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# Introducing Great Cow BASIC

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Hello, and welcome to Great Cow BASIC help. This help file is intended to act as a backup to several other documents - to clarify topics which may not be made clear adequately in other places.

For information on installing GCBASIC and several other programs that may be helpful, please see the "Getting Started with Great Cow BASIC" page at <http://gcbasic.sourceforge.net/starting.html>.

If you're new to programming, you should try the Great Cow BASIC tutorial. This explains everything in a step-by-step manner, and assumes no prior knowledge.

If you've programmed in another language, then the demonstration files and command reference may be the best place to turn.

If there's anything else that you need help on, please visit the [Great Cow BASIC forum](#).

## About GCBASIC

Need to compile a program with Great Cow BASIC, but don't know where to begin?

Try these instructions:

1. First, download and install GCBASIC. It's best if you let everything install to its default directory (folder).
2. Open up the folder that contains GCBASIC. This is generally [C:\Program Files\GCBASIC](#).
3. Open the folder that contains the program you want to compile. Make sure that you open it in a new window.
4. Drag the icon of the file you want to compile onto "gcbasic.exe". The compiler will open, compile the file, and then close again.
5. A file called "compiled.hex" will have been created. Download this to your microcontroller\*, and you're set to go!

Additional, more detailed instructions are available on the [Getting Started with GCBASIC](#) page.

\*You need a suitable programmer to do this, and instructions should be included with the programmer on how to download to the microcontroller.

About the Command Line Parameters

GCBASIC [/O:output.asm] [/A:assembler] [/P:programmer] [/K:{C|A}] [/V] [/L] [/NP] filename

Switch	Description	Default
/O:filename	Sets the name of the assembly file generated to <i>filename</i> .	Same name as the input file, but with a .asm extension.
/A:assembler	Batch file used to call assembler*. If /A:GCASM is given, GCBASIC will use its internal assembler.	The program will not be assembled
/P:programmer	Batch file used to call programmer*. This parameter is ignored if the program is not assembled.	The program will not be downloaded.
/K:{C A}	Keep original code in assembly output. /K:C will save comments, /K:A will preserve all input code.	No original code left in output.
/V	Verbose mode - compiler gives more detailed information about its activities.	-
/L	Show license and exit.	-
/NP	Do not pause on errors. Use with IDEs.	Pause when an error occurs, and wait for the user to press a key.
filename	The file to compile.	-

\* For the /A: and /P: switches, there are special options available. If %FILENAME% is present, it will be replaced by the name of the .asm file. %FN\_NOEXT% will be replaced by the name of the .asm file but without an extension, and %CHIPMODEL% will be replaced with the name of the chip. The name of the chip will be the same as that on the chip data file.

A batch to to load the ASM from GCBASIC into MPASM. I think that your m.bat should be like this:

```
@ECHO OFF
echo C:\progra~1\microc~1\mpasms~1\MPASMWIN /c- /o- /q+ /l- /x- /w1 %code%.asm
C:\progra~1\microc~1\mpasms~1\MPASMWIN /c- /o- /q+ /l- /x- /w1 %code%.asm
```

### **Why doesn't anything come up when I run gcbasic.exe?**

Great Cow BASIC is a command line compiler. To compile a file, you can drag and drop it onto the gcbasic.exe icon. There are also several Integrated Development Environments, or IDEs, available for GCBASIC. These will give you an area where you can edit your program and a button to send the program to the chip. Several are listed on the GCBASIC website.

### **What chips does Great Cow BASIC support?**

Hopefully, all 8 bit PIC chips (those in the PIC10, PIC12, PIC16 and PIC18 families). If you find one that GCBASIC does not work with properly, please post about it in the Compiler Problems section of the GCBASIC forum. Support for Atmel AVR chips has been added.

### **Is Great Cow BASIC case sensitive?**

No! For example, Set, SET, set, SeT, etc are all treated exactly the same way by GCBASIC.

### **Can I specify the bit of a variable to alter using another variable?**

No. Set variable.othervariable On may not generate an error, but it will not act as expected.

### **Why is x feature not implemented?**

Because it hasn't been thought of, or no-one has been able to implement it! If there are any features that you would like to see in Great Cow BASIC, please post them in the "Open Discussion" section of the GCBASIC forum. Or, if you can, have a go at adding the feature yourself!



