Innovative Technology for a Connected World

BL600 *smart*BASIC Module

User Manual

Release 1.1.50.0r3

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CONTENTS

1. INTRODUCTION

This user manual provides detailed information on Laird Technologies *smart* BASIC language which is embedded inside the BL600-series Bluetooth Low Energy (BLE) modules. This manual is designed to make BLE-enabled end products into a straightforward process and includes the following:

- An explanation of the language's core and extension functions
- Instructions on how to start using the tools
- A detailed description of all language components and examples of their use

The Laird website contains many complex examples which demonstrate complete applications. For those with programming experience, *smart* BASIC is easy to use because it is derived from BASIC language.

BASIC, which stands for **B**eginners **A**ll-Purpose **S**ymbolic **I**nstruction **C**ode, was developed in the early 1960s as a tool for teaching computer programming to undergraduates at Dartmouth College in the United States. From the early 70s to the mid-80s, BASIC, in various forms, was one of the most popular programming languages and the only user programming language in the first IBM PC to be sold in the early 80s. Prior to that, the first Apple computers were also deployed with BASIC.

Both BASIC and *smart* BASIC are interpreted languages – but in the interest of run-time speed on an embedded platform which has limited resources, *smart* BASIC's program text is parsed and saved as bytecodes which are subsequently interpreted by the a run-time engine to execute the application. On the BL600 module platform, the parsing from code test to bytecode is done on a Windows PC using a free cross-compiler. Other platforms with more firmware code space also offer on-board compiling capabilities.

The early BASIC implementations were based on source code statements which, because they were line numbered, resulted in applications which were not structured and liberally used 'GOTO' statements.

At the outset, *smart* BASIC was developed by Laird to offer structured programming constructs and, because of this, is not line numbers based; it offers the usual modern constructs line subroutines, functions, **while**, **if** and **for** loops.

smart BASIC offers further enhancement which acknowledges the fact that user applications will always be in unattended use cases. It forces the development of applications that have an event driven structure, as opposed to the classical sequential processing for which many BASIC applications were written. This means that a typical *smart* BASIC application source code consists of the following:

1. Variable declarations and initialisations
2. Subroutine definitions
3. Event handler routines
4. Startup code

The source code ends with a final statement called WAITEVENT, which never returns. Once the run-time engine reaches the WAITEVENT statement, it waits for events to happen and, when they do, the appropriate handlers written by the user are called to service them.

Why Do We Need Another Language?

Programming languages are designed predominantly for arithmetic operations, data processing, string manipulation, and flow control. Where a program needs to interact with the outside world, line in a Bluetooth Low Energy device, it inevitably becomes more complex due to the diversity of different input and output options. When wireless connections are involved, the complexity increases. To compound the problem, almost all wireless standards are different, requiring a deep knowledge of the specification and silicon implementations in order to make them work.

We believe that if wireless connectivity is going to be widely accepted, there must be an easier way to manage it. *smart* BASIC was developed and designed to extend a simple BASIC-like programming language with all of the tokens that control a wireless connection.

smart BASIC differs from an object oriented language in that the order of execution is generally the same as the order of the text commands. That makes it simpler to construct and understand, particularly if you're not using it every day.

Our other aim in developing *smart* BASIC is to make wireless design of products simple and contain a common look and feel for all platforms. To do this we're embedding *smart* BASIC within our wireless modules along with all of the embedded drivers and protocol stacks that are needed to connect and transfer data. A run-time engine interprets the **customer** applications that are stored there, allowing a complete product design to be implemented without the need for any additional **external** processing capability.

What Are the Reasons for Writing Applications?

smart BASIC for BLE has been designed to make wireless development quick and simple, vastly cutting down time to market. There are three good reasons for writing applications in *smart* BASIC:

- Since the module can auto launch the application every time it powers up, you can implement a complete design within the module. At one end, the radio connect and communicates while at the other end, external interactions are available through the physical interfaces like GPIO, ADCs, I2C, SPI, and UART.
- If you want to add a range of different wireless options to an existing product, you can load applications into a range of modules with different wireless functionality. These present a consistent API interface defined to your host system and allow you to select the wireless standard at the final stage of production.
- If you already have a product with a wired communications link, such as a modem, you can write a *smart* BASIC application for one of our wireless modules that copies the interface for your wired module. This provides a fast way for you to upgrade your product range with the minimum number of changes to any existing end user firmware.

In many cases, the example applications on our website and in the applications manual can be modified to further speed up the development process.

What is in a BLE Module?

Our *smart* BASIC based BLE modules are designed to provide a *complete* wireless processing solution. Each one contains:

- A highly integrated radio with an integrated antenna (external antenna options are available)
- Bluetooth Low Energy Physical and Link Layer
- Higher level stack
- Multiple GPIO and ADC
- Wired communications interfaces like UART, I2C, and SPI
- A *smart* BASIC run-time engine.
- Program accessible Flash Memory which contains a robust flash file system exposing a conventional file system and a database for storing user configuration data
- Voltage regulators and Brown-out detectors

For simple end devices, these modules can completely replace an embedded processing system.

The following block diagram (Figure 1) illustrates the structure of the BLE *smart* BASIC modules from a hardware perspective on the left and a firmware/software perspective on the right:

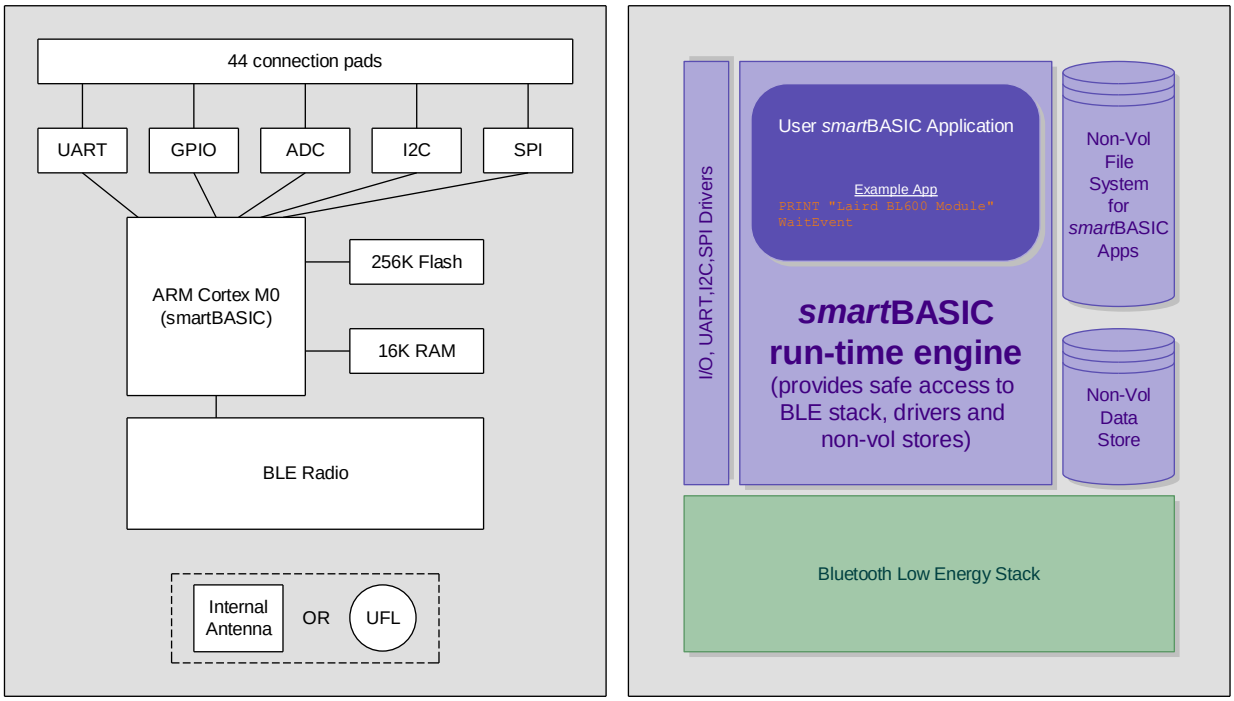

Figure 1: BLE smartBASIC Module block diagram

smart BASIC Essentials

smart BASIC is based upon the BASIC language. It has been designed to be highly efficient in terms of memory usage, making it ideal for low cost embedded systems with limited RAM and code memory.

The core language, which is common throughout all *smart* BASIC implementations, provides the standard functionality of any program, such as:

- Variables (integer and string)

- Arithmetic Functions
- Binary Operators
- Conditionals
- Looping
- Functions and Subroutines
- String Processing Functions
- Arrays (single dimension only)
- I/O Functions
- Memory Management
- Event Handling

The language on the various platforms differs by having a sophisticated set of target specific extensions like BLE for the module described in this manual.

These extensions have been implemented as additional program functions that control the wireless connectivity of the module, including, but not limited to the following:

- Advertising
- Connecting
- Security – Encryption and Authentication
- Power Management
- Wireless Status

Developing with *smart*BASIC

smart BASIC is one of the simplest embedded environment to develop on because a lot of functionality comes prepackaged for you. The compiler which can be internal or external on a Windows PC compiles source text on a line-by-line basis into a stream of bytes, which will be referred to as bytecode, that can be stored to a custom designed flash file system, and then the run-time engine is interprets the application bytecode in-situ from flash.

To simplify development further, Laird provides its own custom developed application called UWTerminal which is a full blown customised terminal emulator for Windows, available on request for free. Chapter 2 – UWTerminal provides a Quick Start Guide to writing BASIC applications using UWTerminal.

UWTerminal also embeds *smart* BASIC to automate its own functionality and in that case the extension
smart BASIC functions facilitate the automation of terminal emulation functionality.

Operating Modes of a *smart*BASIC module

Any platform running *smart* BASIC has up to three different modes of operation:

- **Interactive Mode** – In this mode, commands are sent via a streaming interface which is usually a UART and are executed immediately. This is analogous to the behavior of a modem using AT commands. Interactive Mode can be used by a host processor to directly configure the module**. It is also used to manage the download and storage of**

***smart* BASIC applications in the flash file system that will subsequently be used in run-time mode.**

- **Application Load Mode** – This mode is only available if the platform includes the compiler in the firmware image. The BLE module has limited firmware space and so compilation is only possible outside the module using a *smart* BASIC cross-compiler, provided for free.

  If this feature is available then the platform switches into Load Mode when the compile (AT+CMP) command is sent by the host.

  In this mode the relevant application is checked for syntax correctness on a line-by-line basis, tokenised to minimise storage requirements, and then stored in a non-volatile file system as the compiled application. This application can then be run at any time and can even be designated as the application to be automatically launched on power up.

- **Run-time Mode** – In Run-time Mode, pre-compiled *smart* BASIC applications are read from program memory and executed in-situ from flash. The capability of being able to run the application from flash ensures that as much RAM memory as possible is available to the user application to be used as data variables.

On startup an external GPIO input pin is checked. If the state of the input pin is asserted (high or low, depending on the platform) , if an application called **$autorun$** exists in the file system, then the device enters directly into run-time mode and the application is automatically launched. If that input pin is not asserted, then regardless of the existence of the autorun file, it will enter Interactive mode.

If the auto-run application completes, or encounters a STOP or END statement, then the module returns back to Interactive Mode.

It is therefore possible to write autorun applications that continue to run to control the module's behaviour until power-down, ***providing a complete embedded application***.

The modes of the module and transitions are as illustrated in Figure 2.

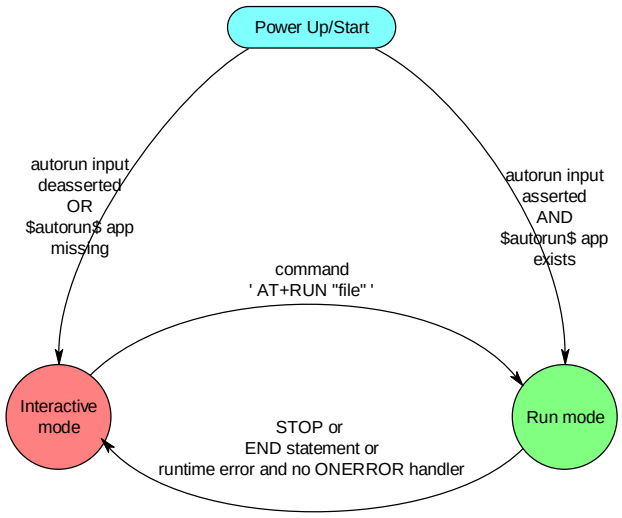

Figure 2: Module modes & transitions

Types of Applications

There are two types of applications used within a *smart* BASIC module. In terms of composition, both are the same but run at different times.

- **Autorun Application** – This is a normal application that is given the specific name "**$autorun$**" and is case insensitive. When a *smart* BASIC module powers up, it looks for an application called "$autorun$". If it finds this application it executes it. Autorun applications may be used to initialise the module to a customer's desired state, make a wireless connection, or provide a complete application program. At the completion of the autorun application, which is when the last statement returns or a STOP or END statement is encountered, a *smart* BASIC module reverts to interactive mode.

  In unattended usage cases, it is expected that the autorun application never terminates and so it will be typical that the last statement in an application will be the WAITEVENT statement.

  Developers should be aware that an autorun application does not need to "complete" and exit to Interactive Mode. The application can be a complete program for an application that runs within the *smart* BASIC module, ***removing the requirement for an external processor***.

  Applications can access the GPIO and ADCs and use ports such as UART, I2C and SPI to interface with peripherals such as displays and sensors.

  NOTE: When the autorun application starts up, by default, if the STDOUT is the UART, then it will be in a closed state. If a PRINT statement is encountered which results in output, then the UART will be automatically opened using default comms paramaters.
- **Other Applications –** Applications can be loaded into the BASIC module and be run under the control of an external host processor using the 'AT+RUN' command. The flash memory supports the storage of multiple applications. Note that the storage space is module dependent. Check the individual module data sheet.

Non Volatile Memory

All *smart* BASIC modules contain user accessible flash memory. The quantity of memory varies between modules; check the relevant datasheet.

The flash memory is available for three purposes:

- **File Storage –** Files which are not applications can be stored in flash memory too, for example X.501 certificates. The most common non-application files are data files for use by applications.
- **Application Storage –** Storage of user applications and the 'AT+RUN' command is used to select which application runs.
- **Non-volatile record s –** Individual blocks of data can be stored in non-volatile memory in a flat database, where each record consists of a 16 bit user defined ID and data consisting of variable length. This is useful for cases where program specific data needs to be preserved across power cycles. For example, passwords.

Using the Module's Flash File System

All *smart* BASIC modules hold data and application files in a simple flash file system which was developed by Laird and has some similarity to a DOS file system. Unlike DOS, it consists of a single directory in which all of the files are stored. When files are deleted from the flash file system, the flash memory used by that file is **not** released. Therefore, repeated downloads and deletions eventually fill the file system, requiring it to be completely emptied.

The command AT I 6 returns statistics related to the flash file system when in command mode and from within a *smart*BASIC application the function SYSINFO(x) where x is 601 to 606 inclusive returns similar information.

Note that the 'Non-volatile records' are stored in a special flash segment and is capable of coping with cases where there is no free unwritten flash but there are many deleted records.

2. GETTING STARTED

This chapter is a quick start guide to using *smart* BASIC to program an application. It shows the key elements of the BASIC language as implemented in the module and guides you through using UWTerminal (a Laird Terminal Emulation utility available for free) and Laird's Development Kit to test and debug your application.

For the purpose of this chapter, the examples are based upon Laird's BL600 series module which is a Bluetooth Low Energy module. However the principles apply to any *smart* BASIC enabled module.

What You Need

To replicate this example, you need the following items:

- A BL600 series development kit
- A copy of the latest UWTerminal application (downloadable from www.lairdtech.com). The version of UWTerninal must be at least v6.21.
  Save the application to a suitable directory on your PC.
- A cross-compiler application with a name typically formatted as "XComp_dddddddd_aaaa_bbbb.exe", where 'dddddddd' is the first non-space 8 characters from the response to the "AT I 0" command and aaaa/bbbb is the hexadecimal output to the command "AT I 13".
  Note aaaa/bbbb is a hash signature of the module so that the correct cross-compiler is used to generate the bytecode for download.
  When an application is launched in the module, the hash value is compared against the signature in the run-time engine and if there is a mismatch the application will be aborted.

Connecting Things Up

The simplest way to power the development board and module is to connect a USB cable to the PC. The development board regulates the USB power rail and feeds it to the module.

Note: The current requirement is typically a few mA with peak currents not exceeding 20mA. We recommend connecting to a powered USB hub or a primary USB port.

UWTerminal

UWTerminal is a terminal emulation application with additional GUI extensions to allow easy interactions with a *smart* BASIC -enabled module. It is similar to other well-known terminal applications such as Hyperterminal. As well as a serial interface, it can also open a TCP/IP connection either as a client or as a server. This aspect of UWTerminal is more advanced and is covered in the UWTerminal User's Guide. The focus of this chapter is its serial mode.

In addition to its function as a terminal emulator it also has *smart* BASIC embedded so you can *smart* BASIC applications locally. This allows you to write *smart* BASIC applications which use the terminal emulation extensions that will enable you to automate the functionality of the terminal emulator.

It may be possible in the future to add BLE extensions so that when UWTerminal is running on a Windows 8 PC which has a Bluetooth 4.0 hardware, then it is planned that an application that runs on a BLE module will also run in the UwTerminal environment.

Before starting UWTerminal, make a note of the serial port number to which the development kit is connected.

Note: The driver for the USB to Serial chipset on the development kit generates a virtual COM port. You can check what this is by selecting **My Computer > Properties > Hardware > Device Manager > Ports (COM & LPT)**.

To use UWTerminal, follow the steps below and note that the screen shots may differ slightly as it is a continually evolving Windows application:

1. Switch on the development board, if applicable.
2. Start the UWTerminal application on your PC to access the opening screen (Figure 3).

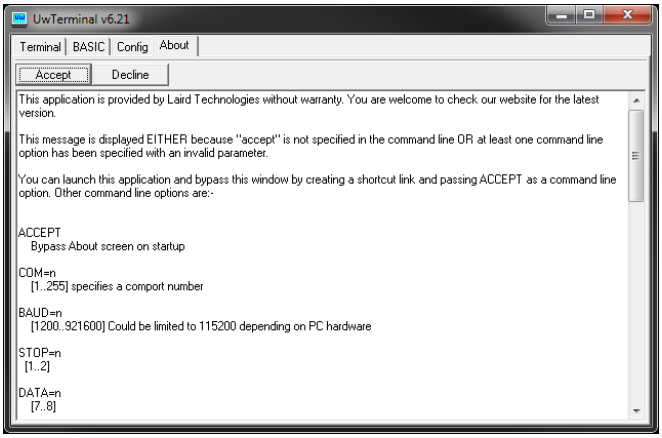

Figure 3: UWTerminal opening screen

3. Click **Accept** to open the configuration screen:

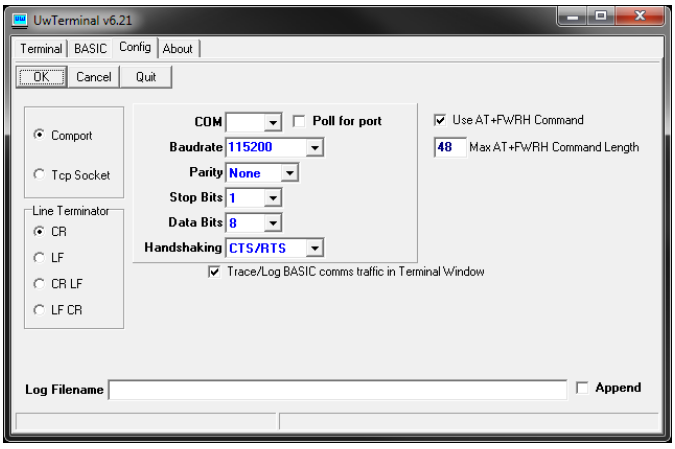

Figure 4: UWTerminal Configuration screen

4. Enter the COM port that you have used to connect the Development Board. The other default parameters should be correct:

Baudrate	**9600**
Parity	**None**
Stop Bits	**1**
Data Bits	**8**
Handshaking	**CTS/RTS**

Please note: **Comport** should be selected on the left and not 'Tcp Socket'.

5. Check **Poll for port** to enable a feature in UWTerminal that attempts to re-open the comport in the event that the devkit is unplugged from the PC and causes the virtual comport to disappear.
6. In Line Terminator, select the characters that will be sent when you type **ENTER**.
7. Once these settings are correct, click **OK** to bring up the main terminal screen.

Getting around UWTerminal

Figure 5: UWTerminal tabs and status lights

The following tabs (with four status lights below) are located at the top of the UWTerminal:

- **Terminal** – Main terminal window. Used to communicate with the serial module.
- **BASIC** – *smart* BASIC window. Can be used to run BASIC applications locally without a device connected to the serial port.

Note: You can use any text editor, such as notepad for writing your *smart* BASICs. However, if you use an advanced text editor or word processor you need to take care that non-standard formatting characters are not incorporated into your BASIC application.

- **Config** – Configuration window. Used to set up various parameters within UWTerminal.
- **About** – Information window that displays when you start UWTerminal. It contains command line arguments information that can facilitate the creation of a shortcut to the application and launch the emulator directly into the terminal screen.

The four 'led' type indicators below the tabs display the status of the RS-232 control lines that are inputs to the PC. The colour will be red, green or white. White signifies that the serial port is not open.

Note: According to RS-232 convention, these are inverted from the logic levels at the GPIO pin outputs on the module. A 0v on the appropriate pin at the module signifies an asserted state

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- **CTS** – Clear to Send. Green indicates that the module is ready to receive data.

- **DSR** – Data Sense Ready. Typically connected to the DTR output of a peripheral.
- **DCD** – Data Carrier Detect.
- **RI** – Ring Indicate.

If the module is operating correctly and there is no radio activity then CTS should be asserted (green), while DSR, DCD and RI are deasserted (red). Again note that if all 4 are white, it means that the serial port of the PC has not been opened as shown below and the button labelled "OpenPort" can be used to open the port.

Please note on the BL600 Development kit, at the time of this manual being written, the DSR line is connected to the SIO25 signal on the module which has to be configured as an output in a *smart* BASIC application so that it drives the PC's DSR line. The DCD line (input on a PC) is connected to SIO29 and should be configured as an output in an application and finally the RI line (again an input on a PC) is connected to SIO30. Please request a schematic of the BL600 development kit to ensure that these SIO lines on the modules are correct.

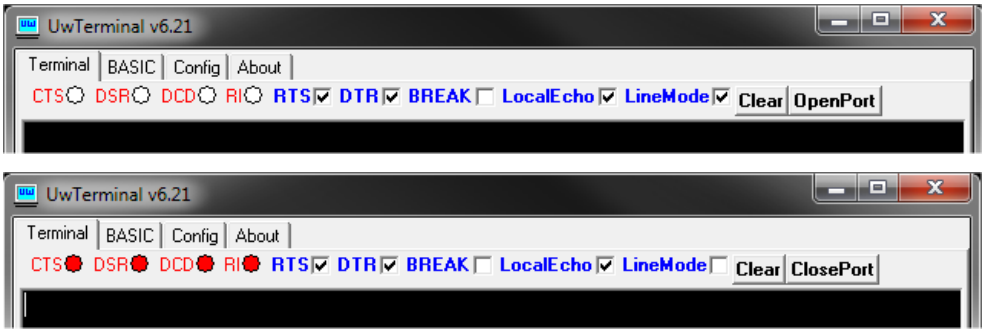


Figure 6: Control options

Next to the indicators are a number of control options (**Error! Reference source not found.**) which can be used to set the signals that appear on inputs to the module.

- **RTS** and **DTR** – The two additional control lines for the RS-232 interface.

Note: If CTS/RTS handshaking is enabled, the RTS checkbox has no effect on the actual physical RTS output pin as it is automatically controlled via the underlying windows driver. To gain manual control of the RTS output, disable 'Handshaking' in the Configuration window.

- **BREAK** – Used to assert a break condition over the RX line at the module. It must be deasserted after use. A TX pin is normally at logic high (< 3v for RS232 voltage levels) when idle; a BREAK condition is where the TX output pin is held low for more than the time it takes to transmit 10 bits.
  If the BREAK checkbox is ticked then the TX output is at non-idle state and no communication is possible with the uart device connected to the serial port.
- **LocalEcho –** Enables local echoing of any characters typed at the terminal. In default operation, this option box should be selected because modules do not reflect back commands entered in the terminal emulator.
- **LineMode** – Delays transmission of characters entered into UWTerminal until you press **Enter**. Enabling LineMode means that **Backspace** can be used to correct mistakes; we recommend that you select this option.

- **Clear** – Removes all characters from the terminal screen.
- **ClosePort** – Close the serial port. This is useful when a USB to serial adaptor is being used to drive the development board which has been briefly disconnected from the PC.
- **OpenPort** – Re-open the serial port after it has been manually closed.

Useful Shortcuts

There are a number of shortcuts that help speed up the use of UWTerminal.

Each time UWTerminal starts, it asks you to acknowledge the Accept screen and to enter the COM port details. If you are not going to change these, you can skip these screens by entering the applicable command line parameters in a shortcut link.

To do this, follow these steps to create a shortcut to UWTerminal on your desktop:

1. Locate the file UwTerminal.exe and right click and then drag and drop onto your desktop, whereupon you will get a dialog box and from there select "Create Shortcut"
2. Right-click the newly created shortcut.
3. Select **Properties**.
4. Edit the **Target** line to add the following commands (Figure 7):

   accept com=n baud=bbb linemode

   (Where *n* is the COM port that is connected to the dev kit and *bbb* is the baudrate)

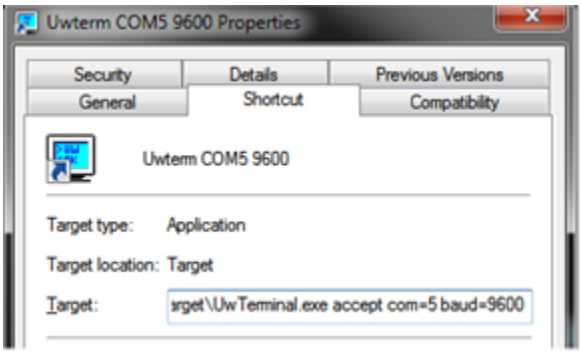


Figure 7: Shortcut properties

Subsequently, starting UWTerminal from this shortcut launches it directly into the terminal screen. At any time, the status bar on the bottom left (Figure 8) shows the comms parameters being used at that time. The two counts on the bottom right (Tx and Rx) display the number of characters transmitted and received.

The information within **{ }** denotes the characters sent when you hit the **ENTER** on the keyboard.

Figure 8: Terminal screen status bar

Using UWTerminal

The first thing to do is to check that the module is communicating with UWTerminal. To do this, follow these steps:

1. Check that the CTS 'led' is green (DSR,DCD,RI should be red).
2. Type '**at**' (without the quotation marks).
3. Press **Enter**. You should get a 00 response as per the following screenshot :-

Figure 9: Interactive command access

UWTerminal supports a range of interactive commands to interact directly with the module. The following ones are typical:

- **AT** – Returns 00 if the module is working correctly.
- **AT I 3** – Shows the revision of module firmware. Check to see that it is the latest version.
- **AT I 13** – Shows the hash value of the *smart* BASIC build
- **AT I 4** – Shows the MAC address of the module
- **AT+DIR** – Lists all of the applications loaded on the module.
- **AT+DEL "filename"** – Deletes an application from the module.
- **AT+RUN "filename"** – Runs an application that is already loaded on the module. Please be aware that if a filename does not contain any spaces, then it is even possible to launch an application by just entering the filename as the command.

The next chapter lists all of the Interactive commands.

First, check to see what is loaded on the module by typing **AT+DIR** and **Enter**:

```
00
at+dir

06      $factory$
00
```

If the module has not been used before then you should not see any lines starting with the 2 digit '06' sequence.

Writing a *smart* BASIC Application

Let's start where every other programming manual starts… with a simple program to display "Hello World" on the screen. We use Notepad to write the *smart* BASIC application.

Tip: if you use TextPad and mark files with .sb extensions as C/C++ files then you should be able to see your application with syntax colour highlighting. It is planned in the future to supply a configuration file for TextPad which will contain syntax highlighting information specifically for *smart* BASIC.

To write this 'Hello World' *smart* BASIC application, follow these steps:

1. Open Notepad.
2. Enter the following text:

```
print "\nHello World\n"
```

3. Save the file with this single line as *test1.sb*.

Note: *smart* BASIC files can have any extension, as UWTerminal which is used to download an application to the module will strip the extension when the file is downloaded to the module.
Laird recommends always using the extension '.sb' as this makes it easy to distinguish between *smart* BASIC files and other files. You can also associate this extension with your favourite editor and enable appropriate syntax highlighting.

As you start to develop more complex applications, you may want to use a more fully-featured editor such as TextPad (trial version downloadable from www.textpad.com) or Notepad++ (free and downloadable from http://notepad-plus.sourceforge.net.)

Tip: if you use TextPad and mark files with .sb extensions as C/C++ files (via Configure | Preferences) then you should be able to see your application with syntax colour highlighting. It is planned in the future to supply a configuration file for TextPad which will contain syntax highlighting information specifically for *smart* BASIC.

You must now load the compiled output of this file into the *smart* BASIC module's File System so that you can run it.

To manage file downloads, right click on any part of the black UWTerminal screen to display the drop-down menu (Figure 10).

