/6	&		AMPERSAND
39.	2/7	'		APOSTROPHE
40.	2/8	(		LEFT PARENTHESIS
41.	2/9	)		RIGHT PARENTHESIS
42.	2/10	*		ASTERISK

43.	2/11	+	PLUS SIGN
44.	2/12	'	COMMA
45.	2/13	-	MINUS SIGN
46.	2/14	.	FULL STOP (Period)
47.	2/15	/	SOLIDUS (Slant)
48.	3/0	0	DIGIT ZERO
49.	3/1	1	DIGIT ONE
50.	3/2	2	DIGIT TWO
51.	3/3	3	DIGIT THREE
52.	3/4	4	DIGIT FOUR
53.	3/5	5	DIGIT FIVE
54.	3/6	6	DIGIT SIX
55.	3/7	7	DIGIT SEVEN
56.	3/8	8	DIGIT EIGHT
57.	3/9	9	DIGIT NINE
58.	3/10	:	COLON
59.	3/11	;	SEMICOLON
60.	3/12	<	LESS-THAN SIGN
61.	3/13	=	EQUALS SIGN
62.	3/14	>	GREATER-THAN SIGN
63.	3/15	?	QUESTION MARK
64.	4/0	@	COMMERCIAL AT
65.	4/1	A	CAPITAL LETTER (Upper-case) A
66.	4/2	B	CAPITAL LETTER (Upper-case) B
67.	4/3	C	CAPITAL LETTER (Upper-case) C
68.	4/4	D	CAPITAL LETTER (Upper-case) D
69.	4/5	E	CAPITAL LETTER (Upper-case) E
70.	4/6	F	CAPITAL LETTER (Upper-case) F
71.	4/7	G	CAPITAL LETTER (Upper-case) G
72.	4/8	H	CAPITAL LETTER (Upper-case) H
73.	4/9	I	CAPITAL LETTER (Upper-case) I
74.	4/10	J	CAPITAL LETTER (Upper-case) J
75.	4/11	K	CAPITAL LETTER (Upper-case) K
76.	4/12	L	CAPITAL LETTER (Upper-case) L
77.	4/13	M	CAPITAL LETTER (Upper-case) M
78.	4/14	N	CAPITAL LETTER (Upper-case) N
79.	4/15	O	CAPITAL LETTER (Upper-case) O
80.	5/0	P	CAPITAL LETTER (Upper-case) P
81.	5/1	Q	CAPITAL LETTER (Upper-case) Q
82.	5/2	R	CAPITAL LETTER (Upper-case) R
83.	5/3	S	CAPITAL LETTER (Upper-case) S
84.	5/4	T	CAPITAL LETTER (Upper-case) T
85.	5/5	U	CAPITAL LETTER (Upper-case) U
86.	5/6	V	CAPITAL LETTER (Upper-case) V
87.	5/7	W	CAPITAL LETTER (Upper-case) W
88.	5/8	X	CAPITAL LETTER (Upper-case) X
89.	5/9	Y	CAPITAL LETTER (Upper-case) Y
90.	5/10	Z	CAPITAL LETTER (Upper-case) Z
91.	5/11	[	LEFT SQUARE BRACKET
92.	5/12	\	REVERSE SLANT (Reverse solidus)
93.	5/13	]	RIGHT SQUARE BRACKET
94.	5/14	^	CIRCUMFLEX ACCENT
95.	5/15	_	UNDERLINE
96.	6/0	`	GRAVE ACCENT
97.	6/1	A	SMALL LETTER (Lower-case) a
98.	6/2	b	SMALL LETTER (Lower-case) b

99.	6/3	c		SMALL LETTER (Lower-case) c
100.	6/4	d		SMALL LETTER (Lower-case) d
101.	6/5	e		SMALL LETTER (Lower-case) e
102.	6/6	f		SMALL LETTER (Lower-case) f
103.	6/7	g		SMALL LETTER (Lower-case) g
104.	6/8	h		SMALL LETTER (Lower-case) h
105.	6/9	i		SMALL LETTER (Lower-case) i
106.	6/10	j		SMALL LETTER (Lower-case) j
107.	6/11	k		SMALL LETTER (Lower-case) k
108.	6/12	l		SMALL LETTER (Lower-case) l
109.	6/13	m		SMALL LETTER (Lower-case) m
110.	6/14	n		SMALL LETTER (Lower-case) n
111.	6/15	o		SMALL LETTER (Lower-case) o
112.	7/0	p		SMALL LETTER (Lower-case) p
113.	7/1	q		SMALL LETTER (Lower-case) q
114.	7/2	r		SMALL LETTER (Lower-case) r
115.	7/3	s		SMALL LETTER (Lower-case) s
116.	7/4	t		SMALL LETTER (Lower-case) t
117.	7/5	u		SMALL LETTER (Lower-case) u
118.	7/6	v		SMALL LETTER (Lower-case) v
119.	7/7	w		SMALL LETTER (Lower-case) w
120.	7/8	x		SMALL LETTER (Lower-case) x
121.	7/9	y		SMALL LETTER (Lower-case) y
122.	7/10	z		SMALL LETTER (Lower-case) z
123.	7/11	{		LEFT CURLY BRACKET (Left brace)
124.	7/12	¦		VERTICAL LINE
125.	7/13	}		RIGHT CURLY BRACKET (Right brace)
126.	7/14	~		TILDE
127.	7/15		DEL	DELETE

Characters in position 0/0 to 1/15, 4/0, 5/11, 5/12, 5/13, 6/0 and 7/11 to 7/15 are "other-characters" according to the definition in 4.1. Additional other-characters may occur in C1 and/or G1 set (see ECMA-35). The number of other-characters is implementation-dependent.

TABLE 2

Exception Codes

The following table specifies the values of the EXTYPE function corresponding to the exceptions specified in this Standard. Nonfatal exceptions are designated by an exclamation-mark (!). The numbers in parentheses following each exception refer to the sections in which that exception is specified.

Overflow (1000)

```
  1001  Overflow in evaluating numeric-constant (5.1, 15.1)
  1002  Overflow in evaluating numeric-expression (5.3)
  1003  Overflow in evaluating numeric-supplied-function (5.4)
  1004  Overflow in evaluating VAL (6.4)
  1005  Overflow in evaluating numeric-array-expression (7.2)
  1006  Overflow in numeric datum for (MAT) READ (10.1, 10.5)
! 1007  Overflow in numeric datum for (MAT) INPUT from terminal (10.2, 10.5)
  1008  Overflow in numeric data for file input (11.4)
  1009  Overflow during evaluation of DET or DOT (7.2)
  1010  Too many digits declared for fixed decimal (15.1, 15.2) (BASIC-2 only)
  1011  Overflow in fixed decimal assignment (15.1, 15.2) (BASIC-2 only)
  1051  Overflow in evaluating string-expression (6.3)
  1052  Overflow in evaluating string-array-expression (7.3)
  1053  Overflow in string datum for (MAT) READ (10.1, 10.5)
! 1054  Overflow in string datum for (MAT) (LINE) INPUT (10.2, 10.5)
  1105  Overflow in string datum for file input (11.4)
  1106  Overflow in string assignment (6.5, 9.1, 7.3)
```

Underflow errors (1500)

The following exceptions are recommended in the Remarks Sections, and are not mandatory.

```
! 1501  Numeric constant underflow (5.1)
! 1502  Numeric expression underflow (5.3)
! 1503  Function value underflow (5.4)
! 1504  VAL underflow (6.4)
! 1505  Array expression underflow (7.2)
! 1506  Numeric DATA underflow (10.1)
! 1507  Numeric input underflow (10.2, 10.5)
! 1508  File numeric input underflow (11.4)
```

Subscript errors (2000)

```
  2001  Subscript out of bounds (5.2, 6.2)
```

Mathematical error (3000)

```
  3001  Division by zero (5.3)
  3002  Negative number raised to nonintegral power (5.3)
  3003  Zero raised to negative power (5.3)
  3004  Logarithm of zero or negative number (5.4)
  3005  Square root of negative number (5.4)
  3006  Zero divisor specified for MOD or REMAINDER (5.4)
  3007  Argument of ACOS or ASIN not in range -1 <= x <= 1 (5.4)
  3008  Attempt to evaluate ANGLE(0,0) (5.4)
  3009  Attempt to invert a singular matrix, or loss of all significance in such attempt (7.2)
```

Uninitialized errors (3100)

The following exceptions are recommended in the Remarks Sections, and are not mandated.