# Acknowledgements

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## Developers and Contributors

Hugh Considine - Main developer of Great Cow Basic

Stefano Bonomi - Two-wire LCD subroutines

Geordie Millar - Swap and Swap4 subroutines

Finn Stokes - 8-bit multiply routine, program memory access code

Evan Venn - Utilities, revised I2C routines and the update to this help file

## Translation Contributors

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## Other Contributors

Russ Hensel - Great Cow BASIC Notes

Chuck Hellebuyck - His documentation for the GLCD and other pieces, see [here](#).

Frank Steinberg - GCB@SYN IDE for Great Cow Basic, see [here](#).

Alexy T. - SynWrite IDE used for GCB IDE, see [here](#).

## About Inputs and Outputs

Most general purpose pins on a microcontroller can function in one of two modes: input mode, or output mode.

When acting as an input, the pin will be placed in high impedance state. The microcontroller will then sense the pin, and the program can read the state of the pin and make decisions based on it.

When in output mode, the microcontroller will connect the pin to either Vcc (the positive supply), or Vss (ground, or the negative supply). The program can then set the state of the pin.

GCBASIC will attempt to determine the direction of each pin, and set it appropriately. However, if the pin is read from and written to, then the pin must be configured to input / output mode by the program, using the appropriate [Dir](#) commands.

## About Configuration

*(Note: This section does not apply to AVR microcontrollers. AVR chips do have a similar configuration settings, but they are controlled through "Configuration Fuses". GCBASIC cannot set these - you **must** use the programmer software.)*

Every PIC chip has a CONFIG word. This is an area of memory on the chip that stores settings which govern the operation of the chip.

The following aspects of the chip are governed by the CONFIG word:

- Oscillator selection - will the chip run from an internal oscillator, or is an external one attached?
- Automatic resets - should the chip reset if the power drops too low? If it detects it is running the same piece of code over and over?
- Code protection - what areas of memory must be kept hidden once written to?
- Pin usage - which pins are available for programming, resetting the chip, or emitting PWM signals?

The exact configuration settings vary amongst chips. To find out a list of valid settings, please consult the datasheet for the PIC chip that you wish to use.

This can all be rather confusing - hence, GCBASIC will automatically set some config settings, unless told otherwise:

- **Low Voltage Programming (LVP) is turned off.** This enables the PGM pin (usually B3 or B4) to be used as a normal I/O pin.
- **Watchdog Timer (WDT) is turned off.** The WDT resets the chip if it runs the same piece of code over and over - this can cause trouble with some of the longer delay routines in GCBASIC.
- **Master Clear (MCLR) is disabled where possible.** On many newer chips this allows the MCLR pin (often PORTA.5) to be used as a standard input port. It also removes the need for a pull-up resistor on the MCLR pin.
- **An oscillator mode will be selected, based on the following rules:**
  1. If the PIC has an internal oscillator, and the internal oscillator is capable of generating the speed specified in the #chip line, then the internal oscillator will be used.
  2. If the clock speed is over 4 Mhz, the external HS oscillator is selected
  3. If the clock speed is 4 MHz or less, then the external XT oscillator mode is selected.

Note that these settings can easily be individually overridden whenever needed. For example, if the Watchdog Timer is needed, adding the line

```
#config WDT = ON
```

This will enable the watchdog timer, without affecting any other configuration settings.

## Using Configuration

Once the necessary CONFIG options have been determined, adding them to the program is easy. On a new line type "#config" and then list the desired options separated by commas, such as in this line:

```
#config OSC = RC, BODEN = OFF
```

GCBASIC also supports this format on 10/12/16 series chips:

```
#config INTOSC_OSC_NOCLKOUT, BODEN_OFF
```

However, for upwards compatibility with 18F chips, you should use the = style config settings.

It is possible to have several #config lines in a program - for instance, one in the main program, and one in each of several #include files. However, care must then be taken to ensure that the settings in one file do not conflict with those in another.

**For more help, see [#config Directive](#)**

## About Arrays

An array is a special type of variable - one which can store several values at once. It is essentially a list of numbers in which each one can be addressed individually through the use of an "index". The index is a value in brackets immediately after the name of the array.

Examples of array names are:

Array/Index	Meaning
Fish(10)	Element 10 of an array called Fish
DataLog(2)	The second number in an array named DataLog
ButtonList(Temp)	An element in the array "ButtonList" that is selected according to the value in the variable "Temp"

## Using Arrays

To use an array, its name is specified, then the index. Arrays can be used everywhere that a normal variable can be used.

