

# GALACTIC STUDIOS BASIC

## 1.17

*User Manual*

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# 1 INTRODUCTION

Galactic Studios BASIC (GSBASIC) is an interactive compiling interpreter for a dialect of BASIC. While it mostly imitates other BASICs, it includes some features inspired by C. It is intended for use in embedded systems. It can execute statements entered at a console or it can load BASIC files and execute them. It has built-in debugging features that allow a running program to be interrupted. The state of that program can then be examined and modified before resuming execution.

GSBASIC contains many built-in functions, and they are documented in section 6. However, when GSBASIC is embedded in a system, that system may provide additional built-in functions. Refer to the system's documentation for a list of its built-in functions.

This manual assumes that you are familiar with programming in a BASIC-like or C-like language.

Galactic Studios BASIC was written by me, Bob Alexander. <http://GalacticStudios.org> is a web site that describes some of my other projects.

The implementation and documentation for GSBASIC are Copyright 2018 by Robert E. Alexander.

## 1.1 Acknowledgements

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## 2 PROGRAM ELEMENTS

### 2.1 Comments

Comments are preceded by a single quote ('), the REM statement, or the C-like double slash (//) and extend to the end of the line. Comments may appear after a statement on the same line.

```
REM This is a comment
' This is another comment
A = 3 ' This comment is on the same line as a statement
A = 4 // And a comment style for you C programmers
```

### 2.2 Statements

A GSBASIC program is composed of a series of statements. Each statement is terminated by a newline (carriage return or line feed). A statement can be continued onto additional lines by typing an underscore (\_) as the last non-space character on the line.

Statement keywords are case-insensitive, so that PRINT, print, Print, and pRiNt are equivalent.

```
print "Hello, World!" ' Legal statement

PRINT _
"Hello, World" ' Multiline statement using underscore

Rem The following statement is illegal because the FOR statement
Rem must be on a new line
Print "Hello, World" For x = 1 to 3
```

### 2.3 Data Types

GSBASIC supports three data types: 32 bit integers, 32 bit floating point numbers, and strings. The maximum length of strings is 64KB. Strings contain single-byte characters; multi-byte encodings (e.g. UTF-8) are not supported.

### 2.4 Literals

GSBASIC recognizes integers, floating point ("float") numbers, and string literals.

An integer literal may be written in decimal or hexadecimal. Hexadecimal numbers are written as in C, e.g. 0x3, 0XAF, or 0x0b, or with a preceding dollar sign, e.g. \$abcd or \$1B. Decimal literals are written as you would expect.

Floating point numbers are written with an optional exponent. Examples of valid floats are 3.14159, 6.02e23, or 6.626E-34. Floats must start with a digit, so you cannot write .123, you must write 0.123.

String literals are written with double quotes, e.g. "Hello, world!". If you want to include a double quote or a control character in the string, use string concatenation with the CHR() function.

### 2.5 Variables

Variables may store integers, floats, strings, arrays, or handles to objects. They are variants, so even if a variable is initialized with a value of one type, it can be assigned a value of another type later. This even allows a variable that holds an integer to be assigned an array, at which point the

variable becomes an array as if it had been in a DIM statement. Conversely, an array defined in a DIM can be assigned to an integer, float or string, and it will no longer be an array.

```
DIM a[10]
a = 1 ' 'a' is no longer an array; it's an integer
DIM a[5, 3] ' it's an array again
```

Variable names must begin with a letter or underscore, and then may contain letters, digits or underscores. A variable name may be as up to 32 characters long. Variable names are case-sensitive.

Variables do not need to be declared before use, but they must be assigned a value before they are used in an expression, i.e. variables do not have a default initialization value.

When a variable holds a string value, array, or handle to an object, the variable is actually holding a reference to the string, array, or object. If you assign that variable to another variable, it does not copy the string, array, or object; it only copies the reference.

## 2.6 Predefined Constants

GSBASIC defines certain identifiers as predefined constants. Examples are PI (defined as 3.14159) and NIL (defined as an uninitialized value). The names of predefined constants are case-insensitive and are reserved words (i.e. you cannot use those names for your own variables, subroutines, or functions).

```
a = PI
PRINT a ' 3.14159 will be printed
a = nil
PRINT a ' This will cause the error "Variable is used before
being assigned a value"
```

## 2.7 Arrays

Arrays can be defined with as many as 3 dimensions. Each element of an array is variable, so it can contain an integer, float, string, or even another array (an array element that holds an array is not equivalent to adding dimension(s) to the array). Each element in an array is allowed to hold a different data type.

Arrays are one-based, i.e. the first element in an array has an index of 1.

Arrays are created with the DIM statement or with an array initializer. Array elements are accessed by enclosing a list of indexes in square brackets (note that this is different from other BASICs, which typically use parentheses). Indexes are integers; if a float is used as an index, it will be cast to integer (i.e. rounded down).

```
DIM a[10], b[6, 2]
a[1] = 1
a[10] = 1
PRINT a[1.9] ' The 1.9 will be rounded down to 1
b[3, 1] = 5 ' An example of multi-dimensional arrays
```

The largest valid index in any dimension of an array can be found using the Ubound built-in function:

```
DIM a[2, 7, 11]
PRINT UBound(a) ' Prints 2
PRINT UBound(a, 1) ' Also prints 2
PRINT UBound(a, 2) ' Prints 7
PRINT UBound(a, 3) ' Prints 11
```

A variable that is an array is actually a reference to an array. If you assign it to another variable, e.g.:

```
DIM a[3]
a[1] = 1
a[2] = 2
a[3] = 3
b = a
```

*b* is now referring to the same values that *a* is. If you change a value, e.g. *a*[1] = 5, *b*[1] will also equal 5.

When you pass an array to a function or subroutine, it is passed by reference. So if you pass *a* to a function and the function changes any of the values of the argument, *a*'s values will be changed when you return from the function.

```
SUB S(x)
    x[1] = 2
ENDSUB

DIM a[3]
a[1] = 100
CALL S(a)
PRINT a[1] ' Prints 2
```

In short, if you're familiar with C, *a* is really a pointer to an array. Assigning *b* to *a* copies the pointer, not the contents of the array.