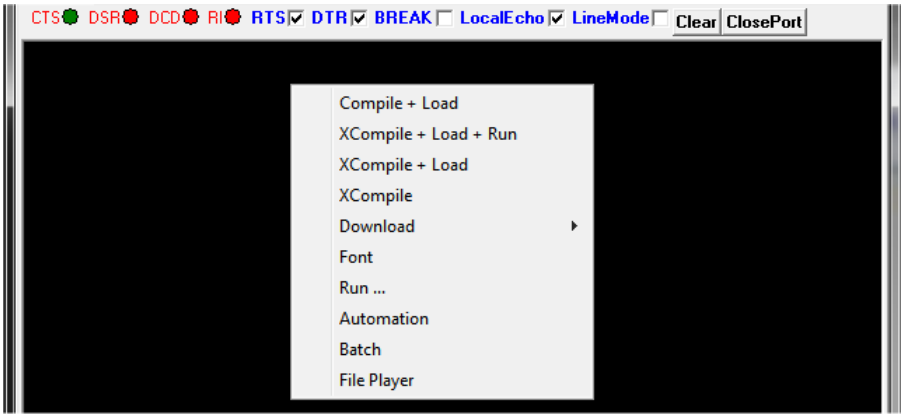


Figure 10: Right-click UWTerminal screen

4. Click **XCompile+Load** and navigate to the directory where you've stored your *test1.sb* file. Note: do not select **Compile+Load**
5. Click **Open**. In UWTerminal, you should see the following display:

```
AT I 0
10    0     B1600Med
AT I 13
10    13    9E56 5F81
<<Cross Compiling [test1.sb]>>

AT+DEL "test1" +
AT+FOW "test1"
AT+FWRH "FE900002250000000000FFFFFFFF569E815FFC10"
AT+FWRH "FB70090054455354312E555743000110CE211000"
AT+FWRH "FB0009000D000A48656C6C6F20576F726C640A00"
AT+FWRH "CC211400A52000000110FD10F510"
AT+FCL
+++ DONE +++
```

Behind the scenes, the shortcut uses Interactive Commands to load the file onto the module. The first two "AT I" commands are used to identify the module so that the correct cross compiler can be invoked resulting in the text **<<Cross Compiling [test1.sb]>>**.

In this example since the compilation is successful, the binary file generated needs to be downloaded and so the **AT+DEL "filename" +** deletes any previous file with the same name that might already be on the module. The new file is downloaded using he **AT+FOW**, **AT+FWRH** and **AT+FCL** commands. The strings following the **AT+FWRH** consists of the binary data generated by the cross compiler. And finally the **+++ DONE +++** signifies that the process of compiling and downloading was successfully accomplished.

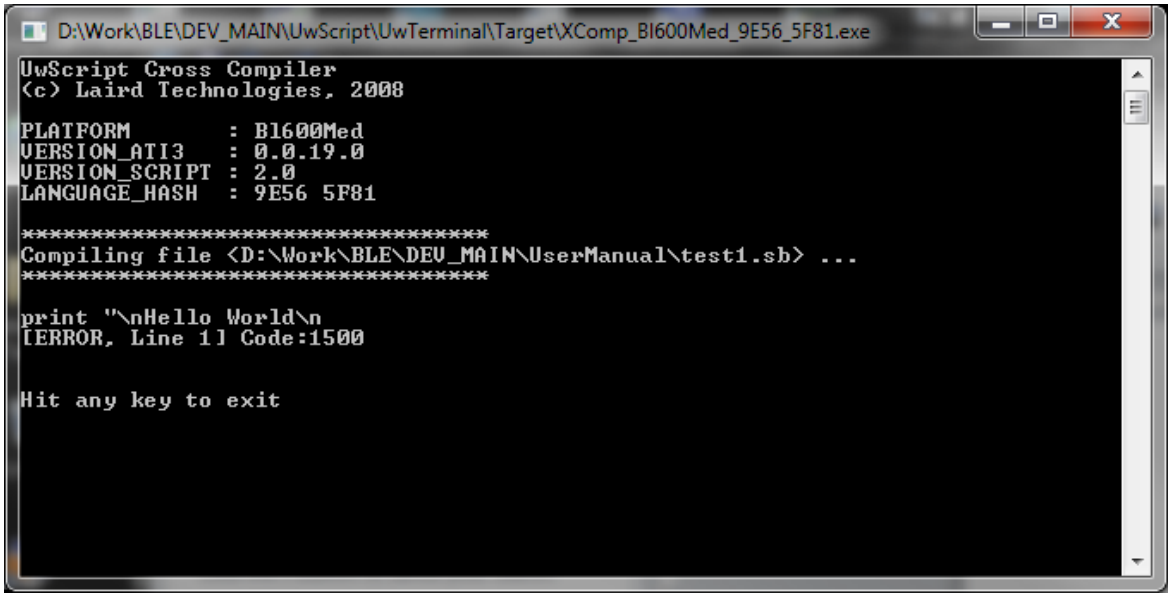
Possible failures in this process is if the cross compiler cannot be located. In this case you should see the following display in a separate window:

```
AT I 0
10    0     B1600Med
AT I 13
```

```
10    13    9E56 5F81
??? Cross Compiler [XComp_Bl600Med_9E56_5F81.exe] not found ???
??? Please save a copy to the same folder as UwTerminal.exe ???
??? If you cannot locate the file, please contact the supplier ???
```

The solution is to locate the cross compiler application mentioned in between the [] brackets and saving it to either the folder containing UWTerminal.exe or the folder that contains the *smart* BASIC application test1.sb

Another cause of a failure is if there is compilation error. Say, for example, the print statement contained an error in the form of a missing " delimiter, then you should see the following display:-



Now that the application has been downloaded into the module, run it by issuing one of the following commands:

test1
or
AT+RUN "test1"

Note: *smart* BASIC commands, variables, and filename are not case sensitive; *smart* BASIC treats *Test1*, *test1* and *TEST1* as the same files.

The screen should display the following result (when both forms of the command are entered):

```
at+run "test1"
Hello World
00

Test1
```

```
Hello World
00
```

You can check the file system on the module by typing **AT+DIR** and **Enter** and you should see:

```
00
at+dir

06      test1
00
```

You have just written and run your first *smart* BASIC program.

To make it a little more complex, try printing "Hello World" ten times. For this we can use the conditional functions within *smart* BASIC. We also introduce the concept of variables and print formatting. Later chapters goes into much more detail, but this gives a flavour of the way they work.

Before we do that, it's worth laying out the rules of the application source syntax.

smart BASIC Statement Format

The format of any line of *smart* BASIC is defined in the following manner:

{ COMMENT | COMMAND | STATEMENT | DIRECTIVE } < COMMENT > { TERMINATOR }

Where anything in *{ }* is mandatory and < > is optional and within each set of *{ }* or < > brackets the character | is used to denote a choice of values.

The various elements of each line are:

- **COMMENT –** A COMMENT token is a ' or // followed by any sequence of characters. Any text after the token is ignored by the parser. A comment can occupy its own line or be placed at the end of a STATEMENT or COMMAND.
  COMMAND – An Interactive Command which is one of the commands that can be executed from Interactive Mode.
- **STATEMENT** – A valid BASIC statement(s) separated by the '**:**' character if there are more than one statement.

> **Note:** When compiling an application, a line can be made of several statements which are separated by the '**:**' character.

- **DIRECTIVE** – A line starting with the '**#**' character. It is used as an instruction to the parser to modify its behaviour, e.g. with #DEFINE and #INCLUDE.
- **TERMINATOR** – The '**\r**' character which corresponds to the **Enter** key on the keyboard.

The *smart* BASIC implementation consists of a command parser and a single line/single pass compiler. It takes each line of text (a series of tokens and depending on their content and its operating mode) and does ***one*** of the following:

- Act on them immediately (such as with AT commands).
- Optionally, if the build includes the compiler, generate a compiled output which is stored and processed at a later time by the run-time engine. This capability is not present in the BL600 due to flash memory constraint.

smart BASIC has been designed to work on embedded systems where there is often a very limited amount of RAM. To make it efficient, you need to declare every variable that you intend to use by using the DIM statement; the compiler can then allocate the appropriate amount of memory space. In the following example program, we are using the variable "i" to count how many times we print "*Hello World*".
smart BASIC allows a couple of different variables types, numbers (32 bit signed integers) and strings.

Our program (stored in a file called *HelloWorld.sb'*) looks like this:

```
'Example Script "helloworld"

DIM i as integer           'declare our variable

for i=1 to 10              'Perform the print ten times
print "Hello World \n"     'The \n forces a new line each time
next                       'Increment the value of i
```

We have introduced a few new things, the first being comments. Any line that starts with an apostrophe ' is ignored by the compiler from the token onwards and treated as a comment, so the opening line is ignored. You can also add comments to a program line by adding an apostrophe proceeded by a space to start the comment.

If you have 'C++' language experience, you can also use the // token to indicate that the rest of the line is a comment.

The second item of interest is the line feed character '\n' which we've added after *Hello World* in the print statement. This tells the **print** command to start a new line. If left out, the ten *Hello World's* would have been concatenated together on the screen. You can try removing it to see what would happen.

Compile and download the file *HelloWorld.sb* to the module (using XCompile+Load in UwTerminal) and then run the application in the usual way:

```
AT+RUN "helloworld"
```

You'll see the following screen output:

```
at+run "helloworld"

Hello World
Hello World
Hello World
Hello World
Hello World
Hello World
```

```
Hello World
Hello World
Hello World
Hello World

00
```

If you now change the print statement in the application to

```
print "Hello World ";I;\n"     'The \n forces a new line each time
```

You'll see the following screen output:

```
at+run "helloworld"

Hello World 1
Hello World 2
Hello World 3
Hello World 4
Hello World 5
Hello World 6
Hello World 7
Hello World 8
Hello World 9
Hello World 10

00
```

If you run **AT+DIR**, you will see that both of these programs are now loaded in memory. They remain there until you remove them with **AT+DEL**.

```
at+dir

06    test1
06    HelloWorld
00
```

Note: All responses to interactive commands are of the format **\nNN\tOptionalText1 \tOptionalText2…\r**
where ***NN*** is always a two digit number and **\t** is the tab character and is terminated by **\r**.
This format has been provided to assist with developing host algorithms that can parse these responses in a stateless fashion. The NN will always allow the host to attach meaning to any response from the module.

Autorun

One of the major features of a *smart* BASIC module is its ability to launch an application autonomously when power is applied. To demonstrate this we will use the last HelloWorld example.

An autorun application is identical to any other BASIC application except for its name, which must be called *$autorun$*. Whenever a *smart* BASIC module is powered up it checks its

nAutoRUN input line (see pinout for the BL600 module) and, if it is asserted (that is, at 0v), it looks for and executes the autorun application.

In the BL600 development kit, the nAutoRUN input pin of the module is connected to the DTR output pin of the USB to UART chip. This means the DTR checkbox in UWTerminal can be used to affect the state of that pin on the BL600 module. The DTR checkbox is always ticked by default hence asserted state which will translate to a 0v at the nAutoRUN input of the module. This means if an autorun application exists in the module's file system it will be automatically launched on power up.

Copy the *smart* BASIC source file "HelloWorld.sb" to "$autorun$.sb" and then cross-compile and download to the module. After it is downloaded if you enter the AT+DIR command you should see:-

```
at+dir

06    test1
06    HelloWorld
06    $autorun$
00
```

TIP: A useful feature of UWTerminal is that the download function strips off the filename extension when it downloads a file into the module file system. This means that you can store a number of different autorun applications on your PC by giving them longer, more descriptive extension names. For example:

$autorun$.HelloWorld

By doing this, each $autorun$ file on your PC is unique and the list is simpler to manage.

Note: If Windows adds a text extension, rename the file to remove it. Do not use multiple extensions in filenames (such as filename.ext1.ext2). The resulting files (after being stripped) may overwrite other files.

Now clear the UWTerminal screen by clicking the 'Clear' button on the toolbar and then enter the command **ATZ** which forces the module to reset itself. You could also hit the 'reset' button on the development kit to achieve the same.

Warning: If the JLINK debugger is connected to the development kit via the ribbon, then the reset button has no effect.

You'll see the following screen output:

```
Hello World 1
Hello World 2
Hello World 3
Hello World 4
Hello World 5
Hello World 6
Hello World 7
Hello World 8
Hello World 9
Hello World 10
```

Next, in UWTerminal clear the screen using the 'Clear' button and then untick the checkbox labelled DTR so that the nAutoRUN input of the module is not asserted, and you will see that after a reset (ATZ or the button), the screen remains blank, which signifies that the autorun application was NOT invoked automatically.

The reason for providing this capability to suppress the launching of the autorun application is purely to ensure that if your autorun application has the WAITEVENT as the last statement then you can still regain control of the module's command interpreter for further development work.

Debugging Applications

One difference with *smart* BASIC is that it does not have program labels (or line numbers for the die-hard senior coders). Because it is designed for a single line compilation in a memory constrained embedded environment, it is more efficient to work without them.

Because of the absence of labels, *smart* BASIC provides facilities for debugging an application by inserting breakpoints into the source code prior to compilation and execution. Multiple breakpoints can be inserted and each breakpoint can have a unique identifier associated with it. These can be used to aid the developer in locating which breakpoint resulted in the break. It is up to the programmer to ensure that all the IDs are unique. The compiler will not check for repeated values.

Each breakpoint statement has syntax:

BP nnnn

where nnnn should be a unique number which is echoed back when the breakpoint is encountered at runtime. It is up to the developer to keep all the *nnnn*'s unique as they are not validated when the source is compiled.

Breakpoints are ignored if the application is launched using the command AT+RUN (or name alone). This allows the application to be run at full speed with breaks if required. However, if the command **AT+DBG** is used to run the application, then all of the debugging commands are enabled.

When the breakpoint is encountered, the runtime engine is halted and the command line interface becomes active. At this point, the response seen in UWTerminal is in the following form:

<linefeed>21 BREAKPOINT nnnn<carriage return>

where **nnnn** is the identifier associated with the **BP nnnn** statement that caused the halt in execution. As the **nnnn** identifier is unique, this allows you to locate the breakpoint line in the source code.

For example, if you create an application called test2.sb with the following content:-

```
DIM i as integer

for i=1 to 10
print "Hello World”;i;”\n"
if i==3 then
bp 3333
endif
next
```

Then when you launch the application using AT+RUN you will see the following:-

```
at+run "test2"

Hello World 1
Hello World 2
Hello World 3
Hello World 4
Hello World 5
Hello World 6
Hello World 7
Hello World 8
Hello World 9
Hello World 10

00
```

And if you launch the application using AT+DBG you will see the following:-

```
at+dbg "test2"

Hello World 1
Hello World 2
Hello World 3
21    BREAKPOINT 3333
```

Having been returned to Interactive mode, the command **? varname** can be used to interrogate the value of any of the application variables, which are preserved during the break from execution. The command **= varname *newvalue*** can then be used to change the value of a variable, if required. For example:

```
? i
08    3
00
= I 42
? i
08    42
00
```

The single step command **SO** (Step Over) can then be invoked to step through the next statements individually (note the first **SO** will rerun the BP statement).

When required, the command RESUME can be used to resume the run-time engine from the current application position as shown below:-

```
at+dbg "test2"

Hello World 1
Hello World 2
Hello World 3
21    BREAKPOINT 3333
= I 8
resume
Hello World 8
Hello World 9
Hello World 10
00
```

Structuring an Application

Applications **must** follow *smart* BASIC syntax rules. However, the single pass compiler places some restrictions on how the application needs to be arranged. This section explains these rules and suggests a structure for writing applications which should adhere to the event driven paradigm.

Typically, do something only when something happens. This *smart* BASIC implementation has been designed from the outset to 'feed' events into the user application to facilitate that architecture, and while waiting for events, the module has been designed to remain in the lowest power state.

smart BASIC uses a single pass compiler which can be extremely efficient in systems with limited memory. They are called "single pass" as the source application is only passed through the parser line by line once. That means that it has no knowledge of any line which it has not yet encountered and it will forget any previous line as soon as the first character of the next line arrives. The implication is that variables and subroutines need to be placed in position before they are first referenced by any function which dictates the structure of a typical application.

In practice, this results in the following structure for most applications:

- **Opening Comments** – Any initial text comments to help document the application.

- **Includes** – The cross compiler which is automatically invoked by UWTerminal allows the use of #DEFINE and #INCLUDE directives to bring in additional source files and data elements. **Variable Declarations** – Declare any global variables. Local variables can be declared within subroutines and functions.
- **Subroutines and Functions** – These should be cited here, prior to any program references. If any of them refer to other subroutines or functions these referred ones should be placed first. The golden rule is that nothing on any line of the application should be "new". Either it should be an inbuilt
  smart BASIC function, or it should have been defined higher up within the application.
- **Event and error handlers** – Normally these reference subroutines, so they should be placed here.
- **Main program** – The final part of the application is the main program. In many cases this may be as simple as an invocation of one of the user functions or subroutines and then finally the WAITEVENT statement.

An example of an application which monitors button presses and reflects them to leds on the BLE development kit is as follows:-

```
'//***************************************************************************
'// Laird Technologies (c) 2013
'//
'// Simple development board button and LED test
'// Tests the functionality of button 0, button 1, LED 0 and LED 1 on the
'// development board
'// DVK-BL600-V01
'//
'// 24/01/2013 Initial version
'//
'//***************************************************************************

'//***************************************************************************
'// Global Variable Declarations
'//***************************************************************************
dim rc '// declare rc as integer variable


'//***************************************************************************
'// Function and Subroutine definitions
'//***************************************************************************

'//===========================================================================
'// This handler is called when button 0 is released
'//===========================================================================
function button0release()
gpiowrite(18,0) '// turns LED 0 off
print "Button 0 has been released \n"
print "LED 0 should now go out \n\n"
endfunc 1

'//===========================================================================
'// This handler is called when button 0 is pressed
'//===========================================================================
function button0press()
gpiowrite(18,1)
print "Button 0 has been pressed \n"
print "LED 0 will light while the button is pressed \n"
endfunc 1
```

```
'//============================================================================
'// This handler is called when button 1 is released
'//============================================================================
function button1release()
gpiowrite(19,0)
print "Button 1 has been released \n"
print "LED 1 should now go out \n\n"
endfunc 1

'//============================================================================
'// This handler is called when button 1 is pressed
'//============================================================================
function button1press()
gpiowrite(19,1)
print "Button 1 has been pressed \n"
print "LED 1 will light while the button is pressed \n"
endfunc 1


'//****************************************************************************
'// Startup code : equivalent to main() in C
'//****************************************************************************
rc = gpiosetfunc(18,2,2) '//sets sio18 (LED0) as a digital out with a weak pull up
rc = gpiosetfunc(19,2,2) '//sets sio19 (LED1) as a digital out with a weak pull up
rc = gpiobindevent(0,16,0) '//binds a gpio high event to an event. sio16 (button 0)
rc = gpiobindevent(1,16,1) '//binds a gpio low event to an event. sio16 (button 0)
rc = gpiobindevent(2,17,0) '//binds a gpio high event to an event. sio17 (button 1)
rc = gpiobindevent(3,17,1) '//binds a gpio low event to an event. sio17 (button 1)

'//============================================================================
'//Bind events to handler functions
'//============================================================================
onevent evgpiochan0 call button0release '//handler for button 0 release
onevent evgpiochan1 call button0press   '//handler for button 0 press
onevent evgpiochan2 call button1release '//handler for button 1 release
onevent evgpiochan3 call button1press   '//handler for button 1 press

print "Ready to begin button and LED test \n"
print "Please press button 0 or button 1 \n\n"

waitevent   '//when program is run it waits here until an event is detected
```

When this application is launched and appropriate buttons are pressed and released, the output is as follows:-

```
AT+RUN "sampleapp"

Ready to begin button and LED test
Please press button 0 or button 1

Button 0 has been pressed
LED 0 will light while the button is pressed
Button 0 has been released
LED 0 should now go out

Button 1 has been pressed
```

```
LED 1 will light while the button is pressed
Button 1 has been released
LED 1 should now go out
```

3. INTERACTIVE MODE COMMANDS

Interactive mode commands allow a host processor or terminal emulator to interrogate and control the operation of a *smart* BASIC based module. Many of these emulate the functionality of AT commands. Others add extra functionality for controlling the filing system and compilation process.

Syntax Unlike commands for AT modems, a space character must be inserted between the "AT", the command, and subsequent parameters. This allows the *smart* BASIC tokeniser to efficiently distinguish between AT commands and other tokens or variables starting with the letters "at".

```
'Example:

AT I 3
```

The response to every interactive mode command has the following form:

<linefeed character> response text <carriage return>

This format simplifies the parsing within the host processor. The response may be one or multiple lines. Where more than one line is returned, the last line has one of the following formats:

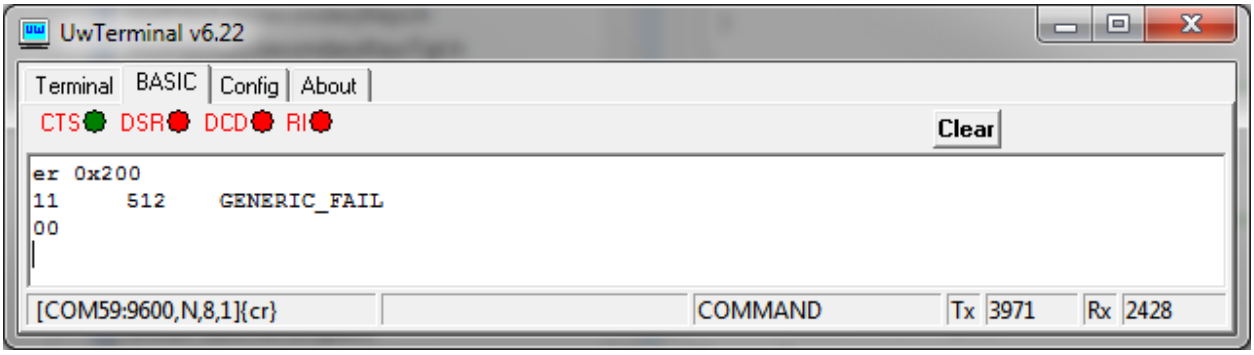
<lf>00<cr> for a successful outcome, or

<lf>01<tab> hex number <tab> optional verbose explanation <cr> for failure.

Note that in the case of the 01 response the "<tab>optional_verbose_explanation" will be missing in resource constrained platforms like the BL600 modules. The 'verbose explanation' is a constant string and since there are over 1000 error codes, these verbose strings can occupy more than 10 kilobytes of flash memory.

The hex number in the response is the error result code consisting of two digits which can be used to help investigate the problem causing the failure. Rather than provide a list of all the error codes in this manual, you can use UWTerminal to obtain a verbose description of an error when it is not provided on a platform.

To get the verbose description, in UWTerminal, click on the BASIC tab and then if the error value is hhhh, enter the command "ER 0xhhhh" and note the 0x prefix to 'hhhh'. This is illustrated in the following screenshot.



If you get the text "UNKNOWN RESULT CODE 0xHHHH", please contact Laird for the latest version of UWterminal.

AT

An Interactive mode command. Must be terminated by a carriage return for it to be processed.

It performs no action other than to respond with "\n00\r". It exists to emulate the behaviour of a device which is controlled using the 'AT' protocol. This is a good command to use to check if the UART has been correctly configured and connected to the host.

AT I or ATI

Provided to give compatibility with the AT command set of Laird's standard Bluetooth modules.

AT i num

Command

Returns \n10\tMM\tInformation\r
\n00\r

Where

\n = linefeed character 0x0A
\t = horizontal tab character 0x09
MM = a *number* (see below)
Information = sting consisting of information requested associated with MM
\r = carriage return character 0x0D

Arguments

num *Integer Constant* - A number in the range 0 to 65,535. Currently defined numbers are:

0	Name of device
3	Version number of Module Firmware
4	MAC address in the form TT AAAAAAAAAAAA
5	Chipset name
6	Flash File System size stats (data segment): Total/Free/Deleted
7	Flash File System size stats (FAT segment) : Total/Free/Deleted
12	Last error code
13	Language hash value
33	BASIC core version number

601	Flash File System: Data Segment: Total Space
602	Flash File System: Data Segment: Free Space
603	Flash File System: Data Segment: Deleted Space
604	Flash File System: FAT Segment: Total Space
605	Flash File System: FAT Segment: Free Space
606	Flash File System: FAT Segment: Deleted Space
1000..1999	See SYSINFO() function definition
2000..2999	See SYSINFO() function definition

Any other number currently returns the manufacturer's name.

For ATi4 the TT in the response is the type of address as follows:-

00	Public IEEE format address
01	Random static address (default as shipped)
02	Random Private Resolvable (used with bonded devices)
03	Random Private Non-Resolvable (used for reconnections)

Please refer to the Bluetooth specification for a further description of the types.

This is an Interactive mode command and **must** be terminated by a carriage return for it to be processed.

Interactive Command: Yes

```
'Example:

AT  i  3
10   3    2.0.1.2
00
AT I 4
10   4    01 D31A920731B0
```

AT i is a core command.

The information returned by this Interactive command can also be useful from within a running application and so a builtin function called SYSINFO(cmdId) can be used to return exactly the same information and cmdid is the same value as used in the list above.

AT+DIR

List all application or data files in the module's flash filing system.

AT+DIR <"string">

Command

Returns

\n06\tFILENAME1\r
\n06\tFILENAME2\r
\n06\tFILENAMEn\r
\n00\r

If there are no files within the module memory, then only \n00\r is sent.

Arguments

string string_constant An optional pattern match string.
If included AT+DIR will only return application names which include this string.

The match string is not case sensitive.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT+DIR

AT+DIR "new"
```

AT+DIR is a core command.

AT+DEL

This command is used to delete a file from the module's flash file system.

When the file is deleted the space it used to occupy does not get marked as free for use again, Hence eventually after many deletions the file system will not have any free space for new files. When that happens the module will respond with an appropriate error code when a new file write is attempted. Use the command AT&F 1 to completely erase and reformat the file system.

At any time you can use the command **ATI 6** to get information about the file system. It will respond as follows:-

10 6 aaaa,bbbb,cccc

Where aaaa is the total size of the file system, bbbb is the free space available and cccc is the deleted space.

From within a *smart* BASIC application you can get aaaa by calling SYSINFO(601), bbbb by calling SYSINFO(602) and cccc by calling SYSINFO(603).

Note that after AT&F 1 has been process, the file system manager context is unstable so there will be an automatic self-reboot.

AT+DEL "filename" (+)

Command

Returns OK

If the file does not exist or if it was successfully erased, it will respond with \n00\r.

Arguments

filename string_constant.

The name of the file to be deleted. The maximum length of filename is 24 characters and should not include the following characters **:*?"<>|**

This is an Interactive Mode command and **must** be terminated by a carriage return for it to be processed.

Adding the "+" sign to an AT+DEL command can be used to force the deletion of an open file. For example, use **AT+DEL "filename" +** to delete an application which you have just exited after running it.

Interactive Command: YES

```
Examples:

AT+DEL "data"
AT+DEL "myapp" +
```

AT+DEL is a core command.

AT+RUN

AT+RUN runs a precompiled application that is stored in the module's flash file system. Debugging statements in the application are disabled when it is launched using AT+RUN.

AT+RUN "filename"

Command

Returns If the filename does not exists the AT+RUN will respond with an error response starting with a 01 and a hex value describing the type of error. When the application aborts or if the application reaches its end, a deferred \n00\r response is sent.

If the compiled file was generated with a non-matching language hash then it will not run with an error value of 0707 or 070C

Arguments

filename string_constant.
The name of the file to be deleted. The maximum length of filename is 24 characters and should not include the following characters **:*?"<>|**

This is an Interactive Mode command and **must** be terminated by a carriage return for it to be processed.

Note: Debugging is disabled when using AT+RUN, hence all **BP nnnn** statements will be inactive. To run an application with debugging active, use AT+DBG.

If any variables exist from a previous run, they are destroyed before the specified application is serviced.

Note: the application "filename" can also be invoked by just entering the name if it does not contain any spaces.

Interactive Command: YES

```
Examples:

AT+RUN "NewApp"

or

NewApp
```

AT+RUN is a core command.

AT+DBG

AT+DBG runs a precompiled application that is stored in the flash file system. In contrast to AT+RUN, debugging is enabled.

AT+DBG "filename"

Command

Returns If the filename does not exists the AT+DBG will respond with an error response. When the application aborts or if the application reaches its end, a deferred \n00\r response is sent.

Arguments

filename string_constant.
The name of the file to be deleted. The maximum length of filename is 24 characters and should not include the following characters **:*?"<>|**

This is an Interactive mode command and **must** be terminated by a carriage return for it to be processed.

Debugging is enabled when using AT+DBG, which means that all **BP nnnn** statements are active. To launch an application without the debugging capability, use **AT+RUN**. You do not need to recompile the application, but this is at the expense of using more memory to store the application.

If any variables exist from a previous run, they are destroyed before the specified application is serviced.

Interactive Command: YES

```
Examples:

AT+DBG "NewApp"
```

AT+DBG is a core command.

AT+SET

AT+SET is used to set a run-time configuration key. Configuration keys are user definable, non-volatile memory storage areas, which are analogous to S registers in modems. Their values are kept over a power cycle but will be deleted if the AT&F* command is used to clear the file system.

AT+SET num = string

Command

Returns If the config key is successfully set or updated, the response is \n00\r.

Arguments

num Integer Constant
The ID of the required configuration key. All of the configuration keys are stored as an array of 16 bit words.

String String_constant
The entire value array is written to the configuration ID and is specified in a single command (in contrast to the returned values of AT+GET). The new value array is specified as fixed format 4 digit hex numbers (with optional H' prefixes).

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

The following Configuration Key IDs are defined.

40	Maximum size of locals simple variables
41	Maximum size of locals complex variables

42	Maximum depth of nested user defined functions and subroutines
43	The size of stack for storing user functions simple variables
44	The size of stack for storing user functions complex variables
45	The size of the message argument queue length

Interactive Command: YES

```
'Example:
AT+SET 40 = "0x0040"
AT+SET 40 = "H'0040"
```

AT+SET is a core command.

Note: These values revert to factory default values if the flash file system is deleted using the "AT & F *" interactive command.

AT+GET

AT+GET is used to read a run-time configuration key. Configuration keys are user definable, non-volatile memory storage areas, which are analogous to S registers in modems. Their values are kept over a power cycle.

AT+GET num

Command

Returns The response to this command is

\n07\tiiii oooo hhhh hhhh hhhh hhhh\r
\n00\r

where each line starting with 07 will have up to 8 words. If the configuration key contains more data words, then more of these 07 lines are displayed.

In each 07 line the **oooo** value (hexadecimal) specifies the start offset of the data in the key. The value **iiii** (hexadecimal) is an echo of the config key ID specified in the command line. The config key data is **hhhh** again in hexadecimal.

Arguments

num Integer Constant
The ID of the required configuration key. All of the configuration keys are stored as an array of 16 bit words.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

See the definition of the AT+SET command for a list of all the predefined configuration keys.

Interactive Command: YES

```
'Example:

AT+GET 40
07    0028 0000 0014
00
```

AT+GET is a core command.

AT+FOW

AT+FOW opens a file to allow it to be written to with raw data. AT+FWR (or AT+FWRH) to write data to it and finally AT+FCL to close it, are typically used for downloading data and precompiled files to the module's flash filing system. For example, data files could be web pages or x.509 certificates or default values for BLE attributes.

AT+FOW "filename"

Command

Returns If the filename is valid, AT+FOW will respond with \n00\r.

Arguments

filename string_constant. The name of the file to be deleted. The maximum length of filename is 24 characters and should not include the following characters **:*?"<>|**

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT+FOW "myapp"
```

AT+FOW is a core command.