## Setting an entire array at once

It is possible to set several elements of an array with a single line of code. This short example shows how:

```
Dim TestVar(10)
TestVar = 1, 2, 3, 4, 5, 6, 7, 8, 9
```

Element 0 of TestVar will be set to the number of items in the list, which in this case is 9. Each element of the array will then be loaded with the corresponding value in the list - so in the example, TestVar(1) will be set to 1, TestVar(2) to 2, and so on.

If there are many items in the array, it may be better to use a [Lookup Table](#) to store the items, and then copy some of the data items into a smaller array as needed.

For more help, see [Declaring arrays with DIM](#)

About Conditions

In GCBASIC (and most other programming languages) a condition is a statement that can be either true or false. Conditions are used when the program must make a decision.

A condition is generally given as a value or variable, a relative operator (such as = or >), and another value or variable. Several conditions can be combined to form one condition through the use of logical operators such as AND and OR.

GCBASIC supports these relative operators:

Symbol	Meaning
=	Equal
<>	Not Equal
<	Less Than
>	Greater Than
<=	Less than or equal to
>=	Equal to or greater than

In addition, these logical operators can be used to combine several conditions into one:

Name	Abbreviation	Condition true if
AND	&	both conditions are true
OR		at least one condition is true
XOR	#	one condition is true
NOT	!	the condition is not true

NOT is slightly different to the other logical operators, in that it only needs one other condition. Other arithmetic operators may be combined in conditions, to change values before they are compared, for example.

GCBASIC has two built in conditions - TRUE, which is always true, and FALSE, which is always false. These can be used to create infinite loops.

It is also possible to test individual bits in conditions. To do this, specify the bit to test, then 1 or 0 (or ON and OFF respectively). Presently there is no way to combine bit tests with other conditions - NOT, AND, OR and XOR will not work.

Example conditions:

Condition	Comments
Temp = 0	Condition is true if Temp = 0
Sensor <> 0	Condition is true if Sensor is not 0
Reading1 >	

Reading2	True if Reading1 is more than Reading2
Mode = 1 AND Time > 10	True if Mode is 1 and Time is more than 10
Heat > 5 OR Smoke > 2	True if Heat is more than 5 or Smoke is more than 2
Light >= 10 AND (NOT Time > 7)	True if Light is 10 or more, and Time is 7 or less
Temp.0 ON	True if Temp bit 0 is on

## About Defines

A define is a type of directive that tells the compiler to find a given word, and replace it with another word or number. Defines are useful for situations where a routine needs to be easily altered. For example, a define could be used to specify the amount of time to run an alarm for once triggered.

It is also possible to use defines to specify ports - thus defines can be used to aid in the creation of code that can easily be adapted to run on a different PIC with different ports.

GCBASIC makes considerable use of defines internally. For instance, the LCD code uses defines to set the ports that it must use to communicate with the LCD.

## Using Defines

To create a define is a matter of using the `#define` directive. Here are some examples of defines:

```
#define Line 34
#define Light PORTB.0
#define LightOn Set PORTB.0 on
```

Line is a simple constant - GCBASIC will find "Line" in the program, and replace it with the number 34. This could be used in a line following program, to make it easier to calibrate the program for different lighting conditions.

Light is a port - it represents a particular pin on the PIC chip. This would be of use if the program had many lines of code that controlled the light, and there was a possibility that the port the light was attached to would need to change in the future.

LightOn is a define used to make the program more readable. Rather than typing "Set PORTB.0 on" over and over, it would then be made possible to type "LightOn", and have the compiler do the hard work.



## About Functions

Functions are a special type of subroutine that can return a value. This means that when the name of the function is used in the place of a variable, GCBASIC will call the function, get a value from it, and then put the value into the line of code in the place of the variable.

Functions may also have parameters - these are treated in exactly the same way as parameters for subroutines. The only exception is that brackets are required around any parameters when calling a function.

## Using Functions

This program uses a function called AverageAD to take two analog readings, and then make a decision based on the average:

```
'Select chip
#chip 16F88, 20
```

```
'Define ports
#define LED PORTB.0
#define Sensor AN0
```

```
'Set port directions
dir LED out
dir PORTA.0 in
```

```
'Main code
Do
    Set PORTB.0 Off
    If AverageAD > 128 Then Set PORTB.0 On
    wait 10 ms
Loop
```

```
Function AverageAD
    'Get 2 readings, divide by 2, store in AverageAD
    'Note the cast, the result of ReadAD needs to be converted to
    'a word before adding, or the result may overflow.
    AverageAD = ([word]ReadAD(Sensor) + ReadAD(Sensor)) / 2

    end function
```

**See Also** [Subroutines](#), [Exit](#)

## About Interrupts

Interrupts are a feature of many microcontrollers. They allow the microcontroller to temporarily pause (interrupt) the code it is running and then start running another piece of code when some event occurs. Once it has dealt with the event, it will return to where it was and continue running the program.