If you want to make a copy of an array, use the `CopyArray` function.

There's more you should know about the `DIM` statement, so read about it in section 4.5.

### 2.7.1 Array Initializers

Arrays can be initialized much as they are in C, with a list of values enclosed in curly braces. Elements in an array initializer can be literals, variables, or expressions.

Array initializers can be nested to make multi-dimensional arrays. The magnitudes of the dimensions are determined by the largest magnitude of any nested array initializer. Unspecified elements in the initializer are set to integer 0. If this is confusing, look at the following example.



```

c = {0, 1, 2} ' c is now an array with three initialized elements

' The following statement creates a two dimensional array with
' a size of [3, 2]. Notice that no DIM statement was used.
' After this statement is executed, d[1, 1] equals 3; d[1, 2]
' was unspecified in the initializer, so it is set to integer
' zero; d[2, 1] equals "Hello"; d[2, 2] equals "world"; d[3, 1]
' equals 1.5; and d[3, 2] is integer zero.
d = {{3}, {"Hello", "world"}, {1 + 0.5}}

```

As mentioned earlier, a single element of an array can hold an array. This can be specified in an array initializer by adding parentheses around a nested initializer. For example, the code:

```

a = {{11, 12, 13, 14, 15}, {21, 22, 23}}

```

creates a 2x4 array that looks like this:

11	12	13	14	15
21	22	23	0	0

Since the array is 2x4, but the second row had only three values in the initializer, the values in the rest of the second row are zero.

If we add parentheses to the initializer:

```

a = { ( {11, 12, 13, 14, 15} ), ( {21, 22, 23} ) }

```

we create a one dimensional array with two elements, each of which is an array:

{11, 12, 13, 14, 15}
{21, 22, 23}

In C, an array initializer is a mechanism for initializing arrays and nothing more. In GSBASIC, an array initializer is actually an expression, which means it can be used within a larger expression. For example, if there is a subroutine s that takes an array as an argument, you can write:

```

call s({1, 2, 3})

```

In short, an array initializer creates an array, and that array can then be assigned to a variable or used as an argument to a function or subroutine that takes an array as a parameter.

### 2.8 Objects and Handles

An object is a collection of data. For example, to store the coordinates of a point on a graph, you need an X value and a Y value. Instead of using two variables (or two items of an array), an object can combine the two values into one variable which could be called a "coordinate object". Then, you need a way to read and write the individual components (the X and Y values) of that object.

An object can take up a large amount of memory, depending on how much information it holds. A handle is a small amount of data, usually an integer that identifies the object. C programmers know it as a "pointer".

GSBASIC does not allow you to define objects in your program. But an application that embeds GSBASIC might use objects internally and make them available to GSBASIC. For example, The Vectrex32 provides a GSBASIC function called LinesSprite, which takes an array containing coordinates and returns a handle to an object that represents a drawing on the screen. In your GSBASIC program, you can then pass that handle to functions that rotate the drawing or hide it or change its size.

## 2.9 Expressions

Expressions consist of literals, variables, function calls and operators. Supported operators are (in priority order):

(, )	Left and right parentheses
+, -, NOT, IsNil	Unary plus, unary minus, logical NOT, test for uninitialized variable
^	Exponent
*, /, MOD	Multiply, divide, modulo
+, -	Add or string concatenate, subtract
<=, <, >=, >	Relational operators
=, <>, !=	Equals, and two ways to express Not Equal
AND, OR, XOR	Logical operators. AND and OR use "short circuit evaluation" (see below).

Operators are case-insensitive, e.g. MOD is the same as mod and IsNil is the same as isnil.

The AND, OR, XOR, and NOT operators return a 0 for false or 1 for true. However, when evaluating their arguments, they treat any non-zero value as true.

Like C, but unlike many BASICs, the AND and OR operators use "short circuit evaluation". This means that the right hand side is evaluated only if necessary. If the left hand side of an AND evaluates to 0, then the AND will return 0 regardless of the value on the right side, so it does not evaluate the right side. Similarly, if the left side of an OR is non-zero, then the OR will return a 1 regardless of the right side's value, so the right side is not evaluated.

This can be very useful. Consider the following code:

```
DIM a[3]
i = 4
if i <= 3 AND a[i] = 0 THEN
    ' do something
ENDIF
```

If *i* is greater than 3, it is important not to evaluate the right side of the AND because it would cause an error. Fortunately, with GSBASIC's short circuit evaluation, the right side will not be evaluated when *i* is greater than 3.

The IsNil operator returns 1 if its operand is uninitialized:

```

PRINT IsNil a      ' Prints 1
b = 2
PRINT IsNil b      ' Prints 0
b = nil
PRINT IsNil b      ' Prints 1

IF IsNil b THEN
    b = 3
ENDIF

```

### 2.9.1 Integer Arithmetic

Numbers in GSBASIC are either integers or floating point numbers ("floats"). Integer arithmetic is faster than floating point arithmetic, and only integers can be used as array indexes, but it's important to understand their peculiar behavior.

The integer 5 is different from the floating point value 5.0. If you divide 5.0 by 2, you get 2.5; if you divide the integer 5 by 2, you get 2. An integer divided by an integer produces an integer.

Numbers can be converted to floats using the Float function; they can be converted to integers using the Int function. Dividing Float(5) by 2 would produce 2.5.

### 2.9.2 Operand Type Promotion Rules

Arithmetic operators (+, -, \*, /, %) operate on numeric operands. If one of the operands is an integer and the other is a float, the integer is promoted to a float.

As mentioned before, the integer expression 5 / 2 equals 2. But 5 / 2.0 would produce 2.5, because the integer 5 would be promoted to a float. Likewise, 5.0 / 2 would equal 2.5.

The logical operators (NOT, AND, OR, and XOR) operate on integers, floats and strings. They cast their operands to integer ones or zeros (true or false), apply the logical operation, and produce an integer one or zero. If an operand is an integer or a float, it is cast to a 0 if the integer or float is zero. If the integer or float is non-zero, it is cast to a one. If an operand is a string, it is cast to a one if it is non-empty; an empty string is cast to a zero.