AT+FWR

AT+FWR writes a string to a file that has previously been opened for writing using AT+FOW. The group of commands (AT+FOW, AT+FWR, AT+FWRH and AT+FCL) are typically used for downloading files to the module's flash filing system. For example, web pages or x.509 certificates or BLE data.

AT+FWR "string"

Command

Returns If the string is successfully written, AT+FWR will respond with \n00\r.

Arguments

string string_constant – A string that is appended to a previously opened file. Any \NN or \r or \n characters present within the string will get de-escaped before they are written to the file.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT+FWR "\nhelloworld\r"
AT+FWR "\00\01\02"
```

AT+FWR is a core command.

AT+FWRH

AT+FWRH writes a string to a file that has previously been opened for writing using AT+FOW. The group of commands (AT+FOW, AT+FWR, AT+FWRH and AT+FCL) are typically used for downloading files to the module's flash filing system. For example, web pages or x.509 certificates or BLE data.

AT+FWRH "string"

Command

Returns If the string is successfully written, AT+FWRH will respond with \n00\r.

Arguments

string string_constant – A string that is appended to a previously opened file. Only hexadecimal characters are allowed and the string is first converted to binary and then appended to the file.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT+FWRH "FE900002250DEDBEEF"
AT+FWRH "000102"

Invalid example

AT+FWRH "hello world"   'because not a valid hex string
```

AT+FWRH is a core command.

AT+FCL

AT+FCL closes a file that has previously been opened for writing using AT+FOW. The group of commands; AT+FOW, AT+FWR, AT+FWRH and AT+FCL are typically used for downloading files to the module's flash filing system.

AT+FCL

Command

Returns If the filename exists, AT+FCL will respond with \n00\r.

Arguments

None

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT+FCL
```

AT+FCL is a core command.

? (Read Variable)

When an application encounters a STOP, BPnnn, or END statement, it will fall into the Interactive Mode of operation and will not discard any global variables created by the application. This allows them to be referenced in Interactive mode.

? var <[index]>

Command

Returns Displays the value of the variable if it had been created by the application. If the variable is an array then the element index MUST be specified using the [n] syntax.

If the variable exists and it is a simple type then the response to this command is

\n08\tnnnnnn\r
\n00\r

If the variable is a string type, then the response is

\n08\t"Hello World"\r
\n00\r

If the variable does not exist then the response to this command is

\n01\tE023\r

Where \n = linefeed, \t = horizontal tab and \r = carriage return

---

Note: If the optional type prefix is present, the output value, when it is an integer constant is displayed in that base. For example:

? h' var returns

\n08\tH'nnnnnn\r

\n00\r

Arguments

Var <[n]> Any valid variable with mandatory [n] if the variable is an array.

For integer variables, the display format can be selected by prefixing the variable with one of the integer type prefixes:

D' := Decimal
H' := Hexadecimal
O' := Octal
B' := Binary

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:
? argc
08     11
00
? h'argc
08     H'0000000B
00
? B'argc
08     B'00000000000000000000001011
? argv[0]
08     "hello"
00
```

? is a core command.

= (Set Variable)

When an application encounters a STOP, BPnnn, or END statement, it will fall into the Interactive mode of operation and will not discard the global variables so that they can be referenced in Interactive mode. The = command is used to change the content of a known variable. When the application is RESUMEd, the variable will contain the new value. It is useful when debugging applications.

= var<[n]> value

Command

Returns If the variable exists and the value is of a compatible type then the variable value is overwritten and the response to this command is:

\n00\r

If the variable exists and it is NOT of compatible type then the response to this command is

\n01\tE027\r

If the variable does not exist then the response to this command is

\n01\tE023\r

If the variable exists but the new value is missing, then the response to this command is

\n01\tE26\r

Where \n = linefeed, \t = horizontal tab and \r = carriage return

Arguments

Var<[n]> The variable whose value is to be changed

value A string_constant or integer_constant of appropriate form for the variable.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples: (after an app exits which had DIM'd a global variable called 'argc')
? argc
08     11
00
= argc 23
00
? argc
08     23
00
```

= is a core command.

SO

SO (Step Over) is used to execute the next line of code in Interactive Mode after a break point has been encountered when an application had been launched using the AT+DBG command.

Use this command after a breakpoint is encountered in an application to process the next statement. SO can then be used repeatedly for single line execution

SO is normally used as part of the debugging process after examining variables using the ? Interactive Command and possibly the **=** command to change the value of a variable.

See also the BP nnnn, AT+DBG, ABORT, and RESUME commands for more details to aid debugging.

SO is a core function.

RESUME

RESUME is used to continue operation of an application from Interactive Mode which had been previously halted. Normally this occurs as a result of execution of a STOP or BP statement within the application. On execution of RESUME, application operation continues at the next statement after the STEP or BP statement.

If used after a SO command, application execution commences at the next statement.

RESUME

Command

Returns If there is nothing to resume (e.g. immediately after reset or if there are no more statements within the application), then an error response is sent.

\n01\tE029\r

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed

Interactive Command: YES

```
Examples:

RESUME
```

RESUME is a core function.

ABORT

Abort is an Interactive Mode command which is used to abandon an application, whose execution has halted because it has processed a STOP or BP statement.

ABORT

Command

Returns Abort is an Interactive Mode command which is used to abandon an application, whose execution has halted because it had processed a STOP or BP statement. It there is nothing to abort then it will return a success 00 response.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:
(Assume the application someapp.sb has a STOP statement somewhere which will invoke command mode)

AT+RUN “someapp”
ABORT
```

ABORT is a core command.

AT+REN

Renames an existing file.

AT+REN “oldname” “newname”

Command

Returns OK if the file is successfully renamed.

Arguments

oldname	string_constant.	The name of the file to be renamed.
Newname	string_constant.	The new name for the file.
		The maximum length of filename is 24 characters.

oldname and *newname* must contain a valid filename, which cannot contain the following seven characters

: * ? " < > |

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:
```

```
AT+REN "oldscript.txt" "newscript.txt"
```

AT+REN is a core command.

AT&F

AT&F provides facilities for erasing various portions of the module's non-volatile memory.

AT&F integermask

Command

Returns OK if file successfully erased.

Arguments

Integermask Integer corresponding to a bit mask or the "*" character

The mask is an additive integer mask, with the following meaning:

1	Erases normal file system and system config keys (see AT+GET and AT+SET for examples of config keys)
2	Not applicable to current modules
4	Not applicable to current modules
8	Not applicable to current modules
16	Erases the User config keys only
32	Not applicable to current modules
*	Erases all data segments

If an asterisk is used in place of a number, then the module is configured back to the factory default state by erasing all flash file segments.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT&F 1       'delete the file system
AT&F 16      'delete the user config keys
AT&F *       'delete all data segments
```

AT&F is a core command.

AT Z or ATZ

Resets the cpu.

AT Z

Command

Returns \n00\r

Arguments
None

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Interactive Command: YES

```
Examples:

AT Z
```

AT Z is a core command.

AT + BTD *

Deletes the bonded device database from the flash.

AT + BTD*

Command

Returns \n00\r

Arguments
None

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Note that the module will self-reboot so that the bonding manager context is reset too.

Interactive Command: YES

```
Examples:

AT+BTD*
```

AT+BTD* is an extension command

AT + MAC "12 hex digit mac address"

This is a command that will be successful one time only as it writes a IEEE mac address to non-volatile memory. This address is then used instead of the random static mac address that comes preprogrammed in the module.

Notes
* If the module has an invalid licence then this address will not be visible.
* If the address "000000000000" is written then it will be treated as invalid and prevent a new address from being entered.

AT + MAC "12 hex digits"

Command

Returns \n00\r
or
\n01 192A\r

Where the error code 192A is "NVO_NVWORM_EXISTS" meaning a IEEE mac address already exists, which can be read using the command AT I 24

Arguments

A string delimited by "" which shall be a valid 12 hex digit mac address that is written to non-volatile memory.

This is an Interactive Mode command and MUST be terminated by a carriage return for it to be processed.

Note that the module will self-reboot if the write is successful. Subsequent invocations of this command will generate an error.

Interactive Command: YES

```
Examples:

AT+MAC "008098010203"
```

AT+MAC is an extension command

4 *SMART*BASIC COMMANDS

smart BASIC contains a wide variety of commands and statements. These include a core set of programming commands found in most languages and extension commands that are designed to expose specific functionality of the platform; for example, Bluetooth Low Energy's GATT, GAP, and security functions.

Because *smart* BASIC is designed to be a very efficient embedded language, users need to take care of the syntax of these commands.

Syntax

smart BASIC commands are classified as one of the following:

- Functions
- Subroutines
- Statements

Functions

A function is a command that generates a return value and is normally used in an expression. For example:

newstr$** = **LEFT$ (***oldstring$***, ***num***)

In other words, functions cannot appear on the left hand side of an assignment statement (which has the equals sign). However, a function may affect the value of variables used as parameters if it accepts them as references rather than as values. This subtle difference is described further in the next section.

Subroutines

A subroutine does not generate a return value and is generally used as the only command on a line. Like a function, it may affect the value of variables used as parameters if it accepts them as references rather than values. For example:

STRSHIFTLEFT (***string$***, ***num***)

This brings us to the definition of the different forms an argument can take, both for a function and a subroutine. When a function is defined, its arguments are also defined in the form of how they are passed – either as **byVal** (by their value) or **byRef** (by reference). For byVal, a copy of the original is passed to the routine; changes to that variable within the block of the routine do not get reflected back to the variable in the caller block of code.

Passing Arguments as byVal

If an argument is passed as byVal, then the function or subroutine only sees a copy of the value. While it is able to change the copy of the variable, on exit, any changes are lost.

Passing Arguments as byRef

If an argument is passed as byRef, then the function or subroutine can modify the variable and, on exit, the variable that was passed to the routine contains the new value.

To understand it, look at the *smart* BASIC subroutine **STRSHIFTLEFT**. It takes a string and shifts the characters to the left by a specified number of places:

STRSHIFTLEFT (***string$***, ***num***)

It is used as a command on *string$*, which is defined as being passed as byRef. This means that when the rotation is complete, *string$* is returned with its new value. ***num*** defines the number of places that the string is shifted and passed as byVal; the original variable ***num*** is unchanged by this subroutine.

Note: Throughout the definition of the following commands, arguments are explicitly stated as being byVal or byRef.

A characteristic of functions, as opposed to subroutines, is that they always return a value. Arguments may be either byVal or byRef. In general and by default, string arguments are passed byRef. The reason for this is twofold:

- It saves valuable memory space because a copy of the string (which may be long) does not need to be copied to the stack.
- A string copy operation is lengthy in terms of cpu execution time. However, in some cases the valuables are passed byVal and in that case, when the function or subroutine is invoked, a constant string in the form "string" can be passed to it.

Note: For arguments specified as byRef, it is not possible to pass a constant value – whether number or string.

Statements

Statements do not take arguments, but instead take arithmetic or string expression lists. The only Statements in *smart* BASIC are PRINT and SPRINT.

Exceptions

Developing a software application that is error free is virtually an impossible task. All functions and subroutines act on the data that is passed to them and there are occasions when the values do not make sense. For example, when a divide operation is requested and the divisor passed to the function is the value 0. In these types of cases it is impossible to generate a return of meaningful value, but the event needs to be trapped so that the effects of doing that operation can be mitigated.

The mitigation process is via the inclusion of an ONERROR handler as explained in detail later in this manual. If the application does NOT provide an ONERROR handler and if an exception is encountered at run-time, then the application will abort to the Interactive Mode. This WILL be disastrous for unattended use cases. A good catchall ONERROR is to invoke a handler in which the module is reset, then at least the module will reset from a known condition.

Language Definitions

Throughout the rest of this manual, the following convention is used to describe *smart* BASIC commands and statements:

Command

Description of the command.

COMMAND (<byRef | byval> *arg1 <AS type>*,..)
FUNCTION / SUBROUTINE / STATEMENT

Returns			
TYPE	Description. Value that a function returns (always byVal).		
Exceptions			
ERRVAL	Description of the error.		
Arguments (a list of the arguments for the command)			
arg1	byRef	TYPE	A description, with type, of the variable.
argn	byVal	TYPE	A description, with type, of the variable.
Interactive Command		Whether the command can be run in Interactive mode using the **!** token.	

```
'Examples

Examples using the command.
```

Always consult the release notes for a particular firmware release when using this manual. Due to continual firmware development, there may be limitations or known bugs in some commands that cause them to differ from the descriptions given in the following chapters.

Variables

One of the important rules is that variables used within an application MUST be declared before they are referenced within the application. In most cases the best place is at the start of the application. Declaring a variable can be thought of as reserving a portion of memory for it. *smart* BASIC does not support forward declarations. If an application references a variable that has not been declared, then the parser reports an **ERROR** aborts the compilation.

Variables are characterised by two attributes:

- Variable Scope
- Variable Class

DIM

The Declare statement is used to declare a number of variables of assorted types to be defined in a single statement.

If it is used within a *FUNCTION* or *SUB* block of code, then those variables will only have local scope. Otherwise they will have validity throughout the application. If a variable is declared within a *FUNCTION* or *SUB* and a variable of the same name already exists with global scope, then this declaration will take over whilst inside the FUNCTION or SUB. However, this practice should be avoided.

DIM *var<,var<,…>>*

Arguments:

- ***Var –*** A complete variable definition with the syntax ***varname <AS type>***. Multiple variables can be defined in any order, with each definition being separated by a comma.

  Each variable (***var***) consists of one mandatory element ***varname*** and one optional element ***AS type*** separated by whitespaces and described as follows:

- ***Vaname*** – A valid variable name.
- ***AS type*** – Where 'type' is *INTEGER* or *STRING*. If this element is missing, then varname is used to define the type of the variable so that if the name ends with a $ character, then it defaults to a *STRING*; otherwise an *INTEGER* .

  A variable can be declared as an array, although only one dimension is allowed. Arrays must always be defined with their size, e.g.

  array [20] – The (20) with round brackets is also allowed.

  The size of an array cannot be changed after it is declared.

  Interactive Command: NO

```
'Example:

DIM temp1 AS INTEGER
DIM temp2                    'will be an INTEGER by default
```

```
DIM temp3$ AS STRING
DIM temp4$                  'will be a STRING by default
DIM temp5$ AS INTEGER       'allowed but not recommended practice as there
                            'is a $ at end of name
DIM temp6 AS STRING         'allowed but not recommended practice as no $
                            'at end of name
DIM a1,a2,a3$,a4            '3 INTEGER variables and 1 STRING variable
```

Variable Scope

The scope of a variable defines where it can be used within an application.

- **Local Variable** – The most restricted scope. These are used within functions or subroutines and are only valid within the function or subroutine. They are declared within the function or subroutine.
- **Global Variable** – Any variables not declared in the body of a subroutine or a function and are valid from the place they are declared within an application. Global Variables remain in scope at the end of an application, which allows the user or host processor to interrogate and modify them using the ? and = commands respectively.
  As soon as a new application is run, they are discarded.

Note: If a local variable has the same name as a global variable, then within a function or a subroutine, that global variable cannot be accessed.

Variable Class

smart BASIC supports two generic classes of variables:

Simple Variables – Numeric variables. There are currently two types of simple variables: INTEGER, which is a signed 32 bit variable (which also has the alias LONG), and ULONG, which is an unsigned 32 bit variable.

Simple variables are scalar and can be used within arithmetic expressions as described later.

- **Complex Variables** – Non-numeric variables. There is currently only one type STRING.

  STRING is an object of concatenated byte characters of any length up to a maximum of 65280 bytes, but for platforms with limited memory, it is further limited and that value can be obtained by submitting the AT I 1004 command when in Interactive mode and using the SYSINFO(1004) function from within an application.

  For example, in the BLE module the limit is 512 bytes since it is always the largest data length for any attribute.

  Complex variables can be used in expressions which are dedicated for that type of variable. In the current implementation of *smart* BASIC, the only general purpose operator that can be used with strings is the '+' operator which is used to concatenate strings.

```
'Example:

DIM i$ as STRING
DIM a$ as STRING
a$ = "Laird"
```

```
i$ = a$ + "Rocks!"
```

Note: To preserve memory, *smart* BASIC only allocates memory to string variables when they are first used and not when they are allocated. If too many variables and strings are declared in a limited memory environment it is possible to run out of memory at run time. If this occurs an *ERROR* is generated and the module will return to Interactive Mode. The point at which this happens depends on the free memory so will vary between different modules.

This return to Interactive Mode is NOT desirable for unattended embedded systems. To prevent this, every application MUST have an *ONERROR* handler which is described later in this user manual.

Note: Unlike in the "C" programming language, strings are not null terminated.

Arrays

Variables can be created as arrays of **single dimensions**; their size (number of elements) must be explicitly stated when they are first declared using the nomenclature [x] or (x) after the variable name, e.g.

DIM array1 [10] AS STRING

DIM array2(10) AS STRING

```
 'Example:

DIM nCmds AS INTEGER
DIM stCmds[20] AS STRING   'declare an array as a string with 20 elements
stCmds[0]="ATS0=1\r"
stCmds[1]="ATS512=4\r"
stCmds[2]="ATS501=1\r"
stCmds[3]="ATS502=1\r"
stCmds[4]="ATS503=1\r"
stCmds[5]="ATS504=1\r"
stCmds[6]="AT&W\r"
nCmds=6

DIM i AS INTEGER
for i 0 to nCmds step 1
  SendData(stCmds[i])
  WaitForOkResp()
Next
```

General Comments on Variables

Variable Names begin with 'A' to 'Z' or '_' and then can have any combination of 'A' to 'Z', '0' to '9' '$' and '_'.

Note: Variables names are not case sensitive, i.e *test$* and *TEST$* are the same variable.

smart BASIC is a strongly typed language and so if the compiler encounters an incorrect variable type then the compilation will fail.

Declaring Variables

Variables are normally declared individually at the start of an application or within a function or subroutine.

```
DIM string$ AS STRING
DIM str1$    '// the $ at the end of the name implies a string
            '// so AS STRING not necessary
DIM temp1 AS INTEGER
DIM alarmstate '// no $ at the of the name implies an integer
               '// so AS INTEGER not necessary
DIM array [10] AS STRING
```

Constants

Numeric Constants

Numeric Constants can be defined in Decimal, Hexadecimal, Octal, or Binary using the following nomenclature:

Decimal	D'1234	or	1234 (default)
Hex	H'1234	or	0x1234
Octal	O'1234		
Binary	B'01010101		

Note: By default, all numbers are assumed to be in decimal format.

The maximum decimal signed constant that can be entered in an application is 2147483647 and the minimum is -2147483648.

A hexadecimal constant consists of a string consisting of characters 0 to 9, and A to F or a to f. It must be prefixed by the two character token H' or h' or 0x.

```
H'1234
h'DEADBEEF
0x1234
```

An octal constant consists of a string consisting of characters 0 to 7. It must be prefixed by the two character token O' or o'.

```
O'1234
o'5643
```

A binary constant consists of a string consisting of characters 0 and 1. It must be prefixed by the two character token B' or b'.

```
B'11011100
```

```
b'11101001
```

A binary constant can consist of 1 to 32 bits and is left padded with 0s.

String Constants

A string constant is any sequence of characters starting and ending with the " character. To embed the " character inside a string constant specify it twice.

```
"Hello World"
"Laird_""Rocks"""  -- in this case the string is stored as Laird_"Rocks"
```

Non-printable characters and print format instructions can be inserted within a constant string by escaping using a starting '\' character and two hexadecimal digits. Some characters are treated specially and only require a single character after the '\' character.

The table below lists the supported characters and the corresponding string.

Character	Escaped String
Linefeed	\n
Carriage return	\r
Horizontal Tab	\t
\	\5C
"	\22 or ""
A	\41
B	\42
etc…	

Compiler related Commands and Directives

#SET

The *smart*BASIC complier converts applications into an internally compiled program on a line by line basis. It has strict rules regarding how it interprets commands and variable types. In some cases it is useful to modify this default behaviour, particularly within user defined functions and subroutines. To allow this, a special directive is provided - #SET.

#SET is a special directive which instructs the complier to modify the way that it interprets commands and variable types. In normal usage you should never have to modify any of the values.

#SET **must** be asserted before the source code that it affects, or the compiler behaviour will not be altered.

#SET can be used multiple times to change the tokeniser behaviour throughout a compilation.

#SET commandID, commandValue

Arguments	
cmdID	Command ID and valid range is 0..10000
cmdValue	Any valid integer value

Currently *smart*BASIC supports the following cmdIDs:

CmdID	MinVal	MaxVal	Default	Comments
1	0	1	0	Default Simple Arguments type for routines. 0 = ByRef, 1=ByVal
2	0	1	1	Default Complex Arguments type for routines. 0 = ByRef, 1=ByVal
3	8	256	32	Stack length for Arithmetic expression operands
4	4	256	8	Stack length for Arithmetic expression constants
5	16	65535	1024	Maximum number of simple global variables per application
6	16	65535	1024	Maximum number of complex global variables per application
7	2	65535	32	Maximum number of simple local variables per routine in an application
8	2	65535	32	Maximum number of complex local variables per routine in an application
9	2	32767	256	Max array size for simple variables in DIM
10	2	32767	256	Max array size for complex variables in DIM

Note: Unlike other commands, #SET may not be combined with any other commands on a line.

```
'Example

#set 1 1   'change default simple args to byRef
#set 2 0   'change default complex args to byVal
```

Arithmetic Expressions

Arithmetic expressions are a sequence of integer constants, variables, and operators. At runtime the arithmetic expression, which is normally the right hand side of an "=" sign, is evaluated. Where it is set to a variable, then the variable takes the value and class of the expression (e.g INTEGER).

If the arithmetic expression is invoked in a conditional statement, its default type is an INTEGER.

Variable types should not be mixed.

```
Examples:

DIM Sum1,bit1,bit2
DIM Volume,height,area
```

```
Sum1 = bit1 + bit2
Volume = height * area
```

Arithmetic Operators can be unitary or binary. A unitary operator acts on a variable or constant which follows it, whereas a binary operator acts on the two entities on either side.

Operators in an expression observe a precedence which is used to evaluate the final result using reverse polish notation. An explicit precedence order can be forced by using the '(' and ')' brackets in the usual manner.

The following is the order of precedence within operators:

- Unitary operators have the highest precedence

!	logical NOT
~	bit complement
-	negative (negate the variable or number – multiplies it by -1)
+	positive (make positive – multiplies it by +1)

- Precedence then devolves to the binary operators in the following order:

*****	Multiply
/	Divide
%	Modulus
+	Addition
-	Substraction
<<	Arithmetic Shift Left
>>	Arithmetic Shift Right
<	Less Than (results in a 0 or 1 value in the expression)
<=	Less Than Or Equal (results in a 0 or 1 value in the expression)
>	Greater Than (results in a 0 or 1 value in the expression)
>=	Greater Than Or Equal (results in a 0 or 1 value in the expression)
==	Equal To (results in a 0 or 1 value in the expression)
!=	Not Equal To (results in a 0 or 1 value in the expression)
&	Bitwise AND
^	Bitwise XOR (exclusive OR)
|	Bitwise OR
&&	Logical AND (results in a 0 or 1 value in the expression)
^^	Logical XOR (results in a 0 or 1 value in the expression)
||	Logical OR (results in a 0 or 1 value in the expression)

Conditionals

Conditional functions are used to alter the sequence of program flow by providing a range of operations based on checking conditions.

Note that *smart* BASIC does not support program flow functionality based on unconditional statements, such as JUMP or GOTO. In most cases where a GOTO or JUMP might be employed, ONERROR conditions are likely to be more appropriate.

Conditional blocks can be nested. This applies to combinations of DO, UNTIL, DOWHILE, FOR, IF, WHILE, and SELECT. The depth of nesting depends on the build of *smart* BASIC, but in general, nesting up to 16 levels is allowed and can be modified using the AT+SET command.

DO / UNTIL

This DO / UNTIL construct allows a block of statements, consisting of one or more statements, to be processed UNTIL a condition becomes true.

DO
statement block
UNTIL *arithmetic expr*

- ***statement block*** – A valid set of program statements. Typically several lines of application
- ***Arithmetic expression*** – A valid arithmetic or logical expression. Arithmetic precedence, is as defined in the section 'Arithmetic Expressions'.

For DO / UNTIL, if the arithmetic expression evaluates to zero, then the statement block is executed again. Care should be taken to ensure this does not result in infinite loops.

Interactive Command: NO

```
DIM A AS INTEGER   'don't really need to supply AS INTEGER
A=1
DO
  A = A+1
  PRINT A
UNTIL A==10        'loop will end when A gets to the value 10
```

DO / UNTIL is a core function.

DO / DOWHILE

This DO / DOWHILE construct allows a block of statements, consisting of one or more statements, to be processed the expression in the DOWHILE statement evaluates to a true condition.

DO
statement block
DOWHILE *arithmetic expr*

- ***statement block*** – A valid set of program statements. Typically several lines of application

- ***Arithmetic expression*** – A valid arithmetic or logical expression. Arithmetic precedence, is as defined in the section 'Arithmetic Expressions'.

For DO / DOWHILE, if the arithmetic expression does not evaluate to zero, then the statement block is executed again. Care should be taken to ensure this does not result in infinite loops.

Interactive Command: NO

```
DIM A AS INTEGER    'don't really need to supply AS INTEGER
A=1
DO
  A = A+1
  PRINT A
DOWHILE A<10        'loop will end when A gets to the value 10
```

DO / DOWHILE is a core function.

FOR / NEXT

The FOR / NEXT composite statement block allows program execution to be controlled by the evaluation of a number of variables. Use of the tokens TO or DOWNTO determines the order of execution. An optional STEP condition allows the conditional function to step at other than unity steps. Given the choice of either TO/DOWNTO and the optional STEP, there are 4 variants as follows:

FOR var = *arithexpr1* TO *arithexpr2*
statement block
NEXT

FOR var = *arithexpr1* TO *arithexpr2* STEP arithexpr3
statement block
NEXT

FOR var = *arithexpr1* DOWNTO *arithexpr2*
statement block
NEXT

FOR var = *arithexpr1* DOWNTO *arithexpr2* STEP arithexpr3
statement block
NEXT

- ***statement block*** – A valid set of program statements. Typically several lines of application which can include nested conditional statement blocks.
- ***var*** – A valid INTEGER variable which can be referenced in the statement block
- ***Arithexpr1*** – A valid arithmetic or logical expression. ***arithexpr1*** is enumerated as the starting point for the FOR NEXT loop.
- ***Arithexpr2*** – A valid arithmetic or logical expression. ***arithexpr2*** is enumerated as the finishing point for the FOR NEXT loop.
- ***Arithexpr3*** – A valid arithmetic or logical expression. ***arithexpr3*** is enumerated as the step in variable values in processing the FOR NEXT loop. If STEP and ***arithexpr3*** are omitted, then a unity step is assumed.

Note: Arithmetic precedence, is as defined in the section 'Arithmetic Expressions'

The lines of code comprising the ***statement block*** are processed with ***var*** starting with the value calculated or defined by **arithexpr1**. When the **NEXT** command is reached and processed, the **STEP** value resulting from ***arithexpr3*** is added to ***var*** if **TO** is specified, or subtracted from ***var*** if **DOWNTO** is specified.

The function continues to loop until the variable ***var*** contains a value less than or equal to ***arithexpr2*** in the case where TO is specified, or greater than or equal to ***arithexpr2*** in the alternative case where **DOWNTO** is specified.

Note: In *smart* BASIC the Statement Block is ALWAYS executed at least once.

Interactive Command: NO

```
DIM A
FOR A=1 TO 2                    'output  -HelloHello
  PRINT "Hello"
NEXT
FOR A=2 DOWNTO 1                'output  -HelloHello
  PRINT "Hello"
NEXT
FOR A=1 TO 4 STEP 2             'output  -HelloHello
  PRINT "Hello"
NEXT
```

FOR / NEXT is a core function.

IF THEN / ELSEIF / ELSE / ENDIF

The IF statement construct allows a block of code to be processed depending on the evaluation of a condition expression. If the statement is true (equates to non-zero), then the following block of application is processed, until an ENDIF, ELSE, or ELSEIF command is reached.

Each ELSEIF allows an alternate statement block of application to be executed if that conditional expression is true and any preceding conditional expressions were untrue.

Multiple ELSEIF commands may be added, but only the statement block immediately following the first true conditional expression encountered is processed within each IF command.

The final block of statements is of the form ELSE and is optional.

IF *arithexpr_1* THEN
statement block A
ENDIF

IF *arithexpr_1* THEN
statement block A
ELSE
statement block B
ENDIF

IF *arithexpr_1* THEN
statement block A
ELSEIF *arithexpr_2* THEN
statement block B
ELSE
statement block C
ENDIF

- ***statement block A|B|C*** – A valid set of program zero or many statements.
- ***Arithexpr_n*** – A valid arithmetic or logical expression. – A valid arithmetic or logical expression. Arithmetic precedence, is as defined in the section 'Arithmetic Expressions'.

All IF constructions must be terminated with an ENDIF statement.

Note: As the arithmetic expression in an IF statement is making a comparison, rather than setting a variable, the double == operator MUST be used, e.g.

IF i==3 THEN : SLEEP(200)

See the Arithmetic Expressions section for more options.

Interactive Command: NO

```
DIM N
N=1
IF N>0 THEN
  PRINT "Laird Rocks"
ENDIF
IF N==0 THEN
```

```
  PRINT "N is 0"
ELSEIF N==1 THEN
  PRINT "N is 1"
ELSE
  PRINT "N is not 0 nor 1"
ENDIF
```

IF is a core function.

WHILE / ENDWHILE

WHILE tests the arithmetic expression that follows it. If it equates to non-zero then the following block of statements is executed until an ENDWHILE command is reached. If it is zero, then execution continues after the next ENDWHILE.

WHILE *arithexpr*
statement block
ENDWHILE

- ***statement block*** – A valid set of zero or more program statements.
- ***Arithexpr*** – A valid arithmetic or logical expression. Arithmetic precedence, is as defined in the section 'Arithmetic Expressions'.

All WHILE commands must be terminated with an ENDWHILE statement.

Interactive Command: NO

```
DIM N
N=0

'now print "Hello" ten times

WHILE N<10
  PRINT "Hello " ;N
  N=N+1
ENDWHILE
```

WHILE is a core function.