Many events can trigger an interrupt, such as a timer reaching its limit, a serial message being received, or a special pin on the microcontroller receiving a signal.

## Using Interrupts

There are two ways to use interrupts in GCBASIC. The first way is to use the `On Interrupt` command. This will automatically enable a given interrupt, and run a particular subroutine when the interrupt occurs.

The other way to deal with interrupts is to create a subroutine called `Interrupt`. GCBASIC will call this subroutine whenever an interrupt occurs, and then your code can check the "flag" bits to determine which interrupt has occurred, and what should be done about it. If you use this approach, then you'll need to enable the desired interrupts manually. It is also essential that your code clears the flag bits, or else the interrupt routine will be called repeatedly.

Some combination of these two methods is also possible - the code generated by `On Interrupt with check` to see if the interrupt is one it recognises. If the interrupt is recognised, `On Interrupt` will deal with it - if not, the `Interrupt` subroutine will be called to deal with the interrupt.

The recommended way is to use `On Interrupt`, as it is both more efficient and easier to set up.

During some sections of code, it is desirable not to have any interrupts occur. If this is the case, then use the `IntOff` command to disable interrupts at the start of the section, and `IntOn` to re-enable them at the end. If any interrupt events occur while interrupts are disabled, then they will be processed as soon as interrupts are re-enabled. If the program does not use interrupts, `IntOn` and `IntOff` will be removed automatically by GCBASIC.

**See Also** [IntOff](#), [IntOn](#), [On Interrupt](#)

## About Lookup Tables

A lookup table is a list of values that are stored in the program memory of the chip, which can be accessed using the ReadTable command.

The advantage of lookup tables is that they are memory efficient, compared to an equivalent set of IF statements.

## Using Lookup Tables

First, the table must be created. The code to create a lookup table is simple - a line that has "Table" and then the name of the table, a list of numbers (up to 254), and then "End Table".

Once the table is created, the ReadTable command is used to read data from it. The ReadTable command requires the name of the table it is to read, the location of the item to retrieve, and a variable to store the retrieved number in.

Lookup tables can store byte or word values. GCBASIC will automatically detect the type of the table depending on the values in it.

Item 0 of a lookup table stores the size of the table. If the ReadTable command attempts to read beyond the end of the table, the value 0 will be returned.

## Advanced use of Lookup Tables

You can use the Table statement to store the data table in EEPROM. If the compiler is told to store a data table in "Data" memory, it will store it in the EEPROM. Here is some example code:

```
#chip 16F628
```

```
'Read table item
  'Must use ReadTable and a variable for the index, or the table won't be
  downloaded to EEPROM
```

```
TableLoc = 2
  ReadTable TestDataSource, TableLoc, SomeVar
```

```
'Write to table , this is not required
  EPWrite 1, 45
```

```
'Table of values to write to EEPROM
  'EEPROM location 0 will store length of table
  'Subsequent locations will each store a value
```

```
Table TestDataSource Store Data
  12
  24
  36
  48
```

60  
72  
End Table

**For more help, see [ReadTable](#)**

## About Scripts

A script is a small section of code that Great Cow BASIC runs when it starts to compile a program. Their main use is to perform calculations that are required to adjust the program for different speed chips.

Scripts are not compiled and downloaded to the microcontroller - GCBASIC reads them, runs them, removes them from the program and then allows any results they have calculated to be used as constants in the program.

Inside a script, constants are treated like variables. Scripts can read the values of constants, and set them to contain new values.

## Using Lookup Tables

Scripts start with "#script" and end with "#endscript". Inside, they can consist of 3 commands:

If

Assignment (=)

Error

If is similar to the If command in normal GCBASIC code, except that it doesn't have an Else clause. It is used to compare the values of constants.

= is identical to that in GCBASIC programs. The constant that is to be set goes on the left side of the =, and the new value goes on the right.

Error is used to display an error message. Anything after the Error command is displayed at the end of compilation, and is saved in the error log for the program.