The string concatenation operator (+) must have a string as one of its operands. If the other operand is an integer or float, it is converted to a string and the concatenation is done.

```

x = 3.14159
print "x equals " + x ' Prints "x equals 3.14159"

```

## 2.10 Control Structures

GSBASIC offers IF...THEN...ELSEIF...ELSE...ENDIF, FOR...NEXT, WHILE...ENDWHILE, and REPEAT...UNTIL control structures.

There are two statements for altering the execution of the FOR, WHILE and REPEAT loops: CONTINUE <loop type> and EXIT <loop type>. The CONTINUE statement jumps to the end of the loop, so that no more code is executed in the current iteration of the loop, and the next iteration of the loop begins (assuming the loop's exit condition is not met). It is similar to C's *continue* statement.

The EXIT statement terminates the loop. It is similar to C's *break* statement.

CONTINUE and EXIT specify which loop they apply to. For example, if a FOR loop contains a WHILE loop, and the WHILE loop contains a CONTINUE FOR statement, then the CONTINUE applies to the FOR loop, not the WHILE. In this way, CONTINUE and EXIT are more versatile than C's *continue* and *break*.

(If a FOR loop contains another FOR loop, and the inner FOR loop contains a CONTINUE FOR or an EXIT FOR, the CONTINUE or EXIT apply to the inner FOR loop. There is no way to have them apply to the outer FOR loop.)

## 2.11 Labels

GSBASIC does not currently support labels, and therefore does not support GOTO statements. However, its looping control structures (FOR...NEXT, WHILE...[DO]...ENDWHILE, REPEAT...UNTIL) support EXIT and CONTINUE to alter their flow.

## 2.12 DATA and READ Statements

GSBASIC does not support DATA or READ statements. However, you can use Array Initializers as a source of hard-coded data.

## 2.13 Functions and Subroutines

GSBASIC provides built-in functions and subroutines, which are described in section 6. You can also define your own functions and subroutines; see the statements FUNCTION and SUB. Functions are different from subroutines in that they return a value.

Integers and floats are passed to functions and subroutines by value. Strings and arrays are passed by reference. If a subroutine or function expects an array as one of its arguments, you can write an array initializer in its place.

```
SUB PrintArray(array)
    FOR x = 1 TO UBOUND(array)
        PRINT array[x]
    NEXT x
ENDSUB

CALL PrintArray({1, 2, 3})
```

Subroutines are invoked by the CALL statement. Functions can also be invoked by CALL, but are more typically called by using them in expressions (e.g.  $c = \text{SQRT}(a * a + b * b)$ ), where their return value can be used.

## 2.14 Variable Scope

A function or subroutine in your program has a local scope. A variable's scope is determined when it is first assigned a value (i.e. when it is created): if the variable is first assigned a value inside a function or subroutine, its scope is limited to the function or subroutine; if a variable is first assigned a value in the main program, it has global scope.

If a variable name that exists in the global scope is used within a function or subroutine, the global variable will be used. If you would like to ensure that a variable accessed within a function or subroutine is a local variable, you can explicitly DIM it:

```
foo = 1
CALL MySubroutine

SUB MySubroutine()
  DIM foo
  ' The following PRINT statement will cause an
  ' uninitialized variable error, since this foo is local
  PRINT foo
ENDSUB
```

## 2.15 Case Sensitivity

Only variable names are case-sensitive. All other program elements are case insensitive (e.g. statements, logical operators like AND, OR and NOT, built-in function names, user function names, predefined constants, and file names).

## 3 USING GSBASIC

GSBASIC accepts statements entered at the command line. Typically, one statement is entered per line, and the statement is executed when you hit Enter. There are two exceptions. First, if the last non-space character on a line is an underscore (\_), GSBASIC will prompt for the rest of the statement to be entered. Second, if the statement begins a block (e.g. a WHILE statement that must be followed by a block of code and an ENDWHILE, a FUNCTION statement that must be followed by a block of code and an ENDFUNCTION) GSBASIC will prompt you to enter additional statements until the block is terminated.

Lines are limited to 200 characters in length.

When GSBASIC is accepting commands, it can be in one of two modes: Immediate Mode or Debug Mode. They are the same except that Debug Mode means that you have interrupted a running BASIC program.

### 3.1 Immediate Mode

GSBASIC uses the prompt "Ready" followed by a newline to show that it's ready for you to enter a statement. If you are continuing a single statement on a new line by using the underscore, GSBASIC will prompt with "\_>". If you are entering a block of code, GSBASIC will prompt you with "&>".

GSBASIC offers a few line-editing features. Their correct functioning depends on the specific console you are using. Under Microsoft Windows, GSBASIC uses the operating system's console. If GSBASIC is embedded in another system, refer to that system's manual for information on the console.

The backspace key works as you would expect, deleting the character at the end of the line.

GSBASIC retains a history of the last 10 unique lines you entered. Assuming the terminal emulator supports arrow keys, you can move through the history list by pressing the Up and Down Arrow keys; otherwise, you can use Ctrl+P and Ctrl+N. The history list is circular.

Ctrl+C causes GSBASIC to discard any statement(s) you're in the process of entering.

## 3.2 Running Programs

GSBASIC has access to a single directory on the host system. On Windows, it's the working directory - typically the directory GSBASIC.exe was run from. When embedded in another system, it's whatever that system provides to GSBASIC. Subdirectories are not currently supported.

If the directory has a file called autorun.bas, GSBASIC will load and run it at startup.

GSBASIC has the LOAD statement to load a BASIC program from the directory and a RUN statement to run it. The LOAD statement takes a string as an argument, so the file name must be enclosed in quotes. If the file is not found, GSBASIC adds a ".BAS" extension to it and tries again. File names are case-insensitive.

```
' Tries to load the file Hello. If not found, tries Hello.bas
load "Hello"
run
```

GSBASIC does not allow you to edit or save programs, so your workflow will be to write the program in an editor of your choice, save it into GSBASIC's working directory, then use GSBASIC's console to load and run it.