! 3101 Uninitialized numeric-variable (5.2)
! 3102 Uninitialized string-variable (6.2)

Parameter error (4000)

4001 Argument of VAL not a numeric-constant (6.4)
4002 Argument of CHR$ out of range (6.4)
4003 Argument of ORD not a valid character or mnemonic (6.4)
4004 Index of SIZE out of range (7.1)
4005 Index in TAB less than one (10.3)
4006 Margin setting less than current zonewidth (10.3, 11.3)
4007 Index of ZONEWIDTH out of range (10.3, 11.3)
4008 Index of LBOUND out of range (7.1)
4009 Index of UBOUND out of range (7.1)
4010 Second argument of REPEAT$ < 0 (6.4)
4101 Value of the string-expression in a set-statement (13.1)
4301 Parameter type or count mismatch between chain-statement and corresponding program-name-line (9.3)
4302 Mismatched dimensions between chain array parameter and corresponding formal-array (9.3)
4303 Numeric parameters passed in chain having different ARITHMETIC options (9.3)

Storage exhausted (5000)

5001 Size of redimensioned array too large (7.2, 7.3, 10.5, 11.4)

Matrix errors (6000)

6001 Mismatched sizes in numeric-array-expression (7.2)
6002 Argument of DET not a square matrix (7.2)
6003 Argument of INV not a square matrix (7.2)
6004 Arguments to IDN do not specify square matrix (7.2)
6005 First index greater than second in redim, or index less than lower bound (7.2, 7.3, 10.5, 11.4)
6101 Mismatched sizes in string-array-expression (7.3)

File use errors (7000)

7001 Channel number not in range 0 <= c <= max (11.1)
! 7002 Channel zero in OPEN, CLOSE, ERASE, or with record-setter (11.1, 11.2)
7003 Nonzero channel in OPEN already active (11.1)
7004 Inactive channel in file statement other than OPEN or ASK (11.1, 11.2, 11.3, 11.4, 11.5)

7050 Keyed file OPEN with wrong collate sequence (11.1) (BASIC-2 only)
7051 LENGTH not greater than zero on OPEN (11.1)
7052 A device is opened as RELATIVE or KEYED (11.1) (BASIC-2 only)
7100 Unrecognizable file attribute in OPEN (11.1)
71xx Implementation-defined failures to provide access toe inaccordance with file attribute (11.1)

7202 The record-setter RECORD is used on a file opened with a file-organization other than RELATIVE (11.2) (BASIC-2 only)
7203 The record-setter KEY is used on a file opened with a file-organization other than KEYED (11.2) (BASIC-2 only)
7204 Record-setter SAME following DELETE, OPEN, or exception (11.2)
7205 Record-setter used on device without that capability (11.2)
7206 The index of a record-setter evaluates to an integer less than one (11.2) BASIC-2 only)
7207 A record-setter specifies an exact-search for the null string (11.2) (BASIC-2 only)
7301 Attempt to ERASE file not opened as OUTIN (11.1)
7302 Output not possible to INPUT file (11.3)
7303 Input not possible from OUTPUT file (11.4)
7305 Attempt to input nonexistent record (11.4)
7308 Attempt to write existing record (11.3)
7311 Attempt to erase a device without erase capability (11.1)
7312 Zonewidth or margin set for non-display file (11.3)
7313 Zonewidth or margin set for INPUT file (11.3)
7314 A write-statement or array-write-statement attempts to access a KEYED file, but does not specify an exact-search in its record-setter (11.3) (BASIC-2 only)
7315 A template-identifier is used on a file opened as DISPLAY or INTERNAL (11.3) (BASIC-2 only)
7316 A write-statement or array-write-statement does not have a template-identifier when attempting to access a file opened as NATIVE (11.3) (BASIC-2 only)
7317 (MAT) PRINT to INTERNAL file (11.3)
7318 (MAT) (LINE) INPUT from INTERNAL file (11.4)
7321 SKIP REST on stream file (11.4)
7322 A data modification statement attempts to access a file opened as INPUT or as OUTPUT (11.5) (BASIC-2 only)
7401 Attempt to trace to inactive channel (12.2)
7402 Attempt to trace to non-display-format or INPUT file (12.2)

Input-output errors (8000)

8001 (MAT) READ beyond end of data (10.1, 10.5)
! 8002 Too few data in input-reply (10.2, 10.5)
! 8003 Too many data in input-reply (10.2, 10.5)
8011 End-of-file encountered on input (11.4)
8012 Too few data in record (11.4)
8013 Too many data in record (11.4)
8101 Nonnumeric datum for (MAT) READ or INPUT of number from DISPLAY record (10.1, 10.5, 11.4)
! 8102 Syntactically incorrect input-reply from terminal (10.2, 10.5)
! 8103 Nonnumeric datum for (MAT) INPUT of number (10.2, 10.5)
8105 Syntactically incorrect input reply from file (11.4)
8120 Type mismatch on INTERNAL input (11.4)
8201 Invalid format-string (10.4, 10.5)
8202 No format-item in format-string for output list (10.4, 10.5)
! 8203 Format-item too short for output string (10.4)
! 8204 Exrad overflow (10.4)
8251 The string-expression of a template-identifier is not a syntactically correct template-element-list (11.3, 11.4, 11.5) (BASIC-2 only)
8252 An expression or array-element does not agree in type (numeric or string) with its associated TEMPLATE field-specifier (11.3, 11.4, 11.5) (BASIC-2 only)
8253 A template-element with a variable-field-count does not coincide with the first element of an array (11.3, 11.4, 11.5) (BASIC-2 only)
8254 There are not enough field-specifiers in a template-statement for all the expressions or array-elements (11.3, 11.4, 11.5) (BASIC-2 only)
8255 A numeric value has significant digits to the left of the available digit places in the field of a template (11.3, 11.5) (BASIC-2 only)

8256 A string value is longer than the length of its field in the template (11.3, 11.5) (BASIC-2 only)
8301 Record length exceeded on output to file (11.3, 11.5)
8302 Input from a record longer than RECSIZE (11.4)
8401 Timeout on (MAT) (LINE) INPUT (10.2, 10.5)
8402 Illegal numeric value specified for time-expression (10.2, 10.5)

Device errors (9000)

9xxx Implementation-defined device failures

Control errors (10000)

10001 Index out of range, no ELSE in on-goto- or on-gosub (8.2)
10002 Return without corresponding gosub or on-gosub (8.2)
10004 No case-block selected and no CASE ELSE (8.4)
10005 Attempt to chain to unavailable program (9.3)
! 10007 Break statement executed when debugging active (12.2)

Graphical errors (11000)

! 11051 Set-statement boundaries with zero width or height (13.1)
! 11052 Viewport boundary not in range (13.1)
! 11053 A boundary of the device window is not in the range [0, 1] (13.1)
! 11054 A boundary of the device viewport is not in the display space (13.1)
! 11056 Set-statement point style out of range (13.2)
! 11062 Set-statement line style out of range (13.2)
! 11085 Set statement color index out of range (13.2, 13.3)
11100 Graphic-output with LINES and fewer than two points, or with AREA and fewer than three points (13.3)

When an exception occurs in a program-unit and is not handled by an exception-handler in that program-unit, the exception which results at the line which invoked the program-unit shall be identified by the value 100000 plus the value specified above for the exception.

APPENDICES

APPENDIX 1

ORGANIZATION OF THE STANDARD

This Standard is organized into a number of sections, each of which covers a group of related features of BASIC. Each section is divided further to treat particular features of BASIC. The final subdivisions of each section are used as follows.

Subsection 1

General Description

This subsection briefly describes the features of BASIC to be treated.

Subsection 2

Syntax

The exact syntax of features of the language is describes in a modified context-free grammar or Backus-Naur Form. The details of this method of syntax specification are described in 3.1.