## Example Script

This script is used in the pwm.h file. It takes the values of the constants PWM\_Freq, PWM\_Duty and ChipMHz, and uses the equations shown in the PIC datasheets to calculate the correct values for the relevant system variables.

```
#script
PR2Temp = int((1/PWM_Freq)/(4*(1/(ChipMHz*1000))))
T2PR = 1
If PR2Temp > 255 Then
    PR2Temp = Int((1 / PWM_Freq) / (16 * (1 / (ChipMHz * 1000))))
    T2PR = 4
    If PR2Temp > 255 Then
        PR2Temp = Int(( 1 / PWM_Freq) / (64 * (1 / (ChipMHz * 1000))))
        T2PR = 16
        If PR2Temp > 255 Then
            Error Invalid PWM Frequency value
        End If
    End If
End If
End If
```

```
DutyCycle = (PWM_Duty * 10.24) * PR2Temp / 1024
    DutyCycleH = (DutyCycle AND 1020) / 4
    DutyCycleL = DutyCycle AND 3
#endscript
```

After this script has run, the values PR2Temp, DutyCycleH and DutyCycleL are used as constants to set up the required variables.

About Subroutines

A subroutine is a small program inside of the main program. Subroutines are typically used when a task needs to be repeated several times in different parts of the main program.

There are two main uses for subroutines:

- Keeping programs neat and easy to read
- Reducing the size of programs by allowing common sections of code to be reused.

When the PIC comes to a subroutine it saves its location in the current program before jumping to the start of, or calling, the subroutine. Once it reaches the end of the subroutine it returns to the main program, and continues to run the code where it left off previously.

Normally, it is possible for subroutines to call other subroutines. There are limits to the number of times that a subroutine can call another sub, which vary from chip to chip:

PIC Family	Instruction Width	Number of subs called
10F*, 12C5*, 12F5*, 16C5*, 16F5*	12	1
12C*, 12F*, 16C*, 16F*, except those above	14	7
18F*, 18C*	16	31

These limits are due to the amount of memory on the PIC which saves its location before it jumps to a new subroutine. Some GCBASIC commands are subroutines, so you should always allow for 2 or 3 subroutine calls more than your program has.

AVR microcontrollers have no fixed limit on how many subroutines can be called at a time, but if too many are called then some variables on the chip may be corrupted. To check if there are too many subroutines, work out the most that will be called at once, then multiply that number by 2 and create an array of that size. If an out of memory error message comes up, there are too many calls.

Another feature of subroutines is that they are able to accept parameters. These are values that are passed from the main program to the subroutine when it is called, and then passed back when the subroutine ends.

Using Subroutines

To call a subroutine is very simple - all that is needed is the name of the sub, and then a list of parameters. This code will call a subroutine named "Buzz" that has no parameters:

Buzz

If the sub has parameters, then they should be listed after the name of the subroutine. This would be the command to call a subroutine named "MoveArm" that has three parameters:

```
MoveArm NewX, NewY, 10
```

If a subroutine has parameters, you may choose to put brackets around them, like so:

```
MoveArm (NewX, NewY, 10)
```

All that this does is change the appearance of the code - it doesn't make any difference to what the code does. Decide which one meets your own personal preference, and then stick with it.

### ***Creating subroutines***

To create a subroutine is almost as simple as using one. There must be a line at the start which has "sub ", and then the name of the subroutine. Also, there needs to be a line at the end of the subroutine which reads "end sub". To create a subroutine called "Buzz", this is the required code:

```
sub Buzz
'code for the subroutine goes here
end sub
```

If the subroutine has parameters, then they need to be listed after the name. For example, to define the "MoveArm" sub used above, use this code:

```
sub MoveArm(ArmX, ArmY, ArmZ)
'code for the subroutine goes here
end sub
```

In the above sub, ArmX, ArmY and ArmZ are all variables. If the call from above is used, the variables will have these values at the start of the subroutine:

```
ArmX = NewX
  ArmY = NewY
  ArmZ = 10
```

When the subroutine has finished running, GCBASIC will copy the values back where possible. NewX will be set to ArmX, and NewY to ArmY. GCBASIC will not attempt to set the number 10 to ArmZ.



## ***Controlling the direction data moves in***

It is possible to instruct GCBASIC not to copy the value back after the subroutine is called. If a subroutine is defined like this:

```
sub MoveArm(In ArmX, In ArmY, In ArmZ)
    'code for the subroutine goes here
end sub
```

Then GCBASIC will copy the values to the subroutine, but will not copy them back.