SELECT / CASE / CASE ELSE / ENDSELECT

SELECT is a conditional command that uses the value of an arithmetic expression to pass execution to one of a number of blocks of statements which are identified by an appropriate CASE nnn statement, where nnn is an integer constant. After completion of the code, which is marked by a CASE nnn or CASE ELSE statement, execution of application moves to the line following the ENDSELECT command. In a sense it is a more efficient implementation of an IF block with many ELSEIF statements.

An initial block of code can be included after the SELECT statement. This will always be processed. When the first CASE statement is encountered, execution will move to the CASE statement corresponding to the computed value of the arithmetic expression in the SELECT command.

After selection of the appropriate CASE, the relevant statement block is executed, until a CASE, BREAK or ENDSELECT command is encountered. If a match is not found, then the CASE ELSE statement block is run.

It is MANDATORY to include a final CASE ELSE statement as the final CASE in a SELECT operation.

SELECT *arithexpr*
** unconditional statement block**
CASE integerconstA
** statement block A**
CASE integerconstB
** statement block B**
CASE integerconstc,integerconstd, integerconste, integerconstf, …
** statement block C**
CASE ELSE
** statement block**
ENDSELECT

- ***unconditional statement block –*** An optional set of program statements, which are always executed.
- ***statement block –*** A valid set of zero or more program statements.
- ***Arithexpr –*** A valid arithmetic or logical expression. Arithmetic precedence, is as defined in the section 'Arithmetic Expressions'.
- ***integerconstX*** – One or more comma seperated integer constants corresponding to one of the possible values of ***arithexpr*** which identifies the block that will get processed.

Interactive Command: NO

```
DIM A,B,C

A=3 : B=4

SELECT A*B
CASE 10
  C=10
CASE 12              ' this block will get processed
  C=12
CASE 14,156,789,1022
  C=-1
CASE ELSE
  C=0
ENDSELECT
PRINT C
```

SELECT is a core function.

BREAK

Break is relevant in a WHILE/ENDWHILE, DO/UNTIL, DO/DOWHILE, FOR/NEXT, or SELECT/ENDSELECT compound construct. It forces the program counter to exit the currently processing block of statements.

For example, in a WHILE/ENDWHILE loop the statement BREAK stops the loop and forces the command immediately after the ENDWHILE to be processed. Similarly, in a DO/UNTIL, the statement immediately after the UNTIL is processed.

BREAK

Interactive Command: NO

```
DIM N
N=0

'now print "Hello" ten times

WHILE N<10
  PRINT "Hello " ;N
  N=N+1
  IF N==5 THEN
    BREAK                'Only 5 Hello will be printed
  ENDIF
ENDWHILE
```

BREAK is a core function.

CONTINUE

CONTINUE is used within a WHILE/ENDWHILE, DO/UNTIL, DO/DOWHILE, or FOR/NEXT compound construct, where it forces the counter to jump to the beginning of the loop.

CONTINUE

Interactive Command: YES

```
WHILE N<10
  N=N+1
  IF N==5 THEN
    CONTINUE             'The 5th Hello will not get printed
  ENDIF
  PRINT "Hello " ;N
ENDWHILE
```

CONTINUE is a core function.

Error Handling

Error handling functions are provided to allow program control for instances where exception are generated for errors. These allow graceful continuation after an error condition is encountered and are recommended for robust operation in an unattended embedded use case scenario.

In an embedded environment, it is recommended to include at least one ONERROR and one ONFATALERROR statement within each application. This ensures that if the module is running unattended then it can reset itself and restart itself without the need for operator intervention.

ONERROR

ONERROR is used to redirect program flow to a handler function that can attempt to modify operation or correct the cause of the error. Three different options are provided in conjunction with ONERROR and they are REDO, NEXT, and EXIT.

The GETLASTERROR() command should be used in the handler routine to determine the type of error that was generated.

ONERROR REDO routine

On return from the routine, the statement that originally caused the error is reprocessed.

ONERROR NEXT routine

On return from the routine, the statement that originally caused the error is skipped and the following statement is processed.

ONERROR EXIT

If an error is encountered, the application will exit and return operation to Interactive Mode.

Arguments:

- ***routine –*** The handler SUB that is called when the error is detected. This must be a SUB routine which takes no parameters. It must not be a function. It must exist within the application PRIOR to this ONERROR command being compiled.

Interactive Command: NO

```
DIM A,B,C
SUB HandlerOnErr()
  PRINT "Divide by 0 error"
ENDSUB
A=100 : B=0
ONERROR NEXT HandlerOnErr
C=A/B
```

ONERROR is a core function.

ONFATALERROR

ONFATALERROR is used to redirect program flow to a subroutine that can attempt or modify operation or correct the cause of a fatal error. Three different options are provided – REDO, NEXT, and EXIT.

The GETLASTERROR() command should be used in the subroutine to determine the type of error that was generated.

ONFATALERROR REDO routine

On return from the routine, the statement that originally caused the error is reprocessed.

ONFATALNERROR NEXT routine

On return from the routine, the statement that originally caused the error is skipped and the following statement is processed.

ONFATALNERROR EXIT

If an error is encountered, the application will exit and return the operation to Interactive mode.

Arguments:

- ***Routine –*** The handler SUB that is called when the error is detected. This must be a SUB routine which takes no parameters. It must not be a function. It must exist within the application PRIOR to this ONFATALERROR command being compiled.

Interactive Command: NO

```
DIM A,B,C
SUB HandlerOnErr()
  PRINT "Divide by 0 error"
ENDSUB
A=100 : B=0
ONFATALERROR NEXT HandlerOnErr
C=A/B
```

ONFATALERROR is a core function.

Event Handling

An application written for an embedded platform is left unattended and in most cases waits for something to happen in the real world, which it detects via an appropriate interface. When something happens it needs to react to that event. This is unlike sequential processing where the program code order is written in the expectation of a series of preordained events. Real world interaction is not like that and so this implementation of *smart* BASIC has been optimised to force the developer of an application to write applications as a group of handlers used to process events in the order as and when those events occur.

This section describes the statements used to detect and manage those events.

WAITEVENT

WAITEVENT is used to wait for an event, at which point an event handler is called. The event handler must be a function that takes no arguments and returns an INTEGER.

If the event handler returns a zero value, then the next statement after WAITEVENT is processed. Otherwise WAITEVENT will continue to wait for another event.

WAITEVENT

Interactive Command: NO

```
FUNCTION Func0()
  PRINT "\nEV0"
ENDFUNC 1

FUNCTION Func1()
  PRINT "\nEV1"
ENDFUNC 0

ONEVENT EV0 CALL Func0
ONEVENT EV1 CALL Func1

WAITEVENT                        'wait  for an event  to occur

PRINT "\n Got here because EV0 happened"
```

WAITEVENT is a core function.

ONEVENT

ONEVENT is used to redirect program flow to a predefined FUNCTION that can respond to a specific event when that event occurs. This is commonly an external event, such as an I/O pin change or a received data packet, but can be a software generated event too.

ONEVENT symbolic_name CALL routine

When a particular event is detected, program execution is directed to the specified subroutine.

ONEVENT symbolic_name DISABLE

A previously declared ONEVENT for an event is unbound from the specified subroutine. This allows for complex applications that need to optimise runtime processing by allowing an alternative to using a SELECT statement.

Events are detected from within the run-time engine – in most cases via interrupts - and will only be processed by an application when a WAITEVENT statement is processed.

Until the WAITEVENT all events are held in a queue.

Note: When WAITEVENT services an event handler, if the return value from that routine is non-zero, then it will continue to wait for more events. A zero value will force the next statement after WAITEVENT to be processed

Arguments:

- ***Routine –*** The FUNCTION that is called when the error is detected. This must be a function which returns an INTEGER and takes no parameters. It must not be a SUB routine. It must exist within the application PRIOR to this ONEVENT command.
- ***Symbolic_Name*** – A symbolic event name which is predefined for a specific *smart* BASIC module.

Some Symbolic Event Names:

A partial list of symbolic event names are as follows:-

EVTMRn	Timer n has expired (see Timer Events)
EVUARTRX	Data has arrived in UART interface
EVUARTTXEMPTY	The UART TX ring buffer is empty

Note: Some symbolic names are specific to a particular hardware implementation.

Interactive Command: NO

```
FUNCTION Func0()
  PRINT "\nTimer 0"
ENDFUNC 1

FUNCTION Func1()
  PRINT "\nTimer 1"
ENDFUNC 1
```

```
ONEVENT EVTMR0 CALL Func0
ONEVENT EVTMR1 CALL Func1

TIMERSTART(0,500,0)
TIMERSTART(1,1500,0)

WAITEVENT                       'wait  for an event  to occur
```

ONEVENT is a core function.

Miscellaneous Commands

RESET

This routine is used to force a reset of the module.

RESET ()

Subroutine

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments None

Interactive Command: NO

```
RESET()     'force a reset of the module
```

RESET is a core function.

PRINT

The PRINT statement directs output to an output channel which may be the result of multiple comma or semicolon separated arithmetic or a string expression. The output channel is in most platforms a UART interface.

PRINT *exprlist*

Arguments:

exprlist An expression list which defines the data to be printed consisting of comma or semicolon separated arithmetic or string expressions.

Formatting with PRINT – Expression Lists

Expression Lists are used for outputting data – principally with the PRINT command and the SPRINT command. Two types of Expression List are allowed – arithmetic and string. Multiple valid Expression Lists may be concatenated with a comma or a semicolon to form a complex Expression List.

The use of a comma forces a TAB character between the Expression Lists it separates and a semicolon generates no output. The latter will result in the output of two expressions being concatenated without any whitespace.

Numeric Expression Lists

Numeric variables are formatted in the following form:

<type.base> arithexpr <separator>

Where,

- ***Type*** – Must be INTEGER for integer variables
- ***base*** – Integers can be forced to print in Decimal, Octal, Binary, or Hexadecimal by prefixing with D', O', B', or H' respectively.
  For example, **INTEGER.h' somevar** will result in the content of somevar being output as a hexadecimal string.
- ***Arithexpr –*** A valid arithmetic or logical expression. .
- ***Separator*** – One of the characters **,** or **;** which have the following meaning:

  , insert tab before next variable
  ; print next variable without any intervening whitespace

String Expression Lists

String variables are formatted in the following form:

<type . minchar> strexpr< separator>

- ***Type*** – Must be STRING for string variables. The ***type*** must be followed by a full stop to delineate it from the width field that follows.
- ***minchar*** - An optional parameter which specifies the number of characters to be printed for a string variable or expression. If necessary, leading spaces will be filled with spaces.
- ***strexpr –*** A valid string or string expression.
- ***separator*** – One of the characters , or ; which have the following meaning:

  , Insert tab before next variable
  ; Print next variable without a space

Interactive Command: YES

```
PRINT  "Hello"
DIM A
A=100
PRINT A            'print as decimal
PRINT h'A          'print as hex
PRINT o'A          'print as octal
PRINT b'A          'print as binary
```

PRINT is a core function.

SPRINT

The SPRINT statement directs output to a string variable, which may be the result of multiple comma or semicolon separated arithmetic or a string expression.

It is very useful for creating strings with formatted data.

SPRINT #stringvar, *exprlist*

Arguments:

- ***stringvar*** A pre-declared string variable
- ***exprlist*** An expression list which defines the data to be printed consisting of comma or semicolon separated arithmetic or string expressions.

Formatting with SPRINT – Expression Lists

Expression Lists are used for outputting data – principally with the PRINT command and the SPRINT command. Two types of Expression List are allowed – arithmetic and string. Multiple valid Expression Lists may be concatenated with a comma or a semicolon to form a complex Expression List.

The use of a comma forces a TAB character between the Expression Lists it separates and a semicolon generates no output. The latter will result in the output of two expressions being concatenated without any whitespace.

Numeric Expression Lists

Numeric variables are formatted in the following form:

<type.base> arithexpr <separator>

Where,

- ***Type*** – Must be INTEGER for integer variables
- ***base*** – Integers can be forced to print in Decimal, Octal, Binary, or Hexadecimal by prefixing with D', O', B', or H' respectively.
  For example, **INTEGER.h' somevar** will result in the content of somevar being output as a hexadecimal string.
- ***Arithexpr –*** A valid arithmetic or logical expression. .
- ***Separator*** – One of the characters **,** or **;** which have the following meaning:

  , insert tab before next variable
  ; print next variable without any intervening whitespace

String Expression Lists

String variables are formatted in the following form:

<type . minchar> strexpr< separator>

- ***Type*** – Must be STRING for string variables. The ***type*** must be followed by a full stop to delineate it from the width field that follows.

- ***minchar*** - An optional parameter which specifies the number of characters to be printed for a string variable or expression. If necessary, leading spaces will be filled with spaces.
- ***strexpr –*** A valid string or string expression.
- ***separator*** – One of the characters , or ; which have the following meaning:

  , Insert tab before next variable
  ; Print next variable without a space

Interactive Command: YES

```
DIM A, S$
A=100
SPRINT #S$,A              'S$ var will contain 100
PRINT S$
SPRINT #S$,h'A            'S$ var will contain 64
SPRINT #S$,o'A            'S$ var will contain 144
SPRINT #S$,b'A            'S$ var will contain 1100100
```

SPRINT is a core function.

STOP

STOP is used within an application to stop it running so that the device falls back into Interactive Command line mode.

STOP

It is normally limited to use in the prototyping and debugging phases.

Once in Interactive Mode the command RESUME is used to restart the application from the next statement after the STOP statement.

Interactive Command: NO

```
Examples:

STOP
```

STOP is a core function.

BP

The BP (Breakpoint) statement is used to place a BREAKPOINT in the body of an application. The integer constant that is associated with each breakpoint is just a developer supplied identifier which will get echoed to the standard output when that breakpoint is encountered. This allows the application developer to locate which breakpoint resulted in the output. Execution of the application will then be paused and operation passed back to Interactive Mode.

BP nnnn

After execution is returned to Interactive Mode, either RESUME can be used to continue execution or the Interactive Mode command SO can be used to step through the next

statements. Note that the next state will be the BP statement itself, hence multiple SO commands may need to be issued.

Command

Arguments

nnnn A constant integer identifier for each breakpoint in the range 0 to 65535. The integers should normally be unique to allow the breakpoint to be determined, but this is the responsibility of the programmer. There is no limit to the number of breakpoints that can be inserted into an application other than ensuring that the maximum size of the compiled code does not exceed the 64Kword limit.

Note: It is helpful to make the integer identifiers relevant to the program structure to help the debugging process. A useful tip is to set them to the program line.

Interactive Command: NO

```
Examples:

PRINT "hello"
BP 1234
PRINT "world"
BP 5678
```

BP is a core function.

5. Core Language Built-in Routines

Core Language builtin routines are present in every implementation of *smart* BASIC. These routines provide the basic programming functionality. They are augmented with target specific routines for different platforms which are described in the next chapter.

Information Routines

GETLASTERROR

GETLASTERROR is used to find the value of the most recent error and is most useful in an error handler associated with ONERROR and the ONFATALERROR statements which are described later in this manual.

GETLASTERROR ()

Function

Returns Last error that was generated.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments None

Interactive Command: NO

```
DIM err
err = GETLASTERROR()
print "\nerror  = 0x" ; h'err          'print it as a hex value
```

GETLASTERROR is a core function.

RESETLASTERROR

Resets the last error, so that calling GETLASTERROR() will return a success.

RESETLASTERROR ()

Function

Returns Does not have a return value.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments None

Interactive Command: NO

```
RESETLASTERROR()
```

RESETLASTERROR is a core function.

SYSINFO

Returns an informational integer value depending on the value of **varId** argument.

SYSINFO(varId)

Function

Returns Absolute value of ***var*** as an INTEGER.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

varId *byVal* var *AS INTEGER*

An integer ID which is used to determine which information is to be returned as described below.

0	ID of device, for the BL600 module the value will be 0x42460600
3	Version number of Module Firmware. For example W.X.Y.Z will be returned as a 32 bit value made up as follows:- (W<<26) + (X<<20) + (Y<<6) + (Z) where Y is the Build number and Z is the 'Sub-Build' number
33	BASIC core version number
601	Flash File System: Data Segment: Total Space
602	Flash File System: Data Segment: Free Space
603	Flash File System: Data Segment: Deleted Space
611	Flash File System: FAT Segment: Total Space
612	Flash File System: FAT Segment: Free Space
613	Flash File System: FAT Segment: Deleted Space

1000	BASIC compiler HASH value as a 32 bit decimal value
1001	How RAND() generates values: 0 for PRNG and 1 for hardware assist
1002	Minimum baudrate
1003	Maximum baudrate
1004	Maximum STRING size
1005	Will be 1 for run-time only implementation, 3 for compiler included
2000	Reset Reason 8 : Self-Reset due to Flash Erase 9 : ATZ 10 : Self-Reset due to *smart* BASIC app invoking function RESET()
2002	Timer resolution in microseconds
2003	Number of timers available in a *smart* BASIC Application
2004	Tick timer resolution in microseconds
2005	LMP Version number for BT 4.0 spec
2006	LMP Sub Version number
2007	Chipset Company ID allocated by BT SIG

Interactive Command: No

```
PRINT "\nSysInfo 1000 = ";SYSINFO(1000)    '// BASIC compiler HASH value
PRINT "\nSysInfo 2003 = ";SYSINFO(2003)    '// Number of timers
```

SYSINFO is a core language function.

Event & Messaging Routines

SENDMSGAPP

This function is used to send a EVMSGAPP message to your application so that it can be processed by a handler from the WAITEVENT framework. It is useful for serialised processing.

For messages to be processed the following statement must be processed so that a handler is associated with the message.

ONEVENT EVMSGAPP CALL HandlerMsgApp

Where a handler such as the following has been defined prior to the ONEVENT statement as follows:-

```
FUNCTION HandlerMsgApp(BYVAL nMsgId AS INTEGER, BYVAL nMsgCtx AS INTEGER) AS INTEGER
  '//do something with nMsgId and nMsgCtx
ENDFUNC 1
```

SENDMSGAPP(msgId, msgCtx)

Function

Returns A 0000 if successfully sent.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

msgId ***byVal* msgId *AS INTEGER***

Will be presented to the EVMSGAPP handler in the msgId field

msgCtx ***byVal* msgCtx *AS INTEGER***

Will be presented to the EVMSGAPP handler in the msgCtx field.

Interactive Command: NO

```
DIM rc

FUNCTION HandlerMsgApp(BYVAL nMsgId AS INTEGER, BYVAL nMsgCtx AS INTEGER) AS INTEGER
  PRINT "\nId=";nMsgId;" Ctx=";nMsgCtx  '//output will be 100,200
ENDFUNC 1

ONEVENT EVMSGAPP CALL HandlerMsgApp

rc = SendMsgApp(100,200)

WAITEVENT
```

SENDMSGAPP is a core function.

Arithmetic Routines

ABS

Returns the absolute value of its INTEGER argument.

ABS (var)

Function

Returns Absolute value of ***var*** as an INTEGER.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- If the value of var is 0x80000000 (decimal -2,147,483,648) then an exception is thrown as the absolute value for that value will cause an overflow as 33 bits are required to convey the value.

Arguments

var ***byVal* var *AS INTEGER***

The variable whose absolute value is required.

Interactive Command: No

```
DIM s1 as INTEGER,s2 as INTEGER
S1 = -2 : s2 = 4
PRINT S1, ABS(S1);"\n";s2, ANS(s2)
```

ABS is a core language function.

MAX

Returns the maximum of two integer values.

MAX (var1, var2)

Function

Returns The returned variable is the arithmetically larger of ***var1*** and ***var2***.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

var1 ***byVal*** **var1** ***AS INTEGER***

The first of two variables to be compared.

var2 ***byVal*** **var2** ***AS INTEGER***

The second of two variables to be compared.

Interactive Command: No

```
DIM s1 as INTEGER,s2 as INTEGER
S1 = -2 : s2 = 4
PRINT s1, MAX(s1,s2)
```

MAX is a core language function.

MIN

Returns the minimum of two integer values.

MIN (var1, var2)

Function

Returns The returned variable is the arithmetically smaller of ***var1*** and ***var2***.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

var1 ***byVal*** **var1** ***AS INTEGER***

The first of two variables to be compared.

var2 ***byVal*** **var2** ***AS INTEGER***

The second of two variables to be compared.

Interactive Command: No

```
DIM s1 as INTEGER,s2 as INTEGER
S1 = -2 : s2 = 4
PRINT s1, MIN(s1,s2)
```

MIN is a core language function.

String Routines

When data is displayed to a user, or a collection of octets need to be managed as a set, it is useful to represent them as strings. For example, in Bluetooth Low Energy modules there is a concept of a database of 'attributes' which are just a collection of octets of data up to 512 bytes in length.

To provide the ability to deal with strings, *smart* BASIC contains a number of commands that can operate on STRING variables.

LEFT$

Retrieves the leftmost n characters of a string.

LEFT$(string,length)

Function

Returns The leftmost 'length' characters of string as a STRING object.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The target string which cannot be a const string.

length ***byVal length AS INTEGER***

The number of leftmost characters that are returned.

If 'length' is larger than the actual length of ***string*** then then entire string is returned

Notes: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM newstring$                          ' declare strings
DIM ss as STRING                        ` should really append a $ to the name

ss="Arsenic"
```

```
newstring$ = left$(ss,4)                'get the four leftmost characters
print newstring$; "\n"
```

LEFT$ is a core language function.

MID$

Retrieves a string of characters from an existing string. The starting position of the extracted characters and the length of the string are supplied as arguments.

If 'pos' is positive then the extracted string starts from offet 'pos'. It it is negative then the extracted string starts from offset 'length of string – abs(pos)'

MID$(string, pos, length)

Function

Returns 'length' characters starting at 'pos' of string as a STRING object.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The target string which cannot be a const string.

pos ***byVal pos AS INTEGER***

The position of the first character to be extracted. The leftmost character position is 0 (see examples).

length ***byVal length AS INTEGER***

The number of characters that are returned.

If 'length' is larger than the actual length of ***string*** then the entire string is returned from the position specified. Hence pos=0,length=65535 will return a copy of ***string.***

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function.

Interactive Command: NO

```
DIM newstring$ AS STRING
DIM ss$

Ss$="Arsenic"
Newstring$ = mid$(ss$,0,4)  'get the four leftmost characters
print newstring; "\n"

DIM longstring$ AS STRING
DIM len AS INTEGER  'the Length variable must be an integer
DIM pos AS INTEGER

Longstring$ = "abcdefghijkl"
pos=0 : len = 6
newstring$ = mid$(longstring$,pos,len)
      '//newstring$ will be – abcdef
```

```
pos = 2 : len = 5
newstring$ = mid$(longstring$,pos,len)
      '//newstring$ will be - cdefg

pos = -5 : len = 3
newstring$ = mid$(longstring$,pos,len)
      '//newstring$ will be - hij
```

MID$ is a core language function.

RIGHT$

Retrieves the caller specified number of rightmost characters from a string.

RIGHT$(string, len)

Function

Returns The rightmost segment of length ***len*** from ***string.***

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The target string which cannot be a const string.

length ***byVal length AS INTEGER***

The rightmost number of characters that are returned.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

If 'length' is larger than the actual length of ***string*** then the entire string is returned**.**

Interactive Command: NO

```
DIM newstring$
DIM ss$ as STRING

ss$="Parse"
newstring$ = right$(ss$,4)              : 'get the four rightmost characters
print newstring$; "\n"
```

RIGHT$ is a core function.

STRLEN

STRLEN returns the number of characters within a string.

STRLEN (string)

Function

Returns The number of characters within the string.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The target string which cannot be a const string.

Interactive Command: NO

```
DIM s$
S$="HelloWorld"
PRINT "\n";S$;" is ";STRLEN(S$);" bytes long"
```

STRLEN is a core function.

STRPOS

STRPOS is used to determine the position of the first instance of a string within another string. If the string is not found within the target string a value of -1 is returned.

STRPOS (string1, string2, startpos)

Function

Returns Zero indexed position of ***string2*** within ***string1***

>=0 If ***string2*** is found within ***string*** and specifies the location where found
-1 If ***string2*** is not found within ***string1***

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string1 ***byRef string AS STRING***

The target string in which string2 is to be searched for.

string2 ***byRef string AS STRING***

The string that is being searched for within string1. This may be a single character string.

startpos ***byVAL startpos AS INTEGER***

Where to start the position search.

Note: STRPOS does a case sensitive search.

Note: **string1** and **string2** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

---

Interactive Command: NO

```
DIM s1$,s2$
S1$="Are you there"
S2$="there"
PRINT "\nIn ";S1$;" the word ";S2$;" occurs at position ";STRPOS(S1$,S2$,0)
```

STRPOS is a core function.

STRSETCHR

STRSETCHR allows a single character within a string to be replaced by a specified value. STRSETCHR can also be used to append characters to an existing string by filling it up to a defined index.

If the nIndex is larger than the existing string then it is extended.

The use of STRSETCHR and STRGETCHR, in conjunction with a string variable allows an array of bytes to be created and manipulated.

STRSETCHR (string, nChr, nIndex)

Function

Returns Represents command execution status.

0 If the block is successfully updated
-1 If ***nChr*** is greater than 255 or less than 0
-2 If the string length cannot be extended to accommodate ***nIndex***
-3 If the resultant string is longer than allowed.

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The target string.

nChr ***byVal nCHr AS INTEGER***

The character that will overwrite the existing characters. ***nChr*** must be within the range 0 and 255.

nindex ***byVal nIndex AS INTEGER***

The position in the string of the character that will be overwritten, referenced to a zero index.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM s$
S$="Hello"
PRINT strsetchr(s$,64,0)          'output will be @ello
PRINT strsetchr(s$,64,5)          'output will be Hello@
PRINT strsetchr(s$,64,8)          'output will be Hello@@@@
```

STRSETCHR is a core function.

STRGETCHR

STRGETCHR is used to return the single character at position nIndex within an existing string.

STRGETCHR (string, nIndex)

Function

Returns The ASCII value of the character at position ***nIndex*** within ***string***, where ***nIndex*** is zero based. If ***nIndex*** is greater than the number of characters in the string or <=0 then an error value of -1 is returned.

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The string from which the character is to be extracted.

nindex ***byVal nIndex AS INTEGER***

The position of the character within the string (zero based – see example).

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM s$
S$="Hello"
```

```
 PRINT strgetchr(s$,0)      'output will be  72 which is the ascii value for 'H'
 PRINT strgetchr(s$,1)      'output will be  101 which is the ascii value for 'e'
 PRINT strgetchr(s$,-100)   'output will be  -1 because index is negative
 PRINT strgetchr(s$,6)      'output will be  -1 because index is larger than the string
length
```

STRGETCHR is a core function.

STRSETBLOCK

STRSETBLOCK allows a specified number of characters within a string to be filled or overwritten with a single character. The fill character, starting position and the length of the block are specified.

STRSETBLOCK (string, nChr, nIndex, nBlocklen)

Function

Returns

0 If the block is successfully updated
-1 If nChr is greater than 255
-2 If the string length cannot be extended to accommodate ***nBlocklen***
-3 if the resultant string will be longer than allowed
-4 If ***nChr*** is greater than 255 or less than 0
-5 if the nBlockLen values is negative

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The target string to be modified

nChr ***byVal nChr AS INTEGER***

The character that will overwrite the existing characters.
nChr must be within the range 0 – 255

nindex ***byVal nIndex AS INTEGER***

The starting point for the filling block, referenced to a zero index.

nBlocklen ***byVal nBlocklen AS INTEGER***

The number of characters to be overwritten

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM s$
S$="HelloWorld"
PRINT strsetblock(S$,64,4,2)     'output will be 0
```

```
PRINT S$                    'output will be Hell@@orld
PRINT strsetblock(S$,64,4,200)   'output will be -1
```

STRSETBLOCK is a core function.

STRFILL

STRFILL is used to erase a string and then fill it with a number of identical characters.

STRFILL (string, nChr, nCount)

Function

Returns SWORD Represents command execution status.

0	If successful
-1	If ***nChr*** is greater than 255 or less than 0
-2	If the string length cannot be extended due to lack of memory
-3	If the resultant string is longer than allowed or ***nCount*** is <0.

STRING ***string*** contains the modified string

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The target string to be filled

nChr ***byVal nChr AS INTEGER***

ASCII value of the character to be inserted. The value of nChr should be between 0 and 255 inclusive.

nCount ***byVal nCount AS INTEGER***

The number of occurrences of ***nChr*** to be added.

The total number of characters in the resulting string must be less than the maximum allowable string length for that platform.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM s$
S$="hello"
PRINT strfill(s$,64,7)          'will output 0
PRINT s$                        'will output @@@@@@@
PRINT strfill(s$,-23,7)         'will output -1
```

STRFILL is a core function.

STRSHIFTLEFT

STRSHIFTLEFT shifts the characters of a string to the left by a specified number of characters and dropping the leftmost characters. It is a useful function to have when managing a stream of incoming data, as for example, a UART, I2C or SPI and a string variable is used as a cache and the oldest N characters need to be dropped.

STRSHIFTLEFT (string, numChars)

Function

SUBROUTINE

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The string to be shifted left.

numChrs ***byVal numChrs AS INTEGER***

The number of characters that the string is shifted to the left.

If ***numChrs*** is greater than the length of the string, then the returned string will be empty.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

---

Interactive Command: NO

```
DIM s$
S$="123456789"
Strshiftleft(s$,4)        'drop leftmost 4 characters
PRINT s$           'output will be 56789
```

STRROTLEFT is a core function.

STRCMP

Compares two string variables.

STRCMP(string1, string2)

Function

Returns A value indicating the comparison result:

0 – if ***string1*** exactly matches ***string2*** (the comparison is case sensitive)

1 – if the ASCII value of ***string1*** is greater than ***string2***

-1 - if the ASCII value of ***string1*** is less than ***string2***

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string1 ***byRef string1 AS STRING***

The first string to be compared.

string2 ***byRef string2 AS STRING***

The second string to be compared.

Note: **string1**and **string2** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM s1$,s2$
s1$="hello"
s2$="world"
print strcmp(s1$,s2$)     'outputs   -1
print strcmp(s2$,s1$)     'outputs    1
print strcmp(s1$,s1$)     'outputs    0
```

STRCMP is a core function.

STRHEXIZE$

This function is used to convert a string variable into a string which contains all the bytes in the input string converted to 2 hex characters. It will therefore result in a string which is exactly double the length of the original string.