In order to keep the syntax reasonably simple the syntax specification will allow some constructions which, strictly speaking,are not legal according to this Standard; e.g., it will allow the generation of the statement

```
LET X = A(+1) + A(1,2)
```

in which the array A occurs with differing numbers of subscripts. Rather than ruling such constructions out by a more complicated formal syntax, this Standard instead rules them out by placing restrictions on that syntax.

The primary goal of the syntax is to define the notion of a program and its constituent parts. In addition the syntax defines several other items which are not needed for the definition of a program. These include the input-prompt, which is output to request input, the input-reply and line-input-reply, which are strings supplied in response to a request for input.

Subsection 3

Examples

A short list of valid examples that can be generated by the productions in Subsection 2 is given. The numbering of the examples corresponds to the numbering of the productions, and will not be consecutive if examples are not given for all rules.

Subsection 4

Semantics

The semantic rules in this Standard assign a meaning to the constructions generated according to the syntax.

Subsection 5

Exceptions

This subsection contains a list of those exception conditions which a standard-conforming implementation must recognize. Exception numbers (values of the EXTYPE function) are also given.

Subsection 6

Remarks

This subsection contains remarks which point out certain features of this Standard as well as remarks which make recommendations concerning the implementation of a BASIC language processor in an operating environment.

APPENDIX 2

SCOPE RULES

The scope of an entity is that part of the program where its name is recognized as referring to that object (as opposed to not being recognized at all, or recognized as referring to some other object). In general, an entity is known by only one name, and so the scope of recognition of its name is also the scope in which the object itself can be accessed. In the special case of parameter passing by reference, the same object is known by two different names, and so the object itself may be accessed outside the scope of its name.

In all cases, the indicated scope is the scope of the name of the object in question.

Object	Scope
1. non-parameter variable	program-unit
2. non-parameter array	program-unit
3. program-unit parameter	program-unit (*)
4. inter-proc-def-parameter	internal-proc-def (*)
5. inter-proc-def	program-unit
6. program-unit	program
7. DATA	program-unit
8. channel-number (non-zero)	program-unit
9. channel zero	program
10. IMAGE, TEMPLATE	program-unit (BASIC-2 only for TEMPLATE)
11. GOSUB stack	smaller of program-unit, internal-proc-def, when-lock (BASIC-2 only), or exception-handler (BASIC-2 only)
12. OPTIONs	program-unit
13. filenames	program
14. RND sequence	program
15. [deleted]	
16. [deleted]	
17. Graphic and PRINT set-object	program
18. line-number	program-unit
19. DEBUG and TRACE state	program-unit

Note

Even though the name is known only to the program-unit or internal-proc-def, when a parameter is passed by reference, the object denoted is common to both the invoked and invoking unit.

APPENDIX 3

IMPLEMENTATION-DEFINED FEATURES

A number of the features defined in this Standard have been left for definition by the implementer. However, this will not affect portability, provided that the limits recommended in the various sections are respected.

The way these features are implemented shall be defined in the user or system manual of the specific implementation.

The following is a list of implementation-defined features.

Subsection 2.3

- interpretation of syntactically illegal constructs
- format of error messages

Subsection 2.4

- format of exception messages
- hardware dependent exceptions
- order of exception detection in a line

Subsection 3.2

- certain semantic rules for native data

Subsection 4.1

- other-character
- coding for the native collating sequence

Subsection 4.2

- end-of-line
- maximum physical line length
- effect of parameter list in program-name-line of program not initiated by a chain-statement
- relationship of program-designator and program-name
- effect of non-standard programs

Subsection 4.4

- restrictions on identifiers for procedures compiled independently from the main program

Subsection 5.1

- precision and range of numeric-constants

Subsection 5.2

- initial value of numeric variables

Subsection 5.3

- order of evaluation of numeric-expressions

Subsection 5.4

- accuracy of evaluation of numeric functions
- value of MAXNUM and EPS
- pseudo-random number sequence
- availability of calendar and clock
- time zone for DATE and TIME

Subsection 5.6

- precision and range of numeric values
- precision and range of floating decimal arithmetic
- precision and range of native arithmetic
- accuracy of evaluation of numeric expressions

Subsection 6.2

- maximum length of undeclared string-variables
- initial value of string-variables

Subsection 6.4

- values of CHR$ for the native character set
- values of ORD for the native character set
- availability of calendar and clock
- time-zone for DATE$ and TIME$
- effect of UCASE$ and LCASE$ for other-characters

Subsection 6.6

- collating sequence under OPTION COLLATE NATIVE
- maximum length of declared string-variables without length-max

Subsection 7.1

- maximum lengths of strings in string-arrays with length-max

Subsection 7.2

- value of the inverse of a singular matrix

Subsection 9.1

- maximum length of string parameters without length-max
- value of a defined function when no value has been specified
- initial values of local variables in external functions

Subsection 9.2

- maximum length of string parameters without length-max
- effect of redimensioning an array parameter when an element of that array is also a parameter
- initial values of variables which are not formal parameters to a procedure

Subsection 9.3

- interpretation of the program-designator in a chain-statement
- interpretation of upper-case-letters and lower-case-letters in a program-designator
- initial values of variables in a chained-to program

Subsection 10.2

- input-prompt
- means of requesting input in batch mode
- values (minimum and maximum) and resolution of timeout-expression and time-inquiry

Subsection 10.3

- effect of invoking a function which causes printing while printing
- significance width for printing numeric representations
- exrad width for printing numeric representations
- effect of nonprinting characters on columnar position
- default margin
- default zonewidth
- treatment of trailing space at end of print line
- use of upper-case or lower-case "E" in exrad

Subsection 10.5

- treatment of re-supply of input to a re-dimensioned array

Section 11

- effect of some file operations on devices
- effect of certain combinations of file organization and type

Subsection 11.1

- maximum channel number
- whether a file name with different case letters (lower or upper) denotes the same file or different files
- effect of attempting to open an already oper. file
- number of channels which can be active simultaneously
- attempting to open a file with attributes different from those under which it was created
- attempting to reopen a file under a different ARITHMETIC option
- two program-units attempting to open a file under different attributes or options
- means of insuring preservation of file contents between runs
- effect of certain combinations of file organization and type
- length of records in INTERNAL and NATIVE (for BASIC-2 only) files
- maximum length of records when not specified or available
- value of DATUM for a SEQUENTIAL (BASIC-1) or non-STREAM (BASIC-2 only) file
- value of ask-attribute NAME for channel zero
- meaning of exception codes 7101-7199
- maximum length of keys for KEYED file (BASIC-2 only)

Subsection 11.2

- method of signifying that data is not available for input on a non-file device channel

Subsection 11.3

- means of indicating end-of-record
- default margin and zonewidth
- maximum margin and zonewidth supported
- accuracy of printed numeric values produced by PRINT for DISPLAY files

Subsection 11.4

- number of significant digits for values received from a numeric field in a NATIVE (for BASIC-2 only) file
- effect of input-control-items on files and nonterminal devices
- precision of numeric contents received from display files
- precision of numeric-values that can be retrieved without loss of precision from a NATIVE file (BASIC-2 only)
- retrieving a record from a NATIVE file having contents which are incompatible with the TEMPLATE (BASIC-2 only)
- use of fatal or nonfatal exception procedure on illegal input-reply

Subsection 11.5 (BASIC-2 only)

- effect of data modification statements on files that are not RELATIVE or KEYED
- use of SKIP in incompatible template for REWRITE

Subsection 12.1 (BASIC-2 only)

- value of EXTYPE for locally defined exceptions
- format of EXTEXT$ values

Subsection 12.2

- actions allowed by debugging system
- form of trace reports

Subsection 13.1

- manner of selecting a particular graphic display device
- effect of "inverted" windows

Subsection 13.2

- number of line styles available for graphics
- effect of line styles other than 1
- number of point styles available for graphics
- effect of point styles other than 3
- the number of color values available
- the color associated with each color value

Subsection 13.3

- character size, style, and orientation for graphic labels

Subsection 15.1 (BASIC-2 only)

- the maximum precision available for fixed decimal arithmetic
- the precision of fixed decimal expression and function evaluation
- the accuracy of fixed decimal expression and function evaluation
- definition of "significant digits"
- the accessibility of an INTERNAL format file to programs having different ARITHMETIC options
- the accessibility of a NATIVE format file to programs having different ARITHMETIC options

Table 1

- The number of additional other-characters.

