

# De Re BASIC!

Version 1.82

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## Changes in this Version

- New "computed" forms of the **Goto** and **Gosub** commands.

## About the Title, De Re BASIC!

"De Re" is Latin for "of the thing" or "about".

## About the Cover Art

Thanks to BASIC! user Nicolas Mougin. The images are screenshots from real BASIC! programs available from the Google Play™ store, or from the excellent collection of shared BASIC! programs available at <http://laughton.com/basic/programs>. You can find more information on the BASIC! user forum at <http://rfobasic.freeforums.org/shared-basic-programs-f6.html>.

## Technical Editor

Thanks to Paul Laughton, the original creator of BASIC! and of this document. Thanks also to Mike Leavitt of Lansdowne, VA, USA, for his many contributions and long-time support.

The current editor of this manual monitors <https://github.com/RFO-BASIC/De-Re-Basic/issues> and the BASIC! user forum at <http://rfobasic.freeforums.org/suggestions-for-improving-the-manual-f9.html> for corrections and suggestions.

## Getting BASIC!

You can get BASIC! for your Android device from the **Google Play™** store.

If you prefer to download the installation file (Basic.apk) yourself, or to get previous versions, get it from **Bintray** at <https://bintray.com/rfo-basic/android/RFO-BASIC/>

## BASIC! Forum

Join the community of BASIC! users at <http://rfobasic.freeforums.org>, where you are always welcome.

## BASIC! Tutorial

A BASIC! user, Nick Antonaccio, has written a very nice tutorial for BASIC! You can find it at <http://rfobasic.com>.

## BASIC! Operation

### Permissions

This application requests many permissions, permissions such as sending and receiving SMS messages, making phone calls, record audio, etc. BASIC! does not exercise any of these permissions (except writing to the SD card) on its own. These permissions get exercised by the BASIC! programmer, you. You and only you. You exercise these permissions by means of the programs that you write.

If you write a program that uses the `sms.send` command then BASIC! will attempt to send an SMS message. BASIC! must have permission to send SMS messages for this command to work. If you never use the `sms.send` command then BASIC! will never send an SMS message. You are in control.

The source code for BASIC! is available from the BASIC! web site (<http://laughton.com/basic/>) and the BASIC! GitHub repository (<https://github.com/RFO-BASIC/Basic>). Please feel free to examine this source code if you have any doubt about the use of these permissions.

### Editor

#### Editing the program

The Editor is where BASIC! programs are written and edited. The operation of the Editor is fairly simple. Tap the screen at the point where you want to edit the program. A cursor will appear. Use the keyboard to edit at the cursor location.

When the Enter key is tapped, the new line will automatically indent to the indent level of the previous line. This feature will not work if the Preference, "Editor AutoIndent," is not checked. This feature also may not work if you are using a software keyboard.

If the program that you are editing has been given a name via Save or Load then that program name will be shown in the title bar.

Some Android devices are shipped with "Settings/Developer Option/Destroy Activities" checked and/or "Settings/Energy/Quick Restart" checked. Both of these setting create problems with loading files into the Editor. It appears as if you have gone through the process of loading the file but nothing appears in the editor. The solution to the problem is to uncheck both of these options. Even better, completely turn off Developer Options unless you know that you have a legitimate development need.

If your Android device does not have a physical keyboard, you will see a virtual keyboard. If you see the virtual keyboard, then you will see different things depending upon the way you are holding the device. If the device is in landscape mode then you will see a dialog box with a chunk of the program in a small text input area. You can scroll the small chunk of text up and down in this area but you will not be able to see very much of the program at any one time. It is probably best not to try to edit a program in landscape mode; hold your device in portrait mode while editing.

On some devices, if you do a long touch on the screen, a dialog box will appear. You can use the selections in the box for selecting, copying, cutting and pasting of text, among other things. Other devices have different procedures for invoking the cut and paste functions.

## Line Continuation

A BASIC! source code line may be written on more than one physical line using the line continuation character "~". If "~" is the last thing on a line, except for optional spaces, tabs, or a '%' comment, the line will be merged with the next line. This behavior is slightly different in the Array.load and List.add commands; see the descriptions of those commands for details.

Note: this operation is implemented by a pre-processor that merges the source code lines with continuation characters before the source code is executed. If you have a syntax error in the merged line, it will show as one line in the error message, but it will still be multiple lines in the editor. Only the first physical line will be highlighted, regardless of which line the error is in.

For example, the code line:

```
s$ = "The quick brown fox " + verb$ + " over " + count$ + " lazy dogs"
```

could be written as:

```
s$ = "The quick brown fox " + ~  
    verb$ + ~    % what the fox did  
    " over " + ~  
    count$ + ~    % how many lazy dogs  
    " lazy dogs"
```

## # - Format Line

If a line has the # character at the end of the line, the key words in that line will be capitalized and the # will be removed.

This feature may not work if you are using a virtual keyboard.

This feature will not work if the Preference, "Editor AutoIndent," is not checked.

## Menus

Press the Menu key to access the following menus.

### Run

Runs the current program.

If the program has been changed since it was last saved, you will be given an opportunity to save the program before the run is started.

If a run-time error occurs then the offending line will be shown as selected in the editor.

Sometimes, if a program is re-run too quickly (less than 10 seconds after the end of the previous run) strange runtime errors may occur. If you are having run-time errors that do not make sense, try waiting a bit longer before re-running

### *Load*

Load is used to load a program file into the editor. Programs must be in the directory, "rfo-basic/source/", or one of its subdirectories. (See "Paths Explained", later in this manual.) Program files must have the extension ".bas"

BASIC! checks to see if the current program in the Editor has been changed when Load is tapped. You will be offered the opportunity to save the program if it has been changed. Load will be restarted after the save is done if you choose to save the program.

The "BASIC! Load File" screen shows a sorted list of .bas files and directories. Directories are denoted by the (d) appended to the directory name. Directory entries are at the top of the list. BASIC! programs will be shown with the .bas extension. If there are files in the source/ directory (or subdirectories) that do not have the .bas extension, they will not appear in the list.

Tap on a .bas file to load it into the Editor.

Tap on a directory to display the contents of that directory.

Tap on the ".." at the top of list to back up one directory level. The tap will be ignored if the current directory is the source/ directory.

If you accidentally tap the Load button, you can back out of Load by tapping the BACK key.

### *Save*

Saves the program currently in the editor.

A text input dialog box will appear. Type in the name you want the file saved as and tap OK. The extension .bas will be added to file name if is not already there. If the current program has a name because it was previously loaded or save then that name will be in the text input area.

You can back out of Save by tapping the BACK key.

### *Clear*

The current program in the Editor will be cleared. You will be offered the opportunity to save the current program if it has been changed.

### *Search*

Search for strings in the program being edited. Found strings may be replaced with a different string.

The Search view shows a **Text Window** with the text from the Editor: a **Search For** field and a **Replace With** field.



If there is a block of text currently selected in the Editor, then that text will be placed into the **Search For** field.

The initial location of the search cursor will be at the start of the text regardless of where the cursor was in the Editor text.

Note: The search ignores case. For example, searching for "basic" will find "BASIC" This is because BASIC! converts the whole program to lower case (except characters within quotes) when the program is run.

#### NEXT BUTTON

Start the search for the string in the **Search For** field. The search is started at the current cursor location. If the string is found then it will be selected in **Text Window**.

If the **Done Button** is tapped at this point then the Editor will returned to with the found text selected.

If the **Replace Button** is tapped then the selected text will be replaced.

Pressing the **Next Button** again will start a new search starting at the end of the selected or replaced text.

If no matching text is found then a "string not found" message will be shown. If the **Done Button** is tapped the Editor will be returned to with the cursor at the end of the program. Alternatively, you could change the **Search For** text and start a new search.

#### REPLACE BUTTON

If Next has found and selected some text then that text will be replaced by the contents of the **Replace With** field.

If no text has been found then the message, "Nothing found to replace" will be shown.

#### REPLACE ALL BUTTON

All occurrences of the **Search For** text are replaced with the **Replace With** text. **Replace All** always starts at the start of the text. The last replaced item will be shown selected in the **Text Window**. The number of items replaced will be shown in a message.

#### DONE BUTTON

Returns to the Editor with the changed text. If there is selected text in the **Text Window** then that text will be shown selected in the Editor.

#### BACK KEY

If the BACK key is tapped then the Editor will be returned to with the original text unchanged. All changes made during the Search will be undone. Think of the BACK key as UNDO ALL.

#### *More->Format*

The program currently in the Editor will be formatted. The key words will be capitalized. Program lines will be indented as appropriate for the program structure.

## *More->Delete*

The Delete Command is used to delete files and directories. The command should be used for maintaining files and directories that are used in BASIC! but it can also be used to delete any file or directory on the SD card.

Tapping Delete presents the "BASIC! Delete File" screen. The screen has a sorted list of files and directories. Directories are marked with (d) appended to the name and will appear at the top of the list.

Tapping a file name will cause the "Confirm Delete" dialog box to be shown. Tap the Delete button to delete the file. Tap the No button to dismiss the dialog box and not delete the file.

When a directory name is tapped, the contents of directory are displayed. If the directory is empty the "Confirm Delete" dialog box will be shown. Tap the Delete button to delete the directory. Tap the No button to dismiss to dismiss the dialog box and not delete the directory.

Tapping the ".." at the top of the screen moves up one directory level. Tapping the ".." will have no effect if you are in the root directory.

When BASIC! is first started after installing or re-started after an Exit, the directory listed will be the "<pref base drive>/rfo-basic" directory. If you have changed directories in previous Delete operations then the directory shown will be last directory that you were in.

Exit Delete by tapping the BACK key.

## *More -> Preferences*

### FONT SIZE

Sets the font size (Small, Medium, Large) to be used with the various screens in BASIC!

### SCREEN COLORS

Sets the appearance of the Screens. Choose Black text on a White background, White text on a Black background or White text on a Blue background.

### EDITOR LINES

Check the box if the text lines in the Editor should be underlined.

### CONSOLE LINES

Check the box if the text lines in the output console should be underlined.

### CONSOLE TYPEFACE

Choose the typeface to be used on the Output Console.

### SCREEN ORIENTATION

Choose to allow the Sensors to determine the orientation of the screens or to set a fixed orientation without regard to the Sensors.

Note: The reverse orientations apply to Android 2.3 or newer.

## EDITOR AUTOINDENT

Check the box if you want the Editor to do auto indentation. Enabling auto indentation will also enable the formatting of a line that ends with the "#" character.

Some devices are not able to do auto indenting properly. In some of those devices the AutoIndent feature may cause the Editor to be unusable. If that happens, turn off AutoIndent.

## BASE DRIVE

Some Android devices have several external storage devices (and some have no physical external storage devices). BASIC! will use the system-suggested device as its base drive. The *base drive* is the device where the BASIC! "rfo-basic" directory (base directory) is located. The *base directory* is where BASIC!'s programs and data are stored. (See "Paths Explained", later in this manual.)

If your device does have more than one external storage device they will be listed here. If your device has no external storage devices, your one and only choice will be "No external storage". Tap the device you want to use as the base drive and press the BACK key. You will then be given the choice of either immediately restarting BASIC! with the new base drive or waiting and doing the restart yourself.

In this manual, <pref base drive> means the base drive you selected when you set the Base Drive here. In many devices, the system-suggested drive is "/sdcard".

Note: If you have created a Launcher Shortcut (see Appendix C) with files in one base directory but try to execute that shortcut while using a different base directory, the shortcut will fail to execute. You will get an error message.

## More -> Commands

The Commands command presents the list of the BASIC! commands and functions as copied from Appendix A of this document.

Tapping an alpha key will cause the command list to scroll to commands that start with that character. There will be no scrolling if there is no command that starts with that character.

Note: You can hide the virtual keyboard with the BACK key. If you do that, you will not be able to get it back until you invoke the Commands function again.

Tapping on a particular command causes that command to be copied to the clipboard (not including the page number) and returning to the Editor. You can then paste the command into your BASIC! program.

## More -> About

The About command displays the BASIC! web page for the release of BASIC! that corresponds to the release of the BASIC! that you are using. Make sure that you have a connection to the Internet before selecting About.

## More -> Exit

The only way to cleanly exit BASIC! is to use the Exit command.

Pressing the Home key while in BASIC! leaves BASIC! in exactly the same state it was in when the Home key was tapped. If a program was running, it will still be running when BASIC! is re-entered. If you were in the process of deleting, the Delete screen will be shown when BASIC! is re-entered.

## Run

Pressing the Menu Run button starts the program running. However, if the source in the Editor has been changed, then the Save dialog will be displayed. You may choose to save the changed source or continue without saving.

The BASIC! Output Console will be presented as soon as the program starts to run. You will not see anything on this screen unless one of the following situations occur:

- the program prints something
- the END statement is executed
- you are in Echo mode
- there is a run-time error.

If the program does not print anything then the only indication you would get that the program has finished is if the program ends with an End statement.

If the program does not contain any executable statements then the message, "Nothing to execute" will be displayed.

Tapping the BACK key will stop a running program. Tapping the BACK key when the program run has ended will restart the Editor.

If the program ended with a run-time error, the line where the error occurred will be shown selected in the Editor. If the error occurred in an INCLUDE file then the INCLUDE statement will be shown selected. While this text is selected the Editor "fling scrolling" will not work. Unselect the text to restore the fling scroller.

The Editor cursor will remain where it was when the Run was started if no run-time error occurred.

## Menu

Pressing Menu while a program is running or after the program is stopped will cause the Run Menu to be displayed. (Except when Graphics is running. See the Graphics section for details.)

## Stop

If a program is running, the Stop menu item will be enabled. Tapping Stop will stop the running program. Stop will not be enabled if a program is not running.

## Editor

Editor will not be enabled if a program is running. If the program has stopped and Editor is thus enabled then selecting Editor will cause the Editor to be re-entered. You could also use the BACK key to do this.

## Crashes

BASIC! is a very large and complex program that is constantly under development. From time to time, it will crash. Previous versions of BASIC! supported automatic crash reporting. This feature has been temporarily disabled while we work on an implementation that is more compatible with Android versions 4.2 and later. We apologize for the inconvenience.

## Command Description Syntax

### Upper and Lower Case

Commands are described using both upper and lower case for ease of reading. BASIC! converts every character (except those between double quotation marks) to lower case when the program is run.

### <nexp>, <sexp> and <lexp>

These notations denote a numeric expression (<nexp>), a string expression (<sexp>), and a logical expression (<lexp>). An expression can be a variable, a number, a quoted string or a full expression such as  $(a \cdot x^2 + bx + c)$ .

### <nvar>, <svar> and <lvar>

This notation is used when a variable, not an expression, must be used in the command. Arrays with indices (such as  $n[1,2]$  or  $s[3,4]$ ) are considered to be the same as <nvar>, <svar> and <lvar>.

### Array[] and Array\$[]

This notation implies that an array name without indices must be used.

### Array[{<start>,<length>}] and Array\$[{<start>,<length>}]

In most contexts, numeric expressions inside the brackets are indices specifying a single array element. In some commands, a pair of numeric expressions specifies a segment of the array. Both the start index and length are numeric expressions, and both are optional. This notation is shorthand for:

Array [ { {<start\_nexp>}, {<length\_nexp>} } ] or  
Array\$ [ { {<start\_nexp>}, {<length\_nexp>} } ]

### {something}

Indicates something optional.

### { A | B | C }

This notation suggests that a choice of either A, B, or C, must be made. For example:

Text.open {r|w|a}, fn...

Indicate that either "r" or "w" or "a" must be chosen:

Text.open r, fn...  
Text.open w, fn...  
Text.open a, fn...

## X, ...

Indicates a variable-sized list of items separated by commas. At least one item is required.

## {n} ...

Indicates an optional list of items with zero or more items separated by commas.

## <statement>

Indicate an executable BASIC! statement. A <statement> is usually a line of code but may occur within other commands such as: If <lexp> then <statement>.

## Numbers

Numbers in BASIC! are double-precision floating point (64-bit IEEE 754). This means:

- A printed number will always have decimal point. For example, 99 will print as "99.0". You can print numbers without decimal points by using the Format\$() function. For example FORMAT\$("###",99) will print as "99".
- A number with more than 7 significant digits will be printed in floating point format. For example, the number 12345678 will be printed as 1.2345678E7. The Format\$() function can be used to print large numbers in other than floating point format.
- Mathematical operations on decimal values are imprecise. If you are working with currency you should multiply the number by 100 until you need to print it out. When you print it, you can divide by 100.

You must type decimal numbers with a leading zero. Using .15 will create a syntax error. Using 0.15 will not generate a syntax error.

A logical value (false = 0, true <> 0) is a kind of number.

You can use string functions to convert numbers to strings. STR\$(), INT\$(), HEX\$() and a few others do simple conversions. FORMAT\$() and USING\$() can do more complex formatting.

For the purposes of this documentation, numbers that appear in a BASIC! program are called Numeric Constants.

## Strings

Strings in BASIC! begin and end with quote (") characters. For example: "This is a string" is a string.

Strings can include the quote character by using: \" For example:

```
Print "His name is \"Jimbo\" Jim Giudice."
```

will print: His name is "Jimbo" Jim Giudice.

New line characters may be inserted into a string using: \n

```
Print "Jim\nGiudice"
```

will print:

```
Jim
Giudice
```

Other special characters can be inserted into a string using the CHR\$( ) function.

Strings with numerical characters can be converted to BASIC! numbers using the VAL(<sexp>) function.

For the purposes of this documentation, strings that appear within a BASIC! program are called String Constants.

## Variables

### Variable Names

A BASIC! Variable is a container for some numeric or string value. Variable names must start with the characters "a" through "z" or "#" or "@". The remaining characters in the variable name may also include the numbers 0 through 9 and the underscore (\_).

A variable name may be as long as needed.

Upper case characters can be used in variable names but they will be converted to lower case characters when the program is run. The Variable name "gLoP" is the same as the name "glop" to BASIC!

BASIC! key words should not be used to start the name of a variable. For example, Donut = 5 will be interpreted as Do Nut=5. BASIC! thus will expect this Do statement to be followed by an Until statement somewhere before the program ends. A list of BASIC! commands can be found in Appendix A.

### Variable Types

There are two types of variables: Variables that hold numbers and variables that hold strings. Variables that hold strings end with the character "\$". Variables that hold numbers do not end in "\$".

"Age", "amount" and "height" are all numeric variable names.

"First\_Name\$", "Street\$" and "A\$" are all string variable names.

## Scalar and Array Variables

There are two classes of variables: Scalars and Arrays. A scalar variable can hold one and only one value. An Array variable can hold many values.

### Arrays

An Array is variable that can hold many values organized in a systematically arranged way. The simplest array is the linear array. It can be thought of as a list of values. The array `A[index]` is a linear array. It can hold values that can accessed as `A[1]`, `A[2]`, ..., `A[n]`. The number (variable or constant) inside the square brackets is called the index.

If you wanted to keep a list of ten animals, you could use an array called `Animals$[]` that can be accessed with an index of 1 to 10. For example: `Animals$[5] = "Cat"`

Arrays can have more than one index or dimension. An array with two dimensions can be thought of as a list of lists. Let's assume that we wanted to assign a list of three traits to every animal in the list of animals. Such a list for a "Cat" might be "Purrs", "Has four legs" and "Has Tail". We could set up the Traits array to have two dimensions such that `Traits$[5,2] = "Has four legs"`. If someone asked what are the traits of cat, search `Animals$[index]` until "Cat" is found at index =5. Index=5 can then be used to access `Traits[index,[ 1|2|3]]`

BASIC! arrays can have any number of dimensions of any size. The only limitation is that the total number of elements in any single array must be 50,000 or less.

BASIC! arrays are "one-based". This means that the first element of an array has an index of "1". Attempting to access an array with an index of "0" (or less than 0) will generate a run-time error.

Before an array can be used, it must be dimensioned using the DIM command. The DIM command tells BASIC! how many indices are going to be used and the sizes of the indices. Some BASIC! Commands automatically create a one-dimensional array. Auto-dimensioned array details will be seen in the description of those commands.

Note: It is recommended that the List commands (see below) be used in place of one-dimensional arrays. The List commands provide more versatility than the Array commands.

### Array Segments

Some BASIC! Commands take an array as an input parameter. If the array is specified with nothing in the brackets (for example, `Animals$[]`), then the command reads the entire array.

Most of these commands allow you to limit their operation to a segment of the array, using the notation `"Array[start, length]"`, where both "start" and "length" are numeric expressions.

For example, you can write `Animals$[2,3]`. Usually that means "the animal at row 2 and column 3 of a two dimensional array called `Animals$`". When used to specify an array segment, it has a different meaning: "read only the segment of the `Animals$` array that starts at index 2 and includes 3 items".



Notice that this notation applies only to one-dimensional arrays. In fact, it treats all arrays as one-dimensional, regardless of how they are declared.

Both of the expressions in the "[start, length]" pair are optional. If the "start" value is omitted, the default starting index is 1. If the "length" value is omitted, the default is the length from the starting index to the end of the array. If both are omitted, the default is to use the entire array.

## Array Commands

These commands all operate on Arrays. Commands operate on both numeric and string arrays, unless otherwise indicated.

### *Dim Array[<nexp>{, <nexp> } ... ] {, Array[<nexp>{, <nexp> } ... ] } ...*

The DIM command tells BASIC! how many dimensions an array will have and how big those dimensions are. Multiple arrays can be dimensioned with one Dim statement. String and numeric arrays can be dimensioned in a single DIM command. Examples:

```
DIM A[15]
DIM B$[2,6,8], C[3,1,7,3], D[8]
```

### *UnDim Array[] {, Array[] } ...*

Un-dimensions an array. The command allows the array to be dimensioned again with different dimensions. Multiple arrays can be un-dimensioned with one UnDim statement. The command is very useful when in a loop using commands that automatically dimension an array. Array[] is specified without any index. The command is exactly the same as Array.delete.

### *Array.average <Average\_nvar>, Array[{<start>,<length>}]*

Finds the average of the values in a numeric array (Array[]) or array segment (Array[start,length]), and places the result into <Average\_nvar>.

### *Array.copy SourceArray[{<start>,<length>}], DestinationArray[{{-}<extras>}]*

The previously Dimensioned or Loaded SourceArray will be copied to the DestinationArray. If the Destination Array does not exist, a new array is created. If the Destination Array already exists, some or all of the existing array will be overwritten. The arrays may be either numeric or string arrays but they must both be of the same type.

You may copy an entire array (SourceArray[]) or an array segment (SourceArray[start,length]).

If <start> is <= 1 or <start> is not present then the copy will begin with the first element of the SourceArray. If <length> is not present or if <start>+<length> exceeds the number of elements in the SourceArray then the entire array or segment from <start> to the end of the array will be copied.

If the Destination Array does not exist, the optional <extras> parameter specifies that <extras> empty elements are to be added to the new Destination Array before or after the copy. These elements will be added to the start of the array if the optional minus(-) sign is present. If minus is not present then these elements will be added to end of the array.

The extra elements for a new numeric array will be initialized to zero. The extra elements for a new string array will be the empty string, "".

If the Destination Array already exists, the optional <extras> parameter specifies a starting index into the Destination Array. If the remaining length of the Destination Array starting at the <extras> index is less than the number of elements to be copied from the Source Array, anything that would not fit is not copied.

See the Sample Program file, f26\_array\_copy.bas, for working examples of this command.

### *Array.delete Array[{, Array[]} ...*

Does the same thing as UnDim Array[].

### *Array.length <length\_nvar>, Array[{<start>,<length>}]*

Places the number of elements in an entire array (Array[] or Array\$[]) or an array segment (Array[start,length] or Array\$[start,length]) into <Length\_nvar>.

### *Array.load Array[], <nexp>, ...*

Loads a numeric array Array[] with the list of numeric values <nexp>{,<nexp>..,<nexp>}, or loads a string array Array\$[] with the list of string values <sexp>{,<sexp>..,<sexp>}. The Array[] or Array\$[] will have a single dimension of the size of the number of values in the list.

The array is specified without an index and must not have been previously dimensioned.

The list of <exp>s may be continued onto the next line by ending the line with the "~" character. The "~" character may be used between <nexp> parameters, where a comma would normally appear. It may not be used to split a parameter across multiple lines.

Examples are:

```
Array.load Numbers[], 2, 4, 8, n^2, 32
Array.load Hours[], 3, 4,7,0, 99, 3, 66~
37, 66, 43, 83~
83, n*5, q/2 +j
Array.load Letters$[], "a", "b","c",d$, "e"
```

### *Array.max <Max\_nvar> Array[{<start>,<length>}]*

Finds the maximum value in a numeric array (Array[]) or array segment (Array[start,length]), and places the result into the numeric variable <max\_nvar>.

### *Array.min <Min\_nvar>, Array[{<start>,<length>}]*

Finds the minimum value in a numeric array (Array[]) or array segment (Array[start,length]), and places the result into the numeric variable <min\_nvar>.

### *Array.reverse Array[{<start>,<length>}]*

Reverses the order of values in a numeric or string array (Array[] or Array\$[]) or array segment (Array[start,length] or Array\$[start,length]).

### *Array.search Array[{<start>,<length>}], <value\_exp>, <result\_nvar>{,<start\_nexp>}*

Searches in the numeric or string array (Array[] or Array\$[]) or array segment (Array[start,length] or Array\$[start,length]) for the specified numeric or string value, which may be an expression. If the value is found in the array, its position will be returned in the result numeric variable <result\_nvar>. If the value is not found the result will be zero.

If the optional start expression parameter is present, the search will start at the specified element. The default value is 1.

### *Array.shuffle Array[{<start>,<length>}]*

Randomly shuffles the values of the specified array (Array[] or Array\$[]) or array segment (Array[start,length] or Array\$[start,length]).

### *Array.sort Array[{<start>,<length>}]*

Sorts the values of the specified array (Array[] or Array\$[]) or array segment (Array[start,length] or Array\$[start,length]) in ascending order.

### *Array.std\_dev <sd\_nvar>, Array[{<start>,<length>}]*

Finds the standard deviation of the values in a numeric array (Array[]) or array segment (Array[start,length]), and places the result into the numeric variable <sd\_nvar>.

### *Array.sum <sum\_nvar>, Array[{<start>,<length>}]*

Finds the sum of the values in a numeric array (Array[]) or array segment (Array[start,length]), and then places the result into the numeric variable <sum\_nvar>.

### *Array.variance <v\_nvar>, Array[{<start>,<length>}]*

Finds the variance of the values in a numeric array (Array[]) or array segment (Array[start,length]), and places the result into the numeric variable <v\_nvar>.

## **Data Structures and Pointers in BASIC!**

BASIC! offers commands that facilitate working with Data Structures in ways that are not possible with traditional Basic implementations. These commands provide for the implantation of Lists, Bundles, Stacks and Queues.

### **What is a Pointer**

The central concept behind the implementation of these commands (and many other BASIC! commands) is the *pointer*. A pointer is a numeric value that is an index into a list or table of things.

As an example of pointers think of a file cabinet drawer with folders in it. That file cabinet is maintained by your administrative assistant. You never see the file drawer itself. In the course of your work you will create a new folder into which you put some information. You then give the folder to your assistant to be placed into the drawer. The assistant puts a unique number on the folder and gives you a slip of paper with that unique number on it. You can later retrieve that folder by asking your assistant to bring you the folder with that particular number on it.

In BASIC! you create an information object (folder). You then give that information object to BASIC! to put into a virtual drawer. BASIC! will give you a unique number—a pointer—for that information object. You then use that pointer to retrieve that particular information object.

Continuing with the folder analogy, let's assume that you have folders that contain information about customers. This information could be things such as name, address and phone number. The number that your assistant will give you when filing the folder will become the customer's customer number. You can retrieve this information about any customer by asking the assistant to bring you the folder with the unique customer number. In BASIC! you would use a Bundle to create that customer information object (folder). The pointer that BASIC! returns when you create the customer Bundle becomes the customer number.

Now let's assume that a customer orders something. You will want to create a Bundle that contains all the order information. Such bundles are used by the order fulfillment department, the billing department and perhaps even the marketing department (to SPAM the customer about similar products). Each Bundle could contain the item ordered, the price, etc. The Bundle will also need to contain information about the customer. Rather than replicate the customer information you will just create a customer number field that contains the customer number (pointer). The pointer that gets returned when you create the order bundle becomes the Order Number. You can create different lists of bundles for use by different departments.

It would also be nice to have a list of all orders made by a customer in the customer Bundle. You would do this by creating a List of all order numbers for that customer. When you create the customer bundle, you would ask BASIC! to create an empty List. BASIC! will return a pointer to this empty List. You would then place this pointer into the customer record. Later when the customer places an order, you will retrieve that list pointer and add the order number to the List.

You may also want to create several other Lists of order Bundles for other purposes. You may, for example, have one List of orders to be filled, another List of filled orders, another List of returned orders, another List for billing, etc. All of these Lists would simply be lists of order numbers. Each order number would point to the order Bundle which would point to the Customer Bundle.

If you were to actually create such a database in BASIC! you would probably want to save all these Bundles and Lists onto external storage. Getting that information from the internal data structures to external storage is an exercise left to the user for now.

## Lists

A List is similar to a single-dimension array. The difference is in the way a List is built and used. An array must be dimensioned before being used. The number of elements to be placed in the array must be predetermined. A List starts out empty and grows as needed. Elements can be removed, replaced and inserted anywhere within the list.

Another important difference is that a List is not a variable type. A numeric pointer is returned when a list is created. All further access to the List is by means of that numeric pointer. One implication of this is that it is easy to make a List of Lists. A List of Lists is nothing more than a numeric list containing numeric pointers to other lists.

Lists may be copied into new Arrays. Arrays may be added to Lists.

All of the List commands are demonstrated in the Sample Program file, f27\_list.bas.

## List Commands

### *List.create N/S, <pointer\_nvar>*

Creates a new, empty list of the type specified by the N or S parameter. A list of strings will be created if the parameter is "S". A list of numbers will be created if the parameter is "N"

The pointer to the new list will be returned in the <pointer\_nvar> variable.

The newly created list is empty. The size returned for a newly created list is zero.

### *List.add <pointer\_nexp>, <nexp>{,<nexp>...,<nexp>}*

The values, <nexp>{,<nexp>...,<nexp>} will be added to specified list.

Strings may be added in the same manner except that <sexp> replaces <nexp>.

The list of <exp>s may be continued onto the next line by ending the line with the "~" character. The "~" character may be used between <nexp> parameters, where a comma would normally appear. It may not be used to split a parameter across multiple lines.

Examples are:

```
List.add Nlist, 2, 4, 8 , n^2, 32
```

```
List.add Hours, 3, 4,7,0, 99, 3, 66~  
37, 66, 43, 83~  
83, n*5, q/2 +j
```

```
List.add Name "Bill", "Jones"~  
"James", "Barnes"  
"Jill", "Hanson"
```

### *List.add.list <destination\_list\_pointer\_nexp>, <source\_list\_pointer\_nexp>*

The elements in the source list will be added to the end of the destination list.

The two lists must be of the same type (string or numeric).

### *List.add.array <list\_pointer\_nexp>, Array[{<start>,<length>}]*

The elements of the specified array (Array[]) or array segment (Array[start,length]) will be added to the end of the list.

The Array type must be the same as the list type.

### *List.replace <pointer\_nexp>,<index\_nexp>, <sexp>|<nexp>*

The List element specified by <index\_nexp> in the list pointed to by <pointer\_nexp> will be replaced by the string or numeric expression.

The index is one-based. The first element of the list is 1.

The replacement expression type (string or numeric) must match the list creation type.

### *List.insert <pointer\_nexp>, <index\_nexp>, <sexp>|<nexp>*

The <sexp> or <nexp> value will be inserted into the list pointed to by <pointer\_nexp>. The element will be inserted at the index point, <index\_nexp>. If the value of the index point is equal to one more than the current size of the list, a new item is inserted at the end of the list.

The index is ones based. The first element of the list is 1.

The inserted element expression type must match the type (string or numeric) used in the creation of the list.