STRHEXIZE$ (string)

Function

Returns A printable version of ***string*** which contains only hexadecimal characters and exactly double in length of the input string.

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

String ***byRef string AS STRING***

The string to be converted into hex characters.

Interactive Command: NO

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Associated Commands: STRHEX2BIN

```
DIM S$,T$
S$="\01\02\03\04\05"
T$=strhexize$(S$)
PRINT strlen(S$)                'outputs   5
PRINT strlen(T$)                'outputs   10  and will contain "0102030405"
                                '
```

STRHEXIZE$ is a core function.

STRDEHEXIZE$

STRDEHEXISE$ is used to convert a string consisting of hex digits to a binary form. The conversion stops at the first non hex digit character encountered

STRDEHEXIZE$ (string)

Function

Returns A dehexed version of the string

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The string to be converted in-situ.

If a parsing error is encountered a nonfatal error is generated which needs to be handled otherwise the application will abort.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM S$,T$
S$="40414243"
PRINT strlen(S$)                'outputs 8
T$ = strdehexize$(S$)
PRINT strlen(T$)                'outputs 4  S$="@ABC"
S$="4041hello4243"
PRINT strlen(S$)                'outputs 13
```

```
T$ = strdehexize$(S$)
PRINT strlen(T$)                'outputs 2   S$="@A"
```

STRDEHEXISE$ is a core function.

STRHEX2BIN

This function is used to convert up to 2 hexadecimal characters at an offset in the input string into an integer value in the range 0 to 255.

STRHEX2BIN (string,offset)

Function

Returns A value in the range 0 to 255 which corresponds to the (up to) 2 hex characters at the specified in the input string.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The string to be converted into hex characters.

offset ***byVal offset AS INTEGER***
This is the offset from where up to 2 hex characters will be converted into a binary number.

Interactive Command: NO

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Associated Commands: STRHEXIZE

```
DIM S$,B
S$="0102030405"
B=strhex2bin(S$,4)
PRINT B                    'outputs   3
```

STRHEX2BIN is a core function.

STRESCAPE$

STRESCAPE$ is used to convert a string variable into a string which contains only printable characters using a 2 or 3 byte sequence of escape characters using the \NN format.

STRESCAPE$ (string)

Function

Returns A printable version of ***string*** which means at best the returned string is of the same length and at worst not more than three times the length of the input string.

The following input characters are escaped as follows:

carriage return \r

linefeed	\n
horizontal tab	\t
\	\\
"	\"
chr < ' '	\HH
chr >= 0x7F	\HH

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The string to be converted.

If a parsing error is encountered a nonfatal error will be generated which needs to be handled otherwise the script will abort.

Interactive Command: NO

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Associated Commands: STRDEESCAPE

```
DIM S$,T$
S$="Hello\00world"
T$=strescape$(S$)
PRINT strlen(S$)                'outputs   11
PRINT strlen(T$)                'outputs   13
```

STRESCAPE$ is a core function.

STRDEESCAPE

STRDEESCAPE is used to convert an escaped string variable in the same memory space that the string exists in. Given all 3 byte escape sequences are reduced to a single byte, the result will never be a string longer than the original.

STRDEESCAPE (string)

Function

SUBROUTINE

Returns None

The following input characters are escaped:

\r	carriage return
\n	linefeed
\t	horizontal tab
\\	\
“”	“
\HH	ascii byte HH

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- String De-Escape Error (E.g chrs after the \ are not recognized)

Arguments

string ***byRef string AS STRING***

The string to be converted in-situ.

If a parsing error is encountered a nonfatal error is generated which needs to be handled otherwise the application will abort.

Note: **string** cannot be a string constant, e.g. “the cat”, but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM S$,T$
S$=”Hello\5C40world”
PRINT strlen(S$)                ‘outputs 15
strdeescape(S$)
PRINT strlen(S$)                ‘outputs 13 S$=”Hello\40world”
strdeescape(S$)
PRINT strlen(S$)                ‘outputs 11 S$=”Hello@world”
```

STRDEESCAPE is a core function.

STRVALDEC

STRVALDEC converts a string of decimal numbers into the corresponding INTEGER signed value. All leading whitespaces are ignored and then conversion stops at the first non-digit character

STRVALDEC (string)

Function

Returns An integer that represents the decimal value that was contained within string.

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The target string

If STRVALDEC encounters a non-numeric character within the string it will return the value of the digits encountered before the non-decimal character.

Any leading whitespace within the string is ignored.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM S$
S$="  1234"
PRINT "\n";strvaldec(S$)        'outputs    1234
S$=" -1234"
PRINT "\n";strvaldec(S$)        'outputs    -1234
S$=" +1234"
PRINT "\n";strvaldec(S$)        'outputs    1234
S$="  2345hello"
PRINT "\n";strvaldec(S$)        'outputs    2345
S$="  hello"
PRINT "\n";strvaldec(S$)        'outputs    0
```

STRVALDEC is a core function.

STRSPLITLEFT$

STRSPLITLEFT$ returns a string which consists of the leftmost n characters of a string object and then drops those characters from the input string.

STRSPLITLEFT$ (string, length)

Function

Returns The leftmost 'length' characters are returned, and then those characters are dropped from the argument list.

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Memory Heap Exhausted

Arguments

string ***byRef string AS STRING***

The target string which cannot be a const string.

length ***byVal length AS INTEGER***

The number of leftmost characters that are returned before being dropped from the target string.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM OriginalString$, OriginalString$
OriginalString$ = "12345678"
NewString$ = stringsplitleft$ (OrigianlString$, 3)
print NewString$                                    ' The printed value will be 123
print "\n"
print OriginalString$                               ' The printed value will be 45678
```

STRSPLITLEFT$ is a core function.

STRSUM

This function identifies the substring starting from a specified offset and specified length and then does an arithmetic sum of all the unsigned bytes in that substring and then finally adds the signed initial value supplied.

For example, if the string is "\01\02\03\04\05" and offset is 1 and length is 2 and initial value is 1000, then the output will be 1000+2+3=1005.

STRSUM (string, nIndex, nBytes, initVal)

Function

Returns The integer result of the arithmetic sum operation over the bytes in the substring. If nIndex or nBytes are negative, then the initVal will be returned.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

String that contain the unsigned bytes which need to be arithmetically added

nIndex **byVal nIndex AS INTEGER**

Index of first byte into the string

nBytes **ByVal nBytes AS INTEGER**

Number of bytes to process

initVal **ByVal initVal AS INTEGER**

Initial value of the sum

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM Number$, Result1, Result2
Number$="01234"
Result1 = strsum(number$,0,5,0)
print Result1                       ' The printed result will be 250
Result2 = strsum(number$,0,5,10)
```

```
print Result2                          ' The printed result will be 260
```

STRSUM is a core function.

STRXOR

This function identifies the substring starting from a specified offset and specified length and then does an arithmetic exclusive-or (XOR) of all the unsigned bytes in that substring and then finally XORs the signed initial value supplied.

For example, if the string is "\01\02\03\04\05" and offset is 1 and length is 2 and initial value is 1000, then the output will be 1000 ^ 2 ^ 3=1001.

STRSUM (string, nIndex, nBytes, initVal)

Function

Returns The integer result of the xor operation over the bytes in the substring. If nIndex or nBytes are negative, then the initVal will be returned.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

String that contain the unsigned bytes which need to be arithmetically added

nIndex **byVal nIndex AS INTEGER**

Index of first byte into the string

nBytes **ByVal nBytes AS INTEGER**

Number of bytes to process

initVal **ByVal initVal AS INTEGER**

Initial value of the sum

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

```
DIM Number$, Result1, Result2
Number$="01234"
Result1 = strxor(number$,0,5,0)
print Result1                          ' The printed result will be 52
Result2 = strxor(number$,0,5,10)
print Result2                          ' The printed result will be 62
Result2 = strxor(number$,0,5,1000)
print Result2                          ' The printed result will be 988
```

STRXOR is a core function.

Table Routines

Tables provide associative array (or in other word lookup type) functionality within *smart* BASIC programs. They are typically used to allow lookup features to be implemented efficiently so that, for example, parsers can be implemented.

Tables are one dimensional string variables, which are configured by using the TABLEINIT command.

Tables should not be confused with Arrays. Tables provide the ability to perform pattern matching in a highly optimised manner. As a general rule, use tables where you want to perform efficient pattern matching and arrays where you want to automate setup strings or send data using looping variables.

TABLEINIT

TABLEINIT initialises a string variable so that it can be used for storage of multiple TLV tokens, allowing a lookup table to be created.

TLV = Tag, Length, Value

TABLEINIT (string)

Function

Returns INTEGER Indicates success of command:

0 Successful initialisation
<>0 Failure

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

string variable to be used for the Table and given it is a byRef the compiler will not allow a constant string to be passed as an argument. On entry the string can be non-empty, on exit the string will be empty.

Interactive Command: NO

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Associated Commands: **TABLEADD, TABLELOOKUP**

```
DIM T$
T$="Hello"
PRINT "\n";"[";T$;"]"           'output will be [Hello]
PRINT "\n";TABLEINIT(T$)        'output will be   0
PRINT "\n";"[";T$;"]"           'output will be []
```

TABLEINIT is a core function.

TABLEADD

TABLEADD adds the token specified to the lookup table in the string variable and associates the index specified with it. There is no validation to check if nIndex has been duplicated as it is entirely valid that more than one token generate the same iD value

TABLEADD (string, strtok, nID)

Function

Returns INTEGER Indicates success of command:

0 Signifies that the token was successfully added
1 Indicates an error if ***nID*** > 255 or < 0
2 Indicates no memory is available to store token
3 Indicates that the token is too large
4 Indicates the token is empty

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

A String variable that has been initialised as a table using TABLEINIT.

strtok ***byVal strtok AS STRING***

The string token to be added to the table.

nID ***byVal nID AS INTEGER***

The identifier number that is associated with the token and should be in the range 0 to 255.

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Interactive Command: NO

Associated Commands: **TABLEINIT, TABLELOOKUP**

```
DIM T$
DIM resCode
resCode = TABLEINIT(T$)
PRINT TABLEADD(T$,"Hello",1)          'outputs   0
PRINT TABLEADD(T$,"world",2)          'outputs   0
PRINT TABLEADD(T$,"to",300)           'outputs   1
PRINT TABLEADD(T$,"",3)               'outputs   4
```

TABLEADD is a core function.

TABLELOOKUP

TABLELOOKUP searches for the specified token within an existing lookup table which was created using TABLEINIT and multiple TABLEADDs and returns the ID value associated with it.

It is especially useful for creating a parser, for example, to create an AT style protocol over a uart interface.

TABLELOOKUP (string, strtok)

Function

Returns Indicates success of command:

>=0 signifies that the token was successfully found and the value is the ID
-1 if the token is not found within the table
-2 if the specified table is invalid
-3 if the token is empty or > 255 characters

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

string ***byRef string AS STRING***

The lookup table that is being searched

strtok ***byRef strtok AS STRING***

The token whose position is being found

Note: **string** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

---

Interactive Command: NO

Associated Commands: **TABLEINIT, TABLEADD**

```
DIM T$
DIM resCode
resCode = TABLEINIT(T$)
PRINT TABLEADD(T$,"Hello",100)   'outputs   0
PRINT TABLEADD(T$,"world",2)     'outputs   0
PRINT TABLEADD(T$,"to",3)        'outputs   0
PRINT TABLEADD(T$,"you",4)       'outputs   0

PRINT TABLELOOKUP(T$"to")        'outputs   3
PRINT TABLELOOKUP(T$"Hello")     'outputs   100
```

TABLELOOKUP is a core function

Random Number Generation Routines

Random numbers are either generated using pseudo random number generator algorithms or using thermal noise or equivalent in hardware. The routines listed in this section provide the developer with the capability of generating random numbers.

The immediate mode command "AT I 1001" or at runtime SYSINFO(1001) will return 1 if the system generates random numbers using hardware noise or 0 if a pseudo random number generator.

RAND

The RAND function returns a random 32 bit integer. Use the command 'AT I 1001' or from within an application the function SYSINFO(1001), to determine whether the random number is pseudo random or generated in hardware via a thermal noise generator. If 1001 returns 0 then it is pseudo random and 1 if generated using hardware.

RAND ()

Function

Returns A 32 bit integer.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments None

Depending on the platform, the RAND function can be seeded using the RANDSEED function to seed the pseudorandom-number generator. If used, RANDSEED must be called before using RAND. If the platform has a hardware Random Number Generator, then RANDSEED has no effect.

Interactive Command: NO

Associated Commands: RANDSEED

```
PRINT "\nRandom number is ";RAND()
```

RAND is a core language function.

RANDEX

The RANDEX function returns a random 32 bit **positive** integer in the range 0 to X where X is the input argument. Use the command 'AT I 1001' or from within an application the function SYSINFO(1001) to determine whether the random number is pseudo random or generated in hardware via a thermal noise generator. If 1001 returns 0 then it is pseudo random and 1 if generated using hardware.

RANDEX (maxval)

Function

Returns A 32 bit integer.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

maxval ***byVal seed AS INTEGER***

The return value will not exceed the absolute value of this variable

Depending on the platform, the RANDEX function can be seeded using the RANDSEED function to seed the pseudorandom-number generator. If used, RANDSEED must be called before using RANDEX. If the platform has a hardware Random Number Generator, then RANDSEED has no effect.

Interactive Command: NO

Associated Commands: RANDSEED

```
PRINT "\nRandom number is ";RAND()
```

RAND is a core language function.

RANDSEED

On platforms without a hardware random number generator, the RANDSEED function sets the starting point for generating a series of pseudorandom integers. To reinitialize the generator, use 1 as the seed argument. Any other value for seed sets the generator to a random starting point. RAND retrieves the pseudorandom numbers that are generated.

It has no effect on platforms with hardware random number generator.

RANDSEED (seed)

SUBROUTINE

Returns Does not have a return value.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments

Seed ***byVal seed AS INTEGER***

The starting seed value for the random number generator function RAND.

Interactive Command: No

Associated Commands: RAND

```
RANDSEED(1234)
```

RANDSEED is a core language subroutine.

Timer Routines

In keeping with the event driven paradigm of *smart* BASIC, the timer subsystem enables *smart* BASIC applications to be written which allow future events to be generated based on timeouts. To make use of this feature up to N timers, where N is platform dependent, are made available and that many event handlers can be written and then enabled using the ONEVENT statement so that those handlers are automatically invoked. ONEVENT statement is described in detail elsewhere in this manual.

Briefly the usage is, select a timer, register a handler for it, start it with a timeout value and a flag to specify whether it is recurring or single shot. Then when the timeout occurs AND when the application is processing a WAITEVENT statement, the handler will be automatically called.

It is important to understand the significance of the WAITEVENT statement. In a nutshell, a timer handler callback will NOT happen if the runtime engine does not encounter a WAITEVENT statement. Events are synchronous not asynchronous like say interrupts.

All this is illustrated in the sample code fragment below where timer 0 is started so that it will recur automatically every 500 milliseconds and timer 1 is a single shot 1000ms later.

Note, as explained in the WAITEVENT section of this manual, if a handler functions returns a non-zero value then the WAITEVENT statement is reprocessed, otherwise the *smart* BASIC runtime engine will proceed to process the next statement **after** the WAITEVENT statement – not after the handlers ENDFUNC or EXISTFUNC statement. This means that if the WAITEVENT is the very last statement in an application and a timer handler returns a 0 value, then the application will exit the module from Run mode into Interactive mode which will be disastrous for unattended operation.

Timer Events

EVTMRn where n=0 to N where N is platform dependent and is generated when timer n expires. The number of timers (that is, N+1) is returned by the command AT I 2003 or at runtime by SYSINFO(2003)

```
FUNCTION handlerTimer0()
  PRINT "\nTimer 0 has expired"
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION handlerTimer1()
  PRINT "\nTimer 1 has expired"
ENDFUNC 0 //exit from WAITEVENT

ONEVENT EVTMR0 CALL handlerTimer0
ONEVENT EVTMR1 CALL handlerTimer1

TIMERSTART(0,500,1)  //start a 500 millisecond recurring timer
PRINT "\nWaiting for Timer 0"

TIMERSTART(0,1000,0) //start a 1000 millisecond timer
PRINT "\nWaiting for Timer 1"

WAITEVENT
PRINT "\nGot here because TIMER 1 expired and handler returned 0"
```

TIMERSTART

This subroutine starts one of the in-built timers.

The command AT I 2003 will return the number of timers and AT I 2002 will return the resolution of the timer in microseconds.

When the timer expires, an appropriate event is generated, which can be acted upon by a handler registered using the ONEVENT command.

TIMERSTART (number,interval_ms,recurring)

SUBROUTINE:

Arguments:

number ***byVal number AS INTEGER***
The number of the timer. 0 to N where N can be determined by submitting the command AT I 2003 or at runtime returned via SYSINFO(2003).

If the value is not valid, then a runtime error will be thrown with code INVALID_TIMER.

Interval_ms ***byVal interval AS INTEGER***
A valid time in milliseconds, between 1 and 2,147,493,647 (24.8 days). Note although the time is specified in milliseconds, the resolution of the hardware timer may have more granularity than that. Submit the command AT I 2002 or at runtime SYSINFO(2002) to determine the actual granularity in microseconds.

If longer timeouts are required, start one of the timers with 1000 and make it repeating and then implement the longer timeout using *smart* BASIC code.

If the interval is negative or > 2,147,493,647 then a runtime error will be thrown with code INVALID_INTERVAL

If the ***recurring*** argument is set to non-zero, then the minimum value of the interval cannot be less than 10ms

recurring ***byVal recurring AS INTEGER***
Set to 0 for a once-only timer, or non-0 for a recurring timer.

When the timer expires, it will set the corresponding EVTMRn event. That is, timer number 0 sets EVTMR0, timer number 3 sets EVTMR3. The ONEVENT statement should be used to register handlers that will capture and process these events.

If the timer is already running, calling TIMERSTART will reset it to count down from the new value, which may be greater or smaller than the remaining time.

If either ***number*** or ***interval*** is invalid an Error is thrown.

Interactive Command: No

Related Commands: ONEVENT, TIMERCANCEL

```
SUB HandlerOnErr()
  PRINT "Timer Error ";getlasterror()
ENDSUB

FUNCTION handlerTimer0()
  PRINT "\nTimer 0 has expired"
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION handlerTimer1()
  PRINT "\nTimer 1 has expired"
ENDFUNC 0 //exit from WAITEVENT

ONERROR NEXT HandlerOnErr

ONEVENT EVTMR0 CALL handlerTimer0
ONEVENT EVTMR1 CALL handlerTimer1

TIMERSTART(0,-500,1)  //start a -500 millisecond recurring timer
PRINT "\nStarted Timer 0 with invalid inerval"

TIMERSTART(0,500,1)  //start a 500 millisecond recurring timer
PRINT "\nWaiting for Timer 0"

TIMERSTART(0,1000,0) //start a 1000 millisecond timer
PRINT "\nWaiting for Timer 1"

WAITEVENT
PRINT "\nGot here because TIMER 1 expired and handler returned 0"
```

TIMERSTART is a core subroutine.

TIMERRUNNING

This function is used to determine if a timer identified by an index number is still running. The command AT I 2003 will return the valid range of Timer index numbers. It returns 0 to signify that the timer is not running and a non-zero value to signify that it is still running and the value is the number of milliseconds left for it to expire

TIMERRUNNING (number)

Function

Returns: 0 if the timer has expired, otherwise the time in milliseconds left to expire.

Arguments:

number ***byVal number AS INTEGER***
The number of the timer. 0 to N where N can be determined by submitting the command AT I 2003 or at runtime returned via SYSINFO(2003).

If the value is not valid, then a runtime error will be thrown with code INVALID_TIMER.

Interactive Command: No

Related Commands: ONEVENT, TIMERCANCEL

```
SUB HandlerOnErr()
  PRINT "Timer Error ";getlasterror()
ENDSUB

FUNCTION handlerTimer0()
  PRINT "\nTimer 0 has expired"
  PRINT "\nTimer 1 has ";TIMERRUNNING(1);" milliseconds to go"
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION handlerTimer1()
  PRINT "\nTimer 1 has expired"
ENDFUNC 0 //exit from WAITEVENT

ONERROR NEXT HandlerOnErr

ONEVENT EVTMR0 CALL handlerTimer0
ONEVENT EVTMR1 CALL handlerTimer1

TIMERSTART(0,500,1)  //start a 500 millisecond recurring timer
PRINT "\nWaiting for Timer 0"

TIMERSTART(0,2000,0) //start a 1000 millisecond timer
PRINT "\nWaiting for Timer 1"

WAITEVENT
```

TIMERRUNNING is a core function.

TIMERCANCEL

This subroutine stops one of the inbuilt timers so that it will not generate a timeout event.

TIMERCANCEL (number)

SUBROUTINE:

Arguments:

number ***byVal number AS INTEGER***
The number of the timer. 0 to N where N can be determined by submitting the command AT I 2003 or at runtime returned via SYSINFO(2003).

If the value is not valid, then a runtime error will be thrown with code INVALID_TIMER.

Interactive Command: NO

Related Commands: ONEVENT, TIMERCANCEL,TIMERRUNNING

```
FUNCTION handlerTimer0()
  PRINT "\nTimer 0 has expired"
  PRINT "\nCancelling Timer 1"
  TIMERCANCEL(1)
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION handlerTimer1()
  PRINT "\nTimer 1 has expired"
```

```
ENDFUNC 0 //exit from WAITEVENT

ONEVENT EVTMR0 CALL handlerTimer0
ONEVENT EVTMR1 CALL handlerTimer1

TIMERSTART(0,500,1)  //start a 500 millisecond recurring timer
PRINT "\nWaiting for Timer 0"

TIMERSTART(0,1000,0) //start a 1000 millisecond timer
PRINT "\nWaiting for Timer 1, but will never happen because cancelled in 0"

WAITEVENT
```

TIMERCANCEL is a core subroutine.

GETTICKCOUNT

There is a 31 bit free running counter that increments every 1 millisecond (use SYSINFO(2004) or the AT I 2004 command) to determine the actual resolution in microseconds.

This function returns that free running counter. It wraps to 0 when the counter reaches 0x7FFFFFFF.

GETTICKCOUNT ()

Function

Returns: A value in the range 0 to 0x7FFFFFFF (2,147,483,647) in units of milliseconds.

Arguments: **None**

Interactive Command: No

Related Commands: GETTICKSINCE

```
DIM startTick,endTick,elapseMs

startTick = GETTICKCOUNT()
… do something
endTick = GETTICKCOUNT()

'Following code is an illustration – more efficient to use GETTICKSINCE() function
IF endTick > startTick THEN
  elapseMs = endTick – startTick
ELSE
  elapseMs = (0x7FFFFFF – startTick) + endTick
ENDIF

PRINT "\nsomthing took ";elapseMS; "msec to process"
```

GETTICKCOUNT is a core subroutine.

GETTICKSINCE

This function returns the time elapsed since the 'startTick' variable was updated with the return value of GETTICKCOUNT(). It signifies the time in milliseconds.

If 'startTick' is less than 0 which is a value that GETTICKCOUNT() will never return, then a 0 will be returned.

GETTICKSINCE (startTick)

Function

Returns: A value in the range 0 to 0x7FFFFFFF (2,147,483,647) in units of milliseconds.

startTickr ***byVal startTick AS INTEGER***
This is a variable that was updated using the return value from GETTICKCOUNT() and it is used to calculate the time elapsed since that update.

Interactive Command: No

Related Commands: GETTICKCOUNT

```
DIM startTick, elapseMs
startTick = GETTICKCOUNT()
… do something

elapseMs = GETTICKSINCE(startTick)
PRINT "\nsomthing took ";elapseMS; "msec to process"
```

GETTICKCOUNT is a core subroutine.

Serial Communications Routines

In keeping with the event driven architecture of *smart* BASIC, the serial communications subsystem enables *smart* BASIC applications to be written which allow communication events to trigger the processing of user *smart* BASIC code.

Note that if a handler functions returns a non-zero value then the WAITEVENT statement is reprocessed, otherwise the *smart* BASIC runtime engine will proceed to process the next statement **after** the WAITEVENT statement – not after the handlers ENDFUNC or EXISTFUNC statement. Please refer to the detailed description of the WAITEVENT statement for further information.

UART (Universal Asynchronous Receive Transmit)

This section describes all the events and routines used to interact with the UART peripheral available on the platform. Depending on the platform, at a minimum, the UART will consist of a transmit, a receive, a CTS (Clear To Send) and RTS (Ready to Send) line. The CTS and RTS lines are used for hardware handshaking to ensure that buffers do not overrun.

If there is a need for the following low bandwidth status and control lines found on many peripherals, then the user is able to create those using the GPIO lines of the module and interface with those control/status lines using *smart* BASIC code.

Output	DTR	Data Terminal Ready
Input	DSR	Data Set Ready

Output/Input	DCD	Data Carrier Detect
Output/Input	RI	Ring Indicate

The lines DCD and RI are marked as Output or Input because it is possible, unlike a device like a PC where they are always inputs and modems where they are always outputs, to configure the pins to be either so that the device can adopt a DTE (Data Terminal Equipment) or DCE (Data Communications Equipment) role. *Please note that both DCD and RI have to be BOTH outputs or BOTH inputs, one cannot be an output and the other an input.*

UART Events

In addition to the routines for manipulating the UART interface, when data arrives via the receive line it is stored locally in an underlying ring buffer and then an event is generated.

Similarly when the transmit buffer is emptied, events are thrown from the underlying drivers so that user *smart* BASIC code in handlers can perform user defined actions.

The following is a detailed list of all events generated by the UART subsystem which can be handled by user code.

EVUARTRX This event is generated when one or more new characters have arrived and have been stored the local ring buffer.

EVUARTTXEMPTY This event is generated when the last character is transferred from the local transmit ring buffer to the hardware shift register.

```
FUNCTION hdlrUartRx()
  PRINT "\nData has arrived"
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION hdlrUartTxEty()
  PRINT "\nTx buffer is empty"
ENDFUNC 0 //exit from WAITEVENT


ONEVENT EVUARTRX      CALL hdlrUartRx
ONEVENT EVUARTTXEMPTY CALL hdlrUartTxEty

PRINT "\nSend this via uart"

WAITEVENT     //wait for rx, tx and modem status events
```

UARTOPEN

This function is used to open the main default uart peripheral using the parameters specified.

If the uart is already open then this function will fail.

If this function is used to alter the communications parameters, like say the baudrate and the application exits to command mode, then those settings will be inherited by the command mode parser. Hence this is the only way to alter the communications parameters for command mode.

UARTOPEN (baudrate,txbuflen,rxbuflen,stOptions)

Function

Returns:	0	Opened successfully
	0x5208	Invalid baudrate
	0x5209	Invalid parity
	0x520A	Invalid databits
	0x520B	Invalid stopbits
	0x520C	Cannot be DTE (because DCD and RI cannot be inputs)

0x520D	Cannot be DCE (because DCD and RI cannot be outputs)
0x520E	Invalid flow control request
0x520F	Invalid DTE/DCE role request
0x5210	Invalid length of stOptions parameter (must be 5 chrs)
0x5211	Invalid tx buffer length
0x5212	Invalid rx buffer length

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

baudrate ***byVal baudrate AS INTEGER***
The baudrate for the uart. Note that, the higher the baudrate, the more power will be drawn from the supply pins.
AT I 1002 or SYSINFO(1002) returns the minimum valid baudrate
AT I 1003 or SYSINFO(1003) returns the maximum valid baudrate

txbuflen ***byVal txbuflen AS INTEGER***
Set the transmit ring buffer size to this value. If set to 0 then a default value will be used by the underlying driver

rxbuflen ***byVal rxbuflen AS INTEGER***
Set the receive ring buffer size to this value. If set to 0 then a default value will be used by the underlying driver

stOptions ***byVal stOptions AS STRING***
This string (can be a constant) MUST be exactly 5 characters long where each character is used to specify further comms parameters as follows:-

Character Offset :
0: DTE/DCE role request - 'T' for DTE and 'C' for DCE
1: Parity – 'N' for none, 'O' for odd and 'E' for even
2: Databits – '5','6','7','8',9'
3: Stopbits – '1','2'
4: Flow Control – 'N' for none, 'H' for CTS/RTS hardware, 'X' for xon/xof

Please note: there will be further restrictions on the options based on the hardware as for example a PC implementation cannot be configured as a DCE role. Likewise many microcontroller uart peripherals are not capable of 5 bits per character – but a PC is.

Note: In a DTE equipment DCD and RI are inputs, while in DCE they are outputs.
Interactive Command: No

Related Commands: UARTINFO, UARTCLOSE, UARTWRITE, UARTREAD, UARTREADMATCH UARTGETDSR, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rc

//--- Handler to process receive data
```

```
FUNCTION hdlrUartRx()
  PRINT "\nData has arrived"
ENDFUNC 1 //remain blocked in WAITEVENT

//--- Register event handler for receive data

ONEVENT EVUARTRX      CALL hdlrUartRx

//--- Open comport so that DCD and RI are inputs

rc=UartOpen(9600,0,0,"CN81H")    //open as DCE at 9600 baudrate, no parity
                                 //8 databits, 1 stopbits, cts/rts flow control
if rc!= 0 then
  print "\nFailed to open UART interface with error code ";interger.h' rc
else
  print "\nUART open success"
endif

WAITEVENT     //wait for rx, events
```

UARTOPEN is a core function.

UARTCLOSE

This subroutine is used to close a uart port which had been opened with UARTOPEN.

If after the uart is closed, a print statement is encountered, the uart will be automatically re-opened at the default rate (9600N81) so that the data generated by the PRINT statement is sent.

This routine is safe to call if it is already closed.

When this subroutine is invoked, the receive and transmit buffers are both flushed. If there is any data in either of these buffers when the UART is closed, it will be lost. This is because the execution of UARTCLOSE takes a very short amount of time, while the transfer of data from the buffers will take much longer.

In addition please note that when a *smart* BASIC application completes execution with the UART closed, it will automatically be reopened in order to allow continued communication with the module in command mode using the default communications settings.