It should be noted that implementation-defined features may cause the same program to produce different results on different implementations, for these and possibly other reasons :

- The logical flow of a program may be affected by the algorithm used for the pseudo-random number sequence.
- The logical flow of a program may be affected by the value of machine infinitesimal and/or the value of MAXNUM and/or the precision for numeric values.
- The initial value of variables may affect the logical flow of a program which contains logical errors.
- The order of evaluation of numeric-expressions may affect the logical flow of a program.

APPENDIX 4

INDEX OF SYNTACTIC OBJECTS

This Appendix indexes all occurences of terminal symbols and metanames in the syntax. Each reference has the form cc. s-pp, where cc. s indicates the section and subsection in which the metaname occurs and pp indicates the number of the production. An asterisk following a reference indicates that the metaname is defined in that production. **Symbols and metanames used only in BASIC-2 are shown in bold.**

Example: 4.1-07 refers to Section 4.1, Subsection 4.1.2 (the Syntax subsection), production rule 7.

0	4.1-07	7.1-09	
1	4.1-07	7.1-09	
2	4.1-07		
3	4.1-07		
4	4.1-07		
5	4.1-07		
6	4.1-07		
7	4.1-07		
8	4.1-07		
9	4.1-07		
A	4.1-09		
ABS	5.4-01		
ACCESS	11.1-08	11.1-22	
ACOS	5.4-01		
AND	8.1-03		
ANGLE	5.4-01	5.6-03	
AREA	13.2-04	13.3-05	
ARITHMETIC	5.6-03	15.1-01	
ASIN	5.4-01		
ASK	10.3-08	11.1-18	13.1-04
AT	13.3-12		
ATN	5.4.01		
B	4.1-09		
BASE	7.1-09		
BEGIN	11.2-05		
BREAK	12.2-02		
C	4.1-09		
CALL	9.2-14		
CASE	8.4-13	8.4-16	8.4-21
CAUSE	**12.1-13**		
CEIL	5.4-01		
CHAIN	9.3-01		
CHR	6.4-01		
CLEAR	13.2-02		
CLIP	13.1-01	13.1-06	
CLOSE	11.1-16		
COLLATE	6.6-01	**11.1-29**	**11.1-31**
COLOR	13.2-03	13.2-07	
CON	7.2-06		

CONTINUE	**12.1-11**				
COS	5.4-01				
COSH	5.4-01				
COT	5.4-01				
CSC	5.4.01				
D	4.1-09				
DATA	10.1-06				
DATE	5.4-01	6.4-01			
DATUM	11.1-22				
DEBUG	12.2-01				
DECIMAL	5.6-03				
DECLARE	5.6-04				
DEF	9.1-05	9.1-07	9.1-20	**15.2-07**	
DEG	5.4-01				
DEGREES	5.6-03				
DELETE	**11.5-06**				
DET	7.2-10				
DEVICE	13.1-01	13.1-06			
DIM	7.1-01				
DISPLAY	11.4-14				
DO	8.3-04	8.3-07			
DOT	7.2-10				
E	4.1-09	5.1-08	**11.3-N22**		
ELAPSED	10.2-07				
ELSE	8.2-03	8.2-06	8.4-01	8.4-09	8.4-21
ELSEIF	8.4-07				
END	4.2-18	8.4-10	8.4-22	9.1-13	9.2-10
	11.2-05	**12.1-07**	**12.1-17**		
EPS	5.4-01				
ERASABLE	11.1-22				
ERASE	11.1-17				
EXCEPTION	**12.1-03**	**12.1-09**	**12.1-13**		
EXIT	8.3-07	8.3-18	9.1-18	9.2-11	**12.1-12**
EXLINE	**12.1-18**				
EXP	5.4-01				
EXTERNAL	9.1-15	9.1-22	9.2-13	9.2-19	**15.2-06**
EXTEXT	**12.1-19**				
EXTYPE	**12.1-18**				
F	4.1-09				
FILETYPE	11.1-22				
FIXED	5.6-03	**15.1-01**			
FOR	8.3-12	8.3-18			
FP	5.4-01				
FUNCTION	9.1-12	9.1-13	9.1-15	9.1-18	9.1-21
	9.1-22	**15.2-05**	**15.2-06**		
G	4.1-09				
GO	8.2-02	8.2-03	8.2-04	8.2-06	
GOSUB	8.2-04	8.2-06			
GOTO	8.2-02	8.2-03			
GRAPH	13.3-04				
H	4.1-09				

HANDLER	**12.1-12**	**12.1-16**	**12.1-17**		
I	4.1-09				
IDN	7.2-06				
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IMAGE	10.4-05				
IN	**12.1-03**				
INPUT	10.2-01	10.2-08	10.5-04	10.5-06	11.1-08
	11.4-01	11.4-02	11.4-03	11.4-04	
INT	5.4-01				
INTERNAL	11.1-14				
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IP	5.4-01				
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J	4.1-09				
K	4.1-09				
KEY	**11.1-31**	**11.2-10**			
KEYED	**11.1-24**				
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LBOUND	7.1-12				
LCASE	6.4-01				
LEN	6.4-02				
LENGTH	11.1-15				
LET	5.5-02	6.5-02	9.1-16	9.1-17	
LINE	10.2-08	10.5-06	11.4-03	11.4-04	13.2-05
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LOG	5.4-01				
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LOG2	5.4-01				
LOOP	8.3-09				
LTRIM	6.4-01				
M	4.1-09				
MARGIN	10.3.07	10.3-10	11.1-22	11.3-05	
MAT	7.2-02	7.3-02	10.5-01	10.5-04	10.5-06
	10.5-09	11.3-02	11.3-07	11.4-02	
	11.4-04	11.4-08	**11.5-03**		
MAX	5.4-01	13.2-07			
MAXLEN	6.4-03				
MAXNUM	5.4-01				
MAXSIZE	7.1-12				
MIN	5.4-01				
MISSING	10.1-03				
MOD	5.4-01				
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NAME	11.1-01	11.1-22			
NATIVE	5.6-03	6.6-01	**11.1-29**	**11.1-N26**	
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O	4.1-09				
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ON	8.2-03	8.2-06	12.2-01	12.2-03	
OPEN	11.1-01				
OPTION	5.6-01				
OR	8.1-02				
ORD	6.4-02				
ORGANIZATION	11.1-09	11.1-22			
OUTIN	11.1-08				
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PI	5.4-01				
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POS	6.4-02				
PRINT	10.3-01	10.4-01	10.5-09	11.3-01	11.3-02
PROGRAM	4.2-02				
PROMPT	10.2-04				
Q	4.1-09				
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RAD	5.4-01				
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RELATIVE	**11.1-24**				
REM	4.3-01				
REMAINDER	5.4-01				
REPEAT	6.4-01				
REST	11.1-17	11.4-01	11.4-07		
RESTORE	10.1-05				
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simple-string-variable 6.2-02 6.2-03* 6.2-07 6.4-03 6.6-06
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string-array-declaration 7.1-03 7.1-08* 7.1-10
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string-array-expression 7.3-02 7.3-03*
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string-function-let-statement 4.2-12 9.1-17*

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string-identifier 4.4-01 4.4-04* 6.2-03 6.2-05 9.1-08
string-let-statement 6.5-01 6.5-02*
string-primary 6.3-02 6.3-03* 7.3-03 7.3-05
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string-variable 6.2-01 6.2-02* 6.3-03 6.5-03 13.1-06
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template-identifier **11.3-N12** **11.3-N13*** **11.4-N11** **11.5-N9**
template-statement **11.3-N14** **11.3-N15***
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then-block 8.4-03 8.4-05*
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when-block	**12.1-02**	**12.1-04***	**12.1-08**
when-line	**4.2-22**	**12.1-02**	**12.1-03***
when-use-block	**12.1-01**	**12.1-02***	
when-use-name-block	**12.1-01**	**12.1-08***	
when-use-name-line	**4.2-22**	**12.1-08**	**12.1-09***
write-control	11.3-06	11.3-07	11.3-08*
write-control-item	11.3-08	11.3-09*	**11.3-N12***
write-statement	4.2-12	11.3-06*	
x	4.1-10		
y	4.1-10		
z	4.1-10		