### *List.remove <pointer\_nexp>,<index\_nexp>*

The list element specified by <index\_nexp> in the list pointed to by <pointer\_nexp> will be removed from the list.

The index is ones based. The first element of the list is 1.

### *List.get <pointer\_nexp>,<index\_nexp>, <svar>|<nvar>*

The list element specified by <index\_nexp> in the list pointed to by <pointer\_nexp> will be returned in the specified string or numeric variable.

The index is ones based. The first element of the list is 1.

The return element variable type must match the type (string or numeric) used in the creation of the list.

### *List.type <pointer\_nexp>, <svar>*

The type of list pointed to by the list pointer will be returned in the String variable.

The upper case character "S" will be returned if the List is a list of strings.

The upper case character "N" will be returned if the list is a list of numbers.

#### *List.size <pointer\_nexp>, <nvar>*

The size of the list pointed to by the list pointer will be returned in the numeric variable.

#### *List.clear <pointer\_nexp>*

The list pointed to by the list pointer will be cleared. The list's size will be set to zero.

#### *List.search <pointer\_nexp>, value/value\$, <result\_nvar>{,<start\_nexp>}*

The list pointed to by the list pointer will be searched for the specified string or numeric value. The position of the found value in the list will be returned in result numeric variable. If the value is not found in the list the result numeric variable value will be zero.

If the optional start expression parameter is present, the search will start at the specified element. The default value is 1.

#### *List.ToArray <pointer\_nexp>, Array\$[] | Array[]*

The list pointed to by the list pointer will be copied into the new, previously non-dimensioned array. The specified array type (string or numeric) must be the same type as the list.

## **Bundles**

A Bundle is a group of values collected together into a single object. A bundle object may contain any number of string and numeric values.

The values are set and accessed by keys. A key is string that identifies the value. For example, a bundle might contain a person's first name and last name. The keys for accessing those name strings could be "first\_name" and "last\_name". An age numeric value could also be placed in the Bundle using an "age" key.

A new, empty bundle is created by using the Bundle.create command. The command returns a pointer to the empty bundle. Because the bundle is represented by a pointer, bundles can be placed in lists. Bundles can also be contained in other bundles. This means that the combination of lists and bundles can be used to create arbitrarily complex data structures.

After a bundle is created, keys and values can be added to the bundle using the bundle.put command. Those values can be retrieved using the keys in the bundle.get command.

There are other bundle commands to facilitate the use of bundles.

## **Bundle Commands**

#### *Bundle.create <pointer\_nvar>*

A new, empty bundle is created. The bundle pointer is returned in <pointer\_nvar>.

Example:

```
Bundle.create bptr
```

***Bundle.put** <pointer\_nexp>, <key\_sexp>, <value\_nexp>/<value\_sexp>*

The value expression will be placed into the specified bundle using the specified key.

The type of the value will be determined by the type of the value expression.

Example:

```
Bundle.put bptr, "first_name", "Frank"  
Bundle.put bptr, "age", 44
```

***Bundle.get** <pointer\_nexp>, <key\_sexp>, <nvar>/<svar>*

Places the value specified by the key string expression into the specified numeric or string variable. The type (string or numeric) of the destination variable must match the type stored with the key.

Example:

```
Bundle.get bptr, "first_name", first_name$  
Bundle.get bptr, "age", age
```

***Bundle.keys** <pointer\_nexp>, <list\_nvar>*

A list of the keys currently in the specified bundle will be placed into a new list whose pointer will be returned in <list\_nvar>.

The key names in the returned list may be extracted using the various list commands.

Example:

```
bundle.keys bptr, list  
list.size list, size  
for i = 1 to size  
  list.get list, i, key$  
  bundle.type bptr, key$, type$  
  if type$ = "S"  
    bundle.get bptr, key$, value$  
    print key$, value$  
  else  
    bundle.get bptr, key$, value  
    print key$, value  
  endif  
next i
```

***Bundle.contain** <pointer\_nexp>, <key\_sexp>, <contains\_nvar>*

If the key specified in the key string expression is contained in the bundle's keys then the "contains" numeric variable will be returned with a non-zero value. The value returned will be zero if the key is not in the bundle.



### *Bundle.type <pointer\_nexp>, <key\_sexp>, <type\_svar>*

Returns the value type (string or numeric) of the specified key in the specified string variable. The <type\_svar> will contain an uppercase "N" if the type is numeric. The <type\_svar> will contain an uppercase "S" if the type is a string.

Example:

```
Bundle.type bptr, "age", type$  
Print type$ % will print N
```

### *Bundle.clear <pointer\_nvar>*

The bundle pointed to by <pointer\_nvar> will be cleared of all tags. It will become an empty bundle.

## Stacks

Stacks are like a magazine for a gun.



The last bullet into the magazine is the first bullet out of the magazine. This is also what is true about stacks. The last object placed into the stack is the first object out of the stack. This is called LIFO (Last In First Out).

An example of the use of a stack is the BASIC! Gosub command. When a Gosub command is executed the line number to return to is "pushed" onto a stack. When a return is executed the return line number is "popped" off of the stack. This methodology allows Gosubs to be nested to any level. Any return statement will always return to the line after the last Gosub executed.

A running example of Stacks can be found in the Sample Program file, f29\_stack.bas.

## Stack Commands

### *Stack.create N/S, <ptr\_nvar>*

Creates a new stack of the designated type (N=Number, S=String). The stack pointer is in <ptr\_nvar>.

### *Stack.push <ptr\_nexp>, <nexp>/<sexp>*

Pushes the <nexp> or <sexp> onto the top of the stack designated by <ptr\_nexp>.

The type of value expression pushed must match the type of the created stack.

### *Stack.pop <ptr\_nexp>, <nvar>/<svar>*

Pops the top-of-the-stack value designated by <ptr\_nexp> and places it into the <nvar> or <svar>.

The type of the value variable must match the type of the created stack.

#### *Stack.peek <ptr\_nexp>, <nvar>/<svar>*

Returns the top-of-stack value of the stack designated by <ptr\_nexp> into the <nvar> or <svar>. The value will remain on the top of the stack.

The type of the value variable must match the type of the created stack.

#### *Stack.type <ptr\_nexp>, <svar>*

The type (numeric or string) of the stack designated by <ptr\_nexp> will be returned in <svar>. If the stack is numeric, the upper case character "N" will be returned. If the stack is a string stack, the upper case character "S" will be returned.

#### *Stack.IsEmpty <ptr\_nexp>, <nvar>*

If the stack designated by <ptr\_nexp> is empty the value returned in <nvar> will be 1. If the stack is not empty the value will be 0.

#### *Stack.clear <ptr\_nexp>*

The stack designated by <ptr\_nexp> will be cleared.

## Queues

A Queue is like the line that forms at your bank. When you arrive, you get in the back of the line or queue. When a teller becomes available the person at the head of the line or queue is removed from the queue to be serviced by the teller. The whole line moves forward by one person. Eventually, you get to the head of the line and will be serviced by the next available teller. A queue is something like a stack except the processing order is First In First Out (FIFO) rather than LIFO.

Using our customer order processing analogy, you could create a queue of order bundles for the order processing department. New order bundles would be placed at the end of the queue. The top-of-the-queue bundle would be removed by the order processing department when it was ready to service a new order.

There are no special commands in BASIC! for Queue operations. If you want to make a queue, create a list.

Use List.add to add new elements to the end of the queue.

Use List.get to get the element at the top of the queue and use List.remove to remove that top of queue element. You should, of course, use List.size before using List.get to insure that there is a queued element remaining

## Comments

### ! - Single Line Comment

If the first character in a line is the "!" character, BASIC! considers the entire line a comment and ignores it. If the "!" appears elsewhere in the line it does not indicate a comment.

### REM - Single Line Comment (legacy)

If the first three characters in a line are "REM" or even "rem", BASIC! considers the entire line a comment and ignores it. If "REM" appears elsewhere in the line it does not indicate a comment.

### !! - Block Comment

When a line begins with the "!!" characters, all lines that follow are considered comments and are ignored by BASIC! The Block quoted section ends at the next line that starts with "!!"

### % - Middle of Line Comment

If the "%" character appears in a line (except within a quoted string) then rest of the line is a comment.

## Expressions

**Numeric <nexp> := {<numeric variable>|<numeric constant> {<noperator>  
<nexp>|<end of line>}}**

### Numeric Operators <noperator>

The numeric operators are listed by precedence. Higher precedence operators are executed before lower precedence operators. Precedence can be changed by using parenthesis.

1. Unary +, Unary –
2. Exponent ^
3. Multiply \*, Divide /
4. Add +, Subtract –

### Numeric Expression Examples

```
a
a*b + 4/d - 2*(d^2)
a + b + d + RND()
b + CEIL(d/25) + 5
```

### Pre- and Post-Increment Operators

++x	Increments the value of x by 1 the before x value is used
--y	Decrements the value of y by 1 the before y value is used
x++	Increments the value of x by 1 after the x value is used
y--	Decrements the value of y by 1 after the y value is used

Note: these operations are implemented by a pre-processor that changes the source code before it is run. If you have a syntax error in a line that contains these operators, the code line will look different from what you typed. You cannot combine any of these operators with each other or with any assignment operator (=, +=, etc.).

**String <sexp> := {<string variable>|<string constant>} { + <sexp> | <end of line>}**

There is only one string operator: +

This operator is called the concatenation operator. It is used to join two strings

**Print "abc" + "def"**  
**will print: abcdef**

## Logical <lexp>

Logical expressions produce false or true results. False and true are represented in BASIC! by the numeric value of zero and not zero. False = 0. True = not 0.

There are two types of logical expressions: Numeric logical expressions and string logical expressions. Both types produce a numerically-represented values of true or false.

**<slexp> := {<string variable>|<string constant>} <logical operator>{<string variable>|<string constant>}**

**<nlexp> := {<numeric variable>|< numeric constant>} <logical operator>{< numeric variable>|< numeric constant>}**

There is also the unique the unary NOT (!) operator. Not inverts the truth of a logical expression.

## Logical Operators

The Logical operators are listed by precedence with the highest precedence first. Precedence may be modified by using parenthesis.

1. Unary Not !
2. Less than "<", Greater than ">", Less than or equal "<=", Greater than or equal ">="
3. Equal "=", Not Equal "<>"
4. And "&", Or "|"

## Examples of Logical Expressions

**1 < 2 (true)**  
**3 <> 4 (true)**  
**"a" < "bcd" (true)**  
**1 & 0 (false)**  
**!(1 & 0) (true)**

## Assignment Operations

Variables get their values by means of assignment statements. Simple assignment statements are of the form:

```
<nvar> = <nexp>
<svar> = <sexp>
```

### LET

The original Basic language used the command, LET, to denote an assignment operation as in:

```
LET <nvar> = <nexp>
```

BASIC! also has the LET command but it is optional. If you use other programming languages, it may look strange to you, but there are two reasons you might use LET.

First, you must use LET if you want to have a variable name start with a BASIC! keyword. Such keywords may not appear at the beginning of a new line. The statement:

```
Letter$ = "B" will be seen by BASIC! as
```

```
LET ter$ = "B"
```

If you really want to use Letter\$ as a variable, you can safely use it by putting it in a LET statement:

```
LET Letter$="B"
```

If you do the assignment in an IF statement, you should also use the LET command:

```
If 1 < 2 then LET letter$="B"
```

Second, assignment is faster with the LET command than without it.

### OpEqual Assignment Operations

```
+=      a += 1 is the same as a = a + 1
*=      b *= 5 + 3 is the same as b = b * (5 + 3)
-=      c -= d is the same as c = c - d
/=      e /= log(37) + 1 is the same as e = e / (log(37) + 1)
```

Note: these operations are implemented by a pre-processor which changes the source code before it is run. If you have a syntax error in a line that contains these operators, the code line will look different from what you typed. If you use one of these operators, you can not use any of the Pre- and Post-Increment Operators on the same line.

## Math Functions

Math functions act like numeric variables in a <nexp> (or <lexp>).

### BOR(<nexp1>, <nexp2>)

The logical bitwise value of <nexp1> OR <nexp2> will be returned. Floating point double precision values will be converted to integers before the operation.

$$\text{BOR}(1,2) = 3$$

### BAND(<nexp1>, <nexp2>)

The logical bitwise value of <nexp1> AND <nexp2> will be returned. Floating point double precision values will be converted to integers before the operation.

$$\text{BAND}(3,1) = 1$$

### BXOR(<nexp1>, <nexp2>)

The logical bitwise value of <nexp1> XOR <nexp2> will be returned. Floating point double precision values will be converted to integers before the operation.

$$\text{BXOR}(7,1) = 6$$

### ABS(<nexp>)

Returns the absolute value of <nexp>.

### SGN(<nexp>)

Returns the signum function of the numerical value of <nexp>, representing its sign.

When the value is:	Return:
> 0	1
= 0	0
< 0	-1

### SQR(<nexp>)

Returns the correctly rounded positive square root of <nexp>.

### CBRT(<nexp>)

Returns the cube root of <nexp>.

### RANDOMIZE(<nexp>)

Creates a pseudorandom number generator for use with the RND() function.

The RANDOMIZE() function always returns zero.

If no RANDOMIZE() has been executed or if RANDOMIZE(0) is executed then the seed will be based upon the time of day in milliseconds since January 1, 1970 00:00:00 UTC.

If the numeric expression <> 0 then the generator will be created using the expression value as the seed. A non-zero seed will always generate the same sequence of pseudorandom numbers.

## RND()

Returns a random number generated by the pseudorandom number generator. If a RANDOMIZE() has not been previously executed then a new random generator will be created using "RANDOMIZE(0)".

The random number will be greater than or equal to zero and less than one. (  $0 \leq n < 1$  ).

**d = FLOOR(6 \* RND() + 1)                      % roll a six-sided die**

## MAX(<nexp>, <nexp>)

Returns the maximum of two numbers as an <nvar>.

## MIN(<nexp>, <nexp>)

Returns the minimum of two numbers as an <nvar>.

## CEIL(<nexp>)

Rounds up towards positive infinity. 3.X becomes 4 and -3.X becomes -3.

## FLOOR(<nexp>)

Rounds down towards negative infinity. 3.X becomes 3 and -3.X becomes -4.

## INT(<nexp>)

Returns the integer part of <nexp>. 3.X becomes 3 and -3.X becomes -3. This operation may also be called truncation, rounding down, or rounding toward zero.

## FRAC(<nexp>)

Returns the fractional part of <nexp>. 3.4 becomes 0.4 and -3.4 becomes -0.4.

FRAC(n) is equivalent to "n – INT(n)".

## MOD(<nexp1>, <nexp2>)

Returns the remainder of <nexp1> divided by <nexp2>.

## ROUND(<value\_nexp>{, <count\_nexp>{, <mode\_sexp>}})

In its simplest form, ROUND(<value\_nexp>), this function returns the closest whole number to <nexp>. You can use the optional parameters to specify more complex operations.

The <count\_nexp> is an optional decimal place count. It sets the number of places to the right of the decimal point. The last digit is rounded. The decimal place count must be >= 0. Omitting the parameter is the same as setting it to zero.

The <mode\_sexp> is an optional rounding mode. It is a one- or two-character mnemonic code that tells ROUND() what kind of rounding to do. It is not case-sensitive. There are seven rounding modes:

Mode:	Meaning:	-3.8	-3.5	-3.1	3.1	3.5	3.8
"HD"	Half-down	-4.0	-3.0	-3.0	3.0	3.0	4.0
"HE"	Half-even	-4.0	-4.0	-3.0	3.0	4.0	4.0
"HU"	Half-up	-4.0	-4.0	-3.0	3.0	4.0	4.0
"D"	Down	-3.0	-3.0	-3.0	3.0	3.0	3.0
"U"	Up	-4.0	-4.0	-4.0	4.0	4.0	4.0
"F"	Floor	-4.0	-4.0	-4.0	3.0	3.0	3.0
"C"	Ceiling	-3.0	-3.0	-3.0	4.0	4.0	4.0

In this table, "down" means "toward zero" and "up" means "away from zero" (toward  $\pm\infty$ )

"Half" refers to behavior when a value is half-way between rounding up and rounding down (x.5 or -x.5). "Half-down" rounds x.5 towards zero and "half-up" rounds x.5 away from zero.

"Half-even" is either "half-down" or "half-up", whichever would make the result **even**. 4.5 and 3.5 both round to 4.0. "Half-even" is also called "banker's rounding", because it tends to average out rounding errors.

If you do not provide a <mode\_sexp>, ROUND() adds +0.5 and rounds down (toward zero). This is legacy behavior, copied from earlier versions of BASIC!. ROUND(n) is NOT the same as ROUND(n, 0).

Examples:

<b>pi = ROUND(3.14159)</b>	<b>% pi is 3.0</b>
<b>pi = ROUND(3.14159, 2)</b>	<b>% pi is 3.14</b>
<b>pi = ROUND(3.14159, , "U")</b>	<b>% pi is 4.0</b>
<b>pi = ROUND(3.14159, 4, "F")</b>	<b>% pi is 3.1415</b>
<b>negpi = ROUND(-3.14159, 4, "D")</b>	<b>% negpi is -3.1416</b>

Note that FLOOR(n) is exactly the same as ROUND(n, 0, "F"), but FLOOR(n) is a little faster. In the same way, CEIL(n) is the same as ROUND(n, 0, "C"), and INT(n) is the same as ROUND(n, 0, "D").

## LOG(<nexp>)

Returns the natural logarithm (base e) of <nexp>.

## LOG10(<nexp>)

Returns the base 10 logarithm of the <nexp>.

## EXP(<nexp>)

Returns e raised to the <nexp> power.



## **POW(<nexp1>, <nexp2>)**

Returns <nexp1> raised to the <nexp2> power.

## **HYPOT(<nexp\_x>, <nexp\_y>)**

Returns  $\text{SQR}(x^2+y^2)$  without intermediate overflow or underflow.

## **PI()**

Returns the double-precision value closest to pi.

## **SIN(<nexp>)**

Returns the trigonometric sine of angle <nexp>. The units of the angle are radians.

## **COS(<nexp>)**

Returns the trigonometric cosine of angle <nexp>. The units of the angle are radians.

## **TAN(<nexp>)**

Returns the trigonometric tangent of angle <nexp>. The units of the angle are radians.

## **SINH(<nexp>)**

Returns the trigonometric hyperbolic sine of angle <nexp>. The units of the angle are radians.

## **COSH(<nexp>)**

Returns the trigonometric hyperbolic cosine of angle <nexp>. The units of the angle are radians.

## **ASIN(<nexp>)**

Returns the arc sine of the angle <nexp>, in the range of  $-\pi/2$  through  $\pi/2$ . The units of the angle are radians.

## **ACOS(<nexp>)**

Returns the arc cosine of the angle <nexp>, in the range of 0.0 through pi. The units of the angle are radians.

## **ATAN(<nexp>)**

Returns the arc tangent of the angle <nexp>, in the range of  $-\pi/2$  through  $\pi/2$ . The units of the angle are radians.

## **ATAN2(<nexp\_y>, <nexp\_x>)**

Returns the angle *theta* from the conversion of rectangular coordinates (*x*, *y*) to polar coordinates (*r*, *theta*). (Please note the order of the parameters in this function.)

## **TODEGREES(<nexp>)**

Converts <nexp> angle measured in radians to an approximately equivalent angle measured in degrees.

## **TORADIANS(<nexp>)**

Converts <nexp> angle measured in degrees to an approximately equivalent angle measured in radians.

## **VAL( <sexp> )**

Converts the <sexp> into a number.

## **LEN(<sexp>)**

Returns the length of the <sexp>.

## **HEX(<sexp>)**

Converts the string expression representing a hexadecimal number to a decimal number.

## **OCT(<sexp>)**

Converts the string expression representing an octal number to a decimal number.

## **BIN(<sexp>)**

Converts the string expression representing a binary number to a decimal number.

## **SHIFT(<value\_nexp>, <bits\_nexp>)**

Bit shift the value expression by <bits\_nexp>, the specified number of bits. If the bits expression is < 0, the value will be shifted left. If the bits expression > 0, the bits will be shifted right. The right shift will replicate the sign bit.

## **ASCII(<sexp>)**

Returns the ASCII value of the first character of <sexp>. A valid ASCII value is between 0 and 255. If <sexp> is an empty string (""), the value returned will be 256 (one more than the largest 8-bit ASCII value). For non-ASCII Unicode characters, ASCII() returns invalid values; use UCODE() instead.

## **UCODE(<sexp>)**

Returns the Unicode value of the first character of <sexp>. If <sexp> is an empty string (""), the value returned will be 65536 (one more than the largest 16-bit Unicode value). If the first character of <sexp> is a valid ASCII character, this function returns the same value as ASCII().

## **Is\_In(<Search\_for\_sexp>, <Search\_in\_sexp>{, <start\_nexp>})**

Searches the <Search\_in\_sexp> string for the <Search\_for\_sexp> string.

If the optional <start\_nexp> string is present then the search will start at that value otherwise the search will start at 1, the first character. <start\_nexp> must be >= 1.

If the <Search\_for\_sexp> string is not in the <Search\_in\_sexp> string, the value returned will be 0, otherwise the value returned will be a ones-based index into the <Search\_in\_sexp> string. The value returned will never be larger than the length of the <Search\_in\_sexp> string.

### **Starts\_with(<Search\_for\_sexp>, <Search\_in\_sexp>{<start\_nexp>})**

If the <Search\_in\_sexp> string starting at <start\_nexp> starts with the <Search\_for\_sexp> string, then the length of the <Search\_for\_sexp> string will be returned. Otherwise zero will be returned.

If the optional <start\_nexp> is present then the search will start at that value. Otherwise the search will start at 1, the first character. <start\_nexp> must be >= 1.

### **Ends\_with(<Look\_for\_sexp>, <look\_in\_sexp>)**

If the <look\_in\_sexp> string does not end with the <Look\_for\_sexp> string, then the value returned will be zero. If the expression does end with the specified expression the value returned will be index into the string where the <Look\_for\_sexp> string starts. The value will always be >= 1.

### **Gr\_collision(<object\_1\_nvar>, <object\_2\_nvar>)**

The object <nvars> are the objects' table numbers returned when the objects were created.

If the boundary boxes of the two objects overlap then the function will return true (not zero). If they do not overlap then the function will return false (zero).

Objects that may be tested for collision are: rectangle, bitmap, circle, arc and oval. In the case of a circle, arc and an oval it will be object's rectangular boundary box that will be used for collision testing, not the actual drawn object.

## **Background()**

A running BASIC! program continues to run when the Home key is tapped. This is called running in the Background. When not in the Background mode, BASIC! is in the Foreground mode. BASIC! exits the Background mode and enters the Foreground mode when the BASIC! icon on the home screen is tapped.

Sometimes a BASIC! programmer wants to know if the program is running in the Background. One reason for this might be to stop music playing while in the Background mode.

The Background() function returns true (1) if the program is running in the background. It returns false (0) if the program is not running in the background.

If you want to be able to detect Background mode while Graphics is open, you must not call `gr.render` while in the Background mode. Doing so will cause the program to stop running until the Foreground mode is re-entered. Use the following code line for all `gr.render` commands:

```
If !background() then gr.render
```

## Time Functions

### CLOCK()

Returns the time in milliseconds since the last boot.

### TIME()

Returns the time in milliseconds since 12:00:00 AM, January 1, 1970 (the "epoch"). The time interval is given for a specific time zone. By default, it is UTC, but you can change it with the `timeZone` command.

`TIME()` (the function) and `Time` (the command) are inverse operations. `TIME()` can take the first six return parameters of the `Time` command directly as input parameters.

### TIME(<year\_exp>, <month\_exp>, <day\_exp>, <hour\_exp>, <minute\_exp>, <second\_exp>)

Like `TIME()`, except the parameters specify a moment in time.

The parameter expressions may be either numeric expressions or string expressions. This is an unusual aspect as it isn't allowed anywhere else in BASIC!. If a parameter is a string, then it must evaluate to a number: digits only, one optional decimal point somewhere, optional leading sign, no embedded spaces. If the string parameter does not follow the rules, BASIC! reports a syntax error, like using a string in a place that expects a numeric expression.

With the **USING\$()** or **FORMAT\_USING\$()** functions, you can express a moment in time as a string in many different ways, formatted for your locale.

## String Functions

### GETERROR\$()

Return the error message that was not printed due to an "onError" intercept.

### CHR\$(<nexp>)

Returns the character represented by the value of <nexp>.

The character "C" is hexadecimal 43, so `Print CHR$(16*4 + 3)` prints: C

<nexp> may have values greater than 255 and thus can be used to generate Unicode characters.

## LEFT\$(<sexp>, <nexp>)

Returns the left-most <nexp> characters of <sexp>.

If <nexp> = 0 then an empty string ("" ) will be returned. If <nexp> is greater than the length of the <sexp> then the entire string will be returned.

## MID\$(<sexp>, <start\_nexp>{, <count\_nexp>})

Returns <count\_nexp> chars in the string <sexp> beginning at <start\_nexp>.

<Start \_nexp> is ones based. A zero value for <start \_nexp> will be changed to one. If <start \_nexp> is greater than the length of the <sexp> then an empty string ("" ) will be returned.

<Count \_nexp> is optional. If the <count \_nexp> parameter is not given then the characters from <start\_nexp> to the end of the string will be returned. If <count \_nexp> is greater than length of the <sexp> then the characters <start \_nexp> through the end of the <sexp> will be returned.

## RIGHT\$(<sexp>, <nexp>)

Returns the right-most <nexp> characters.

If <nexp> = 0 then an empty string ("" ) will be returned. If <nexp> is greater than the length of the <sexp> then the entire string will be returned.

## REPLACE\$(<target\_sexp>, <argument\_sexp>, <replace\_sexp>)

Returns <target\_sexp> with all instances of <argument\_sexp> replaced with <replace\_sexp>.

## WORD\$(<source\_sexp>, <n\_nexp> {, <test\_sexp>})

This function returns a word from a string. The <source\_sexp> string is split into substrings at each location where <test\_sexp> occurs. The <n\_nexp> parameter specifies which substring to return; numbering starts at 1. The <test\_sexp> is removed from the result. The <test\_sexp> parameter is an optional Regular Expression; if it is not given, the source string is split on whitespace. Specifically, the default <test\_sexp> is "\s+".

Leading and trailing occurrences of <test\_sexp> are stripped from <source\_sexp> before it is split. If <n\_nexp> is less than 1 or greater than the number of substrings found in <source\_sexp>, then an empty string ("" ) is returned. Two adjacent occurrences of <test\_sexp> in <source\_sexp> result in an empty string; <n\_nexp> may select this empty string as the return value.

Examples:

```
string$ = "The quick brown fox"
result$ = WORD$(string$, 2);           % result$ is "quick"

string$ = ":a:b:c:d"
delimiter$ = ":"
SPLIT array$, string$, delimiter$     % array$[1] is ""
```

**result\$ = WORD\$(string\$, 1, delimiter\$)    % result\$ is "a", not ""**

This function is similar to the Split command. See the Split command for a note about Regular Expressions.

### **STR\$(<nexp>)**

Returns the string representation of <nexp>.

### **LOWER\$(<sexp>)**

Returns <sexp> in all lower case characters.

### **UPPER\$(<sexp>)**

Returns <nexp> in all upper case characters.

### **VERSION\$()**

Returns the version number of BASIC! as a string.

### **INT\$(<nexp>)**

Returns a string representing the integer part of the numeric expression.

### **HEX\$(<nexp>)**

Returns a string representing the hexadecimal representation of the numeric expression.

### **OCT\$(<nexp>)**

Returns a string representing the octal representation of the numeric expression.

### **BIN\$(<nexp>)**

Returns a string representing the binary representation of the numeric expression.

### **USING\$({<locale\_sexp>}, <format\_sexp> { , <exp>}...)**

Returns a string, using the locale and format expressions to format the expression list.

This function gives BASIC! programs access to the Formatter class of the Android platform. You can find full documentation here: <http://developer.android.com/reference/java/util/Formatter.html>.

The <locale\_sexp> is a string that tells the formatter to use the formatting conventions of a specific language and region or country. For example, "en\_US" specifies American English conventions.

The <format\_sexp> is a string that contains *format specifiers*, like "%d" or "%7.2f," that tell the formatter what to do with the expressions that follow.

The format string is followed by a list of zero or more expressions. Most format specifiers take one argument from the list, in order. If you don't provide as many arguments as your format string needs, you will get a detailed Java error message.

Each expression must also match the type of the corresponding format specifier. If you try to apply a string format specifier, like "%-7s", to a number, or a floating point specifier, like "%5.2f" to a string, you will get a Java error message.

## Locale expression

The **USING\$()** function can localize the output string based on language and region. The locale specifies the language and region with standardized codes. The `<locale_sexp>` is a string containing zero or more codes separated by underscores.

The function accepts up to three codes. The first must be a language code, such as "en", "de", or "ja". The second must be a region or country code, such as "FR", "US", or "IN". Some language and country combinations can accept a third code, called the "variant code".

The function also accepts the standard three-letter codes and numeric codes for country or region. For example, "fr\_FR", "fr\_FRA", and "fr\_250" are all equivalent.

If you want to use the default locale of your Android device, make the `<locale_exp>` an empty string (""), or leave it out altogether. If you leave it out, you must keep the comma: **USING\$(, "%f", x)**

If you make a mistake in the `<locale_sexp>`, you may get an obscure Java error message, but more likely your locale will be ignored, and your string will be formatted using the default locale of your device.

Android devices do not support all possible locales. If you specify a valid locale that your device does not understand, your string will be formatted using the default locale.

## Format expression

If you are familiar with the *printf* functions of C/C++, Perl, or other languages, you will recognize most of format specifiers of this function. The format expression is exactly the same as format string of the Java *Formatter* class, or the *format(String, Object...)* method of the Java *String*, with two exceptions: Boolean format specifiers are not supported, and hex hash specifiers are limited to numeric and string types.

If you have not programmed in one of those other languages, this will be your introduction to a powerful tool for formatting text.

A format expression is a string with embedded format specifiers. Anything that is not a format specifier is copied literally to the function output string. Each embedded format specifier is replaced with the value of an expression from the list, formatted according to the specifier. For example:

<b>PRINT USING\$("", "Pi is approximately %f.", PI())</b>	<b>← function call</b>
<b>Pi is approximately 3.141593.</b>	<b>← printed output for English locale</b>

The `<locale_exp>` is "", meaning "use my default locale".

The <format\_exp>, "Pi is approximately %f", has one format specifier, "%f".  
"%f" means, "use the default decimal floating point output format".  
The expression list has one item, the math function **PI()**.  
In the output, "%f" is replaced by the value of the the **PI()** function.  
Your output may be different if your locale language is not English.

## Format Specifiers

Here is a brief summary of the available format specifiers:

For this type of data	Use these formats	Comments
String	%s %S	%S forces output to upper-case
Number	%f %e %E %g %G %a %A	Standard BASIC! numbers are floating point Use %f for decimal output: "1234.567" Use %e or %E for exponential notation: "1.234e+03" %E writes upper-case: "1.234E+03" %g (%G) lets the system choose %f or %e (%E) %a and %A are "hexadecimal floating point"
Integer	%d %o %x %X	USING\$ can use some math functions as integers Use %d for decimal, %o for octal, %x %X for hex %x writes lower-case abcdef, %X writes upper-case
Special integer	%c %C %t	These specifiers can operate on an integer %c %C output a character, %C writes upper-case %t represents a family of time format specifiers
None	%% %n	These specifiers do not read the expression list %% writes a single "%" to the output %n writes a newline, exactly the same as \n

For more information about %a and %A, see the Android documentation linked above.

Android's %b and %B are not supported because BASIC! has no Boolean type.

Android's %h and %H hash code specifiers are limited to strings and numbers in BASIC!.

For an explanation of **USING\$()** with integer format specifiers, see below.