UARTCLOSE()

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments: **None**

Interactive Command: No

Related Commands: UARTOPEN,UARTINFO, UARTWRITE, UARTREAD, UARTREADMATCH, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv
DIM mdm
```

```
//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control
UartClose()  //close the port
UartClose()  //no harm done doing it again
```

UARTCLOSE is a core subroutine.

UARTINFO

This function is used to query information about the default uart, such as buffer lengths, whether the port is already open or how many bytes are waiting in the receive buffer to be read.

UARTINFO (infoId)

Function

Returns: The value associated with the type of uart information requested

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

infoId ***byVal infoId AS INTEGER***
This specifies the type of uart information requested as follows if the uart is open:-
0 := 1 (the port is open)
And the following specify the type of uart information when the port is open:-
1 := Receive ring buffer capacity
2 := Transmit ring buffer capacity
3 := Number of bytes waiting to be read from receive ring buffer
4 := Free space available in transmit ring buffer

If the uart is closed, then regardless of the value of ***infoId***, a 0 will be returned.
Note: UARTINFO(0) will always return the open/close state of the uart.
Interactive Command: No

Related Commands: UARTOPEN, UARTCLOSE, UARTWRITE, UARTREAD, UARTREADMATCH UARTGETDSR, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv

//--- Handler to process receive data

FUNCTION hdlrUartRx()
  PRINT "\nThis many bytes in rx buffer ";uartinfo(3)
ENDFUNC 1 //remain blocked in WAITEVENT

//--- Register event handler for receive data

ONEVENT EVUARTRX      CALL hdlrUartRx

//--- Open comport so that DCD and RI are outputs

UartClose()
```

```
PRINT "\nUart State ";uartinfo(0) //will print 0

rv=UartOpenDce(300,1,8,1,1)      //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control

PRINT "\nUart State ";uartinfo(0) //will print 1

WAITEVENT     //wait for rx, events
```

UARTINFO is a core subroutine.

UARTWRITE

This function is used to transmit a string of characters.

UARTWRITE (strMsg)

Function

Returns: 0 to N : Actual number of bytes successfully written to the local transmit ring buffer

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPEN

Arguments:

strMsg ***byRef strMsg AS STRING***
The array of bytes to be sent. STRLEN(strMsg) bytes will be written to the local transmit ring buffer. If STRLEN(strMsg) and the return value are not the same then it implies that the transmit buffer did not have enough space to accommodate the data.
If return value does not match the length of the original string, then use STRSHIFTLEFT function to drop the data from the string, so that subsequent calls to this function only retries with data which was not placed in the output ring buffer.

Interactive Command: No

Note: **strMsg** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Related Commands: UARTOPEN,UARTINFO, UARTCLOSE, UARTREAD, UARTREADMATCH UARTGETDSR, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv,cnt
DIM str$

//--- Handler to process receive data

FUNCTION hdlrUartRx()
  PRINT "\nData has arrived"
ENDFUNC 1 //remain blocked in WAITEVENT
```

```
FUNCTION hdlrUartTxEty()
  PRINT "\nTx buffer is empty"
ENDFUNC 0 //exit from WAITEVENT

//--- Register event handler for tx buffer empty

ONEVENT EVUARTTXEMPTY CALL hdlrUartTxEty

//--- Register event handler for receive data

ONEVENT EVUARTRX      CALL hdlrUartRx

//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control
IF rv==0 THEN
  str$="Hello World"
  cnt = UartWrite(str$)
  if cnt > 0 then
    strshiftleft(str$,cnt)
  endif
ENDIF

WAITEVENT     //wait for rx and txempty events
```

UARTWRITE is a core subroutine.

UARTREAD

This function is used to read the content of the receive buffer and **append** it to the string variable supplied.

UARTREAD(strMsg)

Function

Returns: 0 to N : The total length of the string variable – not just what got appended. This means the caller does not need to call strlen() function to determine how many bytes in the string that needs to be processed.

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPENxxx

Arguments:

strMsg ***byRef strMsg AS STRING***
The content of the receive buffer will get **appended** to this string.

Interactive Command: No

Note: **strMsg** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Related Commands: UARTOPEN,UARTINFO, UARTCLOSE, UARTWRITE, UARTREADMATCH, UARTGETDSR, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv,cnt
DIM str$

//--- Handler to process receive data

FUNCTION hdlrUartRx()
  cnt = UartRead(str$)
  PRINT "\nData is ";str$
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION hdlrUartTxEty()
  PRINT "\nTx buffer is empty"
ENDFUNC 0 //exit from WAITEVENT

//--- Register event handler for tx buffer empty

ONEVENT EVUARTTXEMPTY CALL hdlrUartTxEty

//--- Register event handler for receive data

ONEVENT EVUARTRX      CALL hdlrUartRx

//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control

//--- Can read from rx buffer anytime, even outside handler

cnt = UartRead(str$)
PRINT "\nData is ";str$

WAITEVENT     //wait for rx and txempty events
```

UARTREAD is a core subroutine.

UARTREADMATCH

This function is used to read the content of the underlying receive ring buffer and **append** it to the string variable supplied, up to and including the first instance of the specified matching character OR the end of the ring buffer.

This function is very useful when interfacing with a peer which is sends messages terminated by a constant character such as a carriage return (0x0D). In that case, in the handler, if the return value is greater than 0, it implies a terminated message arrived and so can be processed further

UARTREADMATCH(strMsg , chr)

Function

Returns: 0 : data **may** have been appended to the string, but no matching character.
1 to N : The total length of the string variable up to and including the match **chr**.

Note when 0 is returned you can use STRLEN(strMsg) to determine the length of data stored in the string. On some platforms with low amount of RAM resources, the underlying code may decide to leave the data in the receive buffer rather than transfer it to the string.

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPEN

Arguments:

strMsg ***byRef strMsg AS STRING***
The content of the receive buffer will get **appended** to this string up to and including the match character.

chr ***byVal chr AS INTEGER***
The character to match in the receive buffer, for example the carriage return character 0x0D

Interactive Command: No

Note: **strMsg** cannot be a string constant, e.g. "the cat", but must be a string variable and so if you must use a const string then first save it to a temp string variable and then pass it to the function

Related Commands: UARTOPEN,UARTINFO, UARTCLOSE, UARTWRITE, UARTREAD, UARTGETDSR, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv,cnt
DIM str$

//--- Handler to process receive data

FUNCTION hdlrUartRx()
  cnt = UartReadMatch(str$,13) //read up to and including CR
  PRINT "\nData is ";str$
ENDFUNC 1 //remain blocked in WAITEVENT

FUNCTION hdlrUartTxEty()
  PRINT "\nTx buffer is empty"
ENDFUNC 0 //exit from WAITEVENT

//--- Register event handler for tx buffer empty

ONEVENT EVUARTTXEMPTY CALL hdlrUartTxEty

//--- Register event handler for receive data
```

```
ONEVENT EVUARTRX      CALL hdlrUartRx

//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"T081H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control

//--- Can read from rx buffer anytime, even outside handler

cnt = UartRead(str$)
PRINT "\nData is ";str$

WAITEVENT     //wait for rx and txempty events
```

UARTREADMATCH is a core subroutine.

UARTFLUSH

This subroutne is used to flush either or both receive and transmit ring buffers.

This is useful when, for example, you have a character terminated messaging system and the peer sends a very long message and the input buffer fills up. In that case, there is no more space for an incoming termination character and the RTS handshaking line would have been asserted so the message system will stall. A flush of the receive buffer is the best approach to recover from that situation.

UARTSETFLUSH(bitMask)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPEN

Arguments:

bitMask ***byVal bitMask AS INTEGER***
Bit 0 is set to flush the rx buffer and Bit 1 to flush the tx buffer.

Interactive Command: No

Related Commands: UARTOPEN,UARTINFO, UARTCLOSE, UARTWRITE, UARTREAD, UARTREADMATCH, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTGETDSR, UARTSETRTS, UARTSETDCD, UARTBREAK, UARTFLUSH

```
DIM rv

//--- Open comport so that DCD and RI are inputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control

If rv==0 then
  UartFLUSH(1)   //flush the receive buffer
endif
```

UARTFLUSH is a core subroutine.

UARTGETCTS

This function is used to read the current state of the CTS modem status input line.

If the device does not expose a CTS input line, then this function will return a value that signifies an asserted line.

UARTGETCTS()

Function

Returns: 0 : CTS line is NOT asserted
1 : CTS line is asserted

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPEN

Arguments: **None**

Interactive Command: No

Related Commands: UARTOPEN,UARTINFO, UARTCLOSE, UARTWRITE, UARTREAD, UARTREADMATCH, UARTGETDSR, UARTGETDCD, UARTGETRI, UARTSETDTR, UARTSETRTS, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv
DIM mdm

//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control
If rv==0 then
  mdm = UartGetCts()
  PRINT "\nCTS is ";mdm
endif
```

UARTGETCTS is a core subroutine.

UARTSETRTS

This function is used to set the state of the RTS modem control line. When the UART port is closed, the RTS line can be configured as an input or an output and can be available for use a general purpose input/output line.

When the uart port is opened, the RTS output is automatically defaulted to the asserted state. If flow control was enabled when the port was opened then the RTS cannot be manipulated as it is owned by the underlying driver.

UARTSETRTS(newState)

Subroutine

Exceptions
- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPEN

Arguments:

newState ***byVal newState AS INTEGER***
0 to deassert and non-zero to assert

Interactive Command: No

Related Commands: UARTOPEN,UARTINFO, UARTCLOSE, UARTWRITE, UARTREAD, UARTREADMATCH, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTGETDSR, UARTSETDTR, UARTSETDCD, UARTSETRI, UARTBREAK, UARTFLUSH

```
DIM rv

//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control

// RTS output has automatically been asserted

If rv==0 then
  UartSetRts(0)   //has no effect because flow control was enabled
  UartSetRts(1)   //has no effect because flow control was enabled
endif

UartClose()

rv=UartOpenDce(300,1,8,1,0)      //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, no cts/rts flow control

// RTS output has automatically been asserted

If rv==0 then
  UartSetRts(0)   //RTS will be deasserted
  UartSetRts(1)   //RTS will be asserted
endif
```

UARTSETRTS is a core subroutine.

UARTBREAK

This function is used to assert/deassert a BREAK on the transmit output line. A BREAK is condition where the line is in non idle state (that is 0v) for more than 10 to 13 bit times depending on whether parity has been enabled and the number of stopbits.

On certain platforms the hardware may not allow this functionality, contact Laird to determine if your device has the capability. On platforms that do not have this capability, this routine has no effect.

The BL600 module currently does not offer the capability to send a break signal.

UARTBREAK(state)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Uart has not been opened using UARTOPEN

Arguments:

newState ***byVal newState AS INTEGER***
0 to deassert and non-zero to assert

Interactive Command: No

Related Commands: UARTOPEN, UARTINFO, UARTCLOSE, UARTWRITE, UARTREAD, UARTREADMATCH, UARTGETCTS, UARTGETDCD, UARTGETRI, UARTGETDSR, UARTSETRTS, UARTSETDCD, UARTFLUSH

```
DIM rv

//--- Open comport so that DCD and RI are outputs

rv=UartOpen(300,0,0,"TO81H")     //open as DTE at 300 baudrate, odd parity
                                 //8 databits, 1 stopbits, cts/rts flow control

// RI output has automatically been de-asserted

If rv==0 then
  UartBREAK(1)
  PRINT "\nBREAK has been asserted"
  UartBREAK(0)
  PRINT "\nBREAK has been deasserted"
endif
```

UARTBREAK is a core subroutine.

I2C - Also known as Two Wire Interface (TWI)

This section describes all the events and routines used to interact with the I2C peripheral available on the platform. An I2C interface is also known as a Two Wire Interface (TWI) and has a master/slave topology.

An I2C interface allows multiple masters and slaves to communicate over a shared wired-OR type bus consisting of two lines which normally sit at 5 or 3.3v.

The BL600 module can only be configured as an I2C master with the additional constraint that it be the only master on the bus.

The two signal lines are called SCL and SDA. The former is the clock line which is always sourced by the master and the latter is a bi-directional data line which can be driven by any device on the bus.

It is essential to remember that pull up resistors on both SCL and SDA lines are not provided in the module and MUST be provided external to the module.

A very good introduction to I2C can be found at http://www.i2c-bus.org/i2c-primer/ and the reader is encouraged to refer to it before using the api described in this section.

I2C Events

The api provided in the module is synchronous and so there is no requirement for events.

I2COPEN

This function is used to open the main I2C peripheral using the parameters specified.

I2COPEN (nSclSigNo, nSdaSigNo, nClockHz, nCfgFlags, nHande)

Function

Returns:

0	Opened successfully
0x5200	Driver not found
0x5207	Driver already open
0x5225	Invalid Clock Frequency Requested
0x521D	Driver resource unavailable
0x5226	No free PPI channel
0x5202	Invalid Signal Pins
0x5219	I2C not allowed on pins specified

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSclSigNo ***byVal nSclSigNo AS INTEGER***
This is the signal number, as detailed in the module pinout table, that must be used as the I2C clock line – SCL.

nSdaSigNo ***byVal nSdaSigNo AS INTEGER***
This is the signal number, as detailed in the module pinout table, that must be used as the I2C data line – SDA.

nClockHz ***byVal nClockHz AS INTEGER***
This is the clock frequency to use, and can be one of 100000, 250000 or 400000.

nCfgFlags ***byVal nCfgFlags AS INTEGER***
This is a bit mask used to configure the I2C interface. All unused bits are allocated as for future use and MUST be set to 0. Used bits are as follows:-

Bit	Description
0	If set then a 500 microsecond low pulse will NOT be sent on open. This low pulse is used to create a start and stop condition on the bus so that any signal transitions on these lines prior to this open which may have confused a slave can initialise that slave to a known state. The STOP condition should be detected by the slave.
1-31	Unused and MUST be set to 0

nHandle ***byRef nHandle AS INTEGER***
The handle for this interface will be returned in this variable if it was successfully opened. This handle is subsequently used to read/write and close the interface.

Related Commands: I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
```

```
rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif
```

I2COPEN is a core function.

I2CCLOSE

This subroutine is used to close a I2C port which had been opened with I2COPEN.

This routine is safe to call if it is already closed.

I2CCLOSE(handle)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

handle ***byVal handle AS INTEGER***
This is the handle value that was returned when I2COPEN was called which identifies the I2C interface to close.

Interactive Command: No

Related Commands: I2COPEN, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

I2cClose(handle)  //close the port
I2cClose(handle)  //no harm done doing it again
```

I2CCLOSE is a core subroutine.

I2CWRITEREG8

This function is used to write an 8 bit value to a register inside a slave which is identified by an 8 bit register address.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CWRITEREG8(nSlaveAddr, nRegAddr, nRegValue)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

nRegAddr ***byVal nRegAddr AS INTEGER***
This is the 8 bit register address in the addressed slave in range 0 to 255.

nRegValue ***byVal nRegValue AS INTEGER***
This is the 8 bit value to written to the register in the addressed slave.
Please not only the lowest 8 bits of this variable are written.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr, nRegAddr,nRegVal

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

nSlaveAddr=0x68 :  nRegAddr = 0x34 : nRegVal = 0x42
rc = I2cWriteReg8(nSlaveAddr, nRegAddr, nRegVal)
if rc!= 0 then
  print "\nFailed to Write to slave/register"
endif

I2cClose(handle)  //close the port
```

I2CWRITEREG8 is a core function.

I2CREADREG8

This function is used to read an 8 bit value from a register inside a slave which is identified by an 8 bit register address.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CREADREG8(nSlaveAddr, nRegAddr, nRegValue)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

nRegAddr ***byVal nRegAddr AS INTEGER***
This is the 8 bit register address in the addressed slave in range 0 to 255.

nRegValue ***byRef nRegValue AS INTEGER***
The 8 bit value from the register in the addressed slave will be returned in this var.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr, nRegAddr,nRegVal

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

nSlaveAddr=0x68 :  nRegAddr = 0x34
rc = I2cReadReg8(nSlaveAddr, nRegAddr, nRegVal)
if rc!= 0 then
  print "\nFailed to Write to slave/register"
else
  print "\nValue read from register is "; integer.h' nRegVal
endif

I2cClose(handle)  //close the port
```

I2CREADREG8 is a core function.

I2CWRITEREG16

This function is used to write a 16 bit value to 2 registers inside a slave and the first register is identified by an 8 bit register address supplied.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CWRITEREG16(nSlaveAddr, nRegAddr, nRegValue)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

nRegAddr ***byVal nRegAddr AS INTEGER***
This is the 8 bit start register address in the addressed slave in range 0 to 255.

nRegValue ***byVal nRegValue AS INTEGER***
This is the 16 bit value to written to the register in the addressed slave.
Please note only the lowest 16 bits of this variable are written.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr, nRegAddr,nRegVal

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

nSlaveAddr=0x68 :  nRegAddr = 0x34 : nRegVal = 0x4210
rc = I2cWriteReg16(nSlaveAddr, nRegAddr, nRegVal)
if rc!= 0 then
  print "\nFailed to Write to slave/register"
endif

I2cClose(handle)  //close the port
```

I2CWRITEREG16 is a core function.

I2CREADREG16

This function is used to read a 16 bit value from two registers inside a slave which is identified by an 8 bit register address.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CREADREG16(nSlaveAddr, nRegAddr, nRegValue)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

nRegAddr ***byVal nRegAddr AS INTEGER***
This is the 8 bit register address in the addressed slave in range 0 to 255.

nRegValue ***byRef nRegValue AS INTEGER***
The 16 bit value from two registers in the addressed slave will be returned in this variable.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr, nRegAddr,nRegVal

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

nSlaveAddr=0x68 :  nRegAddr = 0x34
rc = I2cReadReg16(nSlaveAddr, nRegAddr, nRegVal)
if rc!= 0 then
  print "\nFailed to Write to slave/register"
else
  print "\nValue read from register is "; integer.h' nRegVal
endif

I2cClose(handle)  //close the port
```

I2CREADREG16 is a core function.

I2CWRITEREG32

This function is used to write a 32 bit value to 4 registers inside a slave and the first register is identified by an 8 bit register address supplied.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CWRITEREG32(nSlaveAddr, nRegAddr, nRegValue)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

nRegAddr ***byVal nRegAddr AS INTEGER***
This is the 8 bit start register address in the addressed slave in range 0 to 255.

nRegValue ***byVal nRegValue AS INTEGER***
This is the 32 bit value to written to the register in the addressed slave.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr, nRegAddr,nRegVal

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

nSlaveAddr=0x68 :  nRegAddr = 0x34 : nRegVal = 0x4210FEDC
rc = I2cWriteReg32(nSlaveAddr, nRegAddr, nRegVal)
if rc!= 0 then
  print "\nFailed to Write to slave/register"
endif

I2cClose(handle)  //close the port
```

I2CWRITEREG32 is a core function.

I2CREADREG32

This function is used to read a 32 bit value from four registers inside a slave which is identified by a starting 8 bit register address.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CREADREG32(nSlaveAddr, nRegAddr, nRegValue)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

nRegAddr ***byVal nRegAddr AS INTEGER***
This is the 8 bit register address in the addressed slave in range 0 to 255.

nRegValue ***byRef nRegValue AS INTEGER***
The 32 bit value from four registers in the addressed slave will be returned in this variable.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr, nRegAddr,nRegVal

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

nSlaveAddr=0x68 :  nRegAddr = 0x34
rc = I2cReadReg32(nSlaveAddr, nRegAddr, nRegVal)
if rc!= 0 then
  print "\nFailed to Write to slave/register"
else
  print "\nValue read from register is "; integer.h' nRegVal
endif

I2cClose(handle)  //close the port
```

I2CREADREG16 is a core function.

I2CWRITEREAD

This function is used to write from 0 to 255 bytes and then immediately after that read 0 to 255 bytes in a single transaction from the addressed slave. It is a 'free-form' function that allows communication with a slave which has a 10 bit address.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one I2C interface is made available. Most likely made available by bit-bashing gpio.

I2CWRITEREAD(nSlaveAddr, stWrite$, stRead$, nReadLen)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nSlaveAddr ***byVal nSlaveAddr AS INTEGER***
This is the address of the slave in range 0 to 127.

stWrite$*** ***byRef stWrite$ AS STRING
This string contains the data that must be written first. If the length of this string is 0 then the write phase is bypassed.

stRead$*** ***byRef stRead$ AS STRING
This string will be written to with data read from the slave if and only if nReadLen is not 0.

nReadLen ***byRef nReadLen AS INTEGER***
On entry this variable contains the number of bytes to be read from the slave and on exit will contain the actual number that were actually read. If the entry value is 0, then the read phase will be skipped.

Interactive Command: No

Related Commands: I2COPEN, I2CCLOSE, I2CWRITEREAD$, I2CWRITEREG8, I2CWRITEREG16, I2CWRITEREG32, I2CREADREG8, I2CREADREG16, I2CREADREG32

```
DIM rc
DIM handle
DIM nSlaveAddr
DIM stWrite$, stRead$, nReadLen

rc=I2cOpen(9,8,100000,0,handle)
if rc!= 0 then
  print "\nFailed to open I2C interface with error code ";interger.h' rc
else
  print "\nI2C open success"
endif

//Write 2 bytes and read 0
nSlaveAddr=0x68 :  stWrite = "\34\35" : stRead$="" : nReadLen = 0
rc = I2cWriteRead(nSlaveAddr, stWrite$, stRead$, nReadLen)
if rc!= 0 then
  print "\nFailed to WriteRead"
else
```

```
  print "\nWrite = ";strhexize$(stWrite$);" Read = ";strhexize$(stRead$)
endif

//Write 3 bytes and read 4
nSlaveAddr=0x68 :  stWrite = "\34\35\43" : stRead$="" : nReadLen = 4
rc = I2cWriteRead(nSlaveAddr, stWrite$, stRead$, nReadLen)
if rc!= 0 then
  print "\nFailed to WriteRead"
else
  print "\nWrite = ";strhexize$(stWrite$);" Read = ";strhexize$(stRead$)
endif

//Write 0 bytes and read 8
nSlaveAddr=0x68 :  stWrite = "" : stRead$="" : nReadLen = 8
rc = I2cWriteRead(nSlaveAddr, stWrite$, stRead$, nReadLen)
if rc!= 0 then
  print "\nFailed to WriteRead"
else
  print "\nWrite = ";strhexize$(stWrite$);" Read = ";strhexize$(stRead$)
endif

I2cClose(handle)  //close the port
```

I2CWRITEREAD is a core function.

SPI Interface

This section describes all the events and routines used to interact with the SPI peripheral available on the platform.

The BL600 module can only be configured as a SPI master.

The three signal lines are called SCK, MOSI and MISO, where the first two are outputs and the last is an input.

A very good introduction to SPI can be found at http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus and the reader is encouraged to refer to it before using the api described in this section.

It is possible to configure the interface to operate in any one of the 4 modes defined for the SPI bus which relate to the phase and polarity of the SCK clock line in relation to the data lines MISO and MOSI. In addition the clock frequency can be configured from 125,000 to 8000000 and it can be configured so that it shifts data in/out most significant bit first or last.

Note a dedicated SPI Chip Select (CS) line is not provided and it is up to the developer to dedicate any spare gpio line for that function if more than one SPI slave is connected to the bus. The SPI interface in this module assumes that prior to calling SPIREADWRITE, SPIREAD or SPIWRITE functions the slave device has been selected via the appropriate gpio line.

SPI Events

The api provided in the module is synchronous and so there is no requirement for events.

SPIOPEN

This function is used to open the main SPI peripheral using the parameters specified.

SPIOPEN (nMode, nClockHz, nCfgFlags, nHande)

Function

Returns:

0	Opened successfully
0x5200	Driver not found
0x5207	Driver already open
0x5225	Invalid Clock Frequency Requested
0x521D	Driver resource unavailable
0x522B	Invalid mode

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

nMode ***byVal nMode AS INTEGER***
This is the mode, as in phase and polarity of the clock line, that the interface shall operate at. Valid values are 0 to 3 inclusive

nClockHz ***byVal nClockHz AS INTEGER***
This is the clock frequency to use, and can be one of 125000, 250000, 500000, 1000000, 2000000, 4000000 or 8000000.

nCfgFlags ***byVal nCfgFlags AS INTEGER***
This is a bit mask used to configure the SPI interface. All unused bits are allocated as for future use and MUST be set to 0. Used bits are as follows:-

Bit	Description
0	If set then the least significant bit is clocked in/out first.
1-31	Unused and MUST be set to 0

nHandle ***byRef nHandle AS INTEGER***
The handle for this interface will be returned in this variable if it was successfully opened. This handle is subsequently used to read/write and close the interface.

Related Commands: SPICLOSE, SPIREADWRITE, SPIWRITE, SPIREAD

```
DIM rc
DIM handle

rc=SpiOpen(0,1000000,0,handle)
if rc!= 0 then
  print "\nFailed to open SPI interface with error code ";interger.h' rc
else
  print "\nSPI open success"
endif
```

SPIOPEN is a core function.

SPICLOSE

This subroutine is used to close a SPI port which had been opened with SPIOPEN.

This routine is safe to call if it is already closed.

SPICLOSE(handle)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

handle ***byVal handle AS INTEGER***
This is the handle value that was returned when SPIOPEN was called which identifies the SPI interface to close.

Interactive Command: No

Related Commands: SPICLOSE, SPIREADWRITE, SPIWRITE, SPIREAD

```
DIM rc
DIM handle

rc=SpiOpen(0,1000000,0,handle)
if rc!= 0 then
  print "\nFailed to open SSPI interface with error code ";interger.h' rc
else
  print "\nSPI open success"
endif

SpiClose(handle)  //close the port
SpiClose(handle)  //no harm done doing it again
```

SPICLOSE is a core subroutine.

SPIREADWRITE

This function is used to write data to a SPI slave and at the same time read the same number of bytes back. Each 8 clock pulses results in one byte being written and one being read.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one SPI interface is made available.

SPIREADWRITE(stWrite$, stRead$)

Subroutine

Exceptions

- Local Stack Frame Underflow

- Local Stack Frame Overflow

Arguments:

stWrite$*** ***byRef stWrite$ AS STRING
This string contains the data that must be written.

stRead$*** ***byRef stRead$ AS STRING
While the data in stWrite$ is being written, the slave sends data back and that data is stored in this variable. Note that on exit this variable will contain the same number of bytes as stWrite$.

Interactive Command: No

Related Commands: SPICLOSE, SPIREADWRITE, SPIWRITE, SPIREAD

```
DIM rc
DIM handle
DIM stWrite$, stRead$
DIM cs_pin
Cs_pin = 14

rc=SpiOpen(0,1000000,0,handle)
if rc!= 0 then
  print "\nFailed to open SPI interface with error code ";interger.h' rc
else
  print "\nSPI open success"
endif

//enable the chip select to the slave
Gpiowrite(cs_pin,0)

//Write 2 bytes and read 2 at the same time
stWrite = "\34\35" : stRead$=""
rc = SpiReadWrite(stWrite$, stRead$)
if rc!= 0 then
  print "\nFailed to ReadWrite"
else
  print "\nWrite = ";strhexize$(stWrite$);" Read = ";strhexize$(stRead$)
endif

//disable the chip select to the slave
Gpiowrite(cs_pin,1)



SpiClose(handle)  //close the port
```

SPIWRITEREAD is a core function.

SPIWRITE

This function is used to write data to a SPI slave and any incoming data to be ignored.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one SPI interface is made available.

SPIWRITE(stWrite$)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

stWrite$*** ***byRef stWrite$ AS STRING
This string contains the data that must be written.

Interactive Command: No

Related Commands: SPICLOSE, SPIREADWRITE, SPIWRITE, SPIREAD

```
DIM rc
DIM handle
DIM stWrite$
DIM cs_pin
Cs_pin = 14

rc=SpiOpen(0,1000000,0,handle)
if rc!= 0 then
  print "\nFailed to open SPI interface with error code ";interger.h' rc
else
  print "\nSPI open success"
endif

//enable the chip select to the slave
Gpiowrite(cs_pin,0)

//Write 2 bytes
stWrite = "\34\35"
rc = SpiWrite(stWrite$)
if rc!= 0 then
  print "\nFailed to Write"
else
  print "\nWrite = ";strhexize$(stWrite$)
endif


//disable the chip select to the slave
Gpiowrite(cs_pin,1)


SpiClose(handle)  //close the port
```

SPIWRITE is a core function.

SPIREAD

This function is used to read data from a SPI slave.

Note a 'handle' parameter is NOT required as this function is used to interact with the main interface. In future an _Ex version of this function will be made available if more than one SPI interface is made available.

SPIREAD(stRead$, nReadLen)

Subroutine

Exceptions

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

stRead$*** ***byRef stRead$ AS STRING
This string will contain the data that is read from the slave.

nReadLen ***byVal nReadLen AS INTEGER***
This specifies the number of bytes to be read from the slave.

Interactive Command: No

Related Commands: SPICLOSE, SPIREADWRITE, SPIWRITE, SPIREAD

```
DIM rc
DIM handle
DIM stRead$
DIM cs_pin
cs_pin = 14

rc=SpiOpen(0,1000000,0,handle)
if rc!= 0 then
  print "\nFailed to open SPI interface with error code ";interger.h' rc
else
  print "\nSPI open success"
endif

//enable the chip select to the slave
Gpiowrite(cs_pin,0)

//Read 2 bytes
rc = SpiRead(stRead$)
if rc!= 0 then
  print "\nFailed to Write"
else
  print "\nRead = ";strhexize$(stRead$)
endif

//disable the chip select to the slave
Gpiowrite(cs_pin,1)
```

```
SpiClose(handle)  //close the port
```

SPIREAD is a core function.

Non-Volatile Memory Management Routines

These commands provide access to the non-volatile memory of the module, as well as providing the ability to use non-volatile storage for individual records.

NVRECORDGET

NVRECORDGET is used to read the value of a user record as a string from non-volatile memory.

NVRECORDGET (*recnum, strvar*)

FUNCTION

Returns:

Returns the number of bytes that were read into ***strvar***.

A negative value is returned if an error was encountered as follows:-

-1	***recnum*** is not in valid range or unrecognised
-2	failed to determine the size of the record
-3	The raw record is less than 2 bytes long – suspect flash corruption
-4	insuffucient RAM memory
-5	failed to read the data record

Exceptions:

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

recnum ***byVal recnum AS INTEGER***
The record number that is to be read, in the range 1 to n, where n depends on the specific module.

strvar ***byRef strvar AS STRING***
The string variable that will contain the data read from the record.

Interactive Command: NO

```
DIM R$
PRINT NVRECORDGET(100,R$)        'print result of operation
PRINT R$                         'print content of record
```

NVRECORDGET is a module function.

NVRECORDGETEX

NVRECORDGETX is used to read the value of a user record as a string from non-volatile memory and if it does not exist or an error occurred, then the specified default string is returned.