## 3.3 Debugging

While a program is running, it can break into Debug Mode either by executing a BP (Breakpoint) statement or in response to your hitting Ctrl+C. Debug Mode is very similar to Immediate Mode; while in Debug Mode, you can execute statements, print or modify variables, and call subroutines and functions in the program. To single-step through your program, enter the STEP statement with an optional count of the number of statements to execute. To resume normal execution, enter the RUN statement.

While in Debug mode, the console prompt is "Debug (depth = *n*)" instead of "Ready". The depth count is important for keeping track of how deeply nested in Debug modes you are. For example, consider this program with a subroutine that contains an infinite loop:

```
call loop()

sub loop
  i = 0
  repeat
    print i
    i = i + 1
  until 1 = 0
endsub
```

When run, this program will start printing out numbers. If you hit Ctrl+C, execution will break somewhere inside the loop and you will be at Debug depth 1.

In Debug mode, you can call functions and subroutines in your program. So let's say you enter "CALL LOOP". It will start printing out numbers again and you will need to break it by hitting Ctrl+C. You will again enter Debug mode but you will be at depth 2. This is because you did not

exit Debug (depth = 1) mode; you called a subroutine from Debug mode and then had to break out of it into a new Debug mode.

Normally, you would exit Debug mode by entering RUN. In this perverse example, RUN will just put you into the infinite loop again, and you can only break out of it by hitting Ctrl+C again. The only way out is to STOP the program. In a more typical scenario, where you call a well-behaved function from Debug mode, and the function returns in a reasonable amount of time, you will stay in Debug (depth = 1) mode and will be able to resume running your program with the RUN command.

### 3.4 Breakpoints

Breakpoints cause your program to pause execution and enter Debug mode. Breakpoints can be hard-coded into your program or set at the command line.

To hard-code a breakpoint into your program, place the BP statement in your program. When the program executes that line, GSBASIC will print the line number of the BP statement, then enter Debug mode. You may have any number of BP statements in the program.

Alternatively, you can set, clear, and display soft breakpoints from Immediate or Debug mode. For details, see the section labeled BP (Breakpoint) Statement

### 3.5 Tracing

In Immediate or Debug Mode, you can give the commands TRON (Trace On) or TROFF (Trace Off). They can even be embedded in your program. When tracing is on, the line number, in brackets, of each statement will be printed before the statement is executed. GSBASIC does not have line numbers like old versions of BASIC do, so the line number that is printed is the actual position of the statement in the program file.

### 3.6 Autorun.bas

When GSBASIC starts up, it looks for a file named autorun.bas in its working directory. If it finds it, GSBASIC loads and runs the autorun.bas program. If autorun.bas exits, GSBASIC enters immediate mode.

## 4 STATEMENTS

### 4.1 BP (Breakpoint)

#### *Description*

Breaks execution of the program and enters Debug mode

#### *Example*

```
BP ' In a program, breaks to the debugger.
BP ' At the command line, prints the "soft" breakpoints.
BP 15 ' Sets a soft breakpoint at line 15
BP CLEAR ' Removes all soft breakpoints
BP CLEAR 15 ' Removes the soft breakpoint at line 15
BP C ' Same as BP CLEAR
BP C 15 ' Same as BP CLEAR 15
```

### *More Information*

This statement can be used at the command line or in a program. When hard-coded into a program, it takes no arguments, and when executed, causes GSBASIC to enter Debug mode.

When used at the command line, in Immediate or Debug mode, it sets, removes, or displays a list of "soft" breakpoints (as opposed to hard-coded breakpoints). Before executing a line of code, GSBASIC will check whether a soft breakpoint has been set there. If it has, GSBASIC will enter Debug mode before the line of code is executed.

Once in Debug mode, GSBASIC will allow you to examine and modify the program's state. Use the RUN statement to leave Debug mode and continue executing the program.

### *See Also*

RUN, Debugging, Breakpoints

## 4.2 CALL

### *Description*

Calls a subroutine or function.

### *Example*

```
CALL FOO  
CALL BAR(1, a, SIN(3.14159))
```

### *More Information*

Subroutines may have any number of parameters. If a subroutine takes no arguments, it is not necessary to have parentheses. (This is not true of function calls in expressions: they must have parentheses even when they have no arguments.)

A function may be called with the CALL statement. The function's return value will be discarded.

### *See Also*

SUB...ENDSUB, FUNCTION...ENDFUNCTION,

Functions, Variable Scope

## 4.3 CHAIN

### *Description*

Ends the currently running program, loads and runs another.

### *Example*

```
CHAIN "lunar.bas"  
CHAIN "lunar" RERUN
```

### *More Information*

The CHAIN statement is the equivalent of a STOP, LOAD, and RUN. The RERUN keyword is optional. In the second example above, the current program chains to lunar.bas and specified RERUN. When lunar.bas exits the calling program will be loaded and run from the beginning. (Some other BASICs have CHAIN ... RETURN which resumes execution at the statement after the CHAIN. GSBASIC does not support that.)



## 4.4 CONTINUE {FOR | REPEAT | WHILE}

### *Description*

Passes control to the next iteration of the nearest enclosing loop of the specified type.

### *Example*

```
a = 0
b = 10
WHILE a < b
    a = a + 1
    PRINT "This text will be printed 10 times"
    CONTINUE WHILE
    PRINT "This text will not be printed"
ENDWHILE

FOR x = 1 TO 10
    PRINT "This text will be printed 10 times"
    REPEAT
        CONTINUE FOR ' Exits REPEAT loop and CONTINUES FOR
    PRINT "This text will not be printed"
    UNTIL a < b
    PRINT "This text will also not be printed"
NEXT x

FOR x = 1 TO 10
    PRINT "This text will be printed 10 times"
    FOR y = 1 TO 10
        PRINT "This text will be printed 100 (10*10) times"
        CONTINUE FOR
        PRINT "This text will not be printed"
    NEXT y
    PRINT "This text will be printed 10 times"
NEXT x
```

### *More Information*

The CONTINUE statement must specify a FOR, REPEAT, or WHILE loop type. It skips the remainder of the code in the specified loop type and continues with the next iteration of that loop. As shown in the examples, this allows the CONTINUE statement to exit out of inner loops on its way to continuing an outer loop.