There is a whole family of time format specifiers: %t<x> where <x> is another letter. They operate on an integer, which they interpret as the number of milliseconds since the beginning of January 1, 1970, UTC (the "epoch"). You can apply time format specifiers to the output of the **TIME()** functions. Note, however, that the %t time specifiers use your local time zone, not the **TimeZone.set** value.

There are more than 30 time format specifiers. A few examples appear below, but to get the full list you should read the Android documentation linked above.

```

PRINT USING$("", "The time is: %tI:%<tM:%<tS %<Tp", time())    % the hard way
PRINT USING$("", "The time is: %tr", time())                  % same thing!
02:27:16 PM                                                    ← example of printed output

t = TIME(2001, 2, 3, 4, 5, 6)                                  % set 2001/02/03 04:05:06
PRINT USING$("sv", "%tA", int(t))                             % day in Swedish, prints "lördag"
PRINT USING$("es", "%tB", int(t))                             % month in Spanish, prints "febrero"
PRINT USING$("", "%tY/%tm/%td", int(t), int(t), int(t))       % prints "2001/02/03"

```



```
PRINT USING$( , "%<tY/%<tm/%<td", int(t))           % prints "2001/02/03"

PRINT USING$( "en_GB", "%<tY/%<tm/%<td", int(t))      % ??? prints "21:05:06"
PRINT USING$( "in_IN", "%<tY/%<tm/%<td", int(t))      % ??? prints "21:05:06"
Note: printed for your local time zone (mine is GMT-7 in February), regardless of locale.
```

## Optional Modifiers

The format specifiers can be used exactly as shown in the table. They have default settings that control how they behave. You can control the settings yourself, fine-tuning the behavior to suit your needs.

You can modify the format specifiers with *index*, *flags*, *width*, and *precision*, as shown in this example:

`"%<index><flags><width>.<precision><specifier>"`  
`"%3$-15.4f"`

## Index

Normally the format specifiers are applied to the arguments in order. You can change the order with an argument index. An index is a number followed by a **\$** character. The argument index **3\$** specifies the third argument in the list.

```
PRINT USING$("","%3$s %s %s","a","b","c")      % prints "c a b"
```

The special argument index "<" lets you reuse an argument.

```
PRINT USING$("", "%00 %<d %<h", int(64))           % prints "100 64 40"
```

In the last example, there is only one argument, but three format specifiers. This is not an error because the argument is reused.

## Flags

There are six flags:

-	left-justify; if no flag, right-justify
+	always show sign; if no flag, show "-" but do not show "+"
0	pad numbers with leading zeros; if no flag pad with spaces
,	use grouping separators for large numbers
(	put parentheses around negative values
#	alternate notation (leading 0 for octal, leading 0x for hexadecimal)

### Width

The **width** control sets the minimum number of characters to print. If the value to format is longer than the width setting, the entire value is printed (unless it would exceed the **precision** setting). If the value to format is shorter than the **width** setting, it is padded to fill the width. By default, it is padded with spaces on the left, but you change this with the "-" and "0" flags.

## Precision

The **precision** control means different things to different data types.

For floating point numbers, **precision** specifies the number of characters to print after the decimal point, padding with trailing zeros if needed.

For string values, it specifies the maximum number of characters to print. If **precision** is less than **width**, only **precision** characters are printed.

```
"%4s", "foo"   → " foo"
"%-4s", "foo"  → "foo "
"%4.2s", "foo" → "fo"
```

The **precision** control is not valid for other types.

In the example above, **%-,15.4f**:

The **flags** "-" and "," mean "left-justify the output" and "use a thousands separator".

The **width** is 15, meaning the output is to be at least 15 characters wide.

The **precision** is 4, so there will be exactly four digits after the decimal point.

The whole format specifier means, "format a floating point number (%f) left-justified ("-") in a space 15 characters wide, with 4 characters after the decimal point, with a thousands separator (","). The characters used for the decimal point and the thousands separator depend on the locale:

```
"1,234.5678"  " for locale "en"
"1 234,5678"  " for locale "fr"
"1.234,5678"  " for locale "it"
```

## Integer values

BASIC! has only double-precision floating point numbers. It does not have an integer type. The **USING\$()** function supports format specifiers ("%d", "%t", "%x") that apply only to integer values.

**USING\$()** has a special relationship with the math functions that intrinsically produce integer results. BASIC! converts the output of these functions to floating point, for storage in numeric variables, but **USING\$()** can get the original integer values. For example:

```
PRINT USING$("", "%d", 123)      % ERROR!
PRINT USING$("", "%d", INT(123)) % No error
```

The functions that can produce integer values for **USING\$()** are:

```
INT() BIN() OCT() HEX()
CEIL() FLOOR()
ASCII() UCODE()
BAND() BOR() BXOR()
SHIFT() TIME()
```

## FORMAT\_USING\$(<locale\_sexp>, <format\_sexp> {, <exp>}...)

Alias for **USING\$()**. You can use the two equivalent functions to make your code easier to read. For example:

```
string$ = FORMAT_USING("", "pi is not %d", int(pi()))  
Print USING$("en_US", "Balance: $%8.2f", balance)
```

## FORMAT\$(<pattern\_sexp>, <nexp>)

Returns a string with <nexp> formatted by the pattern <pattern\_sexp>.

<b>Leading Sign</b>	A negative (-) character for numbers < 0 or a space for numbers >= 0. The Sign and the Floating Character together form the <b>Floating Field</b> .
<b>Floating Character</b>	If the first character of the pattern is not "#" or "." or "-" then that character becomes a "floating" character. This pattern character is typically a "\$". If no floating character is provided then a space character is used. See also <b>Overflow</b> , below.
<b>Decimal Point</b>	The pattern may have one optional decimal point character ("."). If the pattern has no decimal point, then only the whole number is output. Any digits that would otherwise appear after the decimal point are not output.
<b># Character</b> (before decimal, or no decimal)	Each "#" is replaced by a digit from the number. If there are more "#" characters than digits, then the leading "#" character(s) are replaced by <b>space(s)</b> .
<b># Character</b> (after decimal point)	Each "#" is replaced by a digit from the number. If there are more "#" characters than significant digits, then the trailing "#" character(s) are replaced by <b>zero(s)</b> . The number of "#" characters after the pattern decimal point specifies the number of decimal digits that will be output.
<b>% Character</b> (before decimal, or no decimal)	Each "%" is replaced by a digit from the number. If there are more "%" characters than digits, then the leading "%" character(s) are replaced by <b>zero(s)</b> .
<b>% Character</b> (after decimal)	The "%" character is not allowed after the decimal point. This is a syntax error.
<b>Non-pattern Characters</b>	If any pattern character (other than the first) is not # or %, then that character is copied directly into the output. If the character would appear before the first digit of the number, it is replaced by a space. This feature is usually used for commas.
<b>Overflow</b>	If the number of digits exceeds the number of # and % characters, then the output has the ** characters inserted in place of the Floating Field.
<b>Output Size</b>	The number of characters output is always the number of characters in the pattern plus one for the sign plus one more for the space if the pattern has no Floating Character.

## Notes

The sign and the floating character together form a **Floating Field** two characters wide that always appears just before the first digit of the formatted output. If there are any leading spaces in the formatted output, they are placed before the floating field.

The "#" character generates leading spaces, not leading zeros. "###.###" formats 0.123 as ".123". If you want a leading zero, use a "%". For example "%.###", "%#.###", or "###%" all assure a leading zero.

Be careful mixing # and % characters. Doing so except as just shown can produce unexpected results.

The number of characters output is always the number of characters in the pattern plus the two floating characters.

## Examples

Function Call	Output	Width
Format\$( "##,###,###", 1234567)	1,234,567	12 characters
Format\$( "%%,%%,%%,%%.#", 1234567.89)	01,234,567.8	14 characters
Format\$( "\$###,###", 123456)	\$123,456	9 characters
Format\$( "\$###,###", -1234)	-\$1,234	9 characters
Format\$( "\$###,###", 12)	\$12	9 characters
Format\$( "\$%%,%%,%%,%", -12)	-\$000,012	9 characters
Format\$( "##.#", 0)	.0	6 characters
Format\$( "##.#", 0)	0.0	6 characters
Format\$( "\$###.##", -1234.5)	**234.50	8 characters

## User-Defined Functions

User-Defined Functions are BASIC! functions like ABS(n), MOD(a,b) and LEFT\$(a\$,n) except that the operation of the function is defined by the user. User functions should generally be defined at the start of the program and in particular, they should appear before the places where they are called.

User-Defined functions may call other User-Defined Functions. A function can even recursively call itself.

Each time a function is called from another function a certain amount of memory is used for the execution stack. The depth of these nested calls is limited only by the amount of memory that your particular Android device allocates to applications.

## Commands

**Fn.def name|name\$( {nvar} ){svar}|Array[]|Array\$[], ...  
{nvar} ){svar}|Array[]|Array\$[])**

If the function name ends with the \$ character then the function will return a string otherwise it will return a number.

The parameter list can contain as many parameters as needed, or none at all. The parameters may be numeric or string, scalar or array.

The following are all valid:

```
fn.def pi()  
fn.def cut$(a$, left, right)  
fn.def sum(a, b, b, d, e, f, g, h, i, j)  
fn.def sort(v$[], direction)
```

There are two types of parameters: call by reference and call by value. Call by value means that the calling variable value (or expression) will be copied into the called variable. Changes made to the called variable within the function will not affect the value of the calling variable. Call by reference means that the calling variable value will be changed if the called variable value is changed within the function.

Scalar (non-array) function variables can be either call by value or call by reference. Which type the variable will be depends upon how it is called. If the calling variable has the "&" character in front of it, then the variable will be call by reference. If there is no "&" in front of the calling variable name then the variable will be call by value.

```
Fn.def test(a)  
a = 9  
fn.rtn a  
fn.end  
  
a = 1  
print test(a), a %will print: 9, 1  
print test(&a), a %will print: 9, 9
```

Array parameters are of always call by reference.

```
Fn.def test(a[])  
a[1] = 9  
fn.rtn a[1]  
fn.end  
  
dim a[1]  
a[1] = 1  
print test(a[]), a[1] %will print: 9, 9
```

Functions cannot return an array. An array created in a function is destroyed when the function returns.

All variables within an instantiation of a function are private to that instantiation of the function. A variable named v\$ in the main program is not the same as variable v\$ within a function. Furthermore, a variable named v\$ in a recursively called function is not the same v\$ in the calling function.

A function cannot access variables created outside of the function, except as parameters passed by reference.

If a variable is used as a pointer to a data structure (List, Stack, Bundle, or graphical object), it points to the same data structure whether it is used inside or outside of a function. This means that if you pass a pointer to a Bundle, for example, and modify that Bundle inside the function, the changes will be retained when the function returns. It also means that a function can modify graphical objects created outside of the function.

A function can return only a single scalar value, but you can use arrays or pointers to data structures to return information to a function's caller.

However, a function must not return a pointer to a data structure created inside the function. The data structure is destroyed when the function returns, so the pointer is invalid.

### **Fn.rtn <sexp>|<nexp>**

Causes the function to terminate execution. The value in <sexp>|<nexp> will be the return value of the function. The return expression type, string or number, must match the type of the function name.

Fn.rtn statements may appear anywhere in the program that they are needed.

### **Fn.end**

This command ends the definition of a user-defined function. Every function definition must end with fn.end. If the fn.end statement is executed a default value will be returned. If the function type is numeric then the value of 0.0 will be returned. If the function is a string then the empty string ("" ) will be returned.

### **Call <user\_defined\_function>**

Executes the user-defined function. Any value returned by the function will be discarded.

## **Program Control Commands**

### **If / Then / Else / Elseif / Endif**

The IF commands provide for the conditional execution of blocks of statements:

```
IF <condition> { THEN }
  <statement>
  <statement>
  ...
  <statement>
{ ELSEIF<condition> { THEN }
  <statement>
  <statement>
  ...
  <statement>
{ ELSE
  <statement>
  <statement>
  ...
  <statement>
ENDIF
```

IF commands may be nested to any depth. That is, any <statement> in a block may be a full IF command with all of its own <statement> blocks.

See the Sample Program file, F04\_if\_else.bas, for working examples of the IF command.

### **If / Then / Else**

If your conditional block(s) contain only one statement, you may use a simpler form of the IF command, all one line:

If <condition> THEN <statement> { ELSE <statement> }

This is the preferred form if either of the embedded statements is a BREAK, CONTINUE, or GOTO.

## For - To - Step / Next

```
For <nvar> = <nexp_1> To <nexp_2> {Step <nexp_3>}  
    <statement>  
    ...  
    <statement>  
Next {<nvar>}
```

{Step <nexp\_3>} is optional and may be omitted. If omitted then the Step value will be 1. <nvar> will be assigned the value of <nexp\_1>. <nvar> will be compared to <nexp\_2>.

If <nexp\_3> is positive then  
 if <nvar> <= <nexp\_2> then  
 the statements between the For and Next will be executed.

If <nexp\_3> is negative then  
 if <nvar> >= <nexp\_2> then  
 the statements between the For and Next will be executed.

When the Next statement is executed, <nvar> will be incremented or decremented by the Step value and the test will be repeated. The <statement>s will be executed as long as the test is true.

"For-Next loops" can be nested to any level. When For-Next loops are nested, any executed Next statement will apply to the currently executing For statement. This is true no matter what the <nvar> coded with the Next is. For all practical purposes, the <nvar> coded with the Next should be considered to be nothing more than a comment.

## F\_N.continue

If this statement is executed within an active For-Next loop, the rest of the current pass of the loop is skipped. The Next statement executes immediately.

## F\_N.break

If this statement is executed within an active For-Next loop, the rest of the current pass of the loop is skipped and the loop is terminated. The statement immediately following the Next will be executed.

## While <lexp> / Repeat

```
While <lexp>  
    <statement>  
    ...  
    <statement>  
Repeat
```

The <statement>s between the While and Repeat will be executed as long as <lexp> evaluates as true. The <statements>s will not be executed at all if <lexp> starts off false.

While-Repeat loops may be nested to any level. When While-Repeat are nested, any executed Repeat statement will apply to inner most While loop.

### W\_R.continue

If this statement is executed within an active While-Repeat loop, the rest of the current pass of the loop is skipped. The Repeat statement executes immediately.

### W\_R.break

If this statement is executed within an active While-Repeat loop, the rest of the current pass of the loop is skipped and the loop is terminated. The statement immediately following the Repeat will be executed.

### Do / Until <lexp>

```
Do
    <statement>
    ...
    <statement>
Until <lexp>
```

The statements between Do and Until will be executed until <lexp> is true. The <statement>s will always be executed at least once.

Do-Until loops may be nested to any level. Any encountered Until statement will apply to the last executed DO statement.

### D\_U.continue

If this statement is executed within an active Do-Until loop, the rest of the current pass of the loop is skipped. The Until statement executes immediately.

### D\_U.break

If this statement is executed within an active Do-Until loop, the rest of the current pass of the loop is skipped and the loop is terminated. The statement immediately following the Until will be executed.

## Labels, GOTO, GOSUB, and RETURN: Traditional BASIC

Before computer scientists invented the looping structures and user-defined functions described above, program flow was controlled by **GOTO**, **GOSUB**, and **RETURN** statements. These statements are present in BASIC!, too, mainly for compatibility with old BASIC dialects.

A **GOTO** statement is a one-way jump to another place in your program, identified by a **Label**. The program goes to the label and continues execution there.



A **GOSUB** is similar, except that the **Label** is the beginning of a "Subroutine". The program goes to the **Label**, and executes there until it reaches a **Return** statement. Then it "returns", going back to where it came from: the line after the **GoSub** statement.

Extensive use of the **GoTo** command in your program should be generally avoided. It can make code hard to read and harder to debug. Instead, you should use structured elements like **Do...Until**, **While...Repeat**, etc. in conjunction with the **Break** and **Continue** statements.

It is especially serious to use **GoTo** commands inside an **If...Else...Endif**, **For...Next**, or other structured block, jumping to code outside of the block. Doing this consumes system resources and may corrupt BASIC!'s internal data structures. This practice may lead your program to a run-time error:

**Stack overflow. See manual about use of GOTO.**

## Label

A label is a word at the start of a line that is followed by the colon ":", character. Labels must stand alone on the line. For example:

```
This_is_a_Label:
@Label#3:
Loop:
    <statement>
    ...
    <statement>
GoTo Loop
```

Notice that the colon is not part of the label. Use it where the label is defined. Do not use it in the **GoTo** or **GoSub** that jumps to the label.

## GoTo <label>

The next statement that will be executed will be the statement following <label>.

## GoTo <index\_nexp>, <label>...

A "computed GOTO". The index expression is evaluated, rounded to the nearest integer, and used as an index into the list of labels. The program jumps to the statement after the indexed label. If the index does not select any label, the program continues at the statement after the **GoTo**.

For examples, see **GoSub**.

## GoSub <label> / Return

The next statement that will be executed will be the statement following <label>.

The statements following the line beginning with <label> will continue to be executed until a **Return** statement is encountered. Execution will then continue at the statement following the **GoSub** statement.

Example:

```

Message$ = "Have a good day"
GOSUB xPrint
PRINT "Thank you"
<statement>
...
<statement>
END
xPrint:
PRINT Message$
RETURN

```

**This will print:**  
**Have a good day**  
**Thank you**

## GoSub <index\_nexp>, <label>... / Return

A "computed GOSUB". The index expression is evaluated, rounded to the nearest integer, and used as an index into the list of labels. The program jumps to the statement after the indexed label. When the next RETURN instruction executes, the program returns to the statement after this GoSub.

If the index does not select any label, the program continues to the statement after the GoSub. No subroutine is executed, and no Return statement is expected.

Example:

```

d = FLOOR(6 * RND() + 1)           % roll a six-sided die
GOSUB d, Side1, Side2, Side3, Side4, Side5, Side6
PRINT "Welcome back!"
END
Side1:
  <subroutine for side 1>
RETURN
...
Side6:
  <subroutine for side 1>
RETURN

```

## Run <filename\_sexp> {, <data\_sexp>}

This command will terminate the running of the current program and then load and run the BASIC! program named in the filename string expression. The filename is relative to BASIC's "source/" directory. If the filename is "program.bas" and your <pref base drive> is "/sdcard" (the default), then the file "/sdcard/rfo-basic/source/program.bas" will be executed.

The optional data string expression provides for the passing of data to the next program. The passed data can be accessed in the next program by referencing the special variable, ##\$.

Run programs can be chained. A program loaded and run by means of the Run command can also run another program file. This chain can be as long as needed.

When the last program in a Run chain ends, tapping the BACK key will display the original program in the BASIC! editor.

## Switch Commands

The Switch Commands may be used to replace nested if-then-else operations.

```
Sw.begin a
Sw.case 1
    <statement1>
    ...
    <statement2>
Sw.break
Sw.case 2
    <statement3>
    ...
    <statement4>
Sw.break
Sw.case 3
    <statement5>
    ...
    <statement6>
Sw.break
Sw.default
    <statement7>
Sw.end
```

## Nesting Switch Operations

Switch operation can NOT be nested. Do not program switch operations within other switch operations.

### Sw.begin <nexp>|<sexp>

Begins a switch operation.

The <nexp> or <sexp> will be evaluated. The results will then be compared the <nexp> or <sexp> in the sw.case statements.

If <begin\_nexp> = <case\_nexp> or if <begin\_sexp> = <case\_sexp> then the statement following the sw.case will be executed.

### Sw.case <nexp>|<sexp>

The type of parameter, numeric or string, in sw.case must match the expression type of the sw.begin statement.

If multiple sw.case statements have the same parameter, only the first sw.case with the matching parameter will be executed

## Sw.break

Once a matching sw.case has been found then the statements following the sw.case will be executed until a sw.break is encountered.

When the sw.break is encountered then BASIC! looks for the sw.end statement. Execution will then resume with the statement following the sw.end.

If no sw.break is present in a particular sw.case then subsequent sw.cases will be executed until a sw.break is encountered.

## Sw.default

If no matching sw.case is found then the sw.default, if present, will be executed. The sw.default must be placed after all the sw.case statements

## Sw.end

The sw.end terminates a switch operation. Sw.end must eventually follow a sw.begin.

## OnError:

If an "OnError:" label is in a BASIC! program then control will pass to the statement following the "OnError:" label whenever a run-time error occurs.

The error message that would have been printed will not be printed. That error message can be retrieved by the `getError$()` function.

Be careful. An infinite loop will occur if a run-time error occurs within the OnError code.

You should not place an OnError: statement into your program until the program is fully debugged. Premature use of OnError: will make the program difficult to debug.

The OnError: label must stand alone on the line (as with all labels).

## OnConsoleTouch:

Tapping on any line on the output Console that has text on it will cause control to be transferred to this label. Note that the touch must be any printed line of text. It cannot be an empty area of the screen.

After a Console touch interrupt has occurred, you may use the `Console.Line.Touched` command to determine what line of text was touched.

The primary intent of this interrupt is to provide a means for allowing the user to asynchronously interrupt an executing BASIC! program (not in graphics mode). A common reason for such an interrupt would be to have the program request input via an INPUT statement. See the Sample File, `f35_bluetooth.bas`, for an example of this.

For detecting screen touches while in graphics mode, use `onGRtouch`:

onConsoleTouch: must stand alone on the line (as with all labels).

### **ConsoleTouch.Resume**

Resumes execution at the point in the BASIC! program where the touch occurred.

### **OnBackKey:**

Pressing the BACK key normally halts program execution. The OnBackKey: label will intercept the BACK key event and transfer control to the statement following OnBackKey:

If the program is in Graphics mode then the OnBackKey code should terminate the run. If it does not then there will be no stopping the program (other than using a task killer application).

The primary intent of this intercept is to allow the program to save state and status information before terminating.

The onBackKey: label must stand alone on the line (as with all labels).

### **Back.resume**

If a BACK key tap has been trapped by OnBackKey: then the back.resume will cause the program to resume at the point where the BACK key was tapped.

### **OnMenuKey:**

If this label is in the program and the user taps the Menu key, the currently running program will be interrupted. The statements following this label will be executed.

### **MenuKey.resume**

If a Menu key tap has been trapped by OnMenuKey: then MenuKey.resume will cause the program to resume at the point where the Menu key was tapped.

### **OnKeyPress:**

If this label is in the program and the user taps any key, the currently running program will be interrupted. The statements following this label will be executed.

### **Key.Resume**

If a key tap has been trapped by OnKeyPress: then key.resume will cause the program to resume at the point where the key was tapped.

### **End{ <msg\_sexp> }**

The End statement prints a message and stops the execution of the program. You can use the optional <msg\_sexp> argument to specify the message. If you don't, the default message is "END". The empty string ("" ) prints nothing, not even a blank line. The End statement always stops execution, even if the statement has an error.

End statements may be placed anywhere in the program.

## Exit

The Exit statement causes BASIC! to stop running and exit to the Android home screen.

## READ – DATA – RESTORE Commands

These commands approximate the READ, DATA and RESTORE command of Dartmouth Basic.

### **Read.data <number>|<string>{,<number>|<string>...,<number>|<string>}**

The data value to be read with Read.next.

Read.data statements may appear anywhere in the program. You may have as many Read.data statements as you need.

Example: Read.data 1,2,3,"a","b","c"

Read.data is equivalent to the DATA statement in Dartmouth Basic.

### **Read.next <var>, ...**

Reads the data pointed to by the internal NEXT pointer into the next variables. The NEXT pointer is initialized to "1" and is incremented by one each time a new value is read. Data values are read in the sequence in which they appeared in the program Read.data statement.

The data type (number or string) of the variable must match the data type pointed by the NEXT pointer.

Example:

```
Read.next a,b,c,c$  
Read.next d$,e$
```

Read.next is equivalent to the READ statement in Dartmouth Basic

### **Read.from <nexp>**

Sets the internal NEXT pointer to the value of the expression. This command can be set to randomly access the Data.

The command "Read.from 1" is equivalent to the RESTORE command in Dartmouth Basic.

## Debug Commands

The debug commands help you debug your program. The execution of all the debug commands is controlled by the Debug.on command. All of the debug commands will be ignored unless the Debug.on command has been previously executed. This means that you can leave all your debug commands in your program and be assured that they will only be executed if you have turned debugging on with Debug.on.

## Debug.on

Turns on debug mode. All debug commands will be executed when in the debug mode.

## Debug.off

Turns off debug mode. All debug commands (except Debug.on) will be ignored.

## Debug.echo.on

Turns on Echo mode. In Echo mode each line of the running BASIC! program will be printed before it is executed. This can be of great help in debugging. The last few lines executed are usually the cause of program problems. The Echo mode will be turned off by either the Debug.echo.off or the Debug.off commands.

## Debug.echo.off

Turns off the Echo mode.

## Debug.print

This command is exactly the same as the Print command except that the print will occur only while in the debug mode.

## Debug.dump.scalars

Prints a list of all the Scalar variable names and values. Scalar variables are the variable names that are not Arrays or Functions. Among other things, this command will help expose misspelled variable names.

## Debug.dump.array Array[]

Dumps the contents of the specified array. If the array is multidimensional the entire array will be dumped in a linear fashion.

## Debug.dump.bundle <bundlePtr\_nexp>

Dumps the Bundle pointed to by the Bundle Pointer numeric expression.

## Debug.dump.list <listPtr\_nexp>

Dumps the List pointed to by the List Pointer numeric expression.

## Debug.dump.stack <stackPtr\_nexp>

Dumps the Stack pointed to by the Stack Pointer numeric expression.

## Debug.show.scalars

Pauses the execution of the program and displays a dialog box. The dialog box prints a list of all the Scalar variable names and values, the line number of the program line just executed and the text of that

line. Scalar variables are the variable names that are not Arrays or Functions. Among other things, this command will help expose misspelled variable names.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

### **Debug.show.array Array[]**

Pauses the execution of the program and displays a dialog box. The dialog box prints the contents of the specified array, the line number of the program line just executed and the text of that line. If the array is multidimensional the entire array will be displayed in a linear fashion.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

### **Debug.show.bundle <bundlePtr\_nexp>**

Pauses the execution of the program and displays a dialog box. The dialog box prints the Bundle pointed to by the Bundle Pointer numeric expression, the line number of the program line just executed and the text of that line.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

### **Debug.show.list <listPtr\_nexp>**

Pauses the execution of the program and displays a dialog box. The dialog box prints the List pointed to by the List Pointer numeric expression, the line number of the program line just executed and the text of that line.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.



## Debug.show.stack <stackPtr\_nexp>

Pauses the execution of the program and displays a dialog box. The dialog box prints the Stack pointed to by the Stack Pointer numeric expression, the line number of the program line just executed and the text of that line.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

## Debug.watch var, ...

Gives a list of Scalar variables (not arrays) to be watched. The values of these variables will be shown when the Debug.show.watch command is executed. This command is accumulative, meaning that subsequent calls will add new variables into the watch list.

## Debug.show.watch

Pauses the execution of the program and displays a dialog box. The dialog box lists the values of the variables being watched, the line number of the program line just executed and the text of that line.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

## Debug.show.program

Pauses the execution of the program and displays a dialog box. The dialog box shows the entire program, with line numbers, as well as a marker pointing to the executed line.

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

## Debug.show

Pauses the execution of the program and displays a dialog box. The dialog box will contain the last Debug.show.<command> used or by default Debug.show.program .

There are two buttons in the dialog:

Resume: Resumes execution.

Step: Executes the next line while continuing to display the dialog box.

## Console I/O

### Output Console

BASIC! has two types of output screens: The Output Console and the Graphics Screen. This section deals with the Output Console. See the section on Graphics for information about the Graphics Screen.

Information is printed to screen using the Print command. BASIC! Run-time error messages are also displayed on this screen.

There is no random access to locations on this screen. Lines are printed one line after the other.

Although no line numbers are displayed, lines are numbered sequentially as they are printed, starting with 1. These line numbers refer to lines of text output, not to locations on the screen.

### Console.Title { <title\_sexp> }

Changes the title of the console window. If the <title\_sexp> parameter is omitted, the title is changed to the default title, "BASIC! Program Output".

### CLS

The CLS command clears Output Console screen.

### Print [<exp> {,|;}] ...

If the comma (,) separator is used then a comma will be printed between the values of the expressions.

If the semicolon (;) separator is used then nothing will separate the values of the expressions.

If the semicolon is at the end of the line, the output will not be printed until a Print command without a semicolon at the end is executed.

Print with no parameters prints a newline.

Examples:

**Print "New", "Message"**

Prints: New, Message

**Print "New"; " Message"**

Prints: New Message

**Print "New" + " Message"**

Prints: New Message

**Print 100-1; " Luftballons"**

Prints: 99.0 Luftballons

**Print FORMAT\$("##", 99); " Luftballons"**

Prints: 99 Luftballons

```
Print "A";"B";"C";  
Prints: nothing
```

```
Print "D";"E";"F"  
Prints: ABCDEF
```

## Print with User-Defined Functions

Note: Some commands, such as Print, can operate on either strings or numbers. Sometimes it has to try both ways before it knows what to do. First it will try to evaluate an expression as a number. If that fails, it will try to evaluate the same expression as a string.

If this happens, and the expression includes a function, the function will be called twice. If the function has side-effects, such as printing to the console, writing to a file, or changing a global parameter, the side-effect action will also happen twice.

Eventually this problem should be fixed in BASIC!, but until then you should be careful not to call a function, especially a user-defined function, as part of a Print command. Instead, assign the return value of the function to a variable, and then Print the variable. An assignment statement always knows what type of expression to evaluate, so it never evaluates twice.

```
! Do this:  
y = MyFunction(x)  
Print y  
! NOT this:  
Print MyFunction(x)
```

## Console.line.text <line\_nexp>, <text\_svar>

The text of the specified line number of the Console is copied to the <text\_svar>.

## Console.line.touched <line\_nvar> { <press\_lvar> }

After an OnConsoleTouched interrupt indicates the user has touched the console, this command returns information about the touch.

The number of the line that the user touched is returned in the <line\_nvar>.

If the optional <press\_lvar> is present, the type of user touch – a short tap or a long press – is returned in the <press\_lvar>. Its value will be 0 (false) if the touch was a short tap. Its value will be 1 (true) if the touch was a long press.

## Console.save <filename\_sexp>

The current contents of the Console is saved to the text file specified by the filename string expression.

## User Input

### Input <Prompt\_sexp>, <nvar>|<svar>{, <Default\_sexp>|<Default\_nexp>}

Generates an input dialog box.

The <Prompt\_sexp> will become the dialog box prompt.

If a <nvar> is specified, the numeric result is placed into <nvar>. When requesting numeric input, the only key taps that will be accepted are 0-9, "+", "-", and ".".

If a <svar> is specified, the string result is placed into <svar>.

If a Default expression is given then the expression value will be placed into the input area of the dialog box. The Default expression type must match the <nvar> or <svar> type.

If the user taps the BACK key when the dialog box is being displayed, unless there is an "OnError:" the user will see the messages:

Input dialog cancelled

Execution halted

If there is a statement beginning with the "OnError:" label, execution will resume at the statement following the "OnError:" statement.

### **Inkey\$ <svar>**

Reports key taps for the a-z, 0-9, Space and the D-Pad keys. The key value is returned in <svar>.

The D-Pad keys are reported as "up", "down", "left", "right" and "go". If any key other than those have been tapped, the string "key nn" will be returned. Where nn will be the Android key code for that key.

If no key has been tapped, the "@" character is returned in <svar>.

Rapid key taps are buffered in case they come faster than the BASIC! program can handle them.

### **Text.input <svar>{ { <text\_sexp> } , <title\_sexp> }**

This command is similar to "Input" except that it is used to input and/or edit a large quantity of text. It will open a new window with scroll bars and full text editing capabilities. You may set the title of the new window with the optional <title\_sexp> parameter.

If the optional <text\_sexp> is present then that text will be loaded into the text input window for editing. If <text\_sexp> is not present then the text.input text area will be empty. If <title\_sexp> is needed but text.input text area is to be initially empty, use two commas to indicate the <sexp> specifies the title and not the initial text.

When done editing, tap the Finish button. The edited text will be returned in <svar>.