NVRECORDGETEX (*recnum, strvar, strdef*)

FUNCTION

Returns:

Returns the number of bytes that are read into ***strvar***.

Exceptions:

- Local Stack Frame Underflow
- Local Stack Frame Overflow
- Out of memory

Arguments:

recnum ***byVal recnum AS INTEGER***
The record number that is to be read, in the range *1* to *n*, where n depends on the specific module.

strvar ***byRef strvar AS STRING***
The string variable that will contain the data read from the record.

strdef ***byVal strdef AS STRING***
The string variable that will supply the default data if the record does not exist.

Interactive Command: NO

```
DIM R$
PRINT NVRECORDGETEX(100,R$,"hello")     'print result of operation
PRINT R$                                'print content of record
```

NVRECORDGETEX is a module function.

NVRECORDSET

NVRECORDSET is used to write a value to a user record in non-volatile memory.

NVRECORDSET (*recnum, strvar*)

FUNCTION

Returns:

Returns the number of bytes written.

If an invalid record number is specified then -1 is returned. There are a limited number of user records which can be written to, depending on the specific module.

Exceptions:

- Local Stack Frame Underflow
- Local Stack Frame Overflow

Arguments:

recnum ***byVal recnum AS INTEGER***
The record number that is to be read, in the range *1* to *n*, where n depends on the specific module.

strvar ***byRef strvar AS STRING***
The string variable that will contain the data to be written to the record.

WARNING: Programmers should minimise the number of writes as each time a record is changed, flash is used up. The flash filing system does not overwrite previously used locations. At some point there will be no more free flash memory and an automatic defragment operation will occur and this operation will take much longer than normal as a lot of data may need to be re-written to a new flash segment. This sector erase operation could affect the operation of the radio and result in a connection loss.

Interactive Command: NO

```
DIM W$,R$
DIM RC
W$="HelloWorld"
RC=NVRECORDET(500,W$)
PRINT NVRECORDGETEX(500,R$,"hello")    'print result of operation
```

NVRECORDSET is a module function.

Input/Output Interface Routines

I/O and interface commands allow access to the physical interface pins and ports of the *smart* BASIC modules. Most of these commands are applicable to the range of modules. However, some are dependent on the actual I/O availability of each module.

GPIOSETFUNC

This routine is used to set the function of the gpio pin identified by the nSigNum argument.

The module datasheet will contain a pinout table which will mention SIO (Special I/O) pins and the number designated for that special i/o pin corresponds to the nSigNum argument.

GPIOSETFUN (*nSigNum, nFunction, nSubFunc)*

FUNCTION

Returns:

Returns a result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nSigNum **byVal nSigNum AS INTEGER.**
The signal number as stated on the pinout of the module.

nFunction **byVal nFunction ASINTEGER**.
Specifies the configuration of the GPIO pin as follows:
1 := DIGITAL_IN
2 := DIGITAL_OUT
3 := ANALOG_IN
4 := ANALOG_REF
5 := ANALOG_OUT

nSubFunc **byVal nSubFunc INTEGER.**
Configures the pin as follows:

If nFunction := DIGITAL_IN then it consists of 2 bitfields as follows:-
Bits 0..3
1 :- pull down resistor (weak)
2 :- pull up resistor (weak)
3 :- pull down resistor (strong)
4 :- pull up resistor (strong)
Else :- No pull resistors
Bits 4..7
1 :- Wake on high to low transition when in deep sleep mode
2 :- Wake on low to high transition when in deep sleep mode
Else :- No effect in deep sleep mode.
Bits 8..31
Must be 0s

if nFuncType == DIGITAL_OUT
0 := Init output to LOW
1 := Init output to HIGH

if nFuncType == ANALOG_IN
0 := Use Default for system
For BL600 : 10 bit adc and 2/3rd scaling
0x13 := For BL600 : 10 bit adc, 1/3rd scaling
0x11 := For BL600 : 10 bit adc, unity scaling
WARNING:
This subfunc value is 'global' and once changed will apply to all ADC inputs.

Interactive Command: NO

```
DIM number

number = gpiosetfunc(3,1,2)    //remove the pull resistor the DIGITAL_IN pin3
number = gpiosetfunc(4,3,0)    //set gpio pin4 as analog in
number = gpiosetfunc(5,1,0x12) //internal pull up on gpio5 and wake from deep sleep
                               //when there is transition from high to low
```

GPIOSETFUNC is a Module function.

GPIOREAD

This routine is used to read the value from a SIO (special purpose I/O) pin.

The module datasheet will contain a pinout table which will mention SIO (Special I/O) pins and the number designated for that special i/o pin corresponds to the nSigNum argument.

GPIOREAD (*nSigNum*)

FUNCTION

Returns:

Returns the value from the signal. If the signal number is invalid, then it will still return a value and it will be 0. For digital pins, the value will be 0 or 1. For ADC pins it will be a value in the range 0 to M where M is the max value based on the bit resolution of the analogue to digital converter.

Arguments:

nSigNum **byVal nSigNum INTEGER**.
The signal number as stated on the pinout of the module.

Interactive Command: NO

```
DIM signal

signal = gpioread(5)
print signal                    ' the value on gpio pin 3 will be printed.
```

GPIOREAD is a Module function.

GPIOWRITE

This routine is used to write a new value to the GPIO pin. If the pin number is invalid, nothing happens.

GPIOWRITE (*nSigNum, nNewValue*)

SUBROUTINE

Arguments:

nSigNum **byVal *nSigNum* INTEGER**.
The signal number as stated on the pinout of the module.

nNewValue **byVal *nNewValue* INTEGER**.
The value to be written to the port. If the pin is configured as digital then 0 will clear the pin and a non-zero value will set it.
If the pin is configured as analog, then the value is written to the pin.

Interactive Command: NO

```
DIM signal

gpiowrite(5,1)
signal = gpioread(5)
```

```
print signal                          ' the value on gpio pin 3 will be printed.
```

GPIOWRITE is a Module function.

GPIO Events

EVGPIOCHANn where n=0 to N where N is platform dependent and an event is generated when a preconfigured digital input transition occurs. The number of digital inputs that can auto-generate is hardware dependent and in the case of the BL600 module, N can be 0,1,2 or 3.

GPIOBINDEVENT

This routine is used to bind an event to a level transition on a specified special i/o line configured as a digital input so that changes in the input line can invoke a handler in *smart* BASIC user code

GPIOBINDEVENT (*nEventNum, nSigNum, nPolarity)*

FUNCTION

Returns:

Returns a result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nEventNum **byVal *nEventNum* INTEGER**.
The GPIO event number (in the range of 0 - N) which will result in the events EVGPIOCHANn being thrown to the *smart* BASIC runtime engine.

nSigNum **byVal *nSigNum* INTEGER**.
The signal number as stated on the pinout of the module.

nPolarity **byVal *nPolarity* INTEGER**.
States the transition as follows:

0 Low to high transition
1 High to low transition
2 Either a low to high or high to low transition

Interactive Command: NO

```
DIM RC

RC = GpioBindEvent(0,20,0)
```

GPIOBINDEVENT is a Module function.

GPIOUNBINDEVENT

This routine is used to unbind the runtime engine event from a level transition.

GPIOUNBINDEVENT (*nEventNum*)

FUNCTION

Returns:

Returns a result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nEventNum **byVal *nEventNum* INTEGER**.
The GPIO event number (in the range of 0 - N) which will be disabled so that it no longer generates run-time events in *smart* BASIC.

Interactive Command: NO

```
DIM RC

RC = GpioUnBindEvent(0)
```

GPIOUNBINDEVENT is a Module function.

User Routines

As well as providing a comprehensive range of inbuilt functions and subroutines, *smart* BASIC provides the ability for users to write their own, which are referred to as 'user' routines as opposed to 'builtin' routines.

These are typically used to perform frequently repeated tasks within an application and to write event & message handler functions. An application with user routines has optimal modularity enabling reuse of functionality.

SUB

A subroutine is a block of statements which constitute a user routine which does not return a value but takes arguments.

SUB routinename (arglist)
EXITSUB
ENDSUB

A SUB routine MUST be defined before the first instance of its being called. It is good practice to define SUB routines and functions at the beginning of an application, immediately after global variable declarations.

A typical example of a subroutine block would be

```
SUB somename(arg1 AS INTEGER arg2 AS STRING)
```

```
  DIM S AS INTEGER
  S = arg1
  IF arg1 == 0 THEN
    EXITSUB
  ENDIF
ENDSUB
```

Defining the routine name

The function name can be any valid name that is not already in use as a routine or global variable.

Defining the *arglist*

The arguments of the subroutine may be any valid variable types, i.e. INTEGER or STRING.

Each argument can be individually specified to be passed either as byVal or byRef. By default simple variables (INTEGER) are passed by value (byVal) and complex variables (STRING) are passed by reference (byRef).

However, this default behaviour can be varied by using the #SET directive during compilation of an application.

```
#SET 1,0   'Default Simple arguments are BYVAL
#SET 1,1   'Default Simple arguments are BYREF
#SET 2,0   'Default Complex arguments are BYVAL
#SET 2,1   'Default Complex arguments are BYREF
```

When a value is passed by value to a routine, any modifications to that variable will not reflect back to the calling routine. However, if a variable is passed by reference then any changes in the variable will be reflected back to the caller on exit.

The SUB statement marks the beginning of a block of statement which will consist of the body of a user routine. The end of the routine is marked by the ENDSUB statement.

ENDSUB

This statement marks the end of a block of statement belonging to a subroutine. It MUST be included as the last statement of a SUB routine, as it instructs the compiler that there is no more code for the SUB routine.

Note that any variables declared within the subroutine lose their scope once ENDSUB is processed.

EXITSUB

This statement provides an early **run-time** exit from the subroutine.

FUNCTION

A statement beginning with this token marks the beginning of a block of statement which will consist of the body of a user routine. The end of the routine is marked by the ENDFUNC statement.

A function is a block of statements which constitute a user routine that returns a value. A function takes arguments, and can return a value of type simple or complex.

FUNCTION routinename (arglist) AS vartype
EXITFUNC arithemetic_expression_or_string_expression
ENDFUNC arithemetic_expression_or_string_expression

A Function MUST be defined before the first instance of its being called. It is good practice to define subroutines and functions at the beginning of an application, immediately after variable declarations.

A typical example of a function block would be

```
FUNCTION somename(arg1 AS INTEGER arg2 AS STRING) AS INTEGER
  DIM S AS INTEGER
  S = arg1
  IF arg1 == 0 THEN
    EXITFUNC arg1*2
  ENDIF
ENDFUNC arg1 * 4
```

Defining the routine name

The function name can be any valid name that is not already in use. The return variable is always passed as byVal and shall be of type **varType**.

Return values are defined within zero or more optional EXITFUNC statements and ENDFUNC is used to mark the end of the block of statements belonging to the function.

Defining the return value

The variable type **AS varType** for the function may be explicitly stated as one of INTEGER or STRING prior to the routine name. If it is omitted, then the type is derived in the same manner as in the DIM statement for declaring variables. Hence, if function name ends with the $ character then the type will be a STRING otherwise an INTEGER.

Since functions return a value, when used, they must appear on the right hand side of an expression statement or within a *[ ]* index for a variable. This is because the value has to be 'used up' so that the underlying expression evaluation stack does not have 'orphaned' values left on it.

Defining the arglist

The arguments of the function may be any valid variable types, i.e. INTEGER or STRING.

Each argument can be individually specified to be passed either as byVal or byRef. By default, simple variables (INTEGER) are passed byVal and complex variables (STRING) are passed byRef. However, this default behaviour can be varied by using the #SET directive.

```
# SET 1,0   Default Simple arguments are BYVAL
# SET 1,1   Default Simple arguments are BYREF
# SET 2,0   Default Complex arguments are BYVAL
# SET 2,1   Default Complex arguments are BYREF
```

Interactive Command: NO

ENDFUNC

This statement marks the end of a function declaration. Every function must include an ENDFUNC statement, as it instructs the compiler that here is no more code for the routine.

ENDFUNC arithemetic_expression_or_string_expression

This statement marks the end of a block of statement belonging to a function. It also marks the end of scope on any variables declared within that block.

ENDFUNC must be used to provide a return value, through the use of a simple or complex expression.

```
FUNCTION doThis$( byRef s$ as string) AS STRING
  S$=S$+" World"
ENDFUNC S$ + "world"

FUNCTION doThis( byRef v as integer) AS INTEGER
  v=v+100
ENDFUNC v * 3
```

EXITFUNC

Provides a run-time exit point for a function before reaching the ENDFUNC statement.

EXITFUNC arithemetic_expression or string expression

EXITFUNC can be used to provide a return value, through the use of a simple or complex expression. It is usually invoked in a conditional statement to facilitate an early exit from the function.

```
FUNCTION doThis$( byRef s$ as string) AS STRING
  S$=S$+" World"
  IF a==0 THEN
    EXITFUNC S$ + "earth"
  ENDIF
ENDFUNC S$ + "world"
```

6. BLE Extensions Built-in Routines

Bluetooth Low Energy (BLE) extensions are specific to the BT600 *smart* BASIC BLE module and provide a high level managed interface to the underlying Bluetooth stack.

Events and Messages

EVBLE_ADV_TIMEOUT This event is thrown when adverts started using BleAdvertStart() time out and the usage is as per the example below.

EVBLEMSG The BLE subsystem is capable of informing a *smart* BASIC application when a significant BLE related event has occurred and it does so by throwing this message (as opposed to an EVENT, which is akin to an interrupt and has no context or queue associated with it) which contains 2 parameters. The first parameter, to be called

msgID subsequently, identifies what event got triggered and the second parameter, to be called msgCtx subsequestly, conveys some context data associated with that event. The *smart* BASIC application will have to register a handler function which takes two integer arguments to be able to receive and process this message.

Note that the messaging subsystem, unlike the event subsystem, has a queue associated with it and unless that queue is full will pend all messages until they are handled. Only messages that have handlers associated with them will get inserted into the queue. This is to prevent messages that will not get handled from filling that queue.

The list of all triggers and the associated context parameter is as follows:-

MsgId	Description
0	A connection has been established and msgCtx is the connection handle
1	A disconnection event and msgCtx identifies the handle
2	Immediate Alert Service Alert. The 2nd parameter contains new alert level
3	Link Loss Alert. The 2nd parameter contains new alert level
4	A BLE Service Error. The 2nd parameter contains the error code.
5	Thermometer Client Characteristic Descriptor value has changed
6	Thermometer measurement indication has been acknowledged
7	Blood Pressure Client Characteristic Descriptor value has changed
8	Blood Pressure measurement indication has been acknowledged
9	Pairing in progress and display Passkey supplied in msgCtx.
10	A new bond has been successfully created
11	Pairing in progress and authentication key requested. msgCtx is key type.
12	Heart Rate Client Characteristic Descriptor value has changed

An example of how this message can be used is as follows:-

```
DIM connHndl  '//global variable to store connection handle
DIM addr$

addr$=""

'//============================================================================
'// This handler is called when there is a BLE message
'//============================================================================
function HandlerBleMsg(BYVAL nMsgId AS INTEGER, BYVAL nCtx AS INTEGER) as integer
  select nMsgId
  case 0
    '//print "\nBle Connection ";integer.h' nCtx
    rc = BleAuthenticate(nCtx)
    connHndl = nCtx
  case 1
    '//print "\nBle Disonnection ";integer.h' nCtx
    inconn = 0
    '// restart advertising
    rc = BleAdvertStart(ADV_IND,addr$,ADV_INTERVAL_MS,ADV_TIMEOUT_MS,0)
  case else
    print "\nUnknown Ble Msg"
  endselect
endfunc 1

'//============================================================================
```

```
'// This handler is called when data has arrived at the serial port
'//============================================================================
function HandlerBlrAdvTimOut() as integer
   print "\nAdvert stoped via timeout"
   '//-------------------------------------------------------------
   '//  Switch off the system - requires a power cycle to recover
   '//-------------------------------------------------------------
   rc = SystemStateSet(0)
 endfunc 1

'// register the handler for all BLE messages
OnEvent  EVBLEMSG call HandlerBleMsg
'// register the handler for adv timeouts
OnEvent  EVBLE_ADV_TIMEOUT  call HandlerBlrAdvTimOut

'// start adverts
    rc = BleAdvertStart(ADV_IND,addr$,ADV_INTERVAL_MS,ADV_TIMEOUT_MS,0)

'//wait for event and messages
WaitEvent
```

Miscellaneous Functions

This section describes all BLE related functions that are not related to advertising, connection, security manager or GATT.

BLETXPOWERSET

This function is used to set the power of all packets that are transmitted subsequently, it is advisable to recreate the advert packet if this new tx power is to be reflected in advertisement packets.

This function is also very useful to temporarily set the power to the lowest value possible so that a pairing is expedited in the smallest bubble of space.

BLETXPOWERSET(nTxPower)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nTxPower **byVal *nTxPower* AS INTEGER.**
Specifies the new transmit power in dBm units to be used for all subsequent tx packets and valid values are :-

4	Maximum
0	
-4	
-8	
-12	
-16	
-20	
-40	
-65	Whisper Mode

Interactive Command: NO

```
DIM RC

RC = bletxpowerset(0)                    'The transmitted power is set to 0 dBm
//CHECK//--the function does not work on the module
```

BLETXPOWERSET is an extension function.

Adverting Functions

This section describes all the advertising related routines.

An advertisement consists of a packet of information with a header identifying it as one of 4 types along with an optional payload that consists of multiple advertising records, referred to as AD in the rest of this manual.

Each AD record consists of up to 3 fields. The first field is 1 octet in length and contains the number of octets that follow it that belong to that record. The second field is again a single octet and is a tag value which identifies the type of payload that starts at the next octet. Hence the payload data is 'length – 1'. A special NULL AD record consists of only one field , that is, the length field, when it contains just the 00 value.

The specification also allows custom AD records to be created using the 'Manufacturer Specific Data' AD record.

The reader is encouraged to refer to the "Supplement to the Bluetooth Core Specification, Version 1, Part A" which has the latest list of all AD records. You will need to register as at least an Adopter, which is free, to be able to get access to this information. It is available at https://www.bluetooth.org/docman/handlers/downloaddoc.ashx?doc_id=245130

BLEADVERTSTART

This function causes a BLE advertisement events as per the Bluetooth Specification. An advertisement event consists of an advertising packet in each of the three advertising channels.

The type of advertisement packet is determined by the nAdvType argument and the data in the packet is initialised, created and submitted by the **BLEADVRPTINIT**, **BLEADVRPTADDxxx** and **BLEADVRPTCOMMIT** functions respectively.

If the Advert packet type (nAdvType) is specified as 1 (ADV_DIRECT_IND) then the peerAddr$ string must not be empty and should be a valid address.

When filter policy is enabled, the a whitelist consisting of all bonded masters is submitted to the underlying stack so that only those bonded masters will result in scan and connections requests being serviced.

BLEADVERTSTART (nAdvType,peerAddr$,nAdvInterval, nAdvTimeout, nFilterPolicy)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nAdvType **byVal *nAdvType* AS INTEGER.**
Specifies the advertisement type as follows:

0	ADV_IND	invites connection requests
1	ADV_DIRECT_IND	invites connection from addressed device
2	ADV_SCAN_IND	invites scan request for more advert data
3	ADV_NONCONN_IND	will not accept connections or active scans

***peerAddr$*** **byRef *peerAddr$* AS STRING**
It can be an empty string that is omitted if the advertisement type is not ADV_DITRECT_IND.
This parameter is only required when nAdvType == 1

nAdvInterval **byVal *nAdvInterval* *AS* INTEGER**.
The interval between two advertisement events (in milliseconds).
An advertisement event consists of a total of 3 packets being transmitted in the 3 advertising channels.
The range of this interval is between 20 and 10240 milliseconds.

nAdvTimeout **byVal *nAdvTimeout* AS INTEGER**.
The time after which the module stops advertising (in milliseconds). The range of this value is between 0 and 16383000 milliseconds.

nFilterPolicy **byVal *nFilterPolicy* AS INTEGER.**

Specifies the filter policy as follows:

0	Filter Policy	Any
1	Filter Policy	Filter Scan Request
2	Filter Policy	Filter Connection Request
3	Filter Policy	Both

If the filter policy is not 0, then the whitelist is filled with all the addresses of all the devices in the trusted device database.

Interactive Command: NO

```
DIM ReturnCode
DIM Adr$

Adr$=""
ReturnCode = bleadvertstart(0,Adr$,25,60000,0)  'The advertising interval is set to 25
                                                'milliseconds. The module will stop
                                                'advertising after 60000 ms (1 minute)
```

BLEADVERTSTART is an extension function.

BLEADVERTSTOP

This function causes the BLE module to stop advertising.

BLEADVERTSTOP ()

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments None

Interactive Command: NO

```
DIM ReturnCode

ReturnCode = bleadvertstop()            'Causes the BLE module to stop advertising
```

BLEADVERTSTOP is an extension function.

BLEADVRPTINIT

This function is used to create and initialise an advert report with a minimal set of ADs (advertising records) and store it the string specified. It will not be advertised until BLEADVRPTSCOMMIT is called.

This report is used for use with advertisement packets.

BLEADVRPTINIT(advRpt, nDiscoverableMode, nAdvAppearance, nMaxDevName)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

advRpt byRef ***advRpt AS***STRING.
This will contain an advertisement report.

nDiscoverableMode byVal ***nDiscoverableMode AS*** INTEGER.
Specifies the discovery mode of the device as follows:

0 General mode
1 Limited mode

nAdvAppearance byVal ***nAdvAppearance*** AS INTEGER.
Determines whether the appearance advert should be added or omitted as follows:

0 Omit appearance advert
1 Add appearance advert as specified in the Gap service

nMaxDevName byVal ***nMaxDevName*** AS INTEGER.
The n leftmost characters of the device name specified in The Gap service. If this value is set to 0 then the device name will not be included.

Interactive Command: NO

```
DIM RC,advRpt$,scnRpt$,discoverableMode, advAppearance,MaxDevName

ad$=""
scnRpt$=""
discoverableMode = 0
advAppearance = 1
nMaxDevName = 10

RC = bleadvrptinit(advRpt$, discoverableMode, advAppearance, MaxDevName)
RC = bleadvrptscommit(advRpt$,scnRpt$)
```

BLEADVRPTINIT is an extension function.

BLESCANRPTINIT

This function is used to create and initialise a scan report which will be sent in a SCAN_RSP message. It will not be used until BLEADVRPTSCOMMIT is called.

This report is used for use with SCAN_RESPONSE packets.

BLESCANRPTINIT(scanRpt)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

scanRpt **byRef *scanRpt AS*STRING.**
This will contain a scan report.

Interactive Command: NO

```
DIM RC,advRpt$,scnRpt$,discoverableMode, advAppearance,MaxDevName

ad$=""
scnRpt$=""
discoverableMode = 0
advAppearance = 1
nMaxDevName = 10

RC = bleadvrptinit(advRpt$, discoverableMode, advAppearance, MaxDevName)
RC = blescanrptinit(scnRpt$)
RC = bleadvrptscommit(advRpt$,scnRpt$)
```

BLESCANRPTINIT is an extension function.

BLEADVRPTADDUUID16

This function is used to add a 16 bit uuid service list AD (Advertising record) to the advert report. This consists of all the 16 bit service UUIDs that the device supports as a server.

BLEADVRPTADDUUID16 (advRpt, nUuid1, nUuid2, nUuid3, nUuid4, nUuid5, nUuid6)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

AdvRpt **byRef *AdvRpt AS* STRING**.
The advert report onto which the 16 bit uuids AD record is added.

Uuid1	***byVal uuid1 AS INTEGER*** Uuid in the range 0 to FFFF, if value is outside that range it will be ignored, so set the value to -1 to have it be ignored and then all further UUID arguments will also be ignored.
Uuid2	***byVal uuid2 AS INTEGER*** Uuid in the range 0 to FFFF, if value is outside that range it will be ignored, so set the value to -1 to have it be ignored and then all further UUID arguments will also be ignored.
Uuid3	***byVal uuid3 AS INTEGER*** Uuid in the range 0 to FFFF, if value is outside that range it will be ignored, so set the value to -1 to have it be ignored and then all further UUID arguments will also be ignored.
Uuid4	***byVal uuid4 AS INTEGER*** Uuid in the range 0 to FFFF, if value is outside that range it will be ignored, so set the value to -1 to have it be ignored and then all further UUID arguments will also be ignored.
Uuid5	***byVal uuid5 AS INTEGER*** Uuid in the range 0 to FFFF, if value is outside that range it will be ignored, so set the value to -1 to have it be ignored and then all further UUID arguments will also be ignored.
Uuid6	***byVal uuid6 AS INTEGER*** Uuid in the range 0 to FFFF, if value is outside that range it will be ignored, so set the value to -1 to have it be ignored.

Interactive Command: NO

```
DIM RC,advRpt$,discoverableMode, advAppearance,MaxDevName

discoverableMode = 0
advAppearance = 1
nMaxDevName = 10

RC = bleadvrptinit(advRpt$, discoverableMode, advAppearance, MaxDevName)

'//BatteryService =  0x180F
'//DeviceInfoService = 0x180A

RC = bleadvrptadduuid(advRpt$,0x180F,0x180A, -1, -1, -1, -1)

'Only the battery and device information services are included in the advert report
```

BLEADVRPTADDUUID is an extension function.

BLEADVRPTSCOMMIT

This function is used to commit one or both advert reports. If the string is empty then that report type is not updated. Both strings can be empty and in that case this call will have no effect.

The advertisements will not happen until they are started using BleAdvertStart() function.

BLEADVRPTSCOMMIT(advRpt, scanRpt)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

advRpt	**byRef *advRpt* AS STRING.** The most recent advert report.
scanRpt	**byRef *scanRpt* AS STRING.** The most recent scan report.

Note: If the any one of the two strings is not valid then the call will be aborted without updating the other report even if this other report is valid.

Interactive Command: NO

```
DIM RC,advRpt$,discoverableMode,advAppearance,MaxDevName
DIM UuidBatteryService, UuidDeviceInfoService

ad$=""
scRpt$=""
discoverableMode = 0
advAppearance = 1
nMaxDevName = 10
UuidBatteryService = 0x180F
UuidDeviceInfoService = 0x180A


RC = bleadvrptinit(advRpt$, discoverableMode, advAppearance, MaxDevName)

RC = bleadvrptadduuid(UuidBatteryService,UuidDeviceInfoService, -1, -1, -1, -1)

RC = bleadvrptscommit(ad$, scRpt$)

'// Only the advert report will be updated.
```

BLEADVRPTSCOMMIT is an extension function.

Connection Functions

This section describes all the connection manager related routines.

The Bluetooth specification stipulates that a peripheral cannot initiate a connection, but can perform disconnections. Only Central Role devices are allowed to connect when an appropriate advertising packet is received from a peripheral.

Events & Messages

See also Events & Messages for BLE related messages that are thrown to the application when there is a connection or disconnection. The message ids that are relevant are (0) and (1) as follows:-

MsgId	Description
0	There is a connection and the context parameter contains the connection handle
1	There is a disconnection and the context parameter contain the connection handle

BLEDISCONNECT

This function causes an existing connection identified by a handle to be disconnected from the peer.

When the disconnection is complete a EVBLEMSG message with msgId = 1 and context containing the handle will be thrown to the *smart* BASIC runtime engine.

BLEDISCONNECT (nConnHandle)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nConnHandle **byVal *nConnHandle* AS INTEGER.**
Specifies the handle of the connection that needs to be dropped.

Interactive Command: NO

```
DIM RC,connHandle

ReturnCode = bledisconnect(connHandle)
```

BLEDISCONNECT is an extension function.

Security Manager Functions

This section describes routines which are used to manage all aspects related to BLE security such as saving, retrieving and deleting link keys and creation of those keys using pairing and bonding procedures.

Events & Messages

The following security manager messages are thrown to the run-time engine using the EVBLEMSG message with the msgID :-

MsgId	Description
9	Pairing in progress and display Passkey supplied in msgCtx.
10	A new bond has been successfully created
11	Pairing in progress and authentication key requested. Type of key is in msgCtx. msgCtx is 1 for passkey_type which will be a number in the range 0 to 999999 and 2 for OOB key which is a 16 byte key.

When msgId 9 is sent the msgCtx parameter contains the passkey to display which will be a value in the range 0 to 999999. It is advisable to display the number with leading 0's so that the passkey is always displayed as a 6 digit decimal number.

To submit a passkey, use the function BLESECMNGRPASSKEY.

BLESECMNGRPASSKEY

This function is used to submit a passkey to the underlying stack during a pairing procedure when prompted by the EVBLEMSG with msgId set to 11. See Events & Messages.

BLESECMNGRPASSKEY(connHandle, nPassKey)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

connHandle **byVal connHandle AS INTEGER**.
This is the connection handle as received via the EVBLEMSG event with msgId set to 0.

nPassKey **byVal *nPassKey* AS INTEGER.**
This is the passkey to submit to the stack. Submit a value outside the range 0 to 999999 to reject the pairing.

Interactive Command: NO

```
DIM rc
DIM connHandle
```

```
function HandlerBleMsg(BYVAL nMsgId AS INTEGER, BYVAL nCtx AS INTEGER) as integer
  select nMsgId
  case BLE_EVBLEMSGID_CONNECT
    connHandle =nCtx
    DbgMsgVal("Ble Connection ",nCtx)


  case BLE_EVBLEMSGID_AUTH_KEY_REQUEST
    DbgMsgVal(" +++ Auth Key Request, type=",nCtx)
    rc=BleSecMngrPassKey(connHandle,123456) '//key is 123456

  case else
    DbgMsg("Unknown Ble Msg" )
  endselect
endfunc 1

OnEvent  EVBLEMSG           call HandlerBleMsg

waitevent
```

BLESECMNGRPASSKEY is an extension function.

BLESECMNGRKEYSIZES

This function is used to set the minimum and maximum key size requirement for subsequent pairings.

BLESECMNGRKEYSIZES(nMinKeysize, nMaxKeysize)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nMinKeysiz **byVal *nMinKeysiz* AS INTEGER**.
The minimum key size (in seconds). The range of this value is between 7 and 16.

nMaxKeysize **byVal *nMaxKeysize* AS INTEGER.**
The maximum key size (in seconds). The range of this value is between nMinKeysize and 16.

Interactive Command: NO

```
DIM RC

RC = blemngrkeysizes(8,15)                  'The key size requirement is set between
                                            '8 and 15 seconds
```

BLESECMNGRKEYSIZES is an extension function.