APPENDIX 5

COMBINED LIST OF PRODUCTION RULES

```
access-mode                 = ACCESS (INPUT / OUTPUT / OUTIN / string-expression)
actual-array                = array-name
array-assignment            = numeric-array-assignment / string-array-assignment
array-declaration           = numeric-array-declaration / string-array-declaration
array-input-statement       = MAT INPUT input-modifier-list? (redim-array-list /
                              variable-length-vector) / MAT INPUT
                              channel-expression input-control colon
                              (redim-array-list / variable-length-vector)
array-line-input-statement  = MAT LINE INPUT input-modifier-list?
                              redim-string-array-list / MAT LINE INPUT
                              channel-expression input-control colon
                              redim-string-array-list
array-list                  = array-name (comma array-name)*
array-name                  = numeric-array / string-array
array-output-list           = array-name (comma array-name)* semicolon?
array-print-list            = array-name (print-separator array-name)*
                              print-separator?
array-print-statement       = MAT PRINT (array-print-list / (USING image colon
                              array-output-list) / MAT PRINT
                              channel-expression print-control colon
                              (array-print-list / array-output-list)
array-read-statement        = MAT READ (missing-recovery colon)? redim-array-list
                              / MAT READ channel-expression read-control
                              colon redim-array-list
array-rewrite-statement     = MAT REWRITE channel-expression rewrite-control colon
                              array-list
array-write-statement       = MAT WRITE channel-expression write-control colon
                              array-list
ask-attribute-name          = core-attribute-name / enhanced-attribute-name
ask-io-item                 = (MARGIN / ZONEWIDTH) numeric-variable
ask-io-list                 = ask-io-item (comma ask-io-item)*
ask-item                    = ask-attribute-name variable variable*
ask-item-list               = ask-item (comma ask-item)*
ask-object                  = WINDOW boundary-variables / VIEWPORT
                              boundary-variables / DEVICE WINDOW
                              boundary-variables / DEVICE VIEWPORT
                              boundary-variables / CLIP string variable /
                              DEVICE SIZE numeric-variable comma
                              numeric-variable comma string-variable /
                              primitive-1 STYLE numeric-variable /
                              primitive-2 COLOR numeric-variable / MAX COLOR
                              numeric-variable
ask-statement               = ASK ask-io-list / ASK channel-setter ask-item-list /
                              ASK ask-object status-clause?
block                       = statement-line / loop / if-block / select-block /
                              image-line
bound-argument              = left-parenthesis actual-array (comma index)?
                              right-parenthesis
boundaries                  = boundary comma boundary comma boundary comma boundary
boundary                    = numeric-expression
```

```
boundary-variables          = numeric-variable comma numeric-variable comma
                              numeric-variable comma numeric-variable
bounds                      = left-parenthesis bounds-range (comma bounds-range)*
                              right-parenthesis
bounds-range                = signed-integer TO signed-integer / signed-integer
break-statement             = BREAK
call-statement              = CALL subprogram-name procedure-argument-list?
case-block                  = case-line block*
case-else-block             = case-else-line block*
case-else-line              = line-number CASE ELSE tail
case-item                   = constant / range
case-line                   = line-number case-statement tail
case-list                   = case-item (comma case-item)*
case-statement              = CASE case-list
cause-statement             = CAUSE EXCEPTION exception-type
chain-statement             = CHAIN programm-designator (WITH function-arg-list)?
channel-expression          = number-sign index
channel-number              = number-sign integer
channel-setter              = channel-expression colon
character                   = quotation-mark / non-quote-character
clear-statement             = CLEAR
close-statement             = CLOSE channel-expression
collate-sequence            = COLLATE (STANDARD / NATIVE / string-expression)
comparison                  = numeric-expression relation numeric-expression /
                              string-expression relation string-expression
concatenation               = ampersand
conditional-statement       = if-statement / on-gosub-statement / on-goto-statement
conjunction                 = relational-term (AND relational-term)*
constant                    = numeric-constant / string-constant
control-transfer            = gosub-statement / goto-statement / if-statement /
                              io-recovery / on-gosub-statement
                              /on-goto-statement
control-variable            = simple-numeric-variable
coordinate-pair             = numeric-expression comma numeric-expression
core-attribute-name         = ACCESS / DATUM / ERASABLE / FILETYPE / MARGIN / NAME
                              / ORGANIZATION / POINTER / RECSIZE / RECTYPE /
                              SETTER / ZONEWIDTH
core-file-attribute         = access-mode / file-organization / record-type /
                              record-size
core-file-org-value         = SEQUENTIAL / STREAM
core-record-setter          = BEGIN / END / NEXT / SAME
core-record-type-value      = DISPLAY / INTERNAL
data-list                   = datum (comma datum)*
data-statement              = DATA data-list
datum                       = constant / unquoted-string
debug-statement             = DEBUG (ON / OFF)
declarative-statement       = data-statement / declare-statement /
                              dimension-statement / null-statement /
                              option-statement / remark-statement /
                              template-statement
declare-statement           = DECLARE type-declaration
def-statement               = numeric-def-statement / string-def-statement
def-type                    = DEF function-list
defined-function            = numeric-defined-function / string-defined-function /
                              fixed-defined-function
delete-control              = (comma delete-control-item)*
```

```
delete-control-item          = missing-recovery / record-setter
delete-statement             = DELETE channel-expression delete-control
detached-handler             = handler-line exception-handler end-handler-line
digit                        = 0/1/2/3/4/5/6/7/8/9
digit-place                  = asterisk / number-sign / percent-sign
dimension-list               = array-declaration (comma array-declaration)*
dimension-statement          = DIM dimension-list
disjunction                  = conjunction (OR conjunction)*
do-body                      = block* loop-line
do-line                      = line-number do-statement tail
do-loop                      = do-line do-body
do-statement                 = DO exit-condition?
double-quote                 = quotation-mark quotation-mark
e-format-item                = (i-format-item / f-format-item) circumflex-accent
                               circumflex-accent circumflex-accent
                               circumflex-accent*
else-block                   = else-line block*
else-line                    = line-number ELSE tail
elseif-block                 = elseif-then-line block*
elseif-then-line             = line-number ELSEIF relational-expression THEN tail
end-function-line            = line-number END FUNCTION tail
end-handler-line             = line-number END HANDLER tail
end-if-line                  = line-number END IF tail
end-line                     = line-number end-statement tail
end-of-line                  = (implementation-defined)
end-select-line              = line-number END SELECT tail
end-statement                = END
end-sub-line                 = line-number end-sub-statement tail
end-sub-statement            = END SUB
end-when-line                = line-number END WHEN tail
enhanced-attribute-name      = RECORD / KEY / COLLATE
enhanced-file-attribute      = collate-sequence
enhanced-file-org-value      = RELATIVE / KEYED
enhanced-record-setter       = RECORD index / KEY (exact-search / inexact-search)
                               string-expression
enhanced-record-type-value   = NATIVE
equality-relation            = equals-sign / not-equals
erase-statement              = ERASE REST? channel-expression
exception-handler            = block*
exception-type               = index
exit-condition               = (WHILE / UNTIL) relational-expression
exit-do-statement            = EXIT DO
exit-for-statement           = EXIT FOR
exit-function-statement      = EXIT FUNCTION
exit-handler-statement       = EXIT HANDLER
exit-sub-statement           = EXIT SUB
expression                   = numeric-expression / string-expression
expression-list              = expression (comma expression)*
exrad                        = E sign? integer
external-function-def        = external-function-line unit-block* end-function-line
external-function-line       = line-number EXTERNAL FUNCTION
                               (numeric-defined-function /
                               (string-defined-function length-max?))
                               function-parm-list? tail / line-number
                               EXTERNAL FUNCTION fixed-defined-function
                               function-parm-list? tail
```

```
external-function-type      = EXTERNAL FUNCTION function-list
external-sub-def            = external-sub-line unit-block* end-sub-line
external-sub-line           = line-number EXTERNAL sub-statement tail
external-sub-type           = EXTERNAL SUB sub-list
f-format-item               = period number-sign number-sign* / i-format-item
                              period number-sign*
factor                      = primary (circumflex-accent primary)*
field-specifier             = numeric-specifier / string-specifier
file-attribute              = core-file-attribute
file-attribute-list         = (comma file-attribute)*
file-name                   = string-expression
file-organization           = ORGANIZATION (file-organization-value /
                              string-expression)
file-organization-value     = core-file-org-value / enhanced-file-org-value
fixed-declaration           = simple-numeric-variable fixed-point-type? /
                              numeric-array-declaration fixed-point-type?
fixed-defined-function      = numeric-defined-function
fixed-field-count           = SKIP? (integer OF)?
fixed-formal-array          = formal-array fixed-point-type
fixed-point-size            = integer-size period? / integer-size? period
                              fraction-size
fixed-point-type            = asterisk fixed-point-size
floating-characters         = (plus-sign* / minus-sign*) dollar-sign? /
                              dollar-sign* (plus-sign / minus-sign)?
for-body                    = block* next-line
for-line                    = line-number for-statement tail
for-loop                    = for-line for-body
for-statement               = FOR control-variable equals-sign initial-value TO
                              limit (STEP increment)?
formal-array                = array-name left-parenthesis comma* right-parenthesis
format-item                 = (justifier? floating-characters (i-format-item /
                              f-format-item / e-format-item)) / justifier
format-string               = literal-string (format-item literal-string)*
formatted-print-list        = USING image (colon output-list)?
fraction                    = period integer
fraction-size               = integer
function-arg-list           = left-parenthesis function-argument (comma
                              function-argument)* right-parenthesis
function-argument           = expression / actual-array
function-def                = internal-function-def / external-function-def
function-list               = defined-function (comma defined-function)*
function-parameter          = simple-variable / formal-array /
                              numeric-fixed-parameter
function-parm-list          = left-parenthesis function-parameter (comma