If the BACK key is tapped then all text editing is discarded. <svar> will be returned with the original <sexp> text.

The following example grabs the Sample Program file, f01\_commands.bas, to string s\$. It then sends s\$ to text.input for editing. The result of the edit is returned in string r\$. r\$ is then printed to console.

```
grabfile s$, "../source/ Sample_Programs/f01_commands.bas"  
text.input r$,s$  
print r$  
end
```

### TGet <result\_svar>, <prompt\_sexp> {, <title\_sexp>}

Simulates a terminal. The current contents of the Output Console will be displayed in a new window. The last line displayed starts with the prompt string followed by the cursor. The user types in the input and taps enter. The characters that the user typed in will be returned in <result\_svar>. The prompt and response will be displayed on the Output Console.

You may set the title of the text input window with the optional <title\_sexp> parameter.

### Kb.toggle

Toggles the showing or hiding of the soft keyboard. If the keyboard is being shown, it will be hidden. If it is hidden, it will be shown.

Keys may be read using the Inkey\$ command. The command may not work in devices with hard or slide-out keyboards.

The command should be followed by "Pause 1000" to insure that the keyboard visibility has time to change.

### Kb.hide

Hides the soft keyboard.

Note: If the soft keyboard is showing in the Editor when the Run is started, the Kb.toggle command hides the keyboard. The following code will insure that the soft keyboard is shown regardless of whether the keyboard is showing in the Editor.

```
PAUSE 100  
KB.HIDE  
PAUSE 1000  
KB.TOGGLE
```

## Working with Files

Files on Android devices are stored on more or more storage devices. BASIC! uses one of these devices as its *base drive*. In most cases, the *base drive* is the SD card, seen on most Android devices as the directory "/sdcard". You can select a different base drive in the *Menu->Preferences* item BASE DRIVE. In this manual, the notation <pref base drive> refers to the base drive you selected in Preferences.

BASIC! can work with files anywhere on the base drive, but most file operations are done in BASIC!'s *base directory*. Except when the user creates a standalone apk file (see Appendix D), the base directory is <pref base drive>/rfo-basic. All filenames (but not URLs) are relative to a subdirectory of the base drive.

## Paths Explained

A path describes where a file or directory is located relative to some other file or directory.

BASIC! files are stored in subdirectories of the base directory, "<pref base drive>/rfo-basic/". Files are grouped by type, as follows:

BASIC! program files are in: "rfo-basic/source/"

BASIC! data files are in: "rfo-basic/data/"

BASIC! SQLite databases are in: "rfo-basic/databases/"

All of the BASIC! file I/O commands assume a certain default path. The default path depends on the type of file each command expects to handle. The INCLUDE and RUN commands expect to load program files, so they look in "rfo-basic/source/". SQLite operations look for database files in "rfo-basic/databases/". All other file operations look for data files in "rfo-basic/data/".

If you give a filename to a file command, it looks for that file in the default directory for commands of that type. If you want to work with a file that is not in that directory, you will have to specify a path to the appropriate directory.

The "../" path notation means to back up from the current directory by one level. The default path for data files is "<pref base drive>/rfo-basic/data/". The path "../source/" tells BASIC! to back up to the "<pref base drive>/rfo-basic/" directory and look into the "source/" directory.

The default <pref base drive> is the SD card, "/sdcard". If you want to work with a file in the root directory of the SD card, the path from the default path would be: "../.." This tells BASIC! to back up two levels from "/sdcard/rfo-basic/data/" to "/sdcard/". On most Android devices "sdcard" is a symbolic link (shortcut) to a longer path name, such as "/mnt/sdcard" or "/storage/sdcard0". If you want to work with a file in the root directory of the Android device, "/", you can use the FILE.ROOT command to get the full path of the <pref base drive>.

All of these paths get you to a directory where you want to read, write, or create a file. To access that specific file, you add the filename to the path.

- In order to read the file "names.txt" in "/sdcard/rfo-basic/data/", the path would be "names.txt".
- In order to read the program file "sines.bas" in "/sdcard/rfo-basic/source", the path would be "../source/sines.bas".
- In order to access the music file "rain.mp3" in "/sdcard/music/", the path would be "../..music/rain.mp3".

## Paths and Case-sensitivity

While the Android file system is normally case-sensitive. However, the FAT file system, often used on SD cards, memory sticks, etc., is case-insensitive. When handling files on these devices, Android – and

therefore BASIC! – can not differentiate between names that differ only in case. In your BASIC! program, the two paths ".././music/rain.mp3" and ".././MUSIC/Rain.MP3" will both access the same file.

The rules change if you compile the same BASIC! program into a stand-alone apk (see Appendix D). The file system inside the apk is case-sensitive. The paths ".././music/rain.mp3" and ".././MUSIC/Rain.MP3" access different files. If the actual path in your build project is "Assets/<project>/MUSIC/Rain.MP3", then using the second path would succeed, but the first path would fail.

To prevent any error, it is good practice to match case exactly in file paths and names.

### **File.delete <lvar>, <path\_sexp>**

The file or directory at <path\_sexp> will be deleted, if it exists. If the file or directory did not exist before the Delete, the <lvar> will contain zero. If the file or directory did exist and was deleted, the <lvar> will be returned as not zero.

The default path is "<pref base drive>/rfo-basic/data/".

### **File.dir <path\_sexp>, Array\$[]**

This command returns the names of the files in the path specified by <path\_sexp>. The filenames are placed into Array\$[]. Directory names in the list will have the characters "(d)" after the file names. The files and directories will be sorted alphabetically with the directories at the top of the list.

The default path is "<pref base drive>/rfo-basic/data/".

### **File.exists <lvar>, <path\_sexp>**

This command reports if the <path\_sexp> directory or file exists. If the directory or file does not exist, the <lvar> will contain zero. If the file or directory does exist, the <lvar> will be returned as not zero.

The default path is "<pref base drive>/rfo-basic/data/".

### **File.mkdir <path\_sexp>**

Before you can use a directory, the directory must exist. The Mkdir command is used to create directories.

The default path is "<pref base drive>/rfo-basic/data/".

The path to create a new directory, "homes", in "<pref base drive>/rfo\_basic/data/" would be "homes/", or simply "homes".

The path to create a new directory, "icons", in the root directory of the SD card would be ".././icons".

### **File.rename <Old\_Path\_sexp>, <New\_Path\_sexp>**

The file or directory at Old\_Path will be renamed to New\_Path.

The default path is "<pref base drive>/rfo-basic/data/"

The Rename operation can not only change the name of a file or a directory, it can also move the file or directory to another directory.

For example:

```
Rename "../testfile.txt", "/data/testfile1.txt"
```

Will remove the file, testfile.txt, from "<pref base drive>/", place it into "sdcard/rfo-basic/data/" and also rename it to testfile1.txt.

## File.root <svar>

Returns the canonical path from the file system root to "<pref base drive>/rfo-basic/data", the default data directory, in <svar>. The <pref\_base\_drive> is expanded to the full absolute path from the file system root, "/".

## File.size <size\_nvar>, <path\_sexp>

The size, in bytes, of the file at <path\_sexp> will be returned in <size\_nvar>. If there is no file at <path\_sexp>, the system will generate a run-time error.

The default path is "<pref base drive>/rfo-basic/data/".

## File.type <type\_nvar>, <path\_sexp>

Returns a one-character type indicator in <type\_nvar> for the file at <path\_sexp>. The <path\_sexp> is appended to the default data path, "<pref base drive>/rfo-basic/data/". The type indicator values are:

Indicator:	Meaning:
"d"	"directory" – path names a directory
"f"	"file" – path names a regular file
"o"	"other" – path names a special file
"x"	file does not exist

## Text File I/O

The text file I/O commands are to be exclusively used for text (.txt) files. Text files are made up of lines of characters that end in CR (Carriage Return) and/or NL (New Line). The text file input and output commands read and write entire lines.

The default path is "<pref base drive>/rfo-basic/data/"

## Text.open {r|w|a}, <file\_table\_nvar>, <path\_sexp>

The file specified by the <path\_sexp> is opened.



The first parameter describes the file I/O mode for this file.

r = Read

w = Write from the start of the file. Writes over any existing data in the file.

a = Append. Writing starts after the last line in the file.

A file table number is placed into <file\_table\_nvar>. This value is for use in subsequent text.readln, text.writeln or text.close commands.

If a file being opened for read does not exist then the <file\_table\_nvar> will be set to -1. The BASIC! programmer can check for this and either create the file or report the error to the user. Opening a file for append that does not exist creates an empty file. Finally, opening a file for write that already exists deletes the contents of the file; that is, it replaces the existing file with a new, empty one.

### Text.close <file\_table\_nvar>

The previously opened file represented by <file\_table\_nvar> will be closed.

Note: It is essential to close an output file if you have written over 8k bytes to it. If you do not close the file then the file will only contain the first 8k bytes.

### Text.readln <file\_table\_nvar>, <line\_svar>

If <file\_table\_nvar> = -1 then a run-time error will be thrown.

The next line from the specified, previously opened file is read into <line\_svar>.

After the last line in the file has been read, the characters "EOF" will be placed into <line\_svar>.

This example reads an entire file and prints each line.

```
Text.open r, file_number, "testfile.txt"  
Do  
Text.readln file_number, line$  
Print line$  
Until line$ = "EOF"  
Text.close file_number
```

The file will not be closed when the end of file is read. Subsequent reads from the file will continue to return "EOF"

When you are done reading a file, the Text.close command should be used to close the file.

### Text.writeln <file\_table\_nexp>, <parms same as print>

The parameters that follow the file table pointer are parsed and processed exactly the same as the **Print** command parameters. This command is essentially a **Print** to a file.

After the last line has been written to the file, the **Text.close** command should be used to close the file.

**Text.WriteLine** with no parameters writes a newline.

### **Text.position.get <file\_table\_nvar>, <position\_nvar>**

Get the position of the next line to be read or written to the file. The position of the first line in the file is 1. The position is incremented by one for each line read or written. The position information can be used for setting up random file data access.

Note: If a file is opened for append, the position returned will be relative to the end of the file. The position returned for the first line to be written after a file is opened for append will be 1. You will have to add these new positions to the known position of the end of the file when building your random access table.

### **Text.position.set <file\_table\_nvar>, <position\_nexp>**

Sets the position of the next line to read. A position value of 1 will read the first line in the file.

Text.position.set can only be used for files open for reading.

If the position value is greater than the number of lines in the file, the file will be positioned at the end of file. The next read would return EOF. The position returned for Text.position.get at the EOF will be number of lines plus one in the file.

### **GrabURL <result\_svar>, <url\_sexp>{ <timeout\_nexp>}**

The entire source text of the Internet URL <url\_sexp> is copied to the <result\_svar> string. The Split command can then be used to split the <result\_svar> into an array of lines.

If the optional <timeout\_nexp> parameter is non-zero, it specifies a timeout in milliseconds. This is meaningful only if the URL names a file on a remote host. If the timeout time elapses and host does not connect or does not return any data, GrabURL reports a socket timeout run-time error.

### **GrabFile <result\_svar>, <path\_sexp>{ <unicode\_flag\_lexp>}**

The entire contents of the file at <path\_sexp> will be copied to the <result\_svar> string. By default, GrabFile assumes that the file contains binary bytes or ASCII characters. If the optional <unicode\_flag\_lexp> evaluates to true (a non-zero numeric value), GrabFile can read Unicode text. For text files, either ASCII or Unicode, the Split command can then be used to split the <result\_svar> into an array of lines.

The command could be used grab the contents of a text file for direct use with Text.input.

```
GrabFile text$, "MyJournal.txt"  
Text.input EditedText$, text$
```

## Byte File I/O

Byte file I/O can be used to read and write any type of file (.txt, .jpg, .pdf, .mp3, etc.). The data is read and written one byte at a time.

### Byte.open {r|w|a}, <file\_table\_nvar>, <path\_sexp>

The file specified by the path string expression is opened. If the path starts with "http..." then an Internet file will be opened.

The default path is "<pref base drive>/rfo-basic/data/"

The first parameter describes how the file I/O mode for this file.

r = Read

w = Write from the start of the file. Writes over any existing data in the file.

a = Append. Writing starts after the last line in the file.

A file table number is placed into <file\_table\_nvar>. This value is for use in subsequent Byte.read, Byte.write or Byte.close commands.

If a file being opened for read does not exist then the <file\_table\_nvar> will be set to -1. The BASIC! programmer can check for this and either create the file or report the error to the user. Opening a file for append that does not exist creates an empty file. Finally, opening a file for write that already exists deletes the contents of the file; that is, it replaces the existing file with a new, empty one.

### Byte.close <file\_table\_nvar>

Closes the previously opened file.

### Byte.read.byte <file\_table\_nvar>, <byte\_nvar>

If <file\_table\_nvar> = -1 then a run-time error will be thrown.

A single byte is read from the file and placed into <byte\_nvar>. After the last byte in the file has been read, further attempts to read from the file return the value -1.

This example reads a file and prints each byte, and prints "-1" at the end to show that the entire file has been read.

```
Byte.open r, file_number, "testfile.jpg"
Do
  Byte.read.byte file_number, Byte
  Print Byte
Until Byte < 0
Byte.close file_number
```

### **Byte.write.byte <file\_table\_nvar>, <byte\_nexp>|<sexp>**

If the second parameter is a numeric expression then the low order 8 bits of the value will be written to the file as a single byte.

If the second parameter is a string expression then the entire string will be written to the file as 8 bit bytes.

### **Byte.read.buffer <file\_table\_nvar>, <count\_nexp>, <buffer\_svar>**

Read the specified count of bytes (<count\_nexp>) into the buffer string variable (<buffer\_svar>) from the file. If the end of file has been reached, the string length (len(<buffer\_svar>)) will be zero.

### **Byte.write.buffer <file\_table\_nvar>, <sexp>**

The entire contents of the string expression will be written to the file.

### **Byte.position.get <file\_table\_nvar>, <position\_nvar>**

Get the position of the next byte to be read or written. The position of the first byte is 1. The position value will be incremented by 1 for each byte read or written.

The position information can be used for setting up random file data access.

If the file is opened for append, the position returned will be the length of the file plus one.

### **Byte.position.set <file\_table\_nvar>, <position\_nexp>**

Set the position of the next byte to be read from the file. If the position value is greater than the position of the last byte of the file, the position will point to the end of file.

This command can only be used on files open for byte read.

### **Byte.copy <file\_table\_nvar>,<output\_file\_svar>**

Copies the previously open input file represented by <file\_table\_nvar> to the file whose path is specified by <output\_file\_svar>. The default path is "<pref base drive>/rfo-basic/data/".

If <File\_table\_nvar> = -1 then a run-time error will be thrown.

The input file will be completely copied to the to the output file. Both files will then be closed.

You should use Byte.copy if you are using Byte I/O for the sole purpose of copying. It is thousands (literally) of times faster than using Byte.read/Byte.write.

# HTML

## Introduction

The BASIC! HTML package is designed to allow the BASIC! programmer to create user interfaces using HTML and JavaScript. The interface provides for interaction between the HTML engine and BASIC!. The HTML programmer can use JavaScript to send messages to BASIC!. The HTML engine will also report user events such as the BACK key, hyperlink transfers, downloads, form data and errors.

The demo program, f37\_html\_demo.bas, combined with the HTML demo files, htmlDemo1.html and htmlDemo2.html, illustrate the various commands and possibilities. The content of all three files are listed in the Appendix B of this document. They are also delivered with the BASIC! apk. It is highly recommended that all three files be carefully studied to fully understand this interface.

Another demo program, f38\_html\_edit.bas, can be used to edit html files. To use the program, run it and enter the html file name without the html extension. The program will add the ".html"

## Commands

### Html.open {<ShowStatusBar\_lexp> {, <Orientation\_nexp>}}

This command must be executed before using the HTML interface.

The Status Bar will be shown on the Web Screen if the <ShowStatusBar\_lexp> is true (not zero). If the <ShowStatusBar\_lexp> is not present, the Status Bar will not be shown.

The orientation upon opening the HTML screen will be determined by the <Orientation\_nexp> value. <Orientation\_nexp> values are the same as values for the Html.orientation command (see below). If the <Orientation\_nexp> is not present, the default orientation is determined by the orientation of the device.

Both <ShowStatusBar\_lexp> and <Orientation\_nexp> are optional; however, a <ShowStatusBar\_lexp> must be present in order to specify an <Orientation\_nexp>.

Executing a second HTML.OPEN before executing HTML.CLOSE will generate a run-time error.

### Html.orientation <nexp>

The value of the <nexp> sets the orientation of screen as follows:

- 1 = Orientation depends upon the sensors.
- 0 = Orientation is forced to Landscape.
- 1 = Orientation is forced to Portrait.

### Html.load.url <file\_sexp>

Loads and displays the file specified in the string <file\_sexp>. The file may reside on the Internet or on your android device. In either case, the entire URL must be specified.

The command:

```
html.load.url "http://laughton.com/basic/"
```

will load and display the BASIC! home page.

The command:

```
html.load.url "htmlDemo1.html"
```

will load and display the html file "htmlDemo1.html" residing in BASIC!'s default "data" directory, as set by your "Base Drive" preference. You may also use a fully-qualified pathname. With the default "Base Drive" setting, this command loads the same file:

```
html.load.url "file:///sdcard/rfo-basic/data/htmlDemo1.html"
```

When you tap the BACK key on the originally-loaded page, the HTML viewer will be closed and the BASIC! output console will be displayed. If the page that was originally loaded links to another page and then the BACK key is tapped, it will be up to the BASIC! programmer to decide what to do.

### **Html.load.string <html\_sexp>**

Loads and displays the HTML contained in the string expression. The base page for this HTML will be:

```
<pref base drive>/rfo-basic/data/
```

### **Html.post <url\_sexp>, <list\_nexp>**

Execute a Post command to an Internet location.

<url\_sexp> is a string expression giving the url that will accept the Post.

<list\_nexp> is a pointer to a string list which contains the Name/Value pairs needed for the Post.

### **Html.get.datalink <data\_svar>**

A datalink provides a method for sending a message from an HTML program to the BASIC! programmer. There are two parts to a datalink in an HTML file: 1) the JavaScript that defines the datalink function, and 2) the HTML code that calls the datalink function. The BASIC! Program requires a mechanism for communicating with a website's HTML code.

Html.get.datalink gets the next datalink string from the datalink buffer. If there is no datalinked data available then the returned data will be an empty string (""). You should program a loop waiting for data:

```
do  
  html.get.datalink data$  
until data$ <> ""
```

The returned data string will always start with a specific set of four characters—three alphabetic characters followed by a colon (":"). These four characters identify the return datalink data type. Most of the type codes are followed by some sort of data. The codes are:

**BAK:** The user has tapped the BACK key. The data is either "1" or "0".

If the data is "0" then the user tapped BACK in the start screen. Going back is not possible therefore html has been closed.

If the data is "1" then going back is possible. The BASIC! programmer should issue the command `html.go.back` if going back is desired.

**LNK:** The user has tapped a hyperlink. The linked-to url is returned. The transfer to the new url has not been done. The BASIC! programmer must execute an `"html.load.url"` with the returned url (or some other url) for a transfer to occur.

**ERR:** Some sort of fatal error has occurred. The error condition will be returned. This error code always closes the html engine. The BASIC! output console will be displayed.

**FOR:** The user has tapped the Submit button on a form with `action='FORM'` The form name/value pairs are returned.

**DNL:** The user has clicked a link that requires a download. The download url is supplied. It is up to the BASIC! programmer to do the download.

**DAT:** The user has performed some action that has caused some JavaScript code to send data to BASIC! by means of the datalink. The JavaScript function for sending the data is:

```
<script type="text/javascript">
  function doDataLink(data) {
    Android.dataLink(data);
  }
</script>
```

### **Html.go.back**

Go back one HTML screen, if possible.

### **Html.go.forward**

Go forward one HTML screen, if possible.

### **Html.close**

Closes the HTML engine and display.

### **Html.clear.cache**

Clears the HTML cache.

## Html.clear.history

Clears the HTML history.

## TCP/IP Sockets

TCP/IP Sockets provide for the transfer of information from one point on the Internet to another. There are two genders of TCP/IP Sockets: Servers and Clients. Clients must talk to Servers. Servers must talk to Clients. Clients cannot talk to Clients. Servers cannot talk to Servers.

Every Client and Server pair have an agreed-upon protocol. This protocol determines who speaks first and the meaning and sequence of the messages that flow between them.

Most people who use a TCP/IP Socket will use a Client Socket to exchange messages with an existing Server with a predefined protocol. One simple example of this is the Sample Program file, f31\_socket\_time.bas. This program uses a TCP/IP client socket to get the current time from one of the many time servers in the USA.

A TCP/IP Server can be set up in BASIC!; however, there are difficulties. The capabilities of individual wireless networks vary. Some wireless networks allow servers. Most do not. Servers can usually be run on WiFi or Ethernet Local Area Networks (LAN).

If you want to set up a Server, the way most likely to work is to establish the Server inside a LAN. You will need to provide Port tunneling (forwarding) from the LAN's external Internal IP to the device's LAN IP. You must be able to program (setup) the LAN router in order to do this.

Clients, whether running inside the Server's LAN or from the Internet, should connect to the LAN's external IP address using the pre-established, tunneled Port. This external or WAN IP can be found using:

```
Graburl ip$, "http://automation.whatismyip.com/n09230945.asp"
```

This is not the same IP that would be obtained by executing socket.myip on the server device.

Note: The specified IPs do not have to be in the numeric form. They can be in the name form.

The Sample Program, f32\_tcp\_ip\_sockets.bas, demonstrates the socket commands for a Server working in conjunction with a Client. You will need two Android devices to run this program.

## TCP/IP Client Socket Commands

### Socket.client.connect <server\_sexp>, <port\_nexp> { , <wait\_lexp> }

Creates a Client TCP/IP socket and attempts to connect to the Server whose Host Name or IP Address is specified by the Server string expression using the Port specified by Port numeric expression.

The optional "wait" parameter determines if this command waits until a connection is made with the Server. If the parameter is absent or true (non-zero), the command will not return until the connection



has been made or an error is detected. If the Server does not respond, the command should time out after a couple of minutes, but this is not certain.

If the parameter is false (zero), the command completes immediately. Use `socket.server.status` to determine when the connection is made. If you monitor the socket status, you can set your own time-out policy. You must use the **Socket.client.close** command to stop a connection attempt that has not completed.

### **Socket.client.status <status\_nvar>**

Get the current client socket connection status and place the value in the numeric variable <status\_nvar>.

- 0 = Nothing going on
- 2 = Connecting
- 3 = Connected

### **Socket.client.server.ip <svar>**

Returns the IP of the server that this client is connected to in the string variable.

### **Socket.client.read.line <line\_svar>**

Reads a line from the previously connected Server and places the line into the line string variable. The command does not return until the Server sends a line. To avoid an infinite delay waiting for the Server to send a line, the `socket.client.read.ready` command can be repeatedly executed with timeouts.

### **Socket.client.read.ready <nvar>**

If the previously created Client socket has not received a line for reading by `socket.client.read.line` then <nvar> will be returned as zero. Otherwise a non-zero value will be returned.

The `socket.client.read.line` command does not return until a line has been received from the Server. This command can be used to allow your program to time out if a line has not been received within a pre-determined time span. You can be sure that `socket.client.read.line` will return with a line of data if this command returns a non-zero value.

### **Socket.client.read.file <fw\_nexp>**

A file transmitted by a server will be read and written to the file pointed to by <fw\_nexp>, which is derived from a previously executed `byte.open` write command. For example:

```
Byte.open w, fw, "image.jpg"  
Socket.client.read.file fw  
Byte.close fw
```

### **Socket.client.write.line <line\_sexp>**

Send the string expression, <line\_sexp>, to the previously connected Server as UTF-16 characters. End of line characters will be added to the end of the line TCP/IP Server Socket Commands.

### Socket.client.write.bytes <sexp>

Send the string expression, <sexp>, to the previously connected Server as UTF-8 characters. No end-of-line characters will be added by BASIC!. If you need a CR or LF character, you will have to make them part of the <sexp>. Note that if socket.server.read.line is used to receive these bytes, the read.line command will not return until it receives a LF (10, 0x0A) character.

### Socket.client.write.file <fr\_nexp>

A file previously opened for read by byte.open will be transmitted to the client. Example:

```
Byte.open r, fr, "image.jpg"  
Socket.client.write.file fr  
Byte.close fr
```

### Socket.client.close

Closes an open client side connection.

## TCP/IP Server Socket Commands

### Socket.myip <svar>

Returns the IP of the device in <svar>.

If the device is on a WiFi or Ethernet LAN then IP returned will be the device's LAN IP.

Note: This external or WAN IP can be found using:

```
Graburl ip$, "http://automation.whatismyip.com/n09230945.asp"
```

### Socket.server.create <port\_nexp>

Establishes a Server that will listen to the Port specified by the numeric expression, <port\_nexp>.

### Socket.server.connect {<wait\_lexp>}

Directs the previously created Server to accept a connection from the next client in the queue.

The optional "wait" parameter determines if the command waits until a connection is made with a client. If the parameter is absent or true (non-zero), the command waits for the connection. If the parameter is false (zero), the command completes immediately. Use socket.server.status to determine when the connection is made.

In general, it is better (safer, more robust) to set the parameter to false (don't wait) and explicitly monitor the connection's status, since it can avoid a problem if the program exits with no connection made. You must use the **Socket.server.close** command to stop a connection attempt that has not completed.

### Socket.server.status <status\_nvar>

Get the current server socket connection status and place the value in the numeric variable <status\_nvar>.

- 1 = Server socket not created
- 0 = Nothing going on
- 1 = Listening
- 3 = Connected

### Socket.server.read.line <svar>

Reads a line sent from the previously connected Client and places the line into the line string variable, <svar>. The command does not return until the Client sends a line. To avoid an infinite delay waiting for the Client to send a line, the socket.server.read.ready command can be repeatedly executed with timeouts.

### Socket.server.read.ready <nvar>

If the previously accepted Client socket has not sent a line for reading by socket.server.read.line then <nvar> will be returned as zero. Otherwise a non-zero value will be returned.

The socket.server.read.line command does not return until a line has been received from the Client. This command can be used to allow your program to time out if a line has not been received within a pre-determined time span. You can be sure that socket.server.read.line will return with a line of data if socket.server.read.ready returns a non-zero value.

### Socket.server.write.line <sexp>

Send the string expression, <sexp>, to the previously connected Client as UTF-16 characters. End of line characters will be added to the end of the line.

### Socket.server.write.bytes <sexp>

Send the string expression, <sexp>, to the previously connect Client as UTF-8 characters. No end of line characters will be added by BASIC!. If you need a CR or LF character, you will have to make them part of the <sexp>. Note that if socket.client.read.line is used to receive these bytes, the read.line command will not return until it receives a LF (10, 0x0A) character.

### Socket.server.write.file <fr\_nexp>

A file previously made open for read by byte.open will be transmitted to the client. Example:

```
Byte.open r, fr, "image.jpg"
Socket.server.write.file fr
Byte.close fr
```

### Socket.server.read.file <fw\_nexp>

A file transmitted by a server will be read and written to the file pointed to by <fw\_nexp>, which is derived from a previously executed byte.open write command. For example:

```
Byte.open w, fw, "image.jpg"
Socket.server.read.file fw
Byte.close fw
```

### **Socket.server.disconnect**

The connection with the previously connected Client will be closed. A new socket.server.connect can then be executed to connect to the next client in the queue.

### **Socket.server.close**

The previously created Server will be closed. Any currently connected client will be disconnected.

### **Socket.server.client.ip <nvar>**

Returns the IP of the Client currently connected to the Server.

## **FTP Client**

These FTP commands implement a FTP Client

### **Ftp.open <url\_sexp>, <port\_nexp>, <user\_sexp>, <pw\_sexp>**

Connects to the specified url and port. Logs onto the server using the specified user name and password. For example:

```
ftp.open "ftp.laughton.com", 21, "basic", "basic"
```

### **Ftp.close**

Disconnects from the FTP server.

### **Ftp.put <source\_sexp>, <destination\_sexp>**

Uploads specified source file to the specified destination file on connected ftp server.

The source file is relative to the directory, "<pref base drive>/rfo-basic/data/" If you want to upload a BASIC! source file, the file name string would be: "../source/xxxx.bas".

The destination file is relative to the current working directory on the server. If you want to upload to a subdirectory of the current working directory, specify the path to that directory. For example, if there is a subdirectory named "etc" then the filename, "/etc/name" would upload the file into that subdirectory.

### **Ftp.get <source\_sexp>, <destination\_sexp>**

The source file on the connected ftp server is downloaded to the specified destination file on the Android device.

You can specify a subdirectory in the server source file string.

The destination file path is relative to "<pref base drive>/rfo-basic/data/" If you want to download a BASIC! source file, the path would be, "../source/xxx.bas".

## **Ftp.dir <list\_nvar>**

Creates a list of the files in the current working directory and places that list into a BASIC! List data structure. Directories will have the characters, "(d)" appended to the filename.

The following code can be used to print the file names in that list:

```
ftp.dir file_list
list.size file_list,size

for i = 1 to size
    list.get file_list,i,name$
    print name$
next i
```

## **Ftp.cd <new\_directory\_sexp>**

Changes the current working directory to the specified new directory.

## **Ftp.rename <old\_filename\_sexp>, <new\_filename\_sexp>**

Renames the specified old filename to the specified new file name.

## **Ftp.delete <filename\_sexp>**

Deletes the specified file.

## **Ftp.rmdir <directory\_sexp>**

Removes (deletes) the specified directory if and only if that directory is empty.

## **Ftp.mkdir <directory\_sexp>**

Creates a new directory of the specified name.

# **Bluetooth**

BASIC! implements Bluetooth in a manner which allows the transfer of data bytes between an Android device and some other device (which may or may not be another Android device).

Before attempting to execute any BASIC! Bluetooth commands, you should use the Android "Settings" Application to enable Bluetooth and pair with any device(s) with which you plan to communicate.

When Bluetooth is opened using the bt.open command, the device goes into the Listen Mode. While in this mode it will wait for a device to attempt to connect.

For an active attempt to make a Bluetooth connection, you can use the Connect Mode by successfully executing the bt.connect command. Upon executing the bt.connect command the person running the program will be given a list of paired Bluetooth devices and asked to select one to connect to. BASIC! will attempt to connect to that device once it is selected.

You should monitor the state of the Bluetooth using the `bt.status` command. This command will report states of Listening, Connecting and Connected. Once you receive a "Connected" report, you can proceed to read bytes and write bytes to the connected device.

You can write bytes to a connected device using the `bt.write` command.

Data is read from the connected device using the `bt.read.bytes` command; however, before executing `bt.read.bytes`, you need to find out if there is data to be read. You do this using the `bt.read.ready` command.

Once connected, you should continue to monitor the status (using `bt.status`) to insure that the connected device remains connected.

When you are done with a particular connection or with Bluetooth in general, execute `bt.close`.

The sample program, `f35_bluetooth`, is a working example of Bluetooth using two Android devices in a "chat" type application.

## **Bt.open {0|1}**

Opens Bluetooth in Listen Mode. If you do not have Bluetooth enabled (using the Android Settings Application) then the person running the program will be asked whether Bluetooth should be enabled. After `bt.open` is successfully executed, the code will listen for a device that wants to connect.

The optional parameter determines if BT will listen for a secure or insecure connection. If no parameter is given or if the parameter is 1, then a secure connection request will be listened for. Otherwise, an insecure connection will be listened for. It is not possible to listen for either a secure or insecure connection with one `bt.open` command because the Android API requires declaring a specific secure/insecure open.

If `bt.open` is used in graphics mode (after `gr.open`), you will need to insert a "pause 500" statement after the `bt.open` statement.

## **Bt.close**

Closes any previously opened Bluetooth connection. Bluetooth will automatically be closed when the program execution ends.