### *See Also*

EXIT {FOR | REPEAT | WHILE}

## 4.5 DIM

### *Description*

Create or re-create an array. Alternatively, create a local variable.

### *Example*

```
DIM a[10]
' Destroy the previous 'a' array and create a new one
DIM a[2,3]
```

```

b = 1 ' Create a global variable
c = 2 ' Create another local variable

CALL MySubroutine

SUB MySubroutine
    DIM b ' Create a local variable
    b = 3 ' Initialize the local variable
    PRINT c ' print the global variable
ENDSUB

DIM d[b + c], e[3, 4, b] ' Dimensions can be expressions

```

### *More Information*

DIM typically allocates an array. If an array of that name already exists within the same scope, that array is destroyed and a new one is created. Data in the old array is not preserved.

When crating a multi-dimensional array, the numbers of elements in each dimension are separated by commas.

DIM creates variables in the current scope, so when used inside a subroutine or function, DIM creates local variables, both arrays and scalars.

The DIM statement is executable, unlike an array declaration in C. Since it is executed, the dimensions specified for the array can be expressions, as shown in the example above.

### *See Also*

Arrays, Variables, Variable Scope

## 4.6 DIR

### *Description*

Prints out a list of files in the working directory.

### *Example*

```
DIR
```

### *See Also*

Running Programs, Dir Function

## 4.7 EXIT {FOR | REPEAT | WHILE}

### *Description*

Terminate execution of the nearest enclosing loop of the specified type.

### *Example*

```

WHILE a < b
    PRINT "This text will be printed once"
    EXIT WHILE
    PRINT "This text will not be printed"
ENDWHILE

FOR x = 1 TO 10

```

```

PRINT "This text will be printed once"
REPEAT
    PRINT "This text will be printed once"
    EXIT FOR
    PRINT "This text will not be printed"
UNTIL a < b
PRINT "This text will also not be printed"
NEXT x

FOR x = 1 TO 10
    PRINT "This text will be printed 10 times"
    FOR y = 1 TO 10
        PRINT "This text will be printed 10 times"
        EXIT FOR
        PRINT "This text will not be printed"
    NEXT y
    PRINT "This text will be printed 10 times"
NEXT x

```

### More Information

The EXIT statement specifies a FOR, REPEAT, or WHILE loop type. It skips the remainder of the code in the specified loop type and exits the loop. As shown in the examples, this allows the EXIT statement to exit out of inner loops on its way to exiting an outer loop.

### See Also

CONTINUE {FOR | REPEAT | WHILE}

## 4.8 FOR...NEXT

### Description

Repeats a group of statements while a variable counts from a start value to an end value.

### Example

```

last = 100
FOR x = 1 TO last
    PRINT "This will be printed 100 times"
NEXT x

FOR y = last TO last + 10
    PRINT "This will be printed 10 times"
NEXT

FOR z = 10 TO 1 STEP -2.5
    PRINT "This will be printed 4 times"
NEXT z

```

### More Information

The start, end, and optional step values of the loop must be numbers. They are calculated only once, when the loop is entered (i.e. if the end or step value is an expression, the expression is evaluated only once). If no step is specified, the loop variable is incremented by 1 on each iteration.

When a FOR ... NEXT loop starts, BASIC evaluates the start, end, and step values. BASIC evaluates these values only at this time and then assigns start to the counter variable. Before the statement block runs, BASIC compares the counter to end. If counter is already larger than the end value (or smaller if the step is negative), the FOR loop ends and control passes to the statement that follows the NEXT statement. Otherwise, the statement block runs.

Each time BASIC encounters the NEXT statement, it increments the counter by the step and returns to the FOR statement. Again it compares counter to end, and again it either runs the block or exits the loop, depending on the result. This process continues until the counter passes end or an EXIT FOR statement is encountered.

The loop doesn't stop until the counter has passed end. If the counter is equal to end, the loop continues. The comparison that determines whether to run the block is counter <= end if step is positive and counter >= end if step is negative.

Changing the value of start, end, or step doesn't affect the iteration values that were determined when the loop was first entered. The NEXT statement does not need to specify the loop variable.

#### *See Also*

CONTINUE {FOR | REPEAT | WHILE}, EXIT {FOR | REPEAT | WHILE}

## 4.9 FUNCTION...ENDFUNCTION

### *Description*

Defines a user-defined function.

### *Example*

```
FUNCTION MyFunction(a, b)
    RETURN a + b
ENDFUNCTION

FUNCTION PI()
    RETURN 3.14159
ENDFUNCTION

PRINT MyFunction(1, 2) + PI()
```

### *More Information*

A function definition must have a parameter list, even if it is empty (as in the example of Pi(), above). A function must return a value. A function is typically called from an expression. It may also be called from a CALL statement, but if it is, the return value is discarded.

Function names are case-insensitive.

Variables used within a function are global unless they are explicitly created in a DIM statement. Functions may call other subroutines and functions, and may be recursive.

### *See Also*

RETURN, SUB...ENDSUB,

Functions, Variable Scope

## 4.10 IF...[THEN]...[ELSEIF...[THEN]...][ELSE...]ENDIF

### *Description*

Conditional execution.

### *Example*

```
IF a = b AND c <> d THEN
    PRINT "Hello "
ELSEIF e = f THEN
    PRINT "Goodbye "
ELSE
    PRINT "world"
ENDIF
```

### *More Information*

The THEN keywords on the IF and ELSEIF lines are optional. There may be any number of ELSEIFs.

Unlike other versions of BASIC, there is no single-line IF...THEN statement, e.g. you cannot write

```
IF a = b THEN PRINT "Hi" ' This will cause an error
```

## 4.11 LET

### *Description*

Assign a value to a variable.

### *Example*

```
LET a = 1
b = 2 + a
c = {{a, b}, {4, 5}} ' Using an array initializer
```

### *More Information*

The LET keyword is optional.

## 4.12 LOAD

### *Description*

Loads and compiles a program from the working directory into memory.