                              function-parameter)* right-parenthesis
geometric-object             = POINTS / LINES / AREA
geometric-statement         = graphics-verb geometric-object colon point-list
gosub-statement             = (GOSUB / GO SUB) line-number
goto-statement              = (GOTO / GO TO) line-number
graphic-output-statement    = geometric-statement / graphic-text-statement
graphic-text-statement      = graphic-verb TEXT initial-point (comma USING image
                              colon expression-list / colon
                              string-expression)
graphic-verb                = GRAPH
handler-line                = line-number HANDLER handler-name tail
handler-name                = routine-identifier
```

```
handler-return-statement      = RETRY / CONTINUE
i-format-item                 = digit-place digit-place* (comma digit-place
                                digit-place*)*
identifier                    = numeric-identifier / string-identifier /
                                routine-identifier
identifier-character          = letter / digit / underline
if-block                      = if-then-line then-block elseif-block* else-block?
                                end-if-line
if-clause                     = imperative-statement / line-number
if-statement                  = IF relational-expression THEN if-clause (ELSE
                                if-clause)?
if-then-line                  = line-number IF relational-expression THEN tail
image                         = line-number / string-expression
image-line                    = line-number IMAGE colon format-string end-of-line
imperative-statement          = array-assignment / array-input-statement /
                                array-line-input-statement /
                                array-print-statement / array-read-statement /
                                array-write-statement / ask-statement /
                                break-statement / call-statement /
                                cause-statement / chain-statement /
                                close-statement / debug-statement /
                                erase-statement / exit-do-statement /
                                exit-for-statement / exit-function-statement /
                                exit-sub-statement / gosub-statement /
                                goto-statement / input-statement /
                                let-statement / line-input-statement /
                                numeric-function-let-statement /
                                open-statement / print-statement /
                                randomize-statement / read-statement /
                                restore-statement / return-statement /
                                set-statement / stop-statement /
                                string-function-let-statement /
                                trace-statement / write-statement /
                                rewrite-statement / array-rewrite-statement /
                                delete-statement / clear-statement /
                                graphic-output-statement
increment                     = numeric-expression
index                         = numeric-expression
initial-number                = line-number
initial-point                 = comma AT coordinate-pair
initial-value                 = numeric-expression
input-control                 = (comma input-control-item)*
input-control-item            = core-record-setter / missing-recovery /
                                prompt-specifier / timeout-expression /
                                time-inquiry
input-modifier                = prompt-specifier / timeout-expression / time-inquiry
input-modifier-list           = input-modifier (comma input-modifier)* colon
input-prompt                  = [implementation-defined]
input-reply                   = data-list comma? end-of-line
input-statement               = INPUT input-modifier-list? variable-list / INPUT
                                channel-expression input-control colon
                                variable-list (comma SKIP REST)?
integer                       = digit digit*
integer-size                  = integer
internal-def-line             = line-number def-statement tail
```

```
internal-function-def          = internal-def-line / internal-function-line block*
                                 end-function-line
internal-function-line         = line-number FUNCTION (numeric-defined-function /
                                 (string-defined-function length-max?))
                                 function-parm-list? tail / line-number
                                 FUNCTION fixed-defined-function
                                 function-parm-list? tail
internal-function-type         = FUNCTION function-list
internal-proc-def              = internal-function-def / internal-sub-def /
                                 detached-handler
internal-sub-def               = internal-sub-line block* end-sub-line
internal-sub-line              = line-number sub-statement tail
internal-sub-type              = SUB sub-list
io-qualifier                   = INPUT / OUTPUT / OUTIN
io-recovery                    = missing-recovery / not-missing-recovery
io-recovery-action             = exit-do-statement / exit-for-statement / line-number
justifier                      = greater-than-sign / less-than-sign
length-max                     = asterisk integer
let-statement                  = numeric-let-statement / string-let-statement
letter                         = upper-case-letter / lower-case-letter
limit                          = numeric-expression
line                           = case-line / case-else-line / do-line / else-line /
                                 elseif-then-line / end-function-line /
                                 end-handler-line / end-if-line / end-line /
                                 end-select-line / end-sub-line / end-when-line
                                 / external-function-line / external-sub-line /
                                 for-line / handler-line / internal-def-line /
                                 internal-function-line / internal-sub-line /
                                 if-then-line / image-line / loop-line /
                                 next-line / program-name-line / remark-line /
                                 select-line / statement-line / use-line /
                                 when-use-name-line
line-continuation              = ampersand space* tail ampersand
line-input-reply               = character* end-of-line
line-input-statement           = LINE INPUT input-modifier-list? string-variable-list
                                 / LINE INPUT channel-expression input-control
                                 colon string-variable-list
line-number                    = digit digit*
literal-item                   = letter /digit / apostrophe / colon / equals-sign /
                                 exclamation-mark / left-parenthesis /
                                 question-mark / right-parenthesis / semicolon
                                 /slant / space / underline
literal-string                 = literal-item*
loop                           = do-loop / for-loop
loop-line                      = line-number loop-statement tail
loop-statement                 = LOOP exit-condition?
lower-case-letter              = a / b / c / d / e / f / g / h / i / j / k / l / m /
                                 n / o / p / q / r / s / t / u / v / w / x /
                                 y / z
main-program                   = unit-block* end-line
maxsize-argument               = left-parenthesis actual-array right-parenthesis
missing-recovery               = IF MISSING THEN io-recovery-action
multiplier                      = asterisk / slant
next-line                      = line-number next-statement tail
next-statement                 = NEXT control-variable
```

```
non-quote-character          = ampersand / apostrophe / asterisk / circumflex-accent
                               / colon / comma / dollar-sign / equals-sign /
                               exclamation-mark / greater-than-sign /
                               left-parenthesis / less-than-sign /
                               number-sign / percent-sign / question-mark /
                               right-parenthesis / semicolon / slant /
                               underline / unquoted-string-character
not-equals                   = less-than-sign greater-than-sign / greater-than-sign
                               less-than-sign
not-greater                  = less-than-sign equals-sign / equals-sign
                               less-than-sign
not-less                     = greater-than-sign equals-sign / equals-sign
                               greater-than-sign
not-missing-recovery         = IF THERE THEN io-recovery-action
numeric-array                = numeric-identifier
numeric-array-assignment     = MAT numeric-array equals-sign
                               numeric-array-expression
numeric-array-declaration    = numeric-array bounds
numeric-array-element        = numeric-array subscript-part
numeric-array-expression     = (numeric-array numeric-array-operator)? numeric-array
                               / scalar-multiplier numeric-array /
                               numeric-array-value /
                               numeric-array-function-ref
numeric-array-function-ref   = (TRN / INV) left-parenthesis numeric-array
                               right-parenthesis
numeric-array-operator       = sign / asterisk
numeric-array-value          = scalar-multiplier? (CON / IDN / ZER) redim?
numeric-constant             = sign? numeric-rep
numeric-declaration          = simple-numeric-variable / numeric-array-declaration
numeric-def-statement        = DEF numeric-defined-function function-parm-list?
                               equals-sign numeric-expression / DEF
                               fixed-defined-function function-parm-list?
                               equals-sign numeric-expression
numeric-defined-function     = numeric-identifier
numeric-expression           = sign? term (sign term)*
numeric-field-size           = fixed-point-size / E
numeric-fixed parameter      = simple-numeric-variable fixed-point-type /
                               fixed-formal-array
numeric-function             = numeric-defined-function / numeric-supplied-function
numeric-function-let-statement= LET numeric-defined-function equals-sign
                               numeric-expression
numeric-function-ref         = numeric-function function-arg-list? / MAXLEN
                               left-parenthesis (simple-string-variable /
                               string-array) right-parenthesis / MAXSIZE
                               maxsize-argument / SIZE bound-argument /
                               LBOUND bound-argument / UBOUND bound-argument
                               / DET (left-parenthesis numeric-array
                               right-parenthesis) / DOT left-parenthesis
                               numeric-array comma numeric-array
                               right-parenthesis
numeric-identifier           = letter identifier-character*
numeric-let-statement        = LET numeric-variable-list equals-sign
                               numeric-expression
numeric-rep                  = significand exrad?
numeric-specifier            = NUMERIC asterisk numeric-field-size
```

```
numeric-supplied-function   = ABS / ACOS / ANGLE / ASIN / ATN / CEIL / COS / COSH /
                              COT / CSC / DATE / DEG / EPS / EXP / FP /
                              MAXNUM / INT / IP / LOG / LOG10 / LOG2 / MAX /
                              MIN / MOD / PI / RAD / REMAINDER / RND / ROUND
                              / SEC / SGN / SIN / SINH / SQR / TAN / TANH /
                              TIME / TRUNCATE / LEN / ORD / POS / VAL /
                              EXLINE / EXTYPE
numeric-time-expression     = numeric-expression
numeric-type                = NUMERIC numeric-declaration (comma
                              numeric-declaration)* / NUMERIC
                              fixed-point-type? fixed-declaration (comma
                              fixed-declaration)*
numeric-variable            = simple-numeric-variable / numeric-array-element
numeric-variable-list       = numeric-variable (comma numeric-variable)*
on-gosub-statement          = ON index (GOSUB / GO SUB) line-number (comma
                              line-number)* ELSE imperative-statement)?
on-goto-statement           = ON index (GOTO / GO TO) line-number (comma
                              line-number)* (ELSE imperative-statement)?