## **Bt.connect {0|1}**

Commands BASIC! to connect to a particular device. Executing this command will cause a list of paired devices to be displayed. When one of these devices is selected the `bt.status` will become "Connecting" until the device has connected.

The optional parameter determines if BT will seek a secure or insecure connection. If no parameter is given or if the parameter is 1, then a secure connection will be requested. Otherwise, an insecure connection will be requested.

## Bt.disconnect

Disconnects from the connected Bluetooth device and goes into the Listen status. Avoids having to use `bt.close + bt.open` to disconnect and wait for a new connection.

## Bt.reconnect

This command will attempt to reconnect to a device that was previously connected (during this Run) with `Bt.connect` or a prior `Bt.reconnect`. The command cannot be used to reconnect to a device that was connected following a `Bt.open` or `Bt.disconnect` command (i.e. from the Listen status).

You should monitor the Bluetooth status for Connected (3) after executing `bt.reconnect`.

## Bt.status <nvar>

Gets the current Bluetooth connection status and place the value in the numeric variable.

- 1 = Bluetooth not enabled
- 0 = Nothing going on
- 1 = Listening
- 2 = Connecting
- 3 = Connected

## Bt.write {<exp> {,|;}} ...

Writes a text line to the Bluetooth connection.

If the comma (,) separator is used then a comma will be printed between the values of the expressions.

If the semicolon (;) separator is used then nothing will separate the values of the expressions.

If the semicolon is at the end of the line, the output will be transmitted immediately, with no newline character(s) added.

The parameters are the same as the **Print** parameters. This command is essentially a **Print** to the Bluetooth connection, with one difference: a line that ends with a semicolon is transmitted immediately, with no newline character(s) added.

This command with no parameters sends a newline character to the Bluetooth connection.

## Bt.read.ready <nvar>

Reports in the numeric variable the number of messages ready to be read. If the value is greater than zero then the messages should be read until the queue is empty.

## OnBtReadReady:

If a Bluetooth received message is ready (`Bt.read.ready` would return a non-zero value) the currently running program will be interrupted and execution will resume at the statement after this label. You can

then read and handle the message. When done, you can execute the `bt.onReadReady.Resume` command to resume the interrupted program.

### **Bt.onReadReady.Resume**

Resumes the running of the program at the location where it was interrupted by the Bluetooth Read Ready event.

### **Bt.read.bytes <svar>**

The next available message is placed into the specified string variable. If there is no message then the string variable will be returned with an empty string ("").

### **Bt.device.name <svar>**

Returns the name of the connected device in the string variable. A run-time error will be generated if no device (Status <> 3) is connected.

### **Bt.set.uuid <sexp>**

A Universally Unique Identifier (UUID) is a standardized 128-bit format for a string ID used to uniquely identify information. The point of a UUID is that it's big enough that you can select any random 128-bit number and it won't clash with any other number selected similarly. In this case, it's used to uniquely identify your application's Bluetooth service. To get a UUID to use with your application, you can use one of the many random UUID generators on the web.

Many devices have common UUIDs for their particular application. The default BASIC! UUID is the standard Serial Port Profile (SPP) UUID: "00001101-0000-1000-8000-00805F9B34FB".

You can change the default UUID using this command.

Some information about 16 bit and 128 bit UUIDs can be found at:

<http://farwestab.wordpress.com/2011/02/05/some-tips-on-android-and-bluetooth/>

## **Miscellaneous Commands**

### **Browse <url\_sexp>**

If <url\_sexp> starts with "http..." then the internet site specified by <url\_sexp> will be opened and displayed.

If <url\_sexp> starts with "[file:///sdcard/...](#)" then the file will be opened by the application, ThinkFree Mobile. The file types that the free version of ThinkFree Mobile can open are ".txt, .doc,.xls, .rtf".

If your Android device does not already have ThinkFree Mobile Viewer on it, you can find it in the apps section of the Google Play Store. There is also a paid "pro" version that manages additional file types.



Note: You can also use the HTML commands to display (and interact with) web pages located on your device or on the web.

## Swap <nvar\_a>|<svar\_a>, <nvar\_b>|<svar\_b>

The values and in "a" and "b" numeric or string variables are swapped.

## Clipboard

### Clipboard.get <svar>

Copies the current contents of the clipboard into <svar>

### Clipboard.put <sexp>

Places <sexp> into the clipboard.

## Echo.on

Same as debug.echo.on. See debug.echo.on for details.

## Echo.off

Same as debug.echo.off. See debug.echo.off for details.

## Encryption

Encrypts and decrypts a string using a supplied password. The encryption algorithm used is "PBESWithMD5AndDES".

### Encrypt <pw\_sexp>, <source\_sexp>, <encrypted\_svar>

The <source\_sexp> will be encrypted using <pw\_sexp>. The encrypted result will be placed into <encrypted\_svar>.

### Decrypt <pw\_sexp>, <encrypted\_svar>, <decrypted\_svar>

The encrypted data in <encrypted\_svar> will be decrypted using <pw\_sexp>. The decrypted results will be placed into <decrypted\_svar>.

## Ringer

Android devices support three ringtone modes:

Value:	Meaning:	Behavior
0	Silent	Ringer is silent and does not vibrate
1	Vibrate	Ringer is silent but vibrates
2	Normal	Ringer may be audible and may vibrate

"Normal" behavior depends on other device settings set by the user.

Ringer volume is an integer number from zero to a device-dependant maximum. If the volume is zero the ringer is silent.

NOTE: These are system settings. Any change you make persists after your program ends. You may want to record the original settings and change them back when the program exits.

### **Ringer.get.mode <nvar>**

Returns the current ringtone mode in the numeric variable.

### **Ringer.set.mode <nexp>**

Changes the ringtone mode to the specified value. If the value is not a valid mode, the device mode is not changed.

### **Ringer.get.volume <vol\_nvar> { , <max\_nvar> }**

Returns the ringer volume level in the numeric variable. Returns the maximum volume setting in <max\_nvar>, if <max\_nvar> is present.

### **Ringer.set.volume <nvar>**

Changes the ringer volume to the specified value. If the value is less than zero, volume is set to zero. If the value is greater than the device-specific maximum, the volume is set to the maximum level.

## **Text To Speech**

The speech generated will be spoken in the current default language of the device. The default language is set by:

1. Start the Settings Application
2. Select Voice input & output
3. Select Text-to-speech settings
4. Select Language

### **Tts.init**

This command must be executed before speaking.

### **Tts.speak <sexp> { <wait\_lexp> }**

Speaks the string expression. The statement does not return until the string has been fully spoken, unless the optional "wait" parameter is present and evaluates to false (numeric 0). Spoken expressions cannot overlap. A second Tts.speak (or a Tts.speak.toFile) will wait for the speech from an earlier Tts.speak to finish, even if the "wait" flag was false.

### **Tts.speak.toFile <sexp> { <path\_sexp> }**

Converts the string expression to speech and writes it into a wav file. You can specify the name and location of the file with the optional "path" parameter. The default path is "<pref base drive>/rfo-basic/data/tts.wav". The statement does not return until the speech synthesis is complete, but there is no guarantee the file-write is finished. If a previous Tts.speak is still speaking, this statement will not start until that speech completes.

## Tts.stop

Waits for any outstanding speech to finish, then releases Android's text-to-speech engine. Following Tts.stop, if you want to run Tts.speak or Tts.speakToFile again, you will have to run Tts.init again.

## Speech To Text (Voice Recognition)

The Voice Recognition function on Android uses Google Servers to perform the recognition. This means that you must be connected to the Internet and logged into your Google account for this feature to work.

There are two commands for Speech to Text: stt.listen and stt.results.

Stt.listen starts the voice recognition process with a dialog box. Stt.results reports the interpretation of the voice with a list of strings.

The Speech to Text procedures are different for Graphics Mode, HTML mode and simple Console Output mode.

### Stt.listen

Start the voice recognize process by displaying a "Speak Now" dialog box.

Begin speaking.

The recognition will stop when there is a pause in the speaking.

Stt.results should be executed next.

Note: stt.listen is not to be used in HTML mode.

### Stt.results <string\_list\_ptr\_nvar>

The command must not be executed until after a stt.listen is executed (unless in HTML mode).

The recognizer returns several variations of what it thinks it heard as a list of strings. The first string in the list is the best guess.

### Console Mode

The following code illustrates the command in Output Console (not HTML mode and not Graphics mode):

```
PRINT "Starting Recognizer"
Stt.listen
Stt.results theList
LIST.SIZE theList, theSize
FOR k =1 to theSize
    LIST.GET theList, k, theText$
    PRINT theText$
NEXT k
END
```

## Graphics Mode

This command sequence is to be used in graphics mode. Graphics mode exists after `gr.open` and before `gr.close`. (Note: Graphics mode is temporarily exited after `gr.front 0`. Use the Console Mode if you have called `gr.front 0`).

The primary difference is that `gr.render` *must* be called after `stt.listen` and before `stt.results`.

```
PRINT "Starting Recognizer"
Stt.listen
gr.render
Stt.results theList
LIST.SIZE theList, theSize
FOR k =1 to theSize
    LIST.GET theList, k, theText$
    PRINT theText$
NEXT k
END
```

## HTML Mode

This command sequence is used while in HTML mode. HTML mode exists after `html.open` and `html.close`.

The primary difference is that the `stt.listen` command is *not* used in HTML mode. The `stt.listen` function is performed by means of an HTML datalink sending back the string "STT". The sending of "STT" by means of the datalink causes the Speak Now dialog box to be displayed.

When the datalink "STT" string is received by the BASIC! program, the `stt.results` command can be executed normally as it will contain the recognized text.

The sample file, `f37_html_demo.bas`, along with the associated html file, `htmlDemo1.html` (located in "rfo-basic/data/") demonstrates the use of voice recognition in HTML mode.

## Timer Interrupts and Commands

You can set a timer that will interrupt the execution of your program at some set time interval. When this interrupt occurs program execution will transfer to the statements following the `onTimer:` label. When you have done whatever you need to do to handle this Timer event, you use the `Timer.Resume` command to resume the execution of the program at the point where the timer interrupt occurred.

The timer cannot interrupt an executing command. When the timer expires, it arms the interrupt. When the current command completes, the timer triggers, transferring control to the timer interrupt code after the `onTimer:` label. If the current command takes a long time to finish, it may appear that your interrupt is late.

The trigger disables the interrupt. Another timer expiration cannot arm the interrupt unless a `Timer.Resume` first enables the interrupt. The timer interrupt code must exit by running `Timer.Resume`, or the interrupt can occur only once.

### Timer.set <interval\_nexp>

Sets a timer that will repeatedly interrupt program execution after the specified time interval. The interval time units are milliseconds. The program must contain an "onTimer" label when this command is executed.

### OnTimer:

The label after which the timer interrupt code will be placed.

### Timer.Resume

Causes program execution to resume at the point where the timer interrupt occurred.

### Timer.Clear

Clears the repeating timer. No further timer interrupts will occur.

### Sample Code

```
n=0
TIMER.SET 2000

DO
UNTIL n=4
TIMER.CLEAR
PRINT "Timer cleared. No further interrupts."
DO
UNTIL 0

ONTIMER:
n = n + 1
PRINT n*2; " seconds"
TIMER.RESUME
```

### Device <svar>

Returns information about this Android device in the string variable. The information is the device Model, Device Type and OS.

### Device <nvar>

Returns a pointer to a Bundle containing information about this Android device. The Bundle keys are:

**Brand Model Device Product OS Language Local PhoneNumber**

The Bundle values are all strings. The **Language** and **Locale** values are the device's default language and locale (for example, "English" and "en\_US").

### Include FileNamePath

Before the program is run, the BASIC! preprocessor replaces any Include statements with the text from the named file. You can use this to insert another BASIC! program file into your program at this point.

The FileNamePath is given without quotes. The program is not yet running, therefore the path cannot be a string expression.

#### **INCLUDE functions/DrawGraph.bas**

inserts the code from the file "<pref base drive>/rfo-basic/source/functions/DrawGraph.bas" into the program.

### **Pause <ticks\_nexp>**

Stops the execution of the BASIC! program for <ticks\_nexp> milliseconds. One millisecond = 1/1000 of a second. Pause 1000 will pause the program for one second.

### **Popup <message\_sexp>, <x\_nexp>, <y\_nexp>, <duration\_nexp>**

Pops up a small message for a limited duration.

The message is <message\_sexp>.

The duration of the message is either 2 seconds or 4 seconds. If <duration\_nexp> = 0 the duration will be 2 seconds. If <duration\_nexp> <> 0 the duration will be 4 seconds.

The default location for the Popup is the center of the screen. The <x\_nexp>, <y\_nexp> pair gives a displacement from the center. The values may be negative.

### **Select <selection\_nvar>, <Array\$[]>|<list\_nexp> {<title\_sexp> {<message\_sexp> } } {<press\_lvar> }**

The Select command generates a new screen with a list of choices for the user. When the user taps a screen line, the index for that line will be returned.

<selection\_nvar> is the numeric variable into which the selection array index will be returned.

< Array\$[]> is a string array that holds the list of items to be selected. The array is specified without an index but must have been previously dimensioned or loaded via Array.load.

As an alternative to an array, a string-type list may be specified in the <list\_nexp>.

The <title\_sexp> is an optional string expression that will be placed into the title bar at the top of the selection screen. If the parameter is not present, the screen will display a default title. If the expression evaluates to an empty string ("" ) the title will be blank.

The <message\_sexp> is an optional string expression that will be displayed in a short Popup message. If the message is an empty string ("" ) there will be no Popup. If the parameter is absent, the <title\_sexp> string will be used instead, but if the <title\_sexp> is also missing or empty, there will be no Popup.

If you want a <message\_sexp> with no <title\_sexp>, make the <title\_sexp> an empty string, or omit the <title\_sexp> but keep the following comma.

The <press\_lvar> is optional. If present, the type of user tap—long or short—will be returned in <press\_lvar>. The value returned will be 0 (false) if the user selected the item with a short tap. The value returned will be 1 (true) if the user selected the item with a long press.

**Split <result\_array\$[]>, <source\_sexp> {, <test\_sexp>}**

**Split.all <result\_array\$[]>, <source\_sexp> {, <test\_sexp>}**

The <source\_sexp> string will be split into multiple strings that are placed into <result\_array\$[]>. The string is split at each location where <test\_sexp> occurs. The <test\_sexp> occurrences will be removed from the result strings. The <text\_sexp> parameter is optional; if it is not given, the string is split on whitespace.

The <result\_array\$[]> is specified without an index. The array must not have been previously dimensioned.

If the beginning of the source string matches the test string, the first element of the result array will be an empty string. This differs from the WORD\$() function, which strips leading and trailing occurrences of the test string from the source string before splitting.

Two adjacent occurrences of the test expression in the source expression will result in an empty string somewhere in the result array. The Split command discards these empty strings if they occur at the end of the result array. To keep these trailing empty strings, use the Split.all command.

Example:

```
string$ = "a:b:c:d"
delimiter$ = ":"
SPLIT result[], string$, delimiter$

ARRAY.LENGTH length, result$[]
FOR i = 1 TO length
PRINT result$(i) + " ";
NEXT i
PRINT ""
```

Will print: a b c d

Note: The <test\_sexp> is actually a Regular Expression. If you are not getting the results that you expect from the <test\_sexp> then you should examine the rules for Regular Expressions at:

<http://developer.android.com/reference/java/util/regex/Pattern.html>

**Time {<time\_nexp>}, Year\$, Month\$, Day\$, Hour\$, Minute\$, Second\$, WeekDay, isDST**

Returns the current (default) or specified date, time, weekday, and Daylight Saving Time flag in the variables.

You can use the optional first parameter (<time\_nexp>) to specify what time to return in the variables. It is a numeric expression number of milliseconds from 12:00:00 AM, January 1, 1970, as returned by the TIME() function. It may be negative, indicating a time before that date.

The day/date and time are returned as two-digit numeric strings with a leading zero when needed, except Year\$ which is four characters.

The WeekDay is a number from 1 to 7, where 1 means Sunday. You can use it to index an array of day names in your language of choice.

The isDST flag is

- 1 if the current or specified time is in Daylight Saving Time in the current time zone
- 0 if the time is not in Daylight Saving Time (is Standard Time)
- 1 if the system can't tell if the time is in DST

The current time zone is your local time zone unless you change it with the TimeZone command.

All of the return variables are optional. That is, you can omit any of them, but if you want to return only some of them, you need to retain their position by including commas for the omitted return variables. For example:

```
t = TIME(2001, 2, 3, 4, 5, 6)
Time t, Y$, M$, D$      % sets only the year, month, and day
Time t, Y$, M$, D$,,, W % adds the day of the week (7, Saturday)
```

To do the same with the current time, leave out both the first parameter and its comma:

```
Time ,, day$,,, wkday  % returns the today's day and weekday
```

## TimeZone Commands

The TimeZone commands allow you to manage the time zone used by the Time command and the TIME() function. They affect only your BASIC! program, not any other time-related operation on your device.

### TimeZone.set { <tz\_sexp> }

Sets the time zone for your program. If you don't specify a time zone, it is set to the default for your device, which is based on where you are. If you specify a time zone your device does not recognize, it is set to "GMT". (GMT is exactly the same as UTC).

### TimeZone.get <tz\_svar>

Returns the current time zone in the string variable. This is the default time zone for your device and location, unless you have changed it with TimeZone.Set.



## TimeZone.list <tz\_list\_pointer\_nvar>

While time zones are defined by international standards, the only ones that matter to your program are those recognized by your device. This command builds a list of all valid time zone strings and returns a pointer to the list in <tz\_list\_pointer\_nvar>.

## Tone <frequency\_nexp>, <duration\_nexp>

Plays a tone of the specified frequency in hertz (cycles per second) for the specified duration in milliseconds.

The duration produced does not exactly match the specified duration. If you need to get an exact duration, experiment.

Each Android device has a minimum tone duration. If you specify a duration less than this minimum, you will get a run-time error message giving that minimum for that device.

## Vibrate <pattern\_array[{<start>,<length>}]>,<nexp>

The vibrate command causes the device to vibrate in the specified pattern. The pattern is held in a numeric array (pattern\_array[]) or array segment (pattern\_array[start,length]).

The pattern is of the form: pause-time, on-time, ..., pause-time, on-time. The values for pause-time and on-time are durations in milliseconds. The pattern may be of any length. There must be at least two values to get a single buzz because the first value is a pause.

If <nexp> = -1 then the pattern will play once and not repeat.

If <nexp> = 0 then the pattern will continue to play over and over again until the program ends.

If <nexp> > 0 then the pattern play will be cancelled.

See the sample program, f21\_sos.bas, for an example of Vibrate.

## WakeLock <code\_nexp>

The WakeLock command modifies the system screen timeout function. The <code\_nexp> may be one of five values. Values 1 through 4 modify the screen timeout in various ways. Code value 5 releases the WakeLock and restores the system screen timeout function.

Code	WakeLock Type	CPU	Screen	Keyboard Light
<u>1</u>	Partial WakeLock	On*	Off	Off
<u>2</u>	Screen Dim	On	Dim	Off
<u>3</u>	Screen Bright	On	Bright	Off
<u>4</u>	Full WakeLock	On	Bright	Bright
5	No WakeLock	Off	Off	Off

*\* If you hold a partial WakeLock, the CPU will continue to run, regardless of any timers and even after the user taps the power button. In all other WakeLocks, the CPU will run, but the user can still put the device to sleep using the power button.*

Use the WakeLock only when you really need it. Acquiring a WakeLock will increase power and decrease battery life. The WakeLock is always released when the program stops running.

One of the common uses for WakeLock would be in a music player that needs to keep the music playing after the system screen timeout interval. Implementing this requires that BASIC! be kept running. One way to do this is to put BASIC! into an infinite loop:

```
Audio.load n,"B5b.mp3"  
Audio.play n  
WakeLock 1  
Do  
  Pause 30000  
Until 0
```

The screen will turn off when the system screen timeout expires but the music will continue to play.

## WifiLock <code\_nexp>

The WifiLock command allows your program to keep the WiFi connection awake when a time-out would normally turn it off. The <code\_nexp> may be one of four values. Values 1 through 3 acquire a WifiLock, changing the way WiFi behaves when the screen turns off. Code value 4 releases the WifiLock and restores the normal timeout behavior.

Code:	WiFiLock Type	WiFi Operation When Screen is Off
<u>1</u>	Scan Only	WiFi kept active, but only operation is initiating scan and reporting scan results
<u>2</u>	Full	WiFi behaves normally
<u>3</u>	Full High-Performance	WiFi operates at high performance with minimum packet loss and low latency*
4	No WifiLock	WiFi turns off (may be settable on some devices)

\*Full Hi-Perf mode is not available on all Android devices. Devices running Android 3.0.x or earlier, and devices without the necessary hardware, will run in Full mode instead.

Use the WifiLock only when you really need it. Acquiring a WifiLock increases power usage and decreases battery life. The WifiLock is always released when the program stops running.

## Http.post <url\_sexp>, <list\_nexp>, <result\_svar>

Execute a Post command to an Internet location.

<url\_sexp> contains the url ("http://....") that will accept the Post.

<list\_nexp> is a pointer to a string list which contains the Name/Value pairs needed for the Post.

<result\_svar> is where the Post response will be placed.

## MyPhoneNumber <svar>

The phone number of the Android device will be returned in the string variable. If the device is not connected to a cellular network, the returned value will be uncertain.

## Phone.call <sexp>

The phone number contained in the string expression will be called. Your device must be connected to a cellular network to make phone calls.

## Phone.rcv.init

Prepare to detect phone calls using phone.rcv.next.

## Phone.rcv.next <state\_nvar>, <number\_svar>

The state of the phone will be returned in the state numeric value. A phone number may be returned in the string variable.

State = 0. The phone is idle. The phone number will be an empty string.

State = 1. The phone is ringing. The phone number will be in the string.

State = 2. The phone is off hook. If there is no phone number (an empty string) then an outgoing call is being made. If there is a phone number then an incoming phone call is in progress.

States 1 and 2 will be continuously reported as long the phone is ringing or the phone remains off hook.

## Sms.send <number\_sexp>, <message\_sexp>

The SMS message in the string expression <message\_sexp> will be sent to number in the string expression <number\_sexp>. This command does not provide any feedback about the sending of the message. The device must be connected to a cellular network to send SMS message.

## Sms.rcv.init

Prepare to intercept received SMS using the sms.rcv.next command.

## Sms.rcv.next <svar>

Read the next received SMS message from received SMS message queue in the string variable.

The returned string will contain "@" if there is no SMS message in the queue.

The sms.rcv.init command must be called before the first sms.rcv.next command is executed.

Example:

```
SMS.RCV.INIT  
DO
```

```

DO % Loop until SMS received
  PAUSE 5000 % Sleep of 5 seconds
  SMS.RCV.NEXT m$ % Try to get a new message
  UNTIL m$ <> "@" % "@" indicates no new message
  PRINT m$ % Print the new message
UNTIL 0 % Loop forever

```

## Email.send <recipient\_sexp>, <subject\_sexp>, <body\_sexp>

The email message in the Body string expression will be sent to the named recipient with the named subject heading.

## Headset <state\_nvar>, <type\_svar>, <mic\_nvar>

<state\_nvar>: 1.0 if headset plugged in, -1 if no headset plugged in.

<type\_svar>: A string describing the device type.

<mic\_nvar>: 1.0 if the headset has a microphone, -1 if the headset does not have microphone.

## Notify <title\_sexp>, <subtitle\_sexp>, <alert\_sexp>, <wait\_lexp>

This command will cause a Notify object to be placed in the Notify (Status) bar.

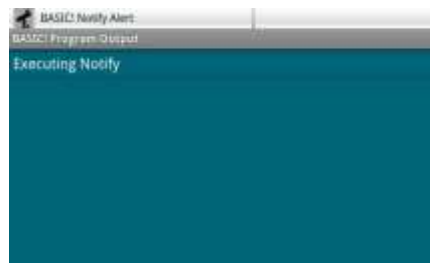
If <wait\_lexp> is not zero (true), then the execution of the BASIC! program will be suspended until the user taps the Notify object. If the value is zero (false), the BASIC! program will continue executing.

The Notify object will be removed when the user taps the object.

```

Print "Executing Notify"
Notify "BASIC! Notify", "Tap to resume running program", ~
"BASIC! Notify Alert", 1
! Execution is suspended and waiting for user to tap the Notify Object
Print "Notified"

```



Note: the icon that appears in the Notify object will be the icon for the application in user-built apk.

## Home

The HOME command does exactly what tapping the Home key would do. The Home Screen is displayed while the BASIC! program continues to run in the background.

## OnBackGround:

When the Background/Foreground state changes, if this label is present in the program than the currently executing program will be interrupted and the code following the label will be executed. The Background() function should be used to determine the new state. The interrupted code should be resumed by executing Background.Resume.

## Background.Resume

Resumes the execution of the program interrupted by a Background/Foreground state change.

## SQLITE

### Overview

The Android operating system provides the ability to create, maintain and access SQLite databases. SQLite implements a [self-contained](#), [serverless](#), [zero-configuration](#), [transactional](#) SQL database engine. SQLite is the [most widely deployed](#) SQL database engine in the world. The full details about SQLite can be found at the [SQLite Home Page \(http://www.sqlite.org/\)](http://www.sqlite.org/).

An excellent online tutorial on SQL can be found at [www.w3schools.com \(http://www.w3schools.com/sql/default.asp\)](http://www.w3schools.com/sql/default.asp).

Database files will be created on the base drive (usually the SD card) in the directory, "<pref base drive>/rfo-basic/databases/".

## SQLITE Commands

### Sql.open <DB\_pointer\_nvar>, <DB\_name\_sexp>

Opens a database for access. If the database does not exist, it will be created.

<DB\_pointer\_nvar> is a pointer to the newly opened database. This value will be set by the sql.open command operation. <DB\_pointer\_nvar> is used in subsequent database commands and should not be altered.

<DB\_name\_sexp> is the filename used to hold this database. The base reference directory is "<pref base drive>/com.rfo.basic/databases/". If <DB\_name\_sexp> = ":memory:" then a temporary database will be created in memory.

Note: You may have more than one database opened at same time. Each opened database must have its own, distinct pointer.

### **Sql.close <DB\_pointer\_nvar>**

Closes a previously opened database. <DB\_pointer\_nvar> will be set to zero. The variable may then be reused in another sql.open command. You should always close an opened database when you are done with it. Not closing a database can reduce the amount of memory available on your Android device.

### **Sql.new\_table <DB\_pointer\_nvar>, <table\_name\_sexp>, C1\$, C2\$, ...,CN\$**

A single database may contain many tables. A table is made of rows of data. A row of data consists of columns of values. Each value column has a column name associated with it.

This command creates a new table with the name <table\_name\_sexp> in the referenced opened database. The column names for that table are defined by the following: C1\$, C2\$, ..., CN\$. At least one column name is required. You may create as many column names as you need.

BASIC! always adds a Row Index Column named "\_id" to every table. The value in this Row Index Column is automatically incremented by one for each new row inserted. This gives each row in the table a unique identifier. This identifier can be used to connect information in one table to another table. For example, the \_id value for customer information in a customer table can be used to link specific orders to specific customers in an outstanding order database.

### **Sql.drop\_table <DB\_pointer\_nvar>, <table\_name\_sexp>**

The table named <table\_name\_sexp> in the opened database pointed to by <DB\_pointer\_nvar> will be dropped from the database if the table exists.

### **Sql.insert <DB\_pointer\_nvar>, <table\_name\_sexp>, C1\$, V1\$, C2\$, V2\$, ..., CN\$, VN\$**

Inserts a new row of data columns and values into a table in a previously opened database.

The <table\_name\_sexp> is the name of the table into which the data is to be inserted. All newly inserted rows are inserted after the last, existing row of the table.

C1\$, V1\$, C2\$, V2\$, ..., CN\$, VN\$: The column name and value pairs for the new row. These parameters must be in pairs. The column names must match the column names used to create the table. Note that the values are all strings. When you need a numeric value for a column, use the BASIC! STR\$(n) to convert the number into a string. You can also use the BASIC! FORMAT\$(pattern\$, N) to create a formatted number for a value. (The Values-as-strings requirement is a BASIC! SQL Interface requirement, not a SQLite requirement. While SQLite, itself, stores all values as strings, it provides transparent conversions to other data types. I have chosen not to complicate the interface with access to these SQLite conversions since BASIC! provides its own conversion capabilities.)

### **Sql.query <cursor\_nvar>, <DB\_pointer\_nvar>, <table\_name\_sexp>, <columns\_sexp> {, <where\_sexp> {, <order\_sexp>}}**

Queries a table of a previously-opened database for some specific data. The command will return a Cursor named <Cursor\_nvar> to be used in stepping through query results.

The <columns\_sexp> is a string expression with a list of the names of the columns to be returned. The column names must be separated by commas. An example is Columns\$ = "First\_name, Last\_name, Sex, Age". If you want to get the automatically incremented Row Index Column then include the "\_id" column name in your column list. Columns may be listed in any order. The column order used in the query will be the order in which the rows are returned.

The optional <where\_sexp> is an SQL expression string used to select which rows to return. In general, an SQL expression is of the form <Column Name> <operator> <Value>. For example, Where\$ = "First\_name = 'John' " Note that the Value must be contained in single quotes. Full details about the SQL expressions can be found [here](#). If the Where parameter is omitted, all rows will be returned.

The optional <order\_sexp> specifies the order in which the rows are to be returned. It identifies the column upon which the output rows are to be sorted. It also specifies whether the rows are to be sorted in ascending (ASC) or descending (DESC) order. For example, Order\$ = "Last\_Name ASC" would return the rows sorted by Last\_Name from A to Z. If the Order parameter is omitted, the rows are not sorted.

If the Order parameter is present, the Where parameter must be present. If you want to return all rows, just set Where\$ = ""

### **Sql.query.length <length\_nvar>, <cursor\_nvar>**

Report the number of records returned by a previous Query command, Given the Cursor returned by a Query, the command writes the number of records into <length\_nvar>. This command cannot be used after all of the data has been read.

### **Sql.query.position <position\_nvar>, <cursor\_nvar>**

Report the record number most recently read using the Cursor of a Query command. Given the Cursor returned by a Query, the command writes the position of the Cursor into <Position\_nvar>. Before the first Next command, the Position is 0. It is incremented by each Next command. A Next command after the last row is read sets its Done variable to true and resets the Cursor to 0. The Cursor can no longer be used, and this command can no longer be used with that Cursor.

### **Sql.next <done\_lvar>, <cursor\_nvar>, C1V\$, C2V\$, ..., CNV\$**

Using the Cursor generated by a previous Query command, step to the Next row of data returned by the query.

C1V\$, C2V\$, CNV\$ are the values associated with the columns listed in the Query Columns\$ string. If any of your values are numeric values that you need to use in arithmetic operations, you can use the BASIC! VAL(str\$) function to convert the value to a number.

The <Done\_lvar> parameter is a Boolean used to signal that the last row of the Query returned rows has been read. When the last returned row has been read, <Done\_lvar> changes from 0 (false) to 1 (true). When <Done\_lvar> becomes true, the Cursor variable is reset to zero. It can no longer be used for sql.next operations. It may be used in a subsequent sql.query statement.

You may have more than one Cursor opened at a time. Each opened Cursor would, of course, have a different variable name.

### **Sql.delete <DB\_pointer\_nvar>, <table\_name\_sexp>{<where\_sexp>{<count\_nvar>}} }**

From the named table of a previously opened database, delete rows selected by the conditions established by the Where string expression. The Count variable reports the number of rows deleted.

The formation of the Where string is exactly the same as described in the sql.query command. Both Where and Count are optional. If the Where string is omitted all rows are deleted, and the Count variable must be omitted, too.

### **Sql.update <DB\_pointer\_nvar>, <table\_name\_sexp>, C1\$, V1\$, C2\$, V2\$,...,CN\$, VN\$: <where\_sexp>**

In the named table of a previously opened database, change column values in specific rows selected by the Where\$ parameter. The C\$,V\$ parameters must be in pairs. The colon character terminates the C\$,V\$ list and must precede the Where\$ in this command.