### *Example*

```
LOAD hello.bas
LOAD hello
LOAD "01_hello" ' Quotes are required for file names that don't
begin with a letter
```

### *More Information*

File names are case-insensitive. LOAD looks for the file you specified and, if it does not find it, appends ".bas" to the string and looks again.

If the file is found, it is loaded, compiled to an intermediate form and prepared for execution. If there are compilation errors, the LOAD will fail.

*See Also*

RELOAD, Running Programs

## 4.13 MEM

*Description*

Prints the amount of memory being used by the program, as well as the free space available.

## 4.14 PRINT

*Description*

Outputs text to the console.

*Example*

```
PRINT "The variable 'a' equals ", a
```

*More Information*

The PRINT statement evaluates a comma-separated list of expressions and outputs them as text to the console, followed by a new line (carriage return and line feed). No spaces or tabs are inserted between expressions.

## 4.15 RELOAD

*Description*

Reloads the current program from the working directory.

*Example*

```
RELOAD
```

*More Information*

Reloads the program that was previously loaded. This is a convenient command to use when you are editing a program in a separate window, saving it, and testing the changes.

*See Also*

LOAD

## 4.16 REPEAT...UNTIL

*Description*

Executes a block of statements until a condition is true.

*Example*

```
REPEAT
    a = a + 1
UNTIL a = 100
```

### *More Information*

The statements inside the REPEAT...UNTIL block will be executed at least once.

### *See Also*

WHILE...[DO]...ENDWHILE, CONTINUE {FOR | REPEAT | WHILE}, EXIT {FOR | REPEAT | WHILE}

## 4.17 RETURN

### *Description*

Returns from a user-defined function or subroutine.

### *Example*

```
RETURN a + b ' Return from a function
RETURN ' Return from a subroutine
```

### *More Information*

The RETURN statement may appear anywhere in a function or subroutine, and may even appear multiple times. The RETURN statement must appear in a function, along with an expression that will be the returned value.

The RETURN statement is optional in a subroutine - the subroutine will automatically return when execution reaches the ENDSUB statement - but if it appears in a subroutine, it must not specify a return value.

### *See Also*

FUNCTION...ENDFUNCTION, SUB...ENDSUB,

Functions

## 4.18 RUN

### *Description*

Executes the program in memory.

### *Example*

```
LOAD "Hello.bas"
RUN
```

### *More Information*

This statement is allowed only in Immediate mode. The program must have been loaded with the LOAD or RELOAD statement. All variables are destroyed before beginning execution.

### *See Also*

LOAD, Immediate Mode, Running Programs

## 4.19 STEP

### *Description*

Execute the specified number of statements.

### *Example*

```
STEP ' Executes one statement
STEP 10 ' Executes 10 statements
```

### *More Information*

The STEP statement may be used in Immediate mode, after a program has been loaded, or in Debug mode. It executes the specified number of statements, then breaks into Debug mode. If no number of statements is specified, one statement will be executed. If a number is specified, it must be an integer literal.

### *See Also*

Debugging

## 4.20 STOP

### *Description*

Terminates the program.

### *Example*

```
STOP
```

### *More Information*

This statement can be used within or program or in Debug mode. It terminates the program and returns to Immediate mode.

## 4.21 SUB...ENDSUB

### *Description*

Defines a user-defined subroutine.

### *Example*

```
SUB TowersOfHanoi(disks, source, destination, temp)
  IF disks = 1 THEN
    PRINT "Move disk from tower ", source, _
          " to tower ", destination
  ELSE
    CALL Hanoi(disks - 1, source, temp, destination)
    CALL Hanoi(1, source, destination, temp)
    CALL Hanoi(disks - 1, temp, destination, source)
  ENDIF
ENDSUB
```



### More Information

A subroutine definition may have a parameter list, but does not require one. A subroutine is invoked from a CALL statement. Subroutine names are case-insensitive.

Variables used within a subroutine are global unless they are explicitly created in a DIM statement. Subroutines may call other subroutines and functions, and may be recursive.

### See Also

RETURN, FUNCTION...ENDFUNCTION,

Functions, Variable Scope

## 4.22 TRON and TROFF

### Description

Turns program tracing on and off.

### Example

```
TRON
RUN
[1] [2] [3] [4] [5] [6] ...
TROFF
```

### More Information

Tracing may be turned on in immediate mode, debug mode, or even from a line in a program. When tracing is on, the current line number will be printed before each line of the program is executed.

### See Also

STEP, Tracing, Debugging

## 4.23 WHILE...[DO]...ENDWHILE

### Description

Executes a block of statements while a condition is true.

### Example

```
WHILE a < 100
    a = a + 1
ENDWHILE
WHILE true DO ' An infinite loop
ENDWHILE
```

### More Information

The statements inside the WHILE...ENDWHILE will be executed as long as the condition is true.

The DO keyword is optional.

### See Also

REPEAT...UNTIL, CONTINUE {FOR | REPEAT | WHILE}, EXIT {FOR | REPEAT | WHILE}

## 5 BUILT-IN CONSTANTS

These are the constants built in to GSBASIC. There may be additional built-in constants provided by the system that GSBASIC is embedded in; see that system's documentation for a list.

Built-in constant names are case-insensitive.

### 5.1 False

#### *Description*

The integer 0.

#### *Example*

```
REPEAT
UNTIL false ' An infinite loop
```

### 5.2 Nil

#### *Description*

An uninitialized value.

#### *Example*

```
DIM a[10]
a[1] = 1
a[1] = nil
PRINT a[1] ' Causes an error, "Variable is used before being
           ' assigned a value"
IF IsNil a[1] THEN
    a[1] = 3
ENDIF
```

#### *More Information*

Nil can be used to uninitialized a value that was previously initialized.

### 5.3 Pi

#### *Description*

The ratio of a circle's circumference to its diameter; 3.14159.

### 5.4 True

#### *Description*

The integer 1.

#### *Example*

```
WHILE true ' An infinite loop
ENDWHILE
```

## 6 BUILT-IN FUNCTIONS

These are the functions built in to GSBASIC. There may be additional built-in functions provided by the system that GSBASIC is embedded in; see that system's documentation for a list.