BLESECMNGRIOCAP

This function is used to set the user i/o capability for subsequent pairings and is used to determine if the pairing is authenticated or not. This is related to Simple Secure Pairing as described in the following whitepapers:-

https://www.bluetooth.org/docman/handlers/DownloadDoc.ashx?doc_id=86174

https://www.bluetooth.org/docman/handlers/DownloadDoc.ashx?doc_id=86173

In addition the "Security Manager Specification" in the core 4.0 specification Part H provides a full description.

You will need to be registered with the Bluetooth SIG (www.bluetooth.org) to get access to all these documents.

And authenticated pairing is deemed to be one with less than 1 in a million probability that the pairing was comprised by a MITM (Man in the middle) security attack.

The valid user i/o capabilities are as described below.

BLESECMNGRIOCAP (nIoCap)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nIoCap **byVal *nIoCap AS* INTEGER**.
The user i/o capability for all subsequent pairings.
0 None also known as 'Just Works' (unauthenticated pairing)
1 Display with Yes/No input capability (authenticated pairing)
2 Keyboard Only (authenticated pairing)
3 Display Only (authenticated pairing – if other end has input cap)
4 Keyboard only (authenticated pairing)

Interactive Command: NO

```
DIM RC

RC = blesecmngriocap(0)     'Select 'just works' pairing
```

BLESECMNGRIOCAP is an extension function.

BLESECMNGRBONDREQ

This function is used to enable or disable bonding when pairing.

Note this function will be deprecated in future releases. It is recommended it is invoked before calling BleAuthenticate() with the parameter set to 0.

BLESECMNGRBONDREQ (nBondReq)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nBondReq **byVal *nBondReq AS* INTEGER**.
0 Disable
1 Enable

Interactive Command: NO

```
DIM RC,ConnHndl

RC = BleSecMngrBondReq(0)     'Disable
RC = BleAuthenticate(ConnHndl)
```

BLESECMNGRBONDREQ is an extension function.

BLEAUTHENTICATE

This routine is used to induce the device to authenticate the peer. This will be deprecated in future releases of the firmware.

BLEAUTHENTICATE (nConnCtx)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nConnCtx byVal ***nConnCtx*** AS INTEGER.
This is the context value provided in the BLEMSG(0) message which informed the stack that a connection had been established.

Interactive Command: NO

```
DIM RC, conhndl

RC = bleAuthenticate(conhndl)    'Request the master to initiate a pairing.
```

BLEAUTHENTICATE is an extension function.

GATT Server Functions

This section describes all functions related to managing services and profiles from a GATT server perspective.

BLEGAPSVCINIT

This function updates the GAP service, which is mandatory for all approved devices to expose, with the information provided. If it is not called before adverts are started then default values will be exposed. Given this is a mandatory service, unlike other services which need to be registered, this one just needs to be initialised as the underlying BLE stack unconditionally registers it when starting up.

The GAP service contains five characteristics as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.generic_access.xml

BLEGAPSVCINIT (deviceName, nameWritable, nAppearance, nMinConnInterval, nMaxConnInterval, nSupervisionTout, nSlaveLatency)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

deviceName **byRef *deviceName* AS STRING**
The name of the device (e.g. Laird_Thermometer) that will be stored in the 'Device Name' characteristic of the GAP service.

Note when an advert report is created using BLEADCRPTINIT() this field will be read from the service and an attempt will be made to append it in the DeviceName AD. If this name is too long then that function to initialise the advert report will fail and so a default name will be transmitted. It is recommended that the device name submitted in this call be as short as possible.

nameWritable **byVal *nameWritable* AS INTEGER**
If this is non-zero, then the peer device is allowed to write the name of the device. Some profiles allow this to be optionally doable.

nAppearance **byVal *nAppearance* AS INTEGER**
The external appearance of the device and updates the Appearance characteristic of the GAP service. The full list of possible device appearance can be found at org.bluetooth.characteristic.gap.appearance.

nMinConnInterval **byVal *nMinConnInterval* AS INTEGER**
The minimum connection interval and updates the 'Peripheral Preferred

Connection Parameters' characteristic of the GAP service. The range of this value is between 7500 and 4000000 microseconds (rounded to the nearest multiple of 1250 microseconds). This value must be smaller than nMaxConnInterval.

nMaxConnInterval **byVal *nMaxConnInterval* AS INTEGER**
The maximum connection interval and updates the 'Peripheral Preferred Connection Parameters' characteristic of the GAP service. The range of this value is between 7500 and 4000000 microseconds (rounded to the nearest multiple of 1250 microseconds). This value must be larger than nMinConnInterval.

nSupervisionTimeout **byVal *nSupervisionTimeout* AS INTEGER**
The link supervision timeout and updates the 'Peripheral Preferred Connection Parameters' characteristic of the GAP service. The range of this value is between 100000 to 32000000 microseconds (rounded to the nearest multiple of 10000 microseconds).

nSlaveLatency **byVal *nSlaveLatency* AS INTEGER**
The slave latency is the number of communication intervals that a slave may ignore without losing the connection and updates the 'Peripheral Preferred Connection Parameters' characteristic of the GAP service. This value must be smaller than (nSupervisionTimeout/ nMaxConnInterval) -1. i.e. nSlaveLatency < (nSupervisionTimeout / nMaxConnInterval) -1

Interactive Command: NO

```
DIM rc,deviceName$, appearance, MinConnInt, MaxConnInt, ConnSupTimeout, SL

deviceName$ = "Laird_TS"
appearance = 768              'The device will appear as a Generic Thermometer
MinConnInt = 500000           'Minimum acceptable connection interval is 0.5 seconds
MaxConnInt = 1000000          'Maximum acceptable connection interval is 1 second
ConnSupTimeout = 4000000      'Connection supervisory timeout is 4 seconds
SL = 0                        'Slave latency--number of conn events that can be missed

rc = blegapsvcinit(deviceName$,appearance,MinConnInt,MaxConnInt,ConnSupTimeout,SL)
```

BLEGAPSVCINIT is an extension function.

BLESVCREGDEVINFO

This function is used to register the device information service with the GATT server.

The 'Device Information' service contains nine characteristics as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.device_information.xml

The firmware revision string will always be set to "BL600:vW.X.Y.Z" where W,X,Y,Z are as per the revision information which is returned to the command AT I 4.

**BLESVCREGDEVINFO (manfName$, modelNum$, serialNum$, hwRev$,
swRev$, sysId$, regDataList$, pnpId$)**

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

manfName$	**byVal *manfName$* AS STRING** The device's manufacturer name. It can be set as an empty string to omit submission.
modelNum$	**byVal *modelNum$* AS STRING** The device's model number. It can be set as an empty string to omit submission.
serialNum$	**byVal *serialNum$* AS STRING** The device's serial number. It can be set as an empty string to omit submission.
hwRev$	**byVal *hwRev$* AS STRING** The device's hardware revision string. It can be set as an empty string to omit submission.
swRev$	**byVal *swRev$* AS STRING** The device's software revision string. It can be set as an empty string to omit submission.
sysId$	**byVal *sysId$* AS STRING** The device's system Id as defined in the specifications. It can be set as an empty string to omit submission otherwise it shall be a string exactly 8 octets long, where:- Byte 0..4 := Manufacturer Identifier Byte 5..7 := Organisationally Unique Identifier Note: for the special case of the string being exactly 1 character long and containing "@" then the system ID will be created from the mac address if (and only if) an IEEE public address has been set. If the address is the random static variety then this characteristic will be omitted.
regDataList$	**byVal *regDataList$* AS STRING** The device's regulatory certification data list as defined in the specification. It can be set as an empty string to omit submission.
pnpId$	**byVal *pnpId$* AS STRING** The device's plug and play ID as defined in the specification. It can be set as an empty string to omit submission otherwise it shall be exactly 7 octets long, where :- Byte 0 := Vendor Id Source Byte 1,2 := Vendor Id (Byte 1 is LSB) Byte 3,4 := Product Id (Byte 3 is LSB) Byte 5,6 := Product Version (Byte 5 is LSB)

Interactive Command: NO

```
DIM RC, manfName$


manfName$ = "Laird Technologies"
RC = blesvcregdevinfo(manfName$)
```

BLESVCREGDEVINFO is an extension function.

BLESVCREGBATTERY

This function is used to register a Battery service with the GATT server.

The 'Battery' service contains one characteristic as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.battery_service.xml which allows a battery level value as a percentage to be exposed.

The battery level value can be updated in the characteristic at any time using the BLESVCSETBATTLEVEL function after the service has been registered.

BLESVCREGBATTERY (nInitLevel, fEnableNotify)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments

nInitLevel	**byVal *nInitLevel AS* INTEGER** specifies the initial value of the battery in percentage. The range of this value is between 0 and 100 which corresponds to 0 to 100%. Value outside this range will result in this function failing.
fEnableNotify	**byVal *fEnableNotify AS* INTEGER** If this is non-zero then the battery level characteristic will have READ and NOTIFY attributes.

Interactive Command: NO

```
DIM RC

RC = blesvcregbattery(80,0)  'the battery service is now registered with GATT with an
                             'initial battery level of 80% - No notification
```

BLESVCREGBATTERY is an extension function.

BLESVCSETBATTLEVEL

This function is used to set the battery level in percentage as reported in the battery service after it has been registered with the GATT server using the function BLESVCREGBATTERY.

BLESVCSETBATTLEVEL(nNewLevel)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nNewLevel **byVal *nNewLevel AS* INTEGER**
pecifies the value of the battery in percentage. The range of this value is between 0 and 100 which corresponds to 0 to 100%

Interactive Command: NO

```
DIM RC

RC = blesvcregbattery()       'the battery service is now registered with GATT
RC = blesvcsetbattlevel(50)   'The battery value that will be reported
                              'in the battery service is 50 percent.
```

BLESVCSETBATTLEVEL is an extension function.

BLESVCREGHEARTRATE

This function is used to register a heart rate service with the GATT server.

The 'Heart Rate' service contains three characteristics as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.heart_rate.xml

The heart rate value can be updated in the characteristic at any time using the BLESVCSETHEARTRATE function after the service has been registered.

Events & Messages

See also Events & Messages for BLE related messages that are thrown to the application when the client configuration descriptor value is changed by a gatt client. The message id that is relevant is (12) as follows:-

MsgId Description

12 Heart Rate Characteristic notification state has changed. 0 is off and 1 is on.

BLESVCREGHEARTRATE (nBodySensorLoc)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nBodySensorLoc **byVal *nBodySensorLoc* AS INTEGER**
Specifies the position of the heart rate sensor as follows:

0 Other
1 Chest

2 Wrist
3 Finger
4 Hand
5 Ear Lobe
6 Foot

Interactive Command: NO

```
DIM RC

RC = blesvcregheartrate(1)    'The position of the heart rate sensor is on the chest
```

BLESVCREGHEARTRATE is an extension function.

BLESVCSETHEARTRATE

This function is used to set the heart rate in beats per minute as reported in the heart rate service after the heart rate service has been registered using BLESVCREGHEARTRATE.

BLESVCSETHEARTRATE (nHeartRate)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nHeartRate **byVal *nHeartRate* AS INTEGER**
Specifies the value of the heart rate in beats per minute. The valid range of this parameter is between 0 and 1000.

Interactive Command: NO

```
DIM RC

RC = blesvcsetheartrate(99)                 'The heart rate value that will be
reported                                        'in the heart rate service is 99
```

BLESVCSETHEARTRATE is an extension function.

BLESVCADDHEARTRATERR

This function is used to add an RR interval to an array in the heart rate context so that the array will be sent along with the heart rate next time BLESVSETHEARTRATE is called.

According to the specification at http://developer.bluetooth.org/gatt/characteristics/Pages/CharacteristicViewer.aspx?u=org.bluetooth.characteristic.heart_rate_measurement.xml the units for RR interval shall be 1/1024 seconds which equates to slightly less than a millisecond.

BLESVCADDHEARTRATERR (rrInterval)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

rrINterval **byVal *rrInterval* AS INTEGER**
A value in the range 0 to 65535 in units of 1/1024 milliseconds.

Interactive Command: NO

```
DIM RC

RC = blesvcaddheartrateerr(100)
RC = blesvcaddheartrateerr(110)
RC = blesvcaddheartrateerr(105)
RC = blesvcsetheartrate(99)    'send a heart rate of 99 and 3 RR intervals
```

BLESVCADDHEARTRATERR is an extension function.

BLESVCHEARTRATECONTACT

This function is used to modify the sensor contact status in the heart rate context so that the Boolean information will be sent along with the heart rate next time BLESVSETHEARTRATE is called.

BLESVCHEARTRATECONTACT (newStatus)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

newStatus **byVal *newStatus* AS INTEGER**
0 for no contact and 1 for contact

Interactive Command: NO

```
DIM RC

RC = blesvcheartratecontact(1)
RC = blesvcsetheartrate(99)    'send a heart rate of 99 and 3 RR intervals
```

BLESVCHEARTRATECONTACT is an extension function.

BLESVCREGTHERM

This function is used to register a Health Thermometer service with the GATT server.

The 'Health Thermometer' service contains four characteristics as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.health_thermometer.xml

The temperature value can be updated in the characteristic at any time using the BLESVCREGTHERMfunction after the service has been registered.

Events & Messages

See also Events & Messages for BLE related messages that are thrown to the application when the client configuration descriptor value is changed by a gatt client and when the characteristic value is acknowledged by the client. The message id's that are relevant are (5) and (6) respectively as follows:-

MsgId	Description
5	Thermometer Client Characteristic Descriptor value has changed, msgCtx = 0 or 1
6	Thermometer measurement indication has been acknowledged

BLESVCREGTHERM(nTemperatureType)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments

nTemperatureType **byVal *nTemperatureType* AS INTEGER**
The value must be set between 0 and 255 and currently BT SIG allocated values, as of Feb 2013 are:-

1 Armpit
2 Body (General)
3 Ear (Usually ear lobe)
4 Finger
5 Gastro-intestinal Tract
6 Mouth
7 Rectum
8 Toe
9 Tympanum (ear drum)

See http://developer.bluetooth.org/gatt/characteristics/Pages/CharacteristicViewer.aspx?u=org.bluetooth.characteristic.temperature_type.xml for the list of most current values.

Interactive Command: NO

```
DIM rc

rc = blesvcregtherm(2)  'the thermometer service is now registered with GATT
```

BLESVCREGTHERM is an extension function.

BLESVCSETTHERM

This function is used to set the temperature in centigrade as reported in the temperature service which has been registered in the GATT server using the function BLESVCREGTHERM.

The value is supplied as two integers, a mantissa and the exponent, which will be stored and transmitted as a 4 byte IEEE floating point value where the mantissa occupies 3 bytes and the exponent the last byte. The two integer values (mantissa and exponent) are interpreted so that the actual temperature value is **mantissa** times ten to the power of **exponent**. The following examples should make it clearer:-

Temperature	Mantissa	Exponent
37.3	373	-1
37300	373	2
37	37	0
1063	1063	0
1063.45	106345	-2

After this function is called wait for the EVBLEMSG message to arrive with msgId set to 6 which confirms that the measurement data has been confirmed by the gatt client.

BLESVCSETTHERM (nMantissa, nExponent, nUnits, dateTime$)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nMantissa	**byVal *nMantissa* AS INTEGER** The value must be set between -9,000,000 and +9,000,000
nExponent	**byVal *nExponent* AS INTEGER** The value must be set between -128 and +127
nUnits	**byVal *nUnits* AS INTEGER** Set to 0 for Centigrade and 1 for Fahrenheit
dateTime$	**byRef *dateTime$* AS STRING** The string contains a date and time stamp which can be optionally provided. It shall be presented to this function in a strict format and if the validation fails, then the information is omitted. To omit this information just provide an empty string. Otherwise the string SHALL consist of exactly 7 characters made up as follows:- Character 1: Century e.g 0x14

Character 2: Year e.g 0x0D
Character 3: Month e.g 0x03
Character 4: Day e.g 0x10
Character 5: Hour in the range 0 to 23
Character 6: Minute in the range 0 to 59
Character 7: Seconds in the range 0 to 59

Note: Century/Year =00/00 will be accepted and treated as unknown
Month=00 will be accepted and treated as unknown
Day=00 will be accepted and treated as unknown

For example, 15:36:18pm on 14 March 2013 shall be encoded as a string as follows:- "\14\0D\03\0E\10\24\12"

Interactive Command: NO

```
DIM rc


'//=============================================================================
function HandlerBleMsg(BYVAL nMsgId AS INTEGER, BYVAL nCtx AS INTEGER) as integer
  select nMsgId
  case 0
    DbgMsgVal("Ble Connection ",nCtx)
    inconn = 1

  case 1
    DbgMsgVal("Ble Disonnection ",nCtx)
    inconn = 0
    '// restart advertising
    StartAdverts()

  case 5
    DbgMsgVal(" +++ Indication State ",nCtx)
    indst = nCtx

  case 6
    DbgMsg(" === Indication Cnf")
    indcnt = indcnt + 1

  case else
    DbgMsg("Unknown Ble Msg" )
  endselect
endfunc 1

OnEvent  EVBLEMSG           call HandlerBleMsg

rc = blesvcregtherm(2)  'the thermometer service is now registered with GATT

rc = blesvcsettherm(364,-1)      'the temperature value that will be reported in
                                    'the temperature service is 36.4°C


'// when the gatt client acknowledges the data the application will get a EVBLEMSG
'// message with msgId set to (6)
```

```
'// Please refer to the Thermometer sample app provided
```

BleSvcSetTherm is an extension function.

BLESVCREGTXPOWER

This function is used to register a Tx Power service with the GATT server so that a client can determine the transmit power level.

The 'Tx Power' service contains a single characteristic as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.tx_power.xml

The tx power level value is assumed to not change while there is a connection and so the transmit level is supplied as parameter to this function and before this service is registered with the underlying stack, the transmit power will be set to the value requested.

BLESVCREGTXPOWER(nTxLevel)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments

nTxLevel **byVal *nTxLevel* AS INTEGER**
The value must be set as one of the following :-
+4, 0, -4, -8, -12, -16, -20 and -40

Interactive Command: NO

```
DIM rc

rc = blesvcregtxpower(-8)   'the tx power service is now registered with GATT and
                            'trasnmit power is set to -8dBm
```

BLESVCREGTXPOWER is an extension function.

BLESVCREGIMMALERT

This function is used to register an Immediate Alert service with the GATT server to implement an optional service for the Proximity Profile.

The 'Immediate Alert' service contains a single characteristic as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.immediate_alert.xml

It contains a characteristic which can only be written to by a gatt client.

BLESVCREGIMMALERT()

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments None

Interactive Command: NO

```
DIM rc

rc = blesvcregimmalert()
```

BLESVCREGIMMALERT is an extension function.

BLESVCGETIMMALERT

This function is used to read the current Alert Level in the Immediate Alert service within the GATT server when the optional service for the Proximity Profile has been registered.

When the value is changed by the Gatt Client, an EVBLEMSG message is sent to the *smart* BASIC runtime engine which means this value does not need to be polled if a handler for EVBLEMSG is registered. This is shown in the example below.

BLESVCGETIMMALERT()

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments

nAlertLevel **byRef *nAlertLevel* AS INTEGER**
The value will be 0,1 or 2

Interactive Command: NO

```
DIM rc, alertlvl
Function HandlerBleMsg(byVal msgid as integer, byVal ctx as integer) as integer
 Select msgid
  Case 0
   Print "\n BLE Connection with handle "; integer.h' ctx
  Case 1
   Print "\n BLE Disconnection of handle "; integer.h' ctx
  Case 2
   Print "\n Immediate Alert Service Alert - new level = "; ctx
  Case 3
   Print "\n Link Loss Service Alert - new level = "; ctx
  Case 4
   Print "\n Service error = "; integer.h' ctx
  Case else
   Print "\n Unknown msg id"
 EndSelect
Endfunc 1
OnEvent  EVBLEMSG           call HandlerBleMsg
. . .
rc = blesvcregimmalert()
. . .
rc = blesvcgetimmalert(alertlvl)
. . .
rc = BleAdvertStart( . . . )
```

```
waitevent
```

BLESVCGETIMMALERT is an extension function.

BLESVCREGLINKLOSS

This function is used to register a Link Loss service with the GATT server to implement an optional service for the Proximity Profile.

The 'Link Loss' service contains a single characteristic as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.link_loss.xml

It contains a characteristic which can only be written to by a gatt client.

BLESVCREGLINKLOSS(nInitAlertLevel)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments None

Interactive Command: NO

```
DIM rc

rc = blesvcreglinkloss(1)  'register link loss service with initial medium alert
```

BLESVCREGLINKLOSS is an extension function.

BLESVCGETLLOSSLERT

This function is used to read the current Alert Level in the Link Loss Alert service within the GATT server after the service for the Proximity Profile has been registered.

When the value is changed by the Gatt Client, an EVBLEMSG message is sent to the *smart* BASIC runtime engine which means this value does not need to be polled if a handler for EVBLEMSG is registered. This is shown in the example below.

BLESVCGETLLOSSALERT()

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments

nAlertLevel **byRef *nAlertLevel* AS INTEGER**
The value will be 0,1 or 2

Interactive Command: NO

```
DIM rc, alertlvl
Function HandlerBleMsg(byVal msgid as integer, byVal ctx as integer) as integer
 Select msgid
  Case 0
   Print "\n BLE Connection with handle "; integer.h' ctx
  Case 1
   Print "\n BLE Disconnection of handle "; integer.h' ctx
  Case 2
   Print "\n Immediate Alert Service Alert - new level = "; ctx
  Case 3
   Print "\n Link Loss Service Alert - new level = "; ctx
  Case 4
   Print "\n Service error = "; integer.h' ctx
  Case else
   Print "\n Unknown msg id"
 EndSelect
Endfunc 1
OnEvent  EVBLEMSG           call HandlerBleMsg
. . .
rc = blesvcregimmalert()
. . .
rc = blesvcgetimmalert(alertlvl)
. . .
rc = BleAdvertStart( . . . )
waitevent
```

BLESVCGETIMMALERT is an extension function.

BLESVCREGBLOODPRESS

This function is used to register a Blood Pressure service with the GATT server.

The 'Blood Pressure' service contains two mandatory characteristics and a single optional characteristic for 'intermediate cuff pressure' as listed at http://developer.bluetooth.org/gatt/services/Pages/ServiceViewer.aspx?u=org.bluetooth.service.blood_pressure.xml

The optional 'intermediate cuff pressure' characteristic is not implemented but will be provided in a future release if there is a demand.

The blood pressure information can be updated in the characteristics at any time using the BLESVCSETBLOODPRESS function after the service has been registered.

Events & Messages

See also Events & Messages for BLE related messages that are thrown to the application when the client configuration descriptor value is changed by a gatt client and when the characteristic value is acknowledged by the client. The message id's that are relevant are (7) and (8) respectively as follows:-

MsgId	Description
5	Blood Pressure Client Characteristic Descriptor value has changed, msgCtx = 0 or 1

6 Blood Pressure measurement indication has been acknowledged

BLESVCREGBLOODPRESS(nFeature, nUserId, nUnits)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments

nFeature **byVal *nFeature* AS INTEGER**
The value is made up of a bit mask and must be set between 0 and 0xFFFF and the BT SIG allocated bit masks, as of Mar 2013 are:-

0001 Body Movement Detection Support Bit
0002 Cuff Fit Detection Support Bit
0004 Irregular Pulse Detection Support Bit
0008 Pulse Rate Range Detection Support Bit
0010 Measurement Position Detection Support Bit
0020 Multiple Bond Support Bit

See http://developer.bluetooth.org/gatt/characteristics/Pages/CharacteristicViewer.aspx?u=org.bluetooth.characteristic.blood_pressure_feature.xml for the list of most current values.

nUserId **byVal *nUserId* AS INTEGER**
The value shall be in the range 0 to 255, where 255 is 'Unknown User' and 0 to 254 is defined by the service specification.
If a value outside this range is provided, then this field in the blood pressure measurement will be omitted.

nUnits **byVal *nUnits* AS INTEGER**
The value shall be 0 for mmHg and 1 for Pascal. Any other values will result in this function returning with an error code and the service will NOT get registered in the GATT table.

Interactive Command: NO

```
DIM rc

rc = blesvcregbloodpress(2,3,0) 'the thermometer service is now registered with GATT
```

BLESVCREGBLOODPRESS is an extension function.

BLESVCSETBLOODPRESS

When connected to a master device and indications have been enabled, this function is used to send new blood pressure measurement data via the blood pressure service which has been registered in the GATT server using the function BLESVCREGBLOODPRESS.

The measurement data consists of many fields which map to arguments of this function. These parameters are simple integers or strings and the intermediate code translates those to appropriate formats as stipulated in the specification at

http://developer.bluetooth.org/gatt/characteristics/Pages/CharacteristicViewer.aspx?u=org.bluetooth.characteristic.blood_pressure_measurement.xml

After this function is called wait for the EVBLEMSG message to arrive with msgId set to 8 which confirms that the measurement data has been confirmed by the gatt client.

BLESVCSETBLOODPRESS (nSysPress, nDiasPress, nMeanArtPress, nPulseRate, nMeasStatus, dateTime$)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nSysPress **byVal *nSysPress* AS INTEGER**
The value is the systolic pressure in the units as specified using the nUnits parameter in the BLESVCREGBLOODPRESS function.

nDiasPress **byVal *nDiasPress* AS INTEGER**
The value is the diastolic pressure in the units as specified using the nUnits parameter in the BLESVCREGBLOODPRESS function.

nMeanArtPress **byVal *nMeanArtPress* AS INTEGER**
The value is the mean arterial pressure in the units as specified using the nUnits parameter in the BLESVCREGBLOODPRESS function.

nPulseRate **byVal *nPulseRate* AS INTEGER**
The value is the pulse rate in beats per minute and it can be omitted from the report to the peer by specifying a negative value.

nMeasStat **byVal *nMeasStat* AS INTEGER**
The value is made up of a bit mask and must be set between 0 and 0xFFFF and the BT SIG allocated bit masks, as of Mar 2013 are:-

0001 Body Movement Detection Flag
0002 Cuff Fit Detection Flag
0004 Irregular Pulse Detection Flag
0008 Pulse Rate Range Detection Flag: Exceeds Upper Limit
0010 Pulse Rate Range Detection Flag: Below Lower Limit
0010 Measurement Position Detection Flag

Please refer to http://developer.bluetooth.org/gatt/characteristics/Pages/CharacteristicViewer.aspx?u=org.bluetooth.characteristic.blood_pressure_measurement.xml for latest information.

***dateTime$*** **byRef *dateTime$* AS STRING**
The string contains a date and time stamp which can be optionally provided. It shall be presented to this function in a strict format and if the validation fails, then the information is omitted.
To omit this information just provide an empty string. Otherwise the string

SHALL consist of exactly 7 characters made up as follows:-
Character 1: Century e.g 0x14
Character 2: Year e.g 0x0D
Character 3: Month e.g 0x03
Character 4: Day e.g 0x10
Character 5: Hour in the range 0 to 23
Character 6: Minute in the range 0 to 59
Character 7: Seconds in the range 0 to 59

Note: Century/Year =00/00 will be accepted and treated as unknown
Month=00 will be accepted and treated as unknown
Day=00 will be accepted and treated as unknown

For example, 15:36:18pm on 14 March 2013 shall be encoded as a string as follows:- "\14\0D\03\0E\10\24\12"

Interactive Command: NO

```
DIM rc,dt$

'//=============================================================================
function HandlerBleMsg(BYVAL nMsgId AS INTEGER, BYVAL nCtx AS INTEGER) as integer
  select nMsgId
  case 0
    DbgMsgVal("Ble Connection ",nCtx)
    inconn = 1
    adv=0

  case 1
    DbgMsgVal("Ble Disonnection ",nCtx)
    inconn = 0
    '// restart advertising
    StartAdverts()

  case 5
    DbgMsgVal(" +++ Indication State ",nCtx)
    indst = nCtx

  case 6
    DbgMsg(" === Indication Cnf")
    indcnt = indcnt + 1

  case else
    DbgMsg("Unknown Ble Msg" )
  endselect
endfunc 1

OnEvent  EVBLEMSG           call HandlerBleMsg

dt$="\14\0D\03\0E\10\24\12"
rc = blesvcsetbloodpress(120,80,100,72,0,dt$)
  '//where systolic pressure = 120, diastolic pressure = 80
  '//means arterial pressure = 100, pulse rate = 72, measurement status = 0

'// when the gatt client acknowledges the data the application will get a EVBLEMSG
'// message with msgId set to (8)
```

```
'// Please refer to the blood pressure sample app provided
```

BLESVCSETBLOODPRESS is an extension function.

7. Other Extension Built-in Routines

This chapter describes non BLE related extension routines that are not part of the core *smart* BASIC language.

System Configuration Routines

SYSTEMSTATESET

This function is used to alter the power state of the module as per the input parameter.

SYSTEMSTATESET (nNewState)

FUNCTION

Returns:

An integer result code. The most typical value is 0x0000, which indicates a successful operation.

Arguments:

nNewState **byVal *nNewState* AS INTEGER**
New state of the module as follows:-
0 System OFF (Deep Sleep Mode)

Interactive Command: NO

```
DIM rc

rc = SystemStateSet(0)          'Put module in deep sleep
```

SYSTEMSTATESET is an extension function.

Miscellaneous Routines

READPWRSUPPLYMV

This function is used to read the power supply voltage and the value will be returned in milliVolts.

READPWRSUPPLYMV ()

FUNCTION

Returns:

The power supply voltage in millivolts.

Arguments: None

Interactive Command: NO

```
DIM supplyMV

supplyMV = ReadPwrSupplyMv()          'Read supply volts
print "\nSupply voltage is ";supplyMV;"mV"
```

READPWRSUPPLYMV is an extension function.

8. EVENTS & MESSAGES

smart BASIC has been architected so that it is event driven which makes it suitable for embedded platforms where it is normal to wait for something to happen and then respond to that.

To ensure that access to variables and resources end up in race conditions, the event handling is done synchronously which means the *smart* BASIC runtime engine has to process a WAITEVENT statement for any events or messages to be processed. This mechanism guarantees that the code *smart* BASIC will never need the complexity of locking variables and objects.

There are many subsystems which generate events and messages as follows:-

- Timer events, which generate timer expiry events and are described here.
- Messages thrown from with the user's BASIC application as described here.
- Events related to the UART interface as described here.
- GPIO input level change events as described here.
- BLE events and messages as described here.

INDEX

Module specific functions appear in the index with their prefixing underscore.