### **Sql.exec <DB\_pointer\_nvar>, <command\_sexp>**

Execute ANY non-query SQL command string ("CREATE TABLE", "DELETE", "INSERT", etc.) using a previously opened database.

### **Sql.raw\_query <cursor\_nvar>, <DB\_pointer\_nvar>, <query\_sexp>**

Execute ANY SQL Query command using a previously opened database and return a Cursor for the results.

## **Graphics**

### **Introduction**

#### **The Graphics Screen and Graphics Mode**

Graphics are displayed on a new screen that is different from the BASIC! Text Output Screen. The Text Output Screen still exists and can still be written to. You can be returned to the graphics screen using the BACK key or by having the program execute the gr.front command.

The gr.open command opens the graphics screen and puts BASIC! into the graphics mode. BASIC! must be in graphics mode before any other graphics commands can be executed. Attempting to execute any graphics command when not in the graphics mode will result in a run-time error. The graphics mode automatically turns off when the BACK key or MENU key is tapped. BASIC! will continue to run after the BACK key or MENU key is tapped when in graphics mode but the Output Console will be shown.



The BASIC! Output Console is hidden when the graphics screen is being displayed. No run-time error messages will be observable. A haptic feedback alert signals a run-time error. This haptic feedback will be a distinct, short buzz. Tap the BACK key to close the Graphics Screen upon feeling this alert. The error messages can then read from the BASIC! Output Console.

The `gr.front` command can be used to swap the front-most screen between the Output Console and the graphics screen.

When your program ends, the graphics screen will be closed. If you want to keep the graphics screen showing, use a long pause or an infinite loop to keep the program from ending:

```
! Stay running to keep the  
! graphics screen showing  
do  
until 0
```

## Display Lists

BASIC! uses a Display List. The Display List contains pointers to all the graphics objects (circles, lines, etc.) commanded to be drawn. Objects are drawn on the screen in the order in which they appear in the Display List. The Display List objects will not be rendered on the screen until the `gr.render` command is called.

Each draw object command returns the object's Object Number in something called an Object List. This Object Number can be used to change the object on the fly. You can change any of the parameters of any object in the Object List with the `gr.modify` command. This feature allows you easily to create animations without the overhead of having to recreate every object in the Object List.

Each time an object is added to the Object List, its Object Number is also added to the initial Display List. The user may optionally use the `gr.NewDL` command to replace the initial display with a custom display list array. This custom display list array will contain some or all of the Object Numbers in the Object List.

The primary use for custom display lists is to change the Z order of the objects. In other words you can use this feature to change which objects will be drawn on top of other objects.

See the Sample Program file, `f24_newdl`, for a working example of `gr.NewDL`.

## Drawing into Bitmaps

You can draw into bitmaps in addition to drawing directly to the screen. You notify BASIC! that you want to start drawing into a bitmap instead of the screen with the `gr.bitmap.drawinto.start` command. This puts BASIC! into the draw-into-bitmap mode. All draw commands issued while in this mode will draw directly into the bitmap. The objects drawn in this mode will not be placed into the Display List. The object number returned by the draw commands while in this mode should be considered invalid and should not be used for any purpose including `gr.modify`.

The draw-into-bitmap mode is ended when the `gr.bitmap.drawinto.end` command is issued. Subsequent draw commands will place the objects into the display list for rendering on the screen. If you wish to

display the drawn-into bitmap on the screen, issue a `bitmap.draw` command for that bitmap. The drawn-into bitmap may be drawn at any time before, during or after the draw-into process.

## Colors

Android colors consist of a mixture of Red, Green and Blue. Each of the colors can have numerical values ranging from 0 to 255. Black occurs when all three values are zero. White occurs when all three values are 255. Solid Red would occur with Red having a value of 255 while Blue and Green are zero.

Colors also have what is called an Alpha Channel. The Alpha Channel describes the level of opaqueness of the color. An Alpha value of 255 is totally opaque. No object of any color can show through an object with an Alpha value of 255. An Alpha value of zero will render the object invisible.

## Graphics Setup Commands

### **Gr.open alpha, red, green, blue {, <ShowStatusBar\_lexp> {, <Orientation\_nexp>}}**

Opens the Graphics Screen and puts BASIC! into Graphics Mode. The color values become the background color of the graphics screen.

The Status Bar will be shown on the graphics screen if the `<ShowStatusBar_lexp>` is true (not zero). If the `<ShowStatusBar_lexp>` is not present, the Status Bar will not be shown.

The orientation upon opening graphics will be determined by the `<Orientation_nexp>` value. `<Orientation_nexp>` values are the same as values for the `Gr.orientation` command (see below). If the `<Orientation_nexp>` is not present, the default orientation is Landscape.

Both `<ShowStatusBar_lexp>` and `<Orientation_nexp>` are optional; however, a `<ShowStatusBar_lexp>` must be present in order to specify an `<Orientation_nexp>`.

Each `gr.open` command should be followed by a "Pause 1000" command. This will prevent some synchronization problems. The problem manifestation is that you open graphics, draw something and render it. You see what you have drawn and then it disappears.

### **Gr.color alpha, red, green, blue, <style\_nexp>**

Sets the current color for drawing objects. The current color will be used for whatever graphics objects are subsequently drawn until the next color command is executed.

The BASIC! color command has an additional parameter, `<style_nexp>`. The Style determines the stroking and filling of objects. Stroke parameters are set by commands such as `gr.set.stroke` (see below) and the various text style commands. The possible values for `<style_nexp>` are:

0: STROKE. Geometry and text drawn with this style will be stroked, respecting the stroke-related fields on the paint.

1: FILL. Geometry and text drawn with this style will be filled, ignoring all stroke-related settings in the paint.

2: STROKE\_AND\_FILL. Geometry and text drawn with this style will be both filled and stroked at the same time, respecting the stroke-related fields on the paint.

### **Gr.set.AntiAlias <lexp>**

If <lexp> is false (0), AntiAlias will be turned off. If the value is true (not zero) then AntiAlias will be turned on. AntiAlias should generally be on. It is on by default.

AntiAlias must be off to draw single-pixel pixels and single-pixel-wide horizontal and vertical lines.

### **Gr.set.stroke <nexp>**

Sets the line width of objects drawn after this command is issued. The <nexp> value must be >=0. Zero produces the thinnest line and is the default stroke value.

The thinnest horizontal lines and vertical lines will be two pixels wide if AntiAlias is on. Turn AntiAlias off to draw single-pixel-wide horizontal and vertical lines.

Pixels drawn by the gr.set.pixels command will be drawn as a 2x2 matrix if AntiAlias is on. To draw single-pixel pixels, set AntiAlias off and set the stroke = 0.

### **Gr.orientation <nexp>**

The value of the <nexp> sets the orientation of screen as follows:

- 1 = Orientation depends upon the sensors.
- 0 = Orientation is forced to Landscape.
- 1 = Orientation is forced to Portrait.

You can monitor changes in orientation by reading the screen width and height using the the gr.screen command.

### **Gr.StatusBar.Show <nexp>**

This command has been deprecated. To show the status bar on the graphics screen, use the optional fifth parameter in gr.open.

### **Gr.render**

This command displays all the objects that are in the current working Display List. It is not necessary to have a pause command after a gr.render. The gr.render command will not exit until the contents of the Display List have been fully displayed.

### **Gr.screen width, height{, density }**

Returns the screen's width and height, and optionally its density, in the numeric variables. The density, in dots per inch (dpi), is a standardized Android density value (usually 120, 160, or 240 dpi), and not necessarily the real physical density of the screen

This command should be executed after the execution of any gr.orientation command. This is because the gr.orientation command swaps the height and width so the values for height and width will be different if the orientation is changed.

## Gr.scale x\_factor, y\_factor

Scale all drawing commands by the numeric x and y scale factors. This command is provided to allow you to draw in a device-independent manner and then scale the drawing to the actual size of the screen that your program is running on. For example:

```
! Set the device independent sizes  
di_height = 480  
di_width = 800  
  
! get the actual width and height  
  
gr.open 255, 255, 255, 255  
gr.orientation 0  
gr.screen actual_w, actual_h  
  
! calculate the scale factors  
scale_width = actual_w /di_width  
scale_height = actual_h /di_height  
! Set the scale  
gr.scale scale_width, scale_height
```

Now, start drawing based upon di\_height and di\_width. The drawings will be scaled to fit the device running the program.

## Gr.cls

Clears the screen of all objects by disposing of the current Object List and Display List. Creates a new Initial Display List and disposes of any custom display list. All previous gr.color or gr.text {size|align|bold|strike|underline|skew} settings are reset. All previously drawn objects will be deleted. All previous object references are invalidated.

The gr.render command must be called to make the cleared screen visible to the user.

## Gr.close

Closes the opened graphics mode. The program will continue to run. The graphics screen will be removed. The text output screen will be displayed.

## Gr.front flag

Determines whether the graphics screen or the Output Console will be the front-most screen. If flag = 0, the Output Console will be the front-most screen and seen by the user. If flag <>0. the graphics screen will be the front-most screen and seen by the user.

This command is very useful for getting input from the user while in graphics mode. Executing "gr.front 0" will cause the text output screen to be seen by the user. The INPUT command can thus be executed. When the input is received, executing "gr.front 1" will cause the graphics screen to be seen by the user. (Alternatively, the Text.Input command can be used to get text input while in the graphic mode without having to use gr.front.)

Note: When the Output Console is in front of the graphics screen, you can still draw (but not render) onto the graphics screen. The "gr.front 1" must be executed before any gr.render.

Print commands will continue to print to the Output Console even while the graphic screen is in front.

### **Gr.brightness <nexp>**

Sets the brightness of the graphics screen. The value of the numeric expression should be between 0.01 (darkest) and 1.00 (brightest).

## **Graphical Object Creation Commands**

These commands create graphical objects and add them to the Display List. You create each object with parameters that describe what to draw and where. Once it is created, you can read back its parameters by name with the Gr.get.value command. You can change any parameter with the Gr.modify command. The parameters you can modify are listed with each command's description. Along with the parameters listed with each command, every graphical object has two other modifiable parameters, "paint" and "alpha". See the "Gr.modify" and "Gr.paint.get" command descriptions for more details.

There are three commands that create graphics objects that are not in this section: Gr.text.draw, Gr.bitmap.draw, and Gr.clip.

### **Gr.point <object\_number\_nvar>, x, y**

Creates and inserts a point object into the Display List. The point will be located at (x,y). The <object\_number\_nvar> returns the Object List object number for this point. This object will not be visible until the gr.render command is called.

The appearance of the point object is affected by the current stroke weight and the AntiAlias setting. The object is rendered as a square, centered on (x,y) and as big as the current stroke. If AntiAlias is on, it will blur the point, making it larger and dimmer. To color a single pixel, use "Gr.set.stroke 0" and "Gr.set.AntiAlias 0".

The gr.modify parameters for gr.point are: "x" and "y"

### **Gr.line <object\_number\_nvar>, x1, y1, x2, y2**

Creates and inserts a line object into the Display List. The line will start at (x1,y1) and end at (x2,y2). The <object\_number\_nvar> returns the Object List object number for this line. This object will not be visible until the gr.render command is called.

The thinnest horizontal lines and vertical lines are drawn with "gr.set.stroke 0". These lines will be two pixels wide if AntiAlias is on. Turn AntiAlias off to draw single-pixel wide horizontal and vertical lines.

The gr.modify parameters for gr.line are: "x1", "y1", "x2" and "y2"

### **Gr.rect <object\_number\_nvar>, left, top, right, bottom**

Creates and inserts a rectangle object into the Display List. The rectangle will be located within the bounds of the parameters. The rectangle will or will not be filled depending upon the "gr.color fill"

parameter. The <object\_number\_nvar> returns the Object List object number for this rectangle. This object will not be visible until the gr.render command is called.

The gr.modify parameters for gr.rect are: "left", "top", "right" and "bottom".

### **Gr.oval <object\_number\_nvar>, left, top, right, bottom**

Creates and inserts an oval-shaped object into the Display List. The oval will be located within the bounds of the parameters. The oval will or will not be filled depending upon the gr.color fill parameter. The <object\_number\_nvar> returns the Object List object number for this oval. This object will not be visible until the gr.render command is called.

The gr.modify parameters for gr.oval are: "left", "top", "right" and "bottom".

### **Gr.arc <object\_number\_nvar>, left, top, right, bottom, start\_angle, sweep\_angle, fill\_mode**

Creates and inserts an arc-shaped object into the Display List. The arc will be created within the rectangle described by the parameters. It will start at the specified start\_angle and sweep clockwise by the degrees through the specified sweep\_angle. If the color fill parameter is true, the fill\_mode parameter is activated. If fill\_mode is false, the arc will be filled between its end points. If fill\_mode is true, the arc will be filled around the center of the arc. A fill\_mode of true will produce a wedge or pie shaped object. The <object\_number\_nvar> returns the Object List object number for this arc. This object will not be visible until the gr.render command is called.

The gr.modify parameters for gr.arc are: "left", "top", "right", "bottom", "start\_angle", "sweep\_angle" and "fill\_mode". The value for "fill\_mode" is either false (0) or true (not 0).

### **Gr.circle <object\_number\_nvar>, x, y, radius**

Creates and inserts a circle object into the Object List. The circle will be created with the given radius around the designated center (x,y) coordinates. The circle will or will not be filled depending upon the gr.color fill parameter. The <object\_number\_nvar> returns the Object List object number for this circle. This object will not be visible until the gr.render command is called.

The gr.modify parameters for gr.circle are "x", "y", and "radius".

### **Gr.set.pixels <object\_number\_nvar>, pixels[<start>,<length>] {x,y}**

Inserts an array of pixel points into the Object List. The array (pixels[]) or array segment (pixels[start,length]) contains pairs of x and y coordinates for each pixel. The pixels[] array or array segment may be any size but should have an even number of elements.

If the optional x,y expression pair is present, the values will be added to each of the x and y coordinates of the array. This provides the ability to move the pixel array around the screen. The default values for the x,y pair is 0,0. Negative values for the x,y pair are valid.

Pixels will be drawn as 2x2 matrix pixels if AntiAlias is on and the stroke = 0. To draw single-pixel pixels, set AntiAlias off and set the stroke = 0. AntiAlias is on by default.

The gr.modify parameters for this command are "x" and "y".

In addition to modify, the individual elements of the pixel array can be changed on the fly. For example

```
Pixels[3] = 120  
Pixels[4] = 200
```

will cause the second pixel to be located at x = 120, y = 200 at the next rendering.

### **Gr.poly <object\_number\_nvar>, list\_pointer {x, y}**

Draws a closed polygon of any number of sides.

The list\_pointer is a pointer to a List data structure. The list contains x,y coordinate pairs. The first coordinate pair defines the point at which the polygon drawing start. Each subsequent coordinate pair defines a line drawn from the previous coordinate pair to this coordinate pair.

BASIC! will automatically draw the final, polygon-closing line from the last given coordinate pair to the first coordinate pair. This is to insure that the polygon is closed.

The minimum number of coordinate pairs is three pairs (six values). Three pairs define a triangle.

The polygon line width, line color, alpha and fill is determined by previous gr.color and gr.set.stroke commands just like any other drawn object.

If the optional x,y expression pair is present, the values will be added to each of the x and y coordinates of the list. This provides the ability to move the polygon array around the screen. The default values for the x,y pair is 0,0. Negative values for the x,y pair are valid.

The gr.modify parameters are "x", "y" and "list".

See the Sample Program file, f30\_poly, for working examples of gr.poly.

## **Hide and Show Commands**

### **Gr.hide <object\_number\_nvar>**

Hides the object with the specified Object\_number. This change will not be visible until the gr.render command is called.

### **Gr.show <object\_number\_nvar>**

Shows (unhides) the object with the specified Object\_number. This change will not be visible until the gr.render command is called.

## **Touch Query Commands**

If the user touches the screen and then moves the finger without lifting the finger from the screen, the motion can be tracked by repeatedly calling on the touch query commands. This will allow you to

program the dragging of graphics objects around the screen. The Sample Program, f23\_breakout.bas, illustrates this with the code that moves the paddle.

The onGRTouch: label can be used optionally to interrupt your program when a new touch is detected.

The touch commands report on one- or two-finger touches on the screen. If the two fingers cross each other on the x-axis then touch and touch2 will swap.

### **Gr.touch touched, x, y**

Tests for a touch on the graphics screen. If the screen was touched, Touched will be returned as true (not 0) with the (x,y) coordinates of the touch. If Touched is false (0), then the screen has not been touched and the (x,y) coordinates are invalid. The command will continue to return true as long as the screen remains touched.

If you want to detect a single short tap, after detecting the touch, you should loop until touched is false.

```
do
    gr.touch touched, x, y
until touched

~ Touch detected, now wait for
~ finger lifted
do
    gr.touch touched, x, y
until !touched.
```

The returned values are relative to the actual screen size. If you have scaled the screen then you need to similarly scale the returned parameters. If the parameters that you used in gr.scale were scale\_x and scale\_y (gr.scale scale\_x, scale\_y) then divide the returned x and y by those same values.

```
gr.touch touched, x, y
Xscaled = x / scale_x
Yscaled = y / scale_y
```

### **Gr.bounded.touch touched, left, top, right, bottom**

The Touched parameter will be returned true (not zero) if the user has touched the screen within the rectangle defined by the left, top, right, bottom parameters. If the screen has not been touched or has been touched outside of the bounding rectangle, the touched parameter will be return as false (zero). The command will continue to return true as long as the screen remains touched and the touch is within the bounding rectangle.

The bounding rectangle parameters are for the actual screen size. If you have scaled the screen then you need to similarly scale the bounding rectangle parameters. If the parameters that you used in gr.scale were scale\_x and scale\_y (gr.scale scale\_x, scale\_y) then divide left and right by scale\_x and divide top and bottom by scale\_y.



### **Gr.touch2 touched, x, y**

The same as gr.touch except that it reports on second simultaneous touch of the screen.

### **Gr.bounded.touch2 touched, left, top, right, bottom**

The same as gr.bounded.touch except that it reports on second simultaneous touch of the screen.

### **OnGRTouch:**

If this label is present in the program, the currently running program will be interrupted when the user touches the screen. Execution will then continue at the statement following this label. One of the above gr.touch commands can be executed.

### **Gr.onGRTouch.resume**

Resumes the execution of the program at the point where the touch interrupt occurred.

## **Text Commands**

### **Gr.text.align type**

Align the text relative to the (x,y) coordinates given in the "gr.text.draw" command.  
type values: 1 = Left, 2 = Center, 3 = Right.

### **Gr.text.size <nexp>**

Specifies the size of the text in pixels

The size corresponds to the height of the character above the "writing line." Some characters go below the writing line, making the total height of a text field about 30% higher.

### **Gr.text.width <nvar>, <sexp>**

Returns the pixel width of <sexp> in <nvar>. The width is determined by the latest gr.text.size parameter.

### **Gr.get.textbounds <sexp>, left, top, right, bottom**

Gets the boundary rectangle of the string expression <sexp>. The origin of the rectangle is assumed to be 0,0. The value returned for "top" will be a negative number. This is because x coordinate of the gr.text.draw command specifies the lowest part of the text.

If this is confusing, try running this example:

```
gr.open 255,255,255,255
gr.color 255,255,0,0,0
gr.text.size 40
gr.text.align 1
s$ = "This is a test"
gr.get.textbounds s$,l,t,r,b
print l,t,r,b
gr.rect x,l+10,t+50,r+10,b+50
gr.text.draw x,10,50,s$
gr.render
pause 5000
```

### **Gr.text.typeface <nexp>**

Set the text typeface and style.

The values for <nexp> are:

- 1 = Default font
- 2 = Monospace font
- 3 = Sans-serif font
- 4 = Serif font

### **Gr.text.bold <lexp>**

Makes the text appear bold if <lexp> is true (<> 0). If the color fill parameter is 0, only the outline of the bold text will be shown. If fill <>0, the text outline will be filled.

### **Gr.text.skew <nexp>**

Skews the text to give an italic effect. Negative values of <nexp> skew the bottom of the text left. This makes the text lean forward. Positive values do the opposite. Traditional italics can be best imitated with <nexp> = -0.25

### **Gr.text.underline <lexp>**

The drawn text will be underlined if <lexp> is true (<> 0).

### **Gr.text.strike <lexp>**

The text will be drawn with a strike-through line if <lexp> is true (<> 0).

### **Gr.text.draw <object\_number\_nvar>, <x\_nexp>, <y\_nexp>, <text\_object\_sexp>**

Creates and inserts a text object (<text\_object\_sexp>) into the Object List. The text object will use the latest color and text preparatory commands. The <object\_number\_nvar> returns the Object List object number for this text. This object will not be visible until the gr.render command is called.

The y value corresponds to the lowest position of any character in the string.

The 'writing line' lies typically 30% of the gr.text.size higher.

The gr.modify parameters for gr.text.draw are "x", "y", and "text". The value for "text" is a string representing the new text.

## **Bitmap Commands**

Android devices limit the amount of memory available to your program. Bitmaps may use large blocks of memory, and so may exceed the application memory limit. If the limit is exceeded, your program will terminate with an error message displayed on the console screen. If you return the Editor, a line will be highlighted near the one that exceeded the memory limit. It may not be exactly the right line.

Bitmaps use four bytes of memory for each pixel. The amount of memory used depends only on the width and height of the bitmap. The bitmap is not compressed. When you load a bitmap from a file, the file is usually in a compressed format, so the bitmap will usually be larger than the file.

When a bitmap is created, it is added to a list of bitmaps. At the same time, a bitmap object is added to the Object List. Your program works with the bitmap through the bitmap object.

### **Gr.bitmap.create <bitmap\_ptr\_nvar>, width, height**

Creates an empty bitmap of the specified width and height. The specified width and height may be greater than the size of the screen, if needed.

Returns a pointer to the created bitmap object for use with the other gr.bitmap commands.

### **Gr.bitmap.load <bitmap\_ptr\_nvar>, File\_name\$**

Creates a bitmap object from the file specified in the File\_name\$ string. Returns a pointer to the created bitmap object for use with the gr.bitmap commands.

Bitmap image files are assumed to be located in the "<pref base drive>/rfo-basic/data/" directory.

Note: You may include path fields in the file name. For example, "../Cougar.jpg" would cause BASIC! to look for Cougar.jpg in the top level directory of the base drive, usually the SD card. "images/Kitty.png" would cause BASIC! to look in the images(d) sub-directory of the "/sdcard/rfo-basic/data/" ("/sdcard/rfo-basic/data/images/Kitty.png").

Note: Bitmaps loaded with this command cannot be changed with the gr.bitmap.drawinto command. To draw into an image loaded from a file, first create an empty bitmap then draw the loaded bitmap into the empty bitmap.

### **Gr.bitmap.size <bitmap\_ptr\_nvar>, width, height**

Return the pixel width and height of the bitmap pointed to by <bitmap\_ptr\_nvar> into the width and height variables.

### **Gr.bitmap.scale <new\_bitmap\_ptr\_nvar>, <bitmap\_ptr\_nvar>, width, height {<smoothing\_lvar>}**

Scales a previously loaded bitmap (<bitmap\_ptr\_nvar>) to the specified width and height and creates a new bitmap <new\_bitmap\_ptr\_nvar>. The old bitmap still exists; it is not deleted.

Negative values for width and height will cause the image to be flipped left to right or upside down.

Neither the width value nor the height value may be zero.

The optional smoothing logical expression (<smoothing\_lvar>) can be used to request that the scaled image not be smoothed. If the expression is zero (false) then the image will not be smoothed. If the optional parameter is not zero (true) or not specified then the image will be smoothed.

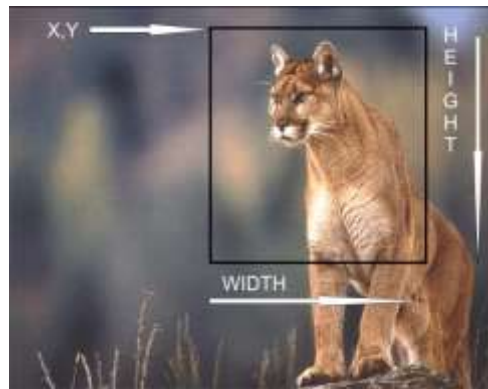
### **Gr.bitmap.delete <bitmap\_ptr\_nvar>**

Deletes a previously loaded or scaled bitmap. The bitmap's memory is returned to the system.

**Gr.bitmap.crop** <new\_bitmap\_object\_nvar>, <source\_bitmap\_object\_nexp>, <x\_nexp>, <y\_nexp>, <width\_nexp>, <height\_nexp>

The previously loaded source bitmap represented by <source\_bitmap\_object\_nexp> will be cropped. The source bitmap is unaffected; a rectangular section is copied into a new, cropped bitmap. A new bitmap object is added to the Object List. A pointer to the new bitmap object is returned in <new\_bitmap\_object\_nvar>.

The <x\_nexp>, <y\_nexp> pair specifies the point within the source bitmap that the crop is to start at. The <width\_nexp>, <height\_nexp> pair defines the size of the rectangular region to crop.



**Gr.bitmap.save** <bitmap\_ptr\_nvar>, <filename\_sexp>{, <quality\_nexp>}

Saves the specified bitmap to a file. The default path is "<pref base drive>/rfo-basic/data/"

The file will be saved as a JPEG file if the filename ends in ".jpg".

The file will be saved as a PNG file if the filename ends in anything else (including ".png").

**Gr.bitmap.draw** <object\_ptr\_nvar>, <bitmap\_ptr\_nvar>, x, y

Creates and inserts a bitmap object into the Object List. The bitmap will be drawn with its upper left corner at the provided (x,y) coordinates. The command returns the Display List object number for this bitmap. This object will not be visible until the gr.render command is called.

The alpha value of the latest gr.color will determine the transparency of the bitmap.

The "gr.modify" parameters for gr.bitmap.draw are "bitmap", "x" and "y".

**Gr.get.bmpixel** <bitmap\_ptr\_nvar>, x, y, alpha, red, green, blue

Returns the color data for the pixel of the specified bitmap at the specified x, y coordinate. The x and y values must not exceed the length or width of the bitmap.

**Gr.bitmap.drawinto.start** <bitmap\_ptr\_nvar>

Puts BASIC! into the draw-into-bitmap mode.

All draw commands issued while in this mode will draw directly into the bitmap. The objects drawn in this mode will not be placed into the display list. The object number returned by the draw commands

while in this mode should be considered invalid and should not be used for any purpose including `gr.modify`.

Note: Bitmaps loaded with the `gr.bitmap.load` command cannot be changed with the `gr.bitmap.drawinto.start` command. To draw into an image loaded from a file, first create an empty bitmap then draw the loaded bitmap into the empty bitmap.

### **Gr.bitmap.drawinto.end**

Ends the draw-into-bitmap mode.

Subsequent draw commands will place the objects into the display list for rendering on the screen. If you wish to display the drawn-into bitmap on the screen, issue a `bitmap.draw` command for that bitmap.

## **Rotate Commands**

### **Gr.rotate.start angle, x, y{<obj\_nvar>}**

Any objects drawn between the `gr.rotate.start` and `gr.rotate.end` will be rotated at the specified angle around the specified (x,y) point. `gr.rotate.start` must be eventually followed by `gr.rotate.end` or you will not get the expected results.

The optional <obj\_nvar> will contain the Object list object number of the object to which `gr.rotate.start` will apply. If you are going to use rotated objects in the array for `gr.NewDI` then you will need to include the `gr.rotate.start` and `gr.rotate.end` objects.

### **Gr.rotate.end {<obj\_nvar>}**

Ends the rotated drawing of objects. Objects created after this command will not be rotated.

The optional <obj\_nvar> will contain the Object list object number of the object to which `gr.rotate.end` will apply. If you are going to use rotated objects in the array for `gr.NewDI` then you will need to include the `gr.rotate.start` object `gr.rotate.start` and `gr.rotate.end` objects.

## **Camera Commands**

There are three ways to use the camera from BASIC!:

- 1) The device's built in Camera User Interface can be used to capture an image. This method provides access to all the image-capture features that you get when you execute the device's Camera application. The difference is the image bitmap is returned to BASIC! for manipulation by BASIC! The `gr.camera.shoot` command implements this mode.
- 2) A picture can be taken automatically when the command is executed. This mode allows for untended, time-sequenced image capture. The command provides for the setting the flash to on, off and auto. The `gr.camera.autoshoot` command implements this mode.

- 3) The third mode is the `gr.camera.manualshoot` command which is much like the `autoshoot` mode. The difference is that a live preview is provided and the image is not captured until the screen is touched.

All pictures are taken at full camera resolution and stored with 100% jpg quality as "`<pref base drive>/rfo-basic/data/image.png`".

All of these commands also return pointers to bitmaps. The bitmaps produced are scaled down by a factor of 4. You may end up generating several other bitmaps from these returned bitmaps. For example, you may need to scale the returned bitmap to get it to fit onto your screen. Any bitmaps that you are not going to draw and render should be deleted using `gr.bitmap.delete` to avoid out-of-memory situations.

The Sample Program, `f33_camera.bas`, demonstrates all the modes of camera operations. It also provides examples of scaling the returned image to fit the screen, writing text on the image and deleting obsolete bitmaps.

The Sample Program, `f34_remote_camera.bas`, demonstrates remote image capture using two different Android devices.

### **Gr.camera.select 1|2**

Selects the Back (1) or Front(2) camera in devices with two cameras. The default camera is the back (opposite the screen) camera.

If only one camera exists, then the default will be that camera. For example, if the device (such as the Nexus 7) only has a Front Camera then it will be the default camera. If the device does not have any installed camera apps, then there will be a run-time error message, "This device does not have a camera." In addition, a run-time error message will be shown if the device does not have the type of camera (front or back) selected.

### **Gr.camera.shoot <bm\_ptr\_nvar>**

The command calls the device's built in camera user interface to take a picture. The image is returned to BASIC! as a bitmap pointed to by the `bm_ptr` numeric variable. If the camera interface does not, for some reason, take a picture, `bm_ptr` will be returned with a zero value.

Many of the device camera interfaces will also store the captured images somewhere else in memory with a date coded filename. These images can be found with the gallery application. BASIC! is not able to prevent these extraneous files from being created.

Note: Some devices like the Nexus 7 do not come with a built in camera interface. If you have installed an aftermarket camera application then it will be called when executing this command. You can take pictures with the Nexus 7 (or similar devices) using the other commands even if you do not have camera application installed. If the device does not have any installed camera apps, then there will be a run-time error message, "This device does not have a camera."

**Gr.camera.autoshoot <bm\_ptr\_nvar>{, <flash\_mode\_nexp> {, focus\_mode\_nexp} }**

An image is captured as soon as the command is executed. No user interaction is required. This command can be used for untended, time-sequence image captures.

The optional flash\_mode numeric expression specifies the flash operation:

<b>0</b>	<b>Auto Flash</b>
<b>1</b>	<b>Flash On</b>
<b>2</b>	<b>Flash Off</b>
<b>3</b>	<b>Torch</b>
<b>4</b>	<b>Red-eye</b>

The default, if no parameter is given, is Auto Flash.

The optional focus\_mode numeric expression specifies the camera focus:

<b>0</b>	<b>Auto Focus</b>
<b>1</b>	<b>Fixed Focus</b>
<b>2</b>	<b>Focus at Infinity</b>
<b>3</b>	<b>Macro Focus (close-up)</b>

The default, if no parameter is given, is Auto Focus.

If you want to specify a focus mode, you must also specify a flash mode.

The command also stores the captured image into the file, "<pref base drive>/rfo-basic/data/image.png".

**Gr.camera.manualShoot <bm\_ptr\_nvar>{, <flash\_mode\_nexp> {, focus\_mode\_nexp} }**

This command is much like gr.camera.autoshoot except that a live preview is shown on the screen. The image will not be captured until the user taps the screen.