open-statement              = OPEN channel-setter NAME file-name
                              file-attribute-list
option                      = ARITHMETIC (DECIMAL / NATIVE) / ANGLE (DEGREES /
                              RADIANS) / COLLATE (NATIVE / STANDARD) / BASE
                              (0 / 1) / ARITHMETIC FIXED fixed-point-type
option-list                 = option (comma option)*
option-statement            = OPTION option-list
other-character             = [implementation-defined]
output-list                 = expression (comma expression)* semicolon?
plain-string-character      = digit / letter / period / plus-sign / minus-sign
point-list                  = coordinate-pair (semicolon coordinate-pair)*
pointer-items               = (pointer-control / io-recovery / pointer-control
                              comma io-recovery)
primary                     = numeric-rep / numeric-variable / numeric-function-ref
                              / left-parenthesis numeric-expression
                              right-parenthesis
primitive-1                 = POINT / LINE
primitive-2                 = primitive-1 / TEXT / AREA
print-control               = (comma print-control-item)*
print-control-item          = core-record-setter / enhanced-record-setter /
                              not-missing-recovery / USING image
print-item                  = expression / tab-call
print-list                  = (print-item? print-separator)* print-item?
print-separator             = comma / semicolon
print-statement             = PRINT print-list / PRINT formatted-print-list / PRINT
                              channel-expression print-control (colon
                              (print-list / output-list))?
procedure                   = external-function-def / external-sub-def
procedure-argument          = expression / actual-array / channel-expression
procedure-argument-list     = left-parenthesis procedure-argument (comma
                              procedure-argument)* right-parenthesis
procedure-parameter         = simple-variable / formal-array / channel-number /
                              numeric-fixed-parameter
procedure-parm-list         = left-parenthesis procedure-parameter (comma
                              procedure-parameter)*
procedure-part              = remark-line* procedure
program                     = program-name-line? main-program procedure-part*
program-designator          = string-expression
```

```
program-line                = line-number (character / line-continuation)*
                              end-of-line
program-name                = routine-identifier
program-name-line           = line-number PROGRAM program-name function-parm-list?
                              tail
program-unit                = main-program / procedure
prompt-specifier            = PROMPT string-expression
protection-block            = when-use-block / when-use-name-block
quoted-string               = quotation-mark quoted-string-character*
                              quotation-mark
quoted-string-character     = double-quote / non-quote-character
randomize-statement         = RANDOMIZE
range                       = (constant TO / IS relation) constant
read-control                = (comma read-control-item)*
read-control-item           = record-setter / missing-recovery /
                              template-identifier
read-statement              = READ (missing-recovery colon)? variable-list / READ
                              channel-expression read-control colon
                              variable-list (comma SKIP REST)?
record-setter               = core-record-setter / enhanced-record-setter
record-size                 = RECSIZE (VARIABLE / string-expression) (LENGTH
                              index)?
record-type                 = RECTYPE (record-type-value / string-expression)
record-type-value           = core-record-type-value / enhanced-record-value
redim                       = left-parenthesis redim-bounds (comma redim-bounds)*
                              right-parenthesis
redim-array                 = array-name redim?
redim-array-list            = redim-array (comma redim-array)*
redim-bounds                = (index TO)? index
redim-numeric-array         = numeric-array redim?
redim-string-array          = string-array redim?
redim-string-array-list     = redim-string-array (comma redim-string-array)*
relation                    = equality-relation / greater-than-sign /
                              less-than-sign / not-greater / not-less
relational-expression       = disjunction
relational-primary          = comparison / left-parenthesis relational-expression
                              right-parenthesis
relational-term             = NOT? relational-primary
remark-line                 = line-number (null-statement / remark-statement)
                              end-of-line
remark-statement            = REM remark-string
remark-string               = character*
restore-statement           = RESTORE line-number
return-statement            = RETURN
rewrite-control             = (comma rewrite-control-item)*
rewrite-control-item        = missing-recovery / record-setter /
                              template-identifier
rewrite-statement           = REWRITE channel-expression rewrite-control colon
                              expression list
routine-identifier          = letter identifier-character*
scalar-multiplier           = primary asterisk
select-block                = select-line remark-line* case-block case-block*
                              case-else-block? end-select-line
select-line                 = line-number select-statement tail
select-statement            = SELECT CASE expression
```

```
set-object                    = (MARGIN / ZONEWIDTH) index / channel-setter
                                pointer-items / channel-setter (MARGIN /
                                ZONEWIDTH) index / WINDOW boundaries /
                                VIEWPORT boundaries / DEVICE WINDOW boundaries
                                / DEVICE VIEWPORT boundaries / CLIP
                                string-expression / primitive-1 STYLE index /
                                primitive-2 COLOR index
set-statement                 = SET set-object
sign                          = plus-sign / minus-sign
signed-integer                = sign? integer
significand                   = integer period? / integer? fraction
simple-numeric-variable       = numeric-identifier
simple-string-declaration     = simple-string-variable length-max?
simple-string-variable        = string-identifier
simple-variable               = simple-numeric-variable / simple-string-variable
statement                     = declarative-statement / imperative-statement /
                                conditional-statement
statement-line                = line-number statement tail
status-clause                 = STATUS numeric-variable
stop-statement                = STOP
string-array                  = string-identifier
string-array-assignment       = MAT string-array substring-qualifier? equals-sign
                                string-array-expression
string-array-declaration      = string-array bounds
string-array-element          = string-array subscript-part
string-array-expression       = string-array-primary (concatenation
                                string-array-primary)? / string-primary
                                concatenation string-array-primary /
                                string-array-primary concatenation
                                string-primary / string-array-value
string-array-primary          = string-array substring-qualifier?
string-array-value            = (string-primary concatenation)?
string-constant               = quoted-string
string-declaration            = simple-string-declaration / string-array-declaration
                                length-max?
string-def-statement          = DEF string-defined-function length-max?
                                function-parm-list? equals-sign
                                string-expression
string-defined-function       = string-identifier
string-expression             = string-primary (concatenation string-primary)*
string-field-size             = integer
string-function               = string-defined-function / string-supplied-function
string-function-let-statement = LET string-defined-function equals-sign
                                string-expression
string-function-ref           = string-function function-arg-list?
string-identifier             = letter identifier-character* dollar-sign
string-let-statement          = LET string-variable-list equals-sign
                                string-expression
string-primary                = string-constant / string-variable /
                                string-function-ref / left-parenthesis
                                string-expression right-parenthesis
string-specifier              = STRING asterisk string-field-size
string-supplied-function      = (CHR / DATE / LCASE / LTRIM / REPEAT / RTRIM / STR /
                                TIME / UCASE / USING) dollar-sign / EXTEXT
                                dollar-sign
```

```
string-type                 = STRING length-max? string-declaration (comma
                              string-declaration)*
string-variable             = (simple-string-variable / string-array-element)
                              substring-qualifier?
string-variable-list        = string-variable (comma string-variable)*
sub-list                    = subprogram-name (comma subprogram-name)*
sub-statement               = SUB subprogram-name procedure-parm-list?
subprogram-def              = internal-sub-def / external-sub-def
subprogram-name             = routine-identifier
subscript                   = index
subscript-part              = left-parenthesis subscript (comma subscript)*
                              right-parenthesis
substring-qualifier         = left-parenthesis index colon index right-parenthesis
tab-call                    = TAB left-parenthesis index right-parenthesis
tail                        = tail-comment? end-of-line
template-element            = fixed-field-count (field-specifier / left-parenthesis
                              template-element-list right-parenthesis) /
                              variable-field-count field-specifier
template-element-list       = template-element (comma template-element)*
template-identifier         = WITH (line-number / string-expression)
template-statement          = TEMPLATE colon template-element-list
term                        = factor (multiplier factor)*
then-block                  = block*
time-expression             = numeric-time-expression / string-time-expression
time-inquiry                = ELAPSED numeric-variable
timeout-expression          = TIMEOUT numeric-time-expression
trace-statement             = TRACE ON (TO channel-expression)?
type-declaration            = numeric-type / string-type / def-type /
                              internal-function-type /
                              external-function-type / internal-sub-type /
                              external-sub-type
unit-block                  = internal-proc-def / block
unquoted-string             = plain-string-character / plain-string-character
                              unquoted-string-character*
                              plain-string-character
unquoted-string-character   = space / plain-string-character
upper-case-letter           = A / B / C / D / E / F / G / H / I / J / K / L / M /
                              N / O / P / Q / R / S / T / U / V / W / X /
                              Y / Z
use-line                    = line-number USE tail
variable                    = numeric-variable / string-variable
variable-field-count        = question-mark OF
variable-length-vector      = array-name left-parenthesis question-mark
                              right-parenthesis
variable-list               = variable (comma variable)*
when-block                  = block*
when-line                   = line-number WHEN EXCEPTION IN tail
when-use-block              = when-line when-block use-line exception-handler
                              end-when-line
when-use-name-block         = when-use-name-line when-block end-when-line
when-use-name-line          = line-number WHEN EXCEPTION USE handler-name tail
write-control                = (comma write-control-item)*
write-control-item          = record-setter / not-missing-recovery /
                              template-identifier
write-statement             = WRITE channel-expression write-control colon
                              expression-list
```