Built-in function names are case-insensitive.

## 6.1 Abs

### *Description*

Returns the absolute value of a number.

### *Example*

```
PRINT Abs(-4.5) ' Prints 4.5
```

### *More Information*

The argument must be an integer or a float. The return type is the same as the argument type.

## 6.2 Acos

### *Description*

Returns the arccosine of a number in radians.

### *Example*

```
PRINT ACos(-1) ' Prints 3.14159
```

### *See Also*

Asin, Atan, Sin, Tan

## 6.3 AppendArrays

### *Description*

Returns an array that has the values of two arrays appended to each other.

### *Example*

```
a = {1, 2, 3}
b = {4, 5}
c = AppendArrays(a, b) ' c will be {1, 2, 3, 4, 5}
d = {{1, 2}}
e = {{3, 4}}
f = AppendArrays(d, e) ' f will be {{1, 2},{3, 4}}
```

### *More Information*

AppendArrays creates a new array, copies the values of the first array argument into it then copies the values of the second array into it. The two array arguments must have the same number of columns but may have different numbers of rows. For example:

```
DIM a[5], b[2], c[2, 5], d[3, 5], e[5, 6], f[2, 3, 4], g[5, 3, 4]
x = AppendArrays(a, b) ' Valid
x = AppendArrays(c, d) ' Valid
x = AppendArrays(f, g) ' Valid
x = AppendArrays(d, e) ' Illegal
x = AppendArrays(a, c) ' Illegal
```

It's sometimes useful to build an array completely with calls to `AppendArray`, e.g. you start with an empty array and append a row at a time to it. This can be done by dimensioning the array with a zero rows. For example:

```
' Start with a 2D array with zero rows
DIM arrayToBuild[0, 2]

' Create newRow as a 2D array of dimension [1, 2]
newRow = {"hello", "world"}

' Build up the array by appending a row
arrayToBuild = AppendArrays(arrayToBuild, newRow)
```

When values are copied to the new array, it is a "shallow copy", i.e. if a value is an array, the copied value will point to the same underlying array.

*See Also*

`CopyArray`, `Arrays`

## 6.4 Asc

Returns the ASCII value of the first character in a string.

*Example*

```
PRINT Asc("ABC") ' prints 65
```

*See Also*

`Chr`

## 6.5 Asin

*Description*

Returns the arcsine of a number in radians.

*Example*

```
PRINT Asin(0) ' Prints 1.5708, which is PI / 2
```

*See Also*

`Acos`, `Atan`, `Sin`

## 6.6 Atan

*Description*

Returns the arctangent of a number in radians.

*Example*

```
PRINT Atan(1) ' Prints 0.7854, which is PI / 4
```

*See Also*

`Acos`, `Asin`

## 6.7 Chr

### *Description*

Returns the character associated with the specified character code.

### *Example*

```
PRINT Chr(33) ' Prints an exclamation mark (ASCII code 33)
```

### *More Information*

The argument must be an integer between 0 and 255.

### *See Also*

Asc

## 6.8 CopyArray

### *Description*

Returns an array that has a copy of the values of the input array.

### *Example*

```
a = {1, 2, 3}
b = CopyArray(a) ' b will be {1, 2, 3}
```

### *More Information*

CopyArray creates a new array and copies the values of the input array argument into it. This is different from assigning one array to another, because an assignment creates two references to the same underlying array. For example:

```
a = {1, 2, 3}
copy = CopyArray(a) ' Copies the values of a into copy
ref = a           ' ref is now referring to the same array data as a
a[1] = 5
PRINT copy[1] ' Prints 1
PRINT ref[1]  ' Prints 5, since a has the same array data as ref
```

When values are copied to the new array, it is a "shallow copy", i.e. if a value is an array, the copied value will point to the same underlying array.

### *See Also*

Arrays

## 6.9 Cos

### *Description*

Returns the cosine of an angle, which is given in radians.

### *Example*

```
PRINT Cos(3.14159) ' Prints -1
```

### *See Also*

Acos, Asin, Atan, Sin

## 6.10 Dir

### Description

Returns the an array containing the names of all the files in the current directory.

### Example

```
PRINT Dir() ' Prints an array of file names
```

### More Information

The file names are sorted into alphabetic order.

### See Also

DIR Statement

## 6.11 Float

### Description

Converts an integer to a float.

### Example

```
a = 5  
a = Float(a) ' Converts a to a float (5.0)
```

### See Also

Int

## 6.12 Instr

### Description

Finds the first occurrence of one string within another.

### Example

```
str = "ABCDEABCDE"  
print Instr(str, "C") ' Prints 3  
print Instr(str, "X") ' Prints 0  
print Instr(4, str, "C") ' Prints 8
```

### More Information

Instr takes two or three arguments. If it is given two arguments, they must both be strings. Instr returns the 1-based position of the second string in the first string. If the second string is not found, Instr returns 0.

If Instr has three arguments, then the first is the 1-based position in the string at which to start the search.

This table summarizes the return values, assuming the call `pos = Instr(start, string1, string2)`:

If	Instr returns
<i>string1</i> is empty	0
<i>string2</i> is empty	<i>start</i>

<code>string2</code> is not found	0
<code>string2</code> is found within <code>string1</code>	Position in <code>string1</code> where match begins
<code>start &gt; length of string1</code>	0

## 6.13 Int

### *Description*

Convert a floating point number to an integer.

### *Example*

```
a = 5.0
PRINT a / 2 ' Prints 2.5
a = Int(a) ' Converts a to an integer
PRINT a / 2 ' Prints 2, because of integer arithmetic
```

### *More Information*

The float is rounded towards zero and then its internal representation is converted to an integer.

### *See Also*

Float

## 6.14 Left

### *Description*

Returns the leftmost n characters of a string.

### *Example*

```
PRINT Left("Hello", 3) ' Prints Hel
PRINT Left("Hello", 6) ' Prints Hello
```

### *See Also*

Len, Mid, Right

## 6.15 Len

### *Description*

Returns the length of a string.