## Other Graphics Commands

**Gr.screen.to\_bitmap <bm\_ptr\_nvar>**

The current contents of the screen will be placed into a bitmap. The pointer to the bitmap will be returned in the bm\_ptr variable. (Please note the idiosyncratic underscore in the command.)

**Gr.get.pixel x, y, alpha, red, green, blue**

Returns the color data for the screen pixel at the specified x, y coordinate. The x and y values must not exceed the width and height of the screen and must not be less than zero.

**Gr.save <filename\_sexp> {<quality\_nexp>}**

Saves the current screen to a file. The default path is "<pref base drive>/rfo-basic/data/".

The file will be saved as a JPEG file if the filename ends in ".jpg".

The file will be saved as a PNG file if the filename ends in anything else (including ".png").

The optional `<quality_nexp>` is used to specify the quality of a saved JPEG file. The value may range from 0 (bad) to 100 (very good). The default value is 50. The quality parameter has no effect on PNG files which are always saved at the highest quality level.

Note: The file size of the JPEG file is inversely proportional to the quality. Lower quality values produce smaller files.

### **Gr.get.type <object\_ptr\_nvar>, <type\_svar>**

Get the type of the specified display list object. The type is a string that matches the name of the command that created the object: "point", "circle", "rect", etc.

### **Gr.get.params <object\_ptr\_nvar>, <param\_array\$[]>**

Get the modifiable parameters of the specified display list object. The parameter strings are returned in the `<param_array$[]>` in no particular order.

### **Gr.get.position <object\_ptr\_nvar>, x, y**

Get the current x,y position of the specified display list object. If the object was specified with rectangle parameters (left, top, right, bottom) then left will be returned in x and top will be returned in y.

### **Gr.get.value <object\_ptr\_nvar>, <tag\_sexp>, {<value\_nvar | value\_svar>}**

The value represented by `<tag_sexp>` ("left", "radius", etc) in the specified object will be returned in `<value_nvar>` or `<value_svar>`. Most parameters are numeric. Only the `gr.text.draw` "text" parameter is returned in a string var. The parameters for each object are given with descriptions of the commands in this manual.

### **Gr.modify <object\_ptr\_nvar>, <tag\_sexp>, {<value\_nvar | value\_svar>}**

The value of the parameter named `<tag_sexp>` in the Display List object `<object_ptr_nvar>` will be changed to `<value_nvar>` or `<value_svar>`. With this command, you can change any of the parameters of any object in the Display List. The parameters you can change are given with the descriptions of the commands in this manual. In addition there are two general purpose parameters, "paint" and "alpha" (see below for details).

For example, suppose a bitmap object was created with `"gr.bitmap.draw BM_ptr, galaxy_ptr, 400, 120"`.

Executing `gr.modify BM_ptr, "x", 420` would move the bitmap from `x = 400` to `x = 420`.

Executing `gr.modify BM_ptr, "y", 200` would move the bitmap from `y = 120` to `y = 200`.

Executing `gr.modify BM_ptr, "bitmap", Saturn_ptr` would change the bitmap of an image of a (preloaded) Galaxy to the image of a (preloaded) Saturn.

## **General Purpose Parameters**

When you create a graphical object, all the graphics settings (color, stroke, text settings, and so forth) are captured in a Paint object. You can use the "paint" parameter to replace the Paint object, changing any graphics setting you want to. See the "Gr.paint.get" command description (below) for more details.



Normally, graphics objects get their alpha channel value (transparency) from the latest Gr.color command. You can change the "alpha" parameter to any value from 0 to 255. Setting alpha to 256 tells BASIC! to use the alpha from the latest color value.

For example, you can make an object slowly appear and disappear, just by changing its alpha with gr.modify.

```
Do  
  For a = 1 to 255 step 10  
    gr.modify object,"alpha",a  
    gr.render  
    pause 250  
  next a  
  
  For a = 255 to 1 step -10  
    gr.modify object,"alpha",a  
    gr.render  
    pause 250  
  next a  
until 0
```

The parameters that you supply for a given object are not verified for correctness for the parameter name spelling. The parameter is also not verified for their appropriateness to the specified object. If you are not getting the expected results check the parameter for object appropriateness and spelling. Giving an object an incorrect parameter will not have any effect upon that object.

The results of gr.modify commands will not be observed until a gr.render command is given.

### **Gr.paint.get <object\_ptr\_nvar>**

BASIC! has Paint objects. The gr.paint.get command gets the object pointer (<object\_ptr\_nvar>) of the last created paint object. The last created paint object is the paint object associated with a draw object when a draw command is executed. This object pointer can be used to change the paint object associated with a draw object by means of the gr.modify command. The gr.modify parameter is "paint".

A Paint object includes all paint-related information in addition to the color. This includes font size, style and so forth. Each command that affects the current paint object (gr.color, gr.text.size, etc.) first inherits the current paint and then modifies it to make a new paint object which then becomes the current paint object.

If you want to modify any of the paint characteristics of an object then you will need to create a current paint object with those parameters changed. For example:

```
gr.color 255,0,255,0,0  
gr.text.size 20  
gr.text.align 2  
gr.paint.get the_paint  
gr.modify shot, "paint", the_paint
```

changes the current text size and alignment as well as the color.

### **Gr\_collision ( <object\_1\_nvar>, <object\_2\_nvar>)**

Gr\_collision is a function, not a command. The <object nvar>s are the objects' table numbers that were returned when the objects were created.

If the boundary boxes of the two objects overlap then the function will return true (not zero). If they do not overlap then the function will return false (zero).

Objects that may be tested for collision are: rectangle, bitmap, circle, arc and oval. In the case of a circle, arc and an oval it will be the object's rectangular boundary box that will be used for collision testing, not the actual drawn object.

### **Gr.clip <object\_ptr\_nvar>, <left\_nexp>, <top\_nexp>, <right\_nexp>, <bottom\_nexp>{, <RO\_nexp>}**

Objects that are drawn after this command is issued will be drawn only within the bounds (clipped) of the specified "clip rectangle."

The clip rectangle is specified by the "left, top, right, bottom" numeric expressions.

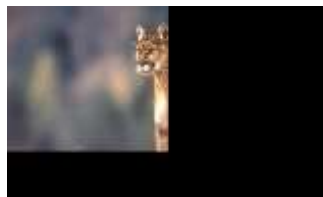
The final, optional, parameter is the Region Operator, <RO\_nexp>. The Region Operator prescribes how this clip will interact with the current clip. The full screen is the current clip before the first clip command is issued. The RO values are:

<b>0</b>	<b>Intersect</b>
<b>1</b>	<b>Difference</b>
<b>2</b>	<b>Replace</b>
<b>3</b>	<b>Reverse Difference</b>
<b>4</b>	<b>Union</b>
<b>5</b>	<b>XOR</b>

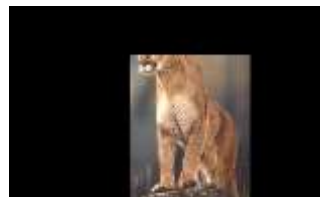
Examples:



**Original**



**Clip 1**

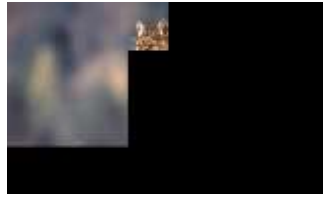


**Clip 2**

**Clip 2 applied to Clip 1 with RO parameter on Clip 2**



**0 = Intersect**



**1 = Difference**



**2 = Replace**



**3 = Reverse Difference**



**4 = Union**



**5 = XOR**

gr.clip is a display list object. It can be modified with gr.modify. The modify parameters are "left" "top" "right" "bottom" "RO".

The gr.show and gr.hide commands can be used with the gr.clip object.

### Gr.NewDL <dl\_array[{<start>,<length>}]>

Gr.NewDL replaces the existing display list with a new display list read from a numeric array (dl\_array[]) or array segment (dl\_array[start,length]) of object numbers. Zero values in the array will be treated as null objects in the display list. Null objects will not be drawn nor will they cause run-time errors.

See the Display List subtopic in this chapter for a complete explanation.

See the Sample Program file, f24\_newdl, for a working example of this command.

### Gr.GetDL <dl\_array[]> {, <keep\_all\_objects\_lexp> }

Writes the current Display List into the numeric dl\_array[] variable. If the Display List is empty, the array will have one entry that does not display anything.

By default, objects hidden with gr.hide are not included in the returned array. To get all objects, including hidden objects, set the optional keep\_all\_objects flag to true (any non-zero value).

## Audio Interface

### Introduction

#### The Audio Interface

BASIC! uses the Android Media Player interface for playing music files. This interface is not the most stable part of Android. It sometimes gets confused about what it is doing. This can lead to random "Forced Close" events. While these events are rare, they do occur.

## Audio File Types

The Music Player is supposed to be able to play WAV, AAC, MP3, WMA, AMR, OGG and MIDI files. I have tried MP3 and WAV files. Your mileage may vary on these other file types.

## Commands

Audio files must be loaded into the Audio File Table (AFT) before they can be played. Each audio file in the AFT has a unique index which is returned by the audio.load command.

### Audio.load <aft\_nvar>, <filename\_sexp>

Loads a music file into the AFT. The AFT index is returned in <aft\_nvar>.

The file must be in the "<pref base drive>/ref-basic/data/" directories or one of its subdirectories.

You can reach outside the "<pref base drive>/ref-basic/data/" by using path fields in the filename. For example, "../Music/Blue Danube Waltz.mp3" would access "<pref base drive>/Music/Blue Danube Waltz.mp3"

### Audio.play <aft\_nexp>

Selects the file from the Audio File Table pointed to by <aft\_nexp> and begins to play it. There must not be an audio file already playing when this command is executed. If there is a file playing, execute audio.stop first.

The music stops playing when the program stops running. To simply start a music file playing and keep it playing, keep the program running. This infinite loop will accomplish that:

```
Audio.load ptr, "my_music.mp3"  
Audio.play ptr  
Do  
  Pause 5000  
Until 0
```

### Audio.stop

Audio.stop terminates the currently-playing music file. The command will be ignored if no file is playing. It is best to precede each audio.play command with an audio.stop command.

### Audio.pause

Pause is like stop except that the next audio.play for this file will resume the play at the point where the play was paused.

### Audio.loop

When the currently playing file reaches the end of file, the file will restart playing from the beginning of the file. There must be a currently playing file when this command is executed.

### Audio.volume <left\_nexp>, <right\_nexp>

Changes the volume of the left and right stereo channels. There must be a currently playing file when this command is executed.

The values should range between 0.0 (lowest) to 1.0 (highest). The human ear perceives the level of sound changes on a logarithmic scale. The ear perceives a 10db change as twice as loud. A 20db change would be four times as loud.

A 1 db change would be about 0.89. One way to implement a volume control would be set up a volume table with 1db level changes. The following code creates a 16 step table.

```
dim volume[16]
x=1
volume [1] = x
for i = 2 to 16
    x = x * 0.89
    volume [i] = x
next i
```

Your code can select volume values from the table for use in the audio.volume command. The loudest volume would be volume[1].

### **Audio.position.current <nvar>**

The current position in milliseconds of the currently playing file will be returned in <nvar>.

### **Audio.position.seek <nexp>**

Moves the playing position of the currently playing file to <nexp> expressed in milliseconds.

### **Audio.length <length\_nvar>, <aft\_nexp>**

Returns the total length of the file in the Audio File Table pointed to by <aft\_nexp>. The length in milliseconds will be returned in <length\_nvar>.

### **Audio.release <aft\_nexp>**

Releases the resources used by the file in the Audio File Table pointed to by <aft\_nexp>. The file must not be currently playing. The specified file will no longer be able to be played.

### **Audio.isdone <lvar>**

If the current playing file is still playing then <lvar> will be set to zero otherwise it will be set to one. This can be used to determine when to start playing the next file in a play list.

```
Audio.play f[x]
Do
    Audio.isdone isdone
    Pause 1000
Until isdone
```

### **Audio.record.start <fn\_svar>**

Start audio recording using the microphone as the audio source. The recording will be saved to the specified file. The file must have the extension .3GP. Recording will continue until the audio.record.stop command is issued.

## Audio.record.stop

Stops the previously started audio recording.

## SoundPool

### Introduction

A SoundPool is a collection of short sound bites that are preloaded and ready for instantaneous play. SoundPool sound bites can be played while other sounds are playing, either while other sound bites are playing or over a currently playing sound file being played by means of Audio.play. In a game, the Audio.play file would be the background music while the SoundPool sound bites would be the game sounds (Bang, Pow, Screech, etc).

A SoundPool is opened using the SoundPool.open command. After the SoundPool is opened, sound bites will be loaded into memory from files using the SoundPool.load command. Loaded sound bites can be played over and over again using the SoundPool.play command.

A playing sound is called a sound stream. Individual sound streams can be paused (SoundPool.pause), individually or as a group, resumed (SoundPool.resume) and stopped (SoundPool.stop). Other stream parameters (priority, volume and rate) can be changed on the fly.

The SoundPool.release command closes the SoundPool. A new SoundPool can then be opened for a different phase of the game. SoundPool.release is automatically called when the program run is terminated.

### Commands

#### Soundpool.open <MaxStreams\_nexp>

The MaxStreams expression specifies the number of Soundpool streams that can be played at once. If the number of streams to be played exceeds this value, the lowest priority streams will be terminated.

Note: A stream playing via audio.play is not counted as a Soundpool stream.

#### Soundpool.load <soundID\_nvar>, <file\_path\_sexp>

The file specified in <file\_path\_sexp> is loaded. Its sound ID is returned in <soundID\_nvar>. The sound ID is used to play the sound and also to unload the sound. The sound ID will be returned as zero if the file was not loaded for some reason.

The default file path is "sdcard/rfo-basic/data/"

Note: It can take a few hundred milliseconds for the sound to be loaded. Insert a "Pause 500" statement after the load if you want to play the sound immediately following the load command.

#### Soundpool.unload <soundID\_nexp>

The specified loaded sound is unloaded.

**Soundpool.play <streamID\_nvar>, <soundID\_nexp>, <rightVolume\_nexp>, <leftVolume\_nexp>, <priority\_nexp>, <loop\_nexp>, <rate\_nexp>**

Starts the specified sound ID playing.

The stream ID is returned in <streamID\_nvar>. If the stream was not started, the value returned will be zero. The stream ID is used to pause, resume and stop the stream. It is also used in the stream modification commands (Soundpool.setrate, Soundpool.setvolume, Soundpool.setpriority and Soundpool.setloop).

The left and right volume values must be in the range of 0 to 0.99 with zero being silent.

The priority is a positive value or zero. The lowest priority is zero.

The loop value of -1 will loop the playing stream forever. Values other than -1 specify the number of times the stream will be replayed. A value of 1 will play the stream twice.

The rate value changes the playback rate of the playing stream. The normal rate is 1. The minimum rate (slow) is 0.5. The maximum rate (fast) is 1.85.

**Soundpool.setvolume <streamID\_nexp>, <leftVolume\_nexp>, <rightVolume\_nexp>**

Changes the volume of a playing stream.

The left and right volume values must be in the range of 0 to 0.99 with zero being silent.

**Soundpool.setrate <streamID\_nexp>, <rate\_nexp>**

Changes the playback rate of the playing stream.

The normal rate is 1. The minimum rate (slow) is 0.5. The maximum rate (fast) is 1.85.

**Soundpool.setpriority <streamID\_nexp>, <priority\_nexp>**

Changes the priority of a playing stream.

The lowest priority is zero.

**Soundpool.pause <streamID\_nexp>**

Pauses the playing of the specified stream. If the stream ID is zero, all streams will be paused.

**Soundpool.resume <streamID\_nexp>**

Resumes the playing of the specified stream. If the stream ID is zero, all streams will be resumed.

**Soundpool.stop <streamID\_nexp>**

Stops the playing of the specified stream.

**Soundpool.release**

Closes the SoundPool and releases all resources. Soundpool.open can be called to open a new SoundPool.

## GPS

These commands provide access to the raw location data provided by an Android device's GPS hardware.

Before attempting to use these commands, make sure that you have GPS turned on in the Android Settings Application.

The Sample Program file, f15\_gps.bas is a running example of the use of the GPS commands.

## Commands

### Gps.open

Turns on the GPS hardware and starts it reporting location information. This command must be issued before using any of the other GPS commands.

### Gps.close

Turns off the GPS hardware and stops the location reports. GPS is automatically closed when you stop your BASIC! program. GPS is not turned off if you tap the HOME key while your GPS program is running.

### Gps.provider <svar>

Returns the name of the GPS provider in <svar>.

### Gps.accuracy <nvar>

Returns the accuracy level in <nvar>. This is an estimate of the uncertainty in the reported location, measured in meters.

### Gps.latitude <nvar>

Returns the latitude in decimal degrees in <nvar>.

### Gps.longitude <nvar>

Returns the longitude in decimal degrees in <nvar>.

### Gps.altitude <nvar>

Returns the altitude in meters in <nvar>.

### Gps.bearing <nvar>

Returns the bearing in degrees in <nvar>.

### Gps.speed <nvar>

Returns the speed in meters per second in <nvar>.

### Gps.time <nvar>

Returns the returns the UTC time in milliseconds since January 1, 1970.



# Sensors

## Introduction

Android devices can have several types of Sensors. Currently, Android's pre-defined Sensors are:

Name of Sensor	Type	Notes
Accelerometer	1	As of API 3 (Cupcake)
Magnetic Field	2	As of API 3
Orientation	3	As of API 3, deprecated API 8
Gyroscope	4	As of API 3
Light	5	As of API 3
Pressure	6	As of API 3
Temperature	7	As of API 3, deprecated API 14
Proximity	8	As of API 3
Gravity	9	As of API 9 (Gingerbread)
Linear Acceleration	10	As of API 9
Rotation Vector	11	As of API 9
Relative Humidity	12	As of API 14 (Ice Cream Sandwich)
Ambient Temperature	13	As of API 14
Uncalibrated Magnetic Field	14	As of API 18 (Jellybean MR2)
Game Rotation Vector	15	As of API 18
Uncalibrated Gyroscope	16	As of API 18
Significant Motion	17	As of API 18

Some details about (most) of these sensors can be found at [Android's Sensor Event](http://developer.android.com/reference/android/hardware/SensorEvent.html) (<http://developer.android.com/reference/android/hardware/SensorEvent.html>) web page.

Not all Android devices have all of these Sensors. Some Android devices may have none of these sensors. The BASIC! command, `sensors.list`, can be used to provide an inventory of the sensors available on a particular device.

Some newer devices may have sensors that are not currently supported by BASIC! Those sensors will be reported as "Unknown, Type = NN" where NN is the sensor type number.

## Sensor Commands

### `Sensors.list <sensor_array$[]>`

This command provides a list of the sensors available on a particular Android device. The `<sensor_array$[]>` parameter must be an un-dimensioned array. Information about the available sensors will be returned in this array. The elements will contain the names and types of the available sensors. For example, "Gyroscope, Type = 4". The following program snip can be used to list the elements of `sensorarray$[]`.

```
sensors.list sensorarray$[]  
array.length size, sensorarray$[]
```

```

for index = 1 to size
  print sensorarray$[ index ]
next index
end

```

### **Sensors.open <type\_nexp>{:<delay\_nexp>}{, <type\_nexp>{:<delay\_nexp>}, ...}**

Opens a list of sensors for reading. The parameter list is the type numbers of the sensors to be opened, followed optionally by a number (0, 1, 2, and 3) that specifies the delay in activating the sensor. 3 is the default (slowest). The delay option is a feature almost nobody should use. The default setting is good for almost everything. The faster settings will burn battery. So unless you know that you really need it, you don't want to use it.

For example, "sensors.open 1, 3", would open the Acceleration and Orientation sensors. This command must be executed before issuing any sensors.read commands. You should only open the sensors that you actually want to read. Each sensor opened drains the battery and increases the background CPU usage.

### **Sensors.read sensor\_type\_nexp, p1\_nvar, p2\_nvar, p3\_nvar**

This command returns that latest values from the sensors specified by the "sensor\_type" parameters. The values are returned are placed into the p1, p2 and p3 parameters. The meaning of these parameters depends upon the sensor being read. Not all sensors return all three parameter values. In those cases, the unused parameter values will be set to zero. See [Android's Sensor Event](#) web page for the meaning of these parameters.

### **Sensors.close**

Closes the previously opened sensors. The sensors' hardware will be turned off preventing battery drain. Sensors are automatically closed when the program run is stopped via the BACK key or Menu->Stop.

## **System**

These commands provide for the execution of System commands on non-rooted devices.

### **Commands**

#### **System.open**

Opens a shell to execute system commands. The working directory is set to "**rfo-basic**". If the working directory does not exist, it is created. If you open a command shell with either Su.open or System.open, you can't open another one of either type without first closing the open one.

#### **System.write <sexp>**

Executes a System command.

#### **System.read.ready <nvar>**

Tests for responses from a System.write command. If the result is non-zero, then response lines are available.

Not all System commands return a response. If there is no response returned after a few seconds then it should be assumed that there will be no response.

### **System.read.line <svar>**

Places the next available response line into the string variable.

### **System.close**

Exits the System Shell mode.

## **Superuser**

These commands provide for the execution of Superuser commands on rooted devices. See the Sample Program, f36\_superuser.bas, for an example using these commands.

### **Commands**

#### **Su.open**

Requests Superuser permission. If granted, opens a shell to execute system commands. The working directory is set to /. If you open a command shell with either Su.open or System.open, you can't open another one of either type without first closing the open one.

#### **Su.write <sexp>**

Executes a Superuser command.

#### **Su.read.ready <nvar>**

Tests for responses from a Su.write command. If the result is non-zero, then response lines are available.

Not all Superuser commands return a response. If there is no response returned after a few seconds then it should be assumed that there will be no response.

#### **Su.read.line <svar>**

Places the next available response line into the string variable.

#### **Su.close**

Exits the Superuser mode.

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## Appendix B – Sample Programs

The programs are loaded into "<pref base drive>/rfo-basic/source/Sample\_Programs" when a new release of BASIC! is installed. You can access them by selecting Menu->Load. Tap the "Sample\_Programs" lines. The sample programs will be listed and can be loaded.

If you load and save one of these programs, the program will be saved in "<pref base drive>/rfo-basic/source/" not in "<pref base drive>/rfo-basic/source/Sample\_Programs"

You can force BASIC! to re-load these programs by:

- Use BASIC! Delete Menu Command, navigate to "sdcard/rfo-basic/source/Sample\_Programs/"
- Delete the "f01\_vxx.xx\_read\_me file"
- Exit BASIC! using Menu->More->
- Re-enter BASIC!

## Appendix C – Launcher Shortcut Tutorial

### Introduction

This tutorial will "compile" a BASIC! program and create an "application" that resides on your Android device home page. This "application" will have its own Icon and Name. The official Android name for this type of "application" is "Shortcut." The BASIC! application must be installed for this to work.

There is also an option to actually build a standalone application .apk file that does not require the BASIC! application to be installed. The process is more difficult but it will result in an application that can be offered on the Google Play Store. See Appendix D.

### How to Make a Shortcut Application (older versions of Android—prior to Android 4.0)

1. Start BASIC!
2. Tap Menu->More->Exit to Exit BASIC!
3. Do a long press on the HOME screen.
4. You should see something like the following:

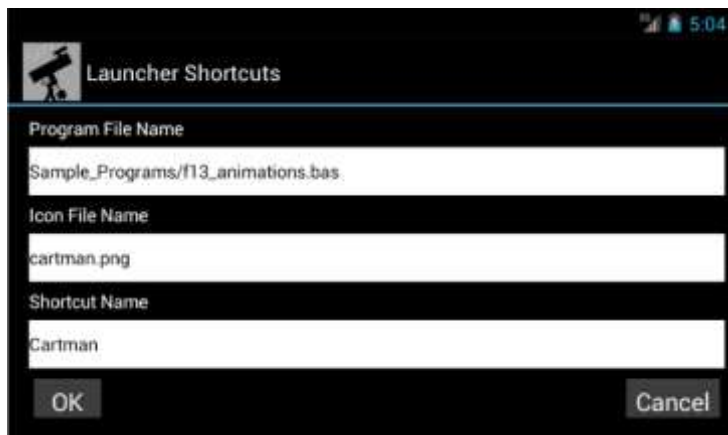


5. Tap Shortcuts.
6. Scroll down the Select Shortcut page until you see the BASIC! icon with the Launcher Shortcuts Label.



7. Tap the BASIC! Icon.

8. This screen will appear:



9. Fill out the Form exactly as shown.

- The Program File Name is Sample\_Programs/f13\_animations.bas
- The Icon File Name is cartman.png
- The Shortcut Name is Cartman

10. Tap OK.



11. You should see something like this on your HOME screen:

12. Tap the Cartman Shortcut.

13. BASIC! will start and run the Cartman Jumping Demo.

## How to Make a Shortcut Application (newer versions of Android—Android 4.0 and later)

1. Select the Apps Page.

2. At the top of the screen, tap Widgets.



3. Scroll horizontally until you see the BASIC! icon that says Launcher Shortcuts.
4. Touch and hold that entry. It will be moved to the Home page.
5. Continue with step 8, above.

## What you need to know

- The icon image file must be located in the "<pref base drive>/rfo-basic/data/" directory.
- The program that you are going to run must be in the "source" directory or one of its sub directories. In this example, the file was located in the Sample\_Programs(d) sub-directory of the "source(d)" directory.
- The icon should be a .png file. A Google search for "icon" will reveal thousands for free icons. Just copy your icon into "rfo-basic/data" on the SD card.
- Be very careful to correctly spell the names of the program and icon files. BASIC! does not check to see if these files actually exist during the "compile" process. If you enter the name of an icon file that does not exist, your shortcut will have the generic Android icon. If the file name you specified does not exist, when you tap the Shortcut you will see an error message in the form of program file in the Editor.
- The Shortcut name should be nine (9) characters or less. Android will not show more than nine characters.
- You can create as many shortcuts as you home screen(s) can handle.
- Tapping "Cancel" in the Launcher Shortcuts dialog will simply cancel the operation and return to the home screen.
- If you plan to use a BASIC! Launcher Shortcut, you should always exit BASIC! using Menu->More->Exit. If a Launched program is running, tapping BACK once or twice will exit BASIC back to the Home Screen.

## Appendix D – Building a Standalone Application

Note: A BASIC! user, Nicolas Mougin, has created a suite of automated tools for generating standalone applications. These tools can be downloaded from his website:

<http://mougin.free.fr/rfo-basic/>

Using Mr. Mougin's tools, you avoid having to do all of the following.

If you have any questions or problems with this tool you can contact Mr. Mougin and other users of the tool at the BASIC! forum in this thread:

<http://rfobasic.freeforums.org/rfo-basic-app-builder-f20.html>

### Introduction

This document will demonstrate how to create a standalone application from a BASIC! program. The resulting application does not need to have BASIC! installed to run. It will have its own application name and application icon. It may be distributed in the Google Play Store or elsewhere. The process involves setting up the Android development environment and making some simple, directed changes to the BASIC! Java source code. Since Google changes the Development Environment every so often, this procedure does not necessarily reflect the latest version of the ADT.

### License Information

BASIC! is distributed under the terms of the [GNU GENERAL PUBLIC LICENSE](#). The license requires that the source code for "derivative works" be made available to anyone who asks. The author of BASIC! interprets this to mean that the license applies only to derivatives of the BASIC! *source interpreter code*. It does not apply to source code for BASIC! applications, i.e., code that you have written using the BASIC! language.

### Before You Start

Run the sample program, **source/my\_program.bas**.

We are going to turn this program into a practice APK.

### Setting Up the Development Environment

1. Download and install the latest version of the Java Development Kit (JDK). Find this by Googling "java jdk download" and going to the listed oracle.com download site. Do not download from any other site. Note: The JDK download includes the Java Run Time Environment (JRE) which is also needed.
2. Visit Android's "Get the Android SDK" page at <http://developer.android.com/sdk/index.html>. From there you can download the Android Developer Tools (ADT) Bundle. The ADT Bundle includes both the developer tools and the Eclipse Integrated Development Environment (IDE).

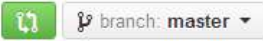
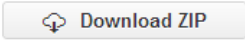
If you do not already have Eclipse installed, we recommend that you download and install the ADT Bundle. If you already have Eclipse installed, or if you use a different IDE, you can download just the SDK Tools instead. The web page has links for both types of download, for Windows, Mac OS X, and Linux, with 32- and 64-bit versions. Choose the link that matches your development computer.

3. The "Get the Android SDK" page has a side bar with links to installation instructions. Choose "Setting Up the ADT Bundle" or "Setting Up an Existing IDE", depending on what you downloaded, and follow the instructions there.

Eclipse changes periodically, and the ADT changes frequently. The instructions below have been changed over time for different versions, most recently for Eclipse 4.2 (Juno) and ADT 22.2, and you may find differences in the version you have installed. Please visit the BASIC! users' forum at <http://rfobasic.freeforums.org> to report any problems you find.

4. BASIC! supports most versions of Android, which can lead to spurious build errors. You may need to change API level checking from Error to Warning:
  - a. Select **Window->Preferences->Android->Lint Error Checking**
  - b. Find **NewApi** and click on it.
  - c. In the dropdown list, change the Severity from Error to Warning.
  - d. Click **Apply**

## Download the BASIC! Source Code from the GitHub Repository

1. Go to: <https://github.com/RFO-BASIC/Basic>.
2. Find the branch/tag selection button:  Click the button and the "Tags" tab to select the tagged release version you want. If you do not select a tag, you will get the source for the latest development build. The latest development source is not guaranteed to be stable.
3. Click the "Download ZIP" button:  found on the right side of the page. The name of the downloaded ZIP file depends on which tag you selected in the previous step.
4. Put the unzipped source files into a folder. For this exercise, name the folder "Cats". You should use a different folder for each new APK that you create.

– OR –

## Download the BASIC! Source Code from the Legacy Archive

1. Go to: <http://laughton.com/basic/versions/index.html> and select the version number you want. For versions later than v01.77, you must download the source from GitHub.
2. Look for the section heading, "**Download BASIC! Source Code.**" Click on the "**here**" to download "Basic.zip".
3. Older versions of this file contain only the BASIC! source code. More recent versions also contain a copy of the Android-loadable Basic.apk file and a copy of this manual.

- Put the unzipped source files into a folder. For this exercise, name the folder "Cats". You should use a different folder for each new APK that you create.

Note: In the remainder of this tutorial, we assume our application is about cats, thus we are using the name "Cats". For your own APK, you should choose a name that matches your application.

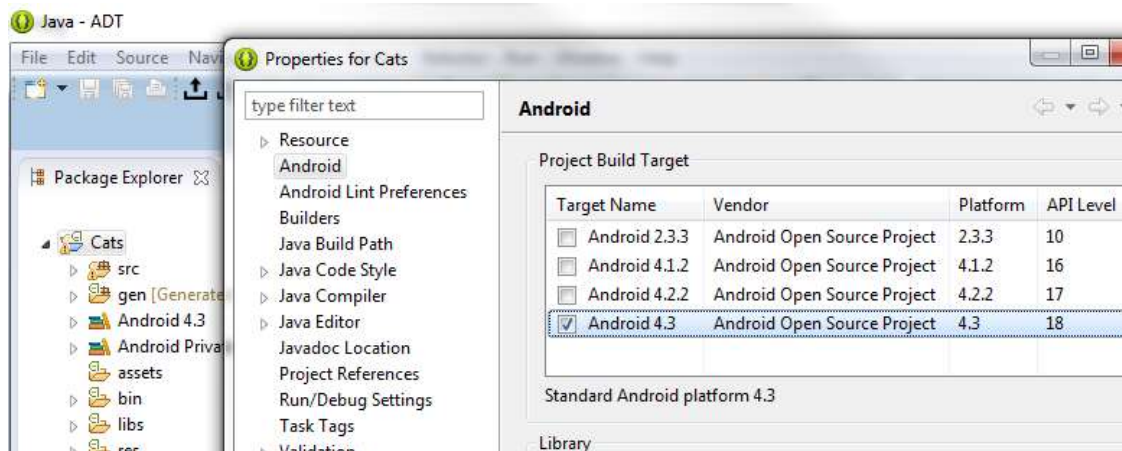
## Create a New Project in Eclipse

Note: to simplify later steps, turn off the automatic build feature of Eclipse before creating the new project:

- On the menu, click **Project**.
- Uncheck **Build Automatically**.