APPENDIX 6

DIFFERENCES BETWEEN MINIMAL BASIC AND ECMA BASIC

The differences between Minimal BASIC and ECMA BASIC (either BASIC-1 or BASIC-2) may be classified as either syntactic incompatibilities or semantic (run-time) differences.

Syntactic Differences

With the following exception, this Standard forms an upward compatible syntactic extension of Standard ECMA-55, Minimal BASIC.

* All arrays in a standard conforming program must be dimensioned before use.

Programs written in Minimal BASIC may therefore produce errors when run on an implementation that conforms to this Standard. Such programs may be modified to run correctly as follows:

- identify all arrays which are implicitly dimensioned;
- insert a dimension-statement covering each such array with upper bound equal to 10. Each such dimension-statement must follow an option-base-statement, if any, and precede any reference to the arrays contained in the dimension-statement.

For example, if a vector A is used in a Minimal BASIC program but is not dimensioned there, inserting

```
DIM A(10)
```

will cause the program to run correctly with respect to the vector A. Since array-names in Minimal BASIC are limited to single letters, there can be no more than 26 such changes needed.

Semantic Differences

In addition, this Standard differs from Minimal BASIC in several other ways that may be classified as "run-time". As a result, a Minimal BASIC program run under a BASIC implementation might produce slightly different results.

* The default lower bound for arrays is 1, not 0 as in Minimal Basic. Programs in Minimal Basic can be made to run correctly if the following statement is introduced prior to any DIM statement.

```
OPTION BASE 0
```

* This Standard specifies that arithmetic be carried out using a floating-point decimal representation, with at least ten decimal digits of precision, whereas Minimal BASIC is more permissive in allowing arithmetic to be carried out using other representations (e.g., floating-point binary), with at least six decimal digits of precision (see 5.6). The only effect should be that the program gives more precise results, which should not cause problems for the user. An option is provided which permits NATIVE arithmetic, which might be defined as in Minimal BASIC for a given implementation.

* The default maximum length for strings must be at least 132, not 18 as in Minimal BASIC. The only difference is that a program might not get a string-overflow exception which it would have gotten in Minimal BASIC. The old behavior can be restored by declaring the maximum length of the strings to be the old maximum.

* It is not necessary to prevalidate an entire input-reply before assignment of values to variables takes place, whereas this was required in Minimal BASIC. Thus, an input-reply of "2,4,x" in response to INPUT I, A(I), J could change the value of A(2), whereas this is not allowed in Minimal BASIC.

* Certain exceptions - overflow, division by zero, and raising to a negative power - are fatal exceptions in ECMA BASIC and nonfatal in Minimal BASIC. However, since the Minimal BASIC Standard specifies that nonfatal exceptions can be treated as fatal under certain circumstances, a Minimal BASIC program should not rely on these exceptions being nonfatal.

APPENDIX 7

LANGUAGE ELEMENTS UNDER CONSIDERATION FOR FUTURE REMOVAL

The gosub-statement, on-gosub-statement, and the return-statement are under consideration for future removal. It is recommended that as users write new programs, or maintain existing programs, they refrain from using these statements, in order to improve compatibility with future versions of this Standard.

The GOSUB facility is being considered for removal because it encourages poor programming practice by allowing the construction of subroutines with several entry points. Furthermore, these "subroutines" are not delineated by any distinctive syntax; any line of a program may be the beginning of such a subroutine. Users are encouraged to avail themselves of the subprogram facilities (see 9.2) described in this Standard when they need subroutines.

Furthermore, the GOSUB facility interacts in a complex way with other aspects of the language (e.g., internal-proc-defs, exception-handlers), thus making it more difficult to understand source code, to implement conforming language processors, and to describe the language correctly. Thus, programmers, implementors, teachers, and writers are all impeded in their work with BASIC.