### *Example*

```
PRINT Len("Hello") ' Prints 5
```

### *See Also*

Left, Mid, Right

## 6.16 Max

### *Description*

Returns the larger of two values.

### Example

```
PRINT Max(5, 8.2) ' Prints 8.2
PRINT Max("Hello", "Goodbye") ' Prints Hello
```

### See Also

Min

## 6.17 Mid

### Description

Returns characters from the middle of a string.

### Example

```
PRINT Mid("Hello", 1, 3) ' Prints Hel
PRINT Mid("Hello", 2, 3) ' Prints ell
PRINT Mid("Hello", 2) ' Prints ello
```

### More Information

Mid can take two or three arguments. The first argument is the string. The second argument is the position in the string at which to start getting characters (the first character is position 1). The optional third argument is the number of characters to get. If the third argument is omitted, all characters from the starting position to the end of the string are returned.

### See Also

Left, Len, Right

## 6.18 Min

### Description

Returns the smaller of two values.

### Example

```
PRINT Min(5, 8.2) ' Prints 5
PRINT Min("Hello", "Goodbye") ' Prints Goodbye
```

### See Also

Max

## 6.19 Rand

### Description

Returns a pseudo-random integer.

### Example

```
PRINT Rand() MOD 10 ' Prints an integer between 0 and 9
```



### *More Information*

The integer returned by `Rand` is between 0 and the maximum positive value an integer can hold. That maximum is platform-dependent, but will always be at least 32,767. The best way to get a random number in a given range is to take the modulo of the value returned by `Rand()`.

Every time a program runs, the sequence of numbers returned by `Rand()` will be the same, i.e. they're pseudo-random, but reproducible. Usually, you will want the sequence to be different every time. In that case, call the `Randomize()` function once at the beginning of your program.

### *See Also*

`Randomize`

## 6.20 `Randomize`

### *Description*

Initializes the pseudo-random number generator.

### *Example*

```
CALL Randomize
```

### *More Information*

Seeds the pseudo-random number generator with an unpredictable value.

### *See Also*

`Rand`

## 6.21 `Right`

### *Description*

Returns the rightmost `n` characters of a string.

### *Example*

```
PRINT Right("Hello", 3) ' Prints llo  
PRINT Right("Hello", 6) ' Prints Hello
```

### *See Also*

`Left`, `Len`, `Mid`

## 6.22 `Round`

### *Description*

Rounds a number to the nearest integer.

### *Example*

```
PRINT Round(5.6) ' Prints 6  
PRINT Round(-3.5) ' Prints -4
```

### *More Information*

The internal representation of the returned value is a float. Round() is different from Int() in two ways: first, it rounds the number whereas Int() discards the fractional part; second, it returns a float whereas Int() returns an integer.

### *See Also*

Truncate

## 6.23 Sin

### *Description*

Returns the sine of an angle, which is given in radians.

### *Example*

```
PRINT Sin(3.14159 / 2) ' Prints 1
```

### *See Also*

Acos, Asin, Atan, Cos, Tan

## 6.24 Sqrt

### *Description*

Returns the square root of a number.

### *Example*

```
PRINT Sqrt(5) ' Prints 2.23606  
PRINT Sqrt(-3.5) ' Prints nan (Not a Number)
```

### *More Information*

Returns a float.

## 6.25 StrComp

### *Description*

Returns -1, 0, or 1, based on the result of a string comparison.

### *Example*

```
PRINT StrComp("HELLO", "HELLO") ' Prints -1  
PRINT StrComp("HELLO", "HELLO", 0) ' Prints -1  
PRINT StrComp("HELLO", "HELLO", 1) ' Prints 0
```

### *More Information*

The third argument is optional and indicates whether the string comparison is case insensitive. If there is no third argument, or if the third argument is 0, the comparison is case-sensitive. If the third argument is non-zero, the comparison is case-insensitive.

The return value is zero if the strings are equal, -1 if the first string is less than the second, and 1 if the first string is greater than the second.

## 6.26 Tan

### *Description*

Returns the tangent of an angle, which is given in radians.

### *Example*

```
PRINT Tan(3.14159 / 4) ' Prints 1
```

### *See Also*

Acos, Asin, Atan, Cos, Sin

## 6.27 ToLower

### *Description*

Returns a copy of a string converted to lower case.

### *Example*

```
PRINT ToLower("HELLO") ' Prints hello
```

### *More Information*

Returns a string that is a copy of the argument, except that letters are converted to lower case. The argument is unchanged.

### *See Also*

ToUpper

## 6.28 ToUpper

### *Description*

Returns a copy of a string converted to upper case.

### *Example*

```
PRINT ToLower("hello") ' Prints HELLO
```

### *More Information*

Returns a string that is a copy of the argument, except that letters are converted to upper case. The argument is unchanged.

### *See Also*

ToLower

## 6.29 Truncate

### *Description*

Rounds a number towards zero.

### *Example*

```
PRINT Truncate(5.6) ' Prints 5  
PRINT Truncate(-3.5) ' Prints -3
```

### *More Information*

Removes the fractional portion of a number. Returns a float. Truncate() is different from Int() in that it returns a float whereas Int() returns an integer.

### *See Also*

## 6.30 Right

### *Description*

Returns the rightmost n characters of a string.

### *Example*

```
PRINT Right("Hello", 3) ' Prints llo
PRINT Right("Hello", 6) ' Prints Hello
```

### *See Also*

Left, Len, Mid

Round

## 6.31 Ubound

### *Description*

Returns the largest index of an array for a given dimension.

### *Example*

```
DIM a[5, 7]
PRINT Ubound(a) ' Prints 5
PRINT Ubound(a, 1) ' Prints 5
PRINT Ubound(a, 2) ' Prints 7
PRINT Ubound(a, 3) ' Prints 0; there is no 3rd dimension

b = 3
PRINT Ubound(b) ' Prints 0, since b is not an array
```

### *More Information*

Ubound accepts one or two arguments. The first argument is an array. If there is no second argument, Ubound returns the largest index for the first dimension of the array. If there is a second argument, it specifies which dimension of the array to return the largest index of.