Now you can create the project.

- Select: **File -> New -> Project...->Android->Android Project from Existing Code**.
- In the **Import Projects** dialog box, browse to the folder where you put the BASIC! source files.
- Under **Projects to Import**, click the project you are importing. Make sure it is checked.
- Under **New Project Name**, change the project name from "Basic" to "Cats". Click **Finish**.
- In the **Package Explorer** window on the left, right-click on **Cats** and select **Properties** (near the bottom of the list).
- In the Properties dialog box, select **Android**:



- Check the highest level of the Android OS available in this list. Do this without regard to the level of OS in your device(s). (Note for KitKat users: BASIC! is currently compiled with API 18. The build works with higher levels, but you may choose to limit the OS level to 4.3, API 18.)
- Click **Apply** then **OK**.

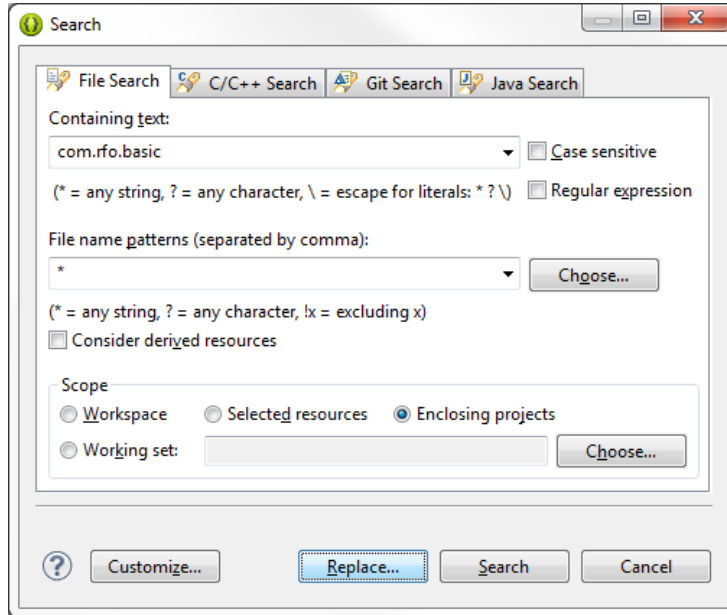
The Basic source is now ready for making an APK.

## Rename the Package

The package name is what makes your application different from every other application that runs on Android devices. No matter what you name your application, it is the package name that Android uses to identify your particular application.

First, use the search-and-replace dialog to update references to the package name.

1. From the Menu Bar, select: **Search->File**.
2. Fill in the dialog like this:

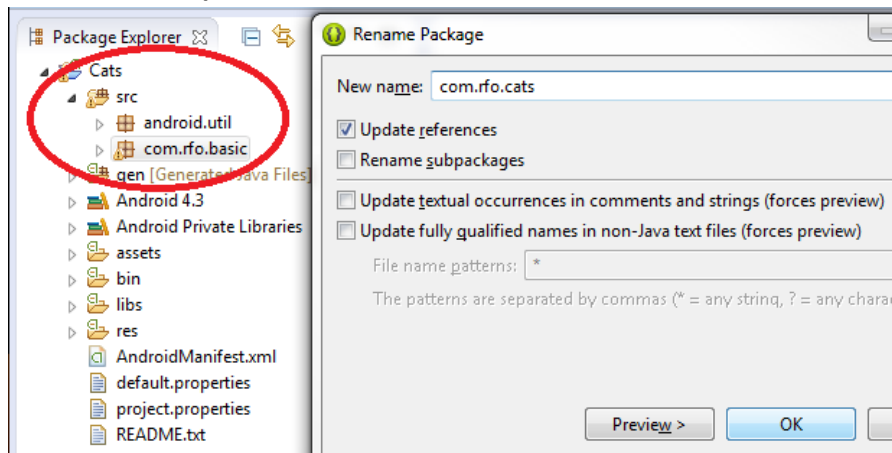


3. Click **Replace**. The Replace Text Matches Dialog Box opens.
4. Enter "com.rfo.cats" in the **With:** field, and click **OK**.

Next, tell Eclipse about the package change.

5. In the **Package Explorer**, click and open the **Cats -> src** hierarchy as shown below.
6. Select the **com.rfo.basic** package.
7. From the Menu Bar, select **File->Rename** to open the **Rename Package** dialog.
8. In the **New name:** field, enter "com.rfo.cats".

9. Make sure the **Update references** box is checked and click **OK**.



Your project is ready to build. Restore the automatic build feature of Eclipse:

10. Click **Project->Build Automatically**. Make sure the checkmark appears.

The project should build without errors.

At this point the package has been successfully renamed. Next we will create a practice APK that you then use to make your own APK.

## Modifications to setup.xml

You can customize your apk with settings in the resource file **setup.xml**. Some changes are required for any apk.

In the **Package Explorer**, expand **Cats/res/values** and then double-click **setup.xml**. The file opens in the window on the right. There are tabs at the bottom of the window that let you change how the file is displayed. If the **Resources** tab is selected, you see a special Eclipse Resource Editor. This editor does not know how to modify all of the properties in this file. Click on the **setup.xml** tab to display the actual XML text, as shown in the image below. In this view, you can also see the comments describing the values you can change for your application.

Be sure you change only values, not names. Names are shown as blue text in quotes. Values are shown as black text with no quotation marks. If you change a name, Java can not find the item to get its value.

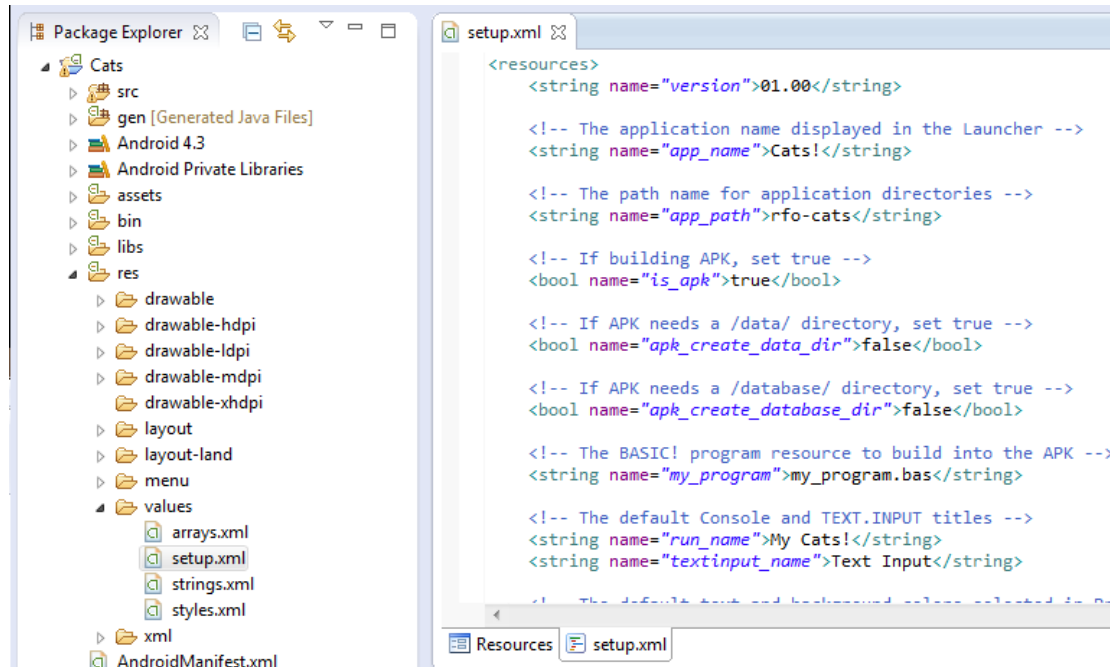
Change the value of "**app\_name**" from **BASIC!** to **Cats!**. This is the name of the application as it will appear on your Android device.

Change the value of "**app\_path**" to **rfo-cats**. This will be the directory on the SD card where your files are stored, if you choose to have a directory for files for your application. Make this change even if you do not choose to create directories for your application. It has implications in other parts of the code.

Change the value of "**is\_apk**" to **true**.

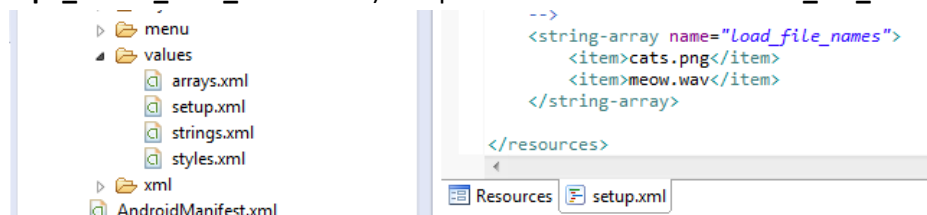
The items **"apk\_create\_data\_dir"** and **"apk\_create\_database\_dir"** are flags that control whether directories are created under **"app\_path"** for your application's files. Since this practice application does not need any directories, change the values of both to **false**.

The item **"load\_file\_names"** is a list of files that you want loaded to the SD card. This practice application uses the sound clip **meow.wav**. Running under standard BASIC!, the program would use the file **rfo-basic/data/meow.wav**. As a standalone application, it can use a file image built into APK. Since the practice application is not using a real file, you can leave the **"load\_file\_names"** list empty.



Save the changes to setup.xml.

Note: If you do want to load files to the SD card, you must allow the creation of the data directory (set **"apk\_create\_data\_dir"** to **true**) and put the file names in the **"load\_file\_names"** list like this:



The files will be loaded from the assets folder. This will be explained in the next section.

At this point, you have modified the source files of the BASIC! interpreter so it can be packaged into a standalone application. You can build and run it, if you like, but it will display a blank Console. That's result you get when you build BASIC! into an application but you don't give it a program to run.

## Advanced Customization with setup.xml

The **setup.xml** file allows more customization than the minimum required for **Cats**.

The `VERSION$()` function gets its value from the item named **"version"**. If your application uses `VERSION$()`, this is where you set the value you want it to return.

The item **"my\_program"** is the name of the BASIC! program you want your application to run. This will be explained in the next section.

The item **"run\_name"** is the default title of the Console. Your program can set the Console title, but you may want to change the default title here. Similarly, **"select\_name"** and **"textinput\_name"** set the names of the screens for the **Select**, **Text.Input**, and **TGet** commands.

If your app uses Console output, you can set the text colors here. The mapping of **"color1"**, **"color2"**, and **"color3"** to text foreground, background, and underline depend on your **Screen Colors** setting under **Preferences**.

As mentioned earlier, the **"load\_file\_names"** is a list of files that you want loaded to the SD card. Any files listed here will be copied from the **assets** directory to the SD card the first time your app runs. This may be the internal Android file system or a file system mounted on an external SD card. After that, your app will access the files from the SD card file system, not from **assets**. Any changes your program makes to these files will be available the next time the app runs.

Several items in **setup.xml** control the splash screen and file-load progress indicator. If you don't change anything, your **Cats** app will display the default BASIC! splash screen briefly. You may not see it because the apk does not load any files.

You can turn off the splash screen by setting **"splash\_display"** to **false**.

The splash screen image is the resource file **res/drawable/splash.png**. To customize the splash screen, replace this file in your project with an image of your own. Your image file must be named **splash.jpg**.

If you do not use a splash screen, you may remove this file from your project to make your apk a little smaller. Do not remove the file **res/drawable/blank.jpg**.

You can also customize the file-load progress indicator. Progress is shown in a pop-up over the splash screen. The title comes from the string **"loading\_msg"**. Each increment of progress is a copy of the string **"progress\_marker "**. The default string is a single period (.).

You can turn off the progress indicator by making the **"loading\_msg"** an empty string.

## Files and Resources

Standard BASIC! loads its sample programs and the data files they need from the **assets** folder of the Eclipse project. Android treats the **assets** folder like a file system. At startup, BASIC! simply copies the entire **assets/rfo-basic** folder to the SD card.

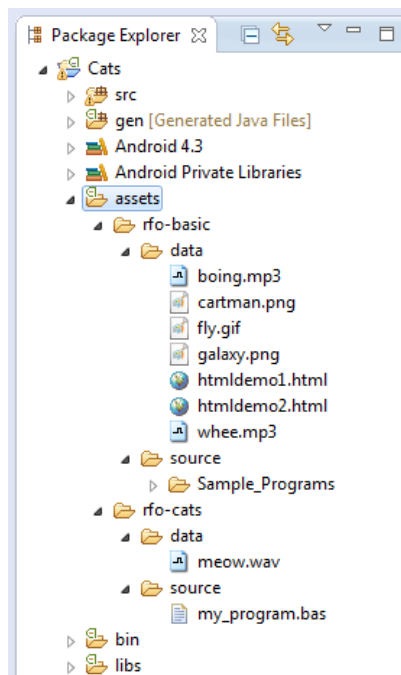


Your application uses the **assets** folder, too.

1. In the **Package Explorer**, expand **Cats/assets/rfo-basic** and its **data** and **source** folders.
2. Right-click **assets** and select **New -> Folder**.
3. In the **Folder name:** field, enter "rfo-cats/data".
4. Click **Finish**.
5. In the same way, create "rfo-cats/source".
6. Drag **assets/rfo-basic/data/meow.wav** to **assets/rfo-cats/data/**.
7. Drag **assets/rfo-basic/source/my\_program.bas** to **assets/rfo-cats/source/**.

Note: the top folder in **assets** must exactly match what you put in the "**app\_path**" item in **res/values/setup.xml**. For this practice program, it is **rfo-cats**.

If you expand your new folders, your **Package Explorer** should look like this:



Your APK does not need anything in **assets/rfo-basic**. Delete the entire folder:

8. In the **Package Explorer**, right-click **Cats/assets/rfo-basic** and select **Delete**.
9. In the confirmation window that appears, click **OK**.
10. You are done making changes! It wouldn't hurt to do a **Project->Clean** here.

## Testing the APK

We are now ready to test this practice APK.

The first thing you will do is to create a Keystore. The Keystore is used to sign your application. Google Play requires this signing. Android devices will not install unsigned APKs. You will use this one Keystore for all your APKs. Preserve and protect it. You will not be able to update your APK without it.

For more information about the Keystore and signing, see:

<http://developer.android.com/tools/publishing/app-signing.html>

1. In the **Package Explorer**, right-click **Cats**.
2. Select: **Android Tools -> Export Signed Application Package**
3. In the **Project Checks** dialog box click **Next**.
4. Select **Create New Keystore**.
  - a. Provide a name and location for the Keystore.
  - b. Provide a password and confirm it.
  - c. Click **Next**.
5. Fill out the **Key Creation** dialog.
  - a. Pick any name for an Alias.
  - b. Enter 25 for Validity (Years)
  - c. Click next.
6. In the **Destination and Key/Certificate Checks** dialog,
  - a. Browse to the folder where you want to put the APK.
  - b. Name the APK "Cats.apk"
  - c. Click next.
7. Now, install and run Cats.apk

The APK will have the BASIC! icon. The name below the icon on your device will be "Cats!". Double click the icon to run your application.

If you have reached this point successfully then you are ready to customize the APK for your application.

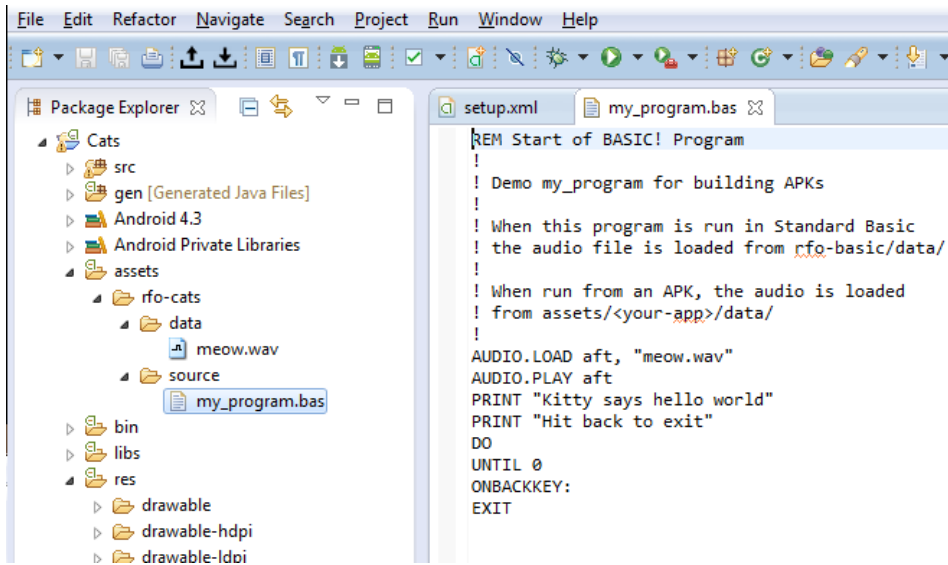
Start over with a new copy of Basic.zip but use names and information particular to your application and then continue below.

## Installing a BASIC! Program into the Application

You must build your BASIC! program into your application by putting it into the **assets** folder, just as you saw in the practice program. One very simple way is to copy your text into **assets/<your-app>/my\_program.bas**. **<your-app>** is the path you named in the **setup.xml** item "app\_path".

1. In the Eclipse **Package Explorer**, expand the **assets** folder.
2. Double-click **assets/<your-app>/source/my\_program.bas**.

3. The file will open in the edit window to the right:



Now you can edit the file directly in Eclipse. If you prefer, you can open your program outside of Eclipse, copy its contents to the clipboard, and paste it into the Eclipse editor. When you are finished, select **File->Save** from the menu bar, or just close the file by clicking the X on the file tab and **Yes** in the **Save Resource** dialog box.

For more complex projects, here is another way to do it.

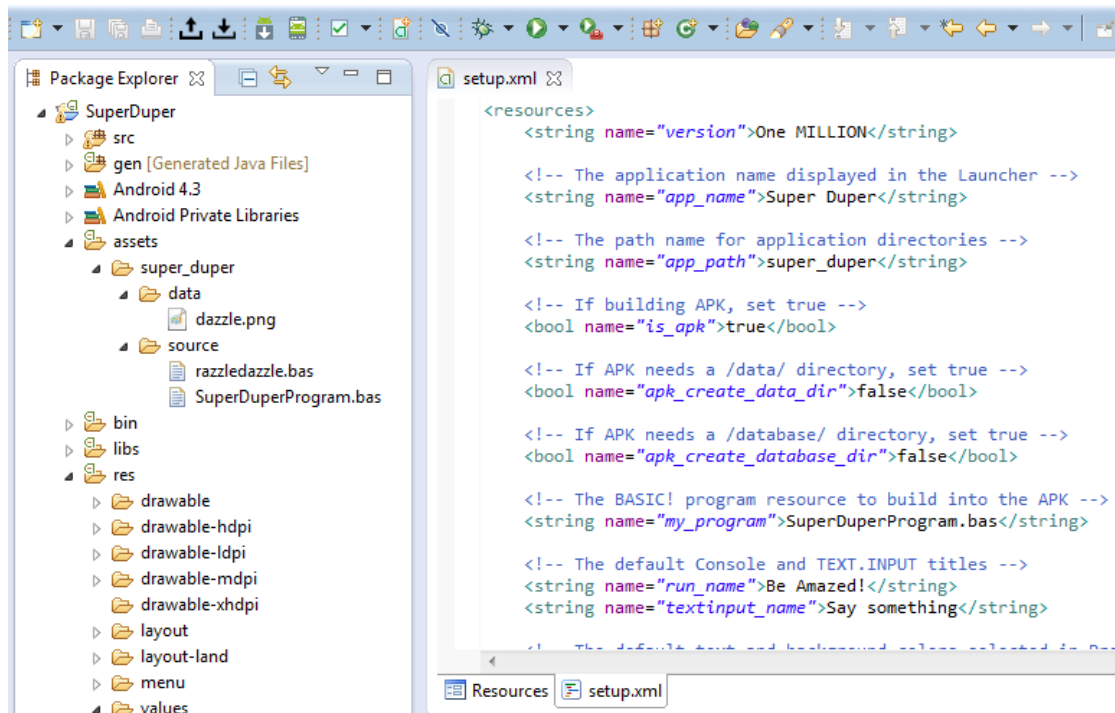
1. In the Eclipse **Package Explorer**, expand your program's **assets** folder.
2. If you have a **my\_program.bas** in your **assets** folder, delete it.
3. In a file browser, browse to the file containing your program.
4. Drag your program from your file browser to your **assets/<your-app>/source** folder in Eclipse.
5. If your program uses **INCLUDE** files, drag them to the **source** folder, too.

With either method, you now have a program to run. If your program uses graphics, audio files, or other resources, you must put them in your Android **assets** folder, too.

If your program uses data files, drag them to your **assets/<your-app>/data** folder.

If your program uses data base files with the ".db" extension, create a new folder for them called **assets/<your-app>/databases** and drag your file into the new folder.

The result might look something like this:

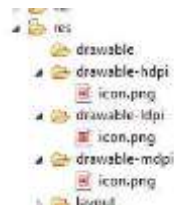


Notice that the top folder in **assets** matches the "**app\_path**" value, and there is a program in its **source** folder named the same as the "**my\_program**" value.

## Application Icons

Android specifies that Application icons must be provided in specific sizes: low dpi (36x36 pixels), medium dpi (48x48 pixels), high dpi (72x72), x-high dpi (96x96), and so on. The icons must be .png files. There are tens of thousands of free icons available on the web. Most image editing programs can be used to re-sample the icons to the proper sizes and to save them as .png files. If you are not going to put your application on the Google Play Store then you do not really need to worry about getting this exactly right.

To get your icon into your application, in res, open drawable-ldpi, drawable-mdpi, drawable-hdpi.



For each of the icon sizes:

1. Outside of Eclipse, copy the icon file
2. In Eclipse, right click on the appropriate **drawable-** for the copied icon's size
3. Select **Paste**

4. Right click on the icon.png file and delete it
5. Select the newly pasted icon and rename it to "icon.png" by selecting **File -> Rename**.

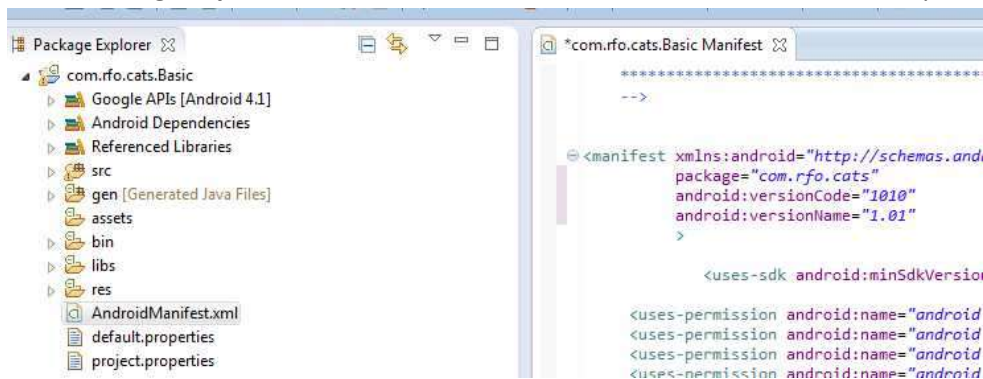
Yes, it is tedious work.

## Modifications to the AndroidManifest.xml File

The **AndroidManifest.xml** file defines many aspects of how your application is built, and how it is presented to the Android system. For example, when you changed the package name, Eclipse wrote the change into the Android manifest.

You can build and run your application with no further changes to AndroidManifest.xml. However, the manifest carries information that your application may not need. You should customize it to suit your application.

In the **Package Explorer**, find the **AndroidManifest.xml** file. Double-click to open it:



Eclipse has special editors to display different views of the Manifest. If you don't see the actual XML text as shown here, click on the rightmost tab at the bottom of the window, labeled **AndroidManifest.xml**.

## Setting the Version Number and Version Name

If you are going to put the application on the Google Play Store, you will need to change the version number and name for each new release.

Make the appropriate changes to the **android:versionCode** and **android:versionName** items of the **<manifest>** tag at the top of **AndroidManifest.xml**.

If you want to use the BASIC! **VERSION\$()** function to have your program read your version number, you will also have to change the version number in **res->values->strings**.

## Permissions

BASIC! uses many features about which the APK user is warned and must approve. Your particular APK may not need all or any of these permissions. The permission notifications are contained in the **<uses-permission>** tags of the **AndroidManifest.xml**. They look like this:

```
<uses-permission android:name=" android.permission. ... " />
```

Look them over. If you feel that your APK does not need them then delete or comment them out.

Please do keep the vibrate permission. If you do not have this permission, your APK may crash when it exits. This is what that permission looks like:

```
<uses-permission android:name="android.permission.VIBRATE" />
```

If your application uses the SD card, do not comment out:

```
<uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE" />
```

Be sure to test your APK after changing permissions.

## Disable the Shortcut Launcher

Each Activity screen that BASIC! can present to a user is declared in an **<activity>** tag in the **AndroidManifest.xml** file. Your application may not use every Activity BASIC! offers. You may remove the unused **<activity>** tags if you wish, but they don't hurt anything if you leave them in.

However, the **<activity>** tags also tell the Android system what events should start your application. You probably do not want your application to respond to these two events:

- 1) A user can launch BASIC! by tapping a file with a ".bas" extension
- 2) A user can use the Shortcut Launcher to create a shortcut for a BASIC! program

You remove these by deleting their tags from the Manifest:

- 1) Find the **<activity>** tag that contains **android:name="Basic"**.
  - a) In it, find the **<intent-filter>** tag that contains **<data android:pathPattern=".\*\\.bas" />**.
  - b) Remove all of the **<intent-filter>** tag, from **<intent-filter>** to **</intent-filter>**.

Do **not** remove the **<activity>** tag.



- 2) There are two shortcut tags:

- Find and remove the **<activity>** tag that contains **android:name="LauncherShortcuts"**.
- Find and remove the **<activity-alias>** tag that contains **android:name="CreateShortcuts"**.



## Launch at device boot

Your APK can be set up to automatically launch just after the Android device has booted. This is accomplished by changing another item in **AndroidManifest.xml**.

Find the **<receiver>** tag with **android:name=".BootUpReceiver"**.

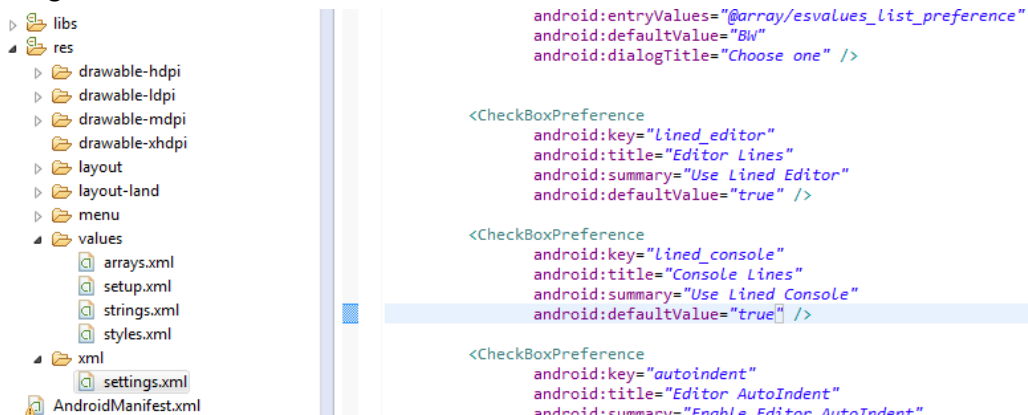
Change **android:enabled="false"** to **android:enabled="true"**.

## Preferences

There are certain preferences such as screen colors and font sizes that you have set for your application. The preferences that you will get with an APK will be BASIC!'s default preferences. You can change the default preferences if you wish.

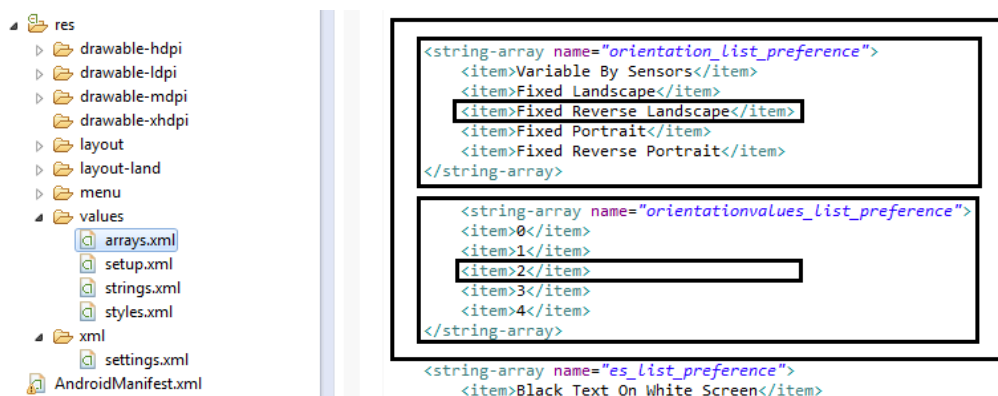
Some preferences are simple check boxes. To change these, open the **res/xml** hierarchy and double click on the **settings.xml** file as shown below:

For example, to change the default Console Lines preference from lined console to unlined console, change the value on the indicated line from **"true"** to **"false"**.



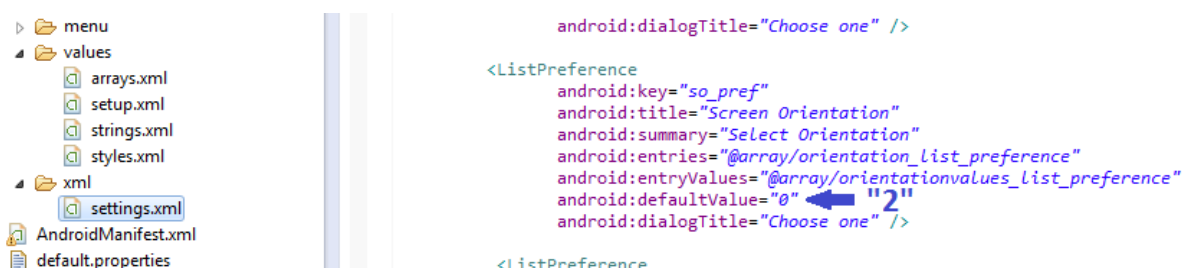
Other preferences are multiple-choice lists. To see the list values, open the **res/values** hierarchy and double click on **arrays.xml**. Each preference has two blocks. The top block lists the words that will be seen on the Android screen. The second block lists the internal names that correspond to the displayed words.

In the image below:



The section marked contains the names and values for the Screen Orientation preference. The top block is the display names. The bottom block is the internal values that correspond to the display name. For example the internal value of **Fixed Reverse Landscape** is **2**.

To set a default value for Screen Orientation, we need to go back to **settings.xml**:





Find the **<ListPreference>** tag with **android:title="Screen Orientation"**. The title is the preference name that you see on the Android screen. The default value is in the **android:defaultValue="0"** line. Here we see the default value for the screen orientation is "0". Looking at the Array.xml file we can see the "0" is the internal name for **Variable By Sensors**. To change the default value to **Fixed Reverse Landscape**, change the "0" to "2".

The other list preferences follow the same logic.

Note: Be sure to test your application with your chosen preferences before burning them into an APK.

## Finished

Create your finished APK in the same way we created the practice APK.

Now that was not too bad, was it?

## Appendix E – BASIC! Distribution License

BASIC! is distributed under the terms of the GNU General Public License which is reproduced here.

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Version 3, 29 June 2007

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