GCBASIC can also be prevented from copying the values back, by adding "Out" before the parameter name. This is used in the EEPROM reading routines - there is no point copying a data value into the read subroutine, so Out has been used to avoid wasting time and memory. The EPRead routine is defined as "Sub EPRead(In Address, Out Data).

Many older sections of code use "#NR" at the end of the line where the parameters are specified. The "#NR" means "No Return", and when used has the same effect as adding "In" before every parameter. Use of "#NR" is not recommended, as it does not give the same level of control.

## ***Using different data types for parameters***

It is possible to use any type of variable as a parameter for a subroutine. Just add "As" and then the data type to the end of the parameter name. For example, to make all of the parameters for the MoveArm subroutine word variables, use this code:

```
sub MoveArm(ArmX As Word, ArmY As Word, ArmZ As Word)
    ...
end sub
```

## ***Optional parameters***

Sometimes, the same value may be used over and over again for a parameter, except in a particular case. If this occurs, a default value may be specified for the parameter, and then a value for that parameter only needs to be given in a call if it is different to the default.

For example, suppose a subroutine to create an error beep is required. Normally it emits a 440 Hz tone, but sometimes a different tone is required. To create the sub, this code would be used:

```
Sub ErrorBeep(Optional OutTone As Word = 440)
    Tone OutTone, 100
End Sub
```

Note the "Optional" before the parameter, and the " = 440" after it. This tells GCBASIC that

if no parameter is supplied, then set the OutTone parameter to 440.

If called using this line:

```
ErrorBeep
```

then a 440 Hz beep will be emitted. If called using this line:

```
ErrorBeep 1000
```

then the sub will produce a 1000 Hz tone.

When using several parameters, it is possible to make any number of them optional. If the optional parameter/s are at the end of the call, then no value needs to be specified. If they are at the start or in the middle, then you must insert commas to allow GCBASIC to tell where the optional parameters are.

### ***Overloading***

It is possible to have 2 subroutines with the same name, but different parameters. This is known as overloading, and GCBASIC will automatically select the most appropriate subroutine for each call.

An example of this is the Print routine in the LCD routines. There are actually several Print subroutines; for example, one has a byte parameter, one a word parameter, and one a string parameter. If this command is used:

```
Print 100
```

Then the Print (byte) subroutine will be called. However, if this command is used:

```
Print 30112
```

Then the Print (word) subroutine will be called. If there is no exact match for a particular call, GCBASIC will use the option that requires the least conversion of variable types. For example, if this command is used:

```
Print PORTB.0
```

The byte print will be used. This is because byte is the closest type to the single bit parameter.

**See Also** [Functions](#), [Exit](#)

About Variables

A variable is an area of memory on the microcontroller that can be used to store a number or a series of letters. This is useful for many purposes, such as taking a sensor reading and acting on it, or counting the number of times the robot has performed a particular task.

Each variable must be given a name, such as "MyVariable" or "PieCounter". Choosing a name for a variable is easy - just don't include spaces or any symbols (other than \_), and make sure that the name is at least 2 characters (letters and/or numbers) long.

Variable Types

There are several different types of variable, and each type can store a different sort of information. These are the variable types that Great Cow BASIC can currently use:

Variable type	Information that this variable can store	Example uses for this type of variable
Bit	A bit (0 or 1)	Flags to track whether or not a piece of code has run
Byte	A whole number between 0 and 255	General purpose storage of data, such as counters
Word	A whole number between 0 and 65535	Storage of extra large numbers
Integer	A whole number between - 32768 and 32767	Anything where a negative number will occur
Long	A whole number between 0 and 2^32 (4.29 billion)	Storing very, very big numbers
Array	A list of whole numbers ranging from 0 to 255	Logs of sensor readings
String	A series of letters, numbers and symbols.	Messages that are to be shown on a screen

Using Variables

Byte variables do not need any special commands to set them up - just put the name of the variable in to the command where the variable is needed.

Other types of variable can be used in a very similar way, except that they must be "dimensioned" first. This involves using the DIM command, to tell Great Cow BASIC that it is dealing with something other than a byte variable.

A key feature of variables is that it is possible to have the microcontroller check a variable, and only run a section of code if it is a given value. This can be done with the IF command.

## String Variables

Strings are defined as follows:

```
'Create buffer variables to store received messages
```

```
Dim Buffer As String
```

String variables default to 10 bytes for chips with less than 16 bytes of RAM, 20 bytes for chips with 16 to 367 bytes, and 40 bytes for devices with more RAM than 367.

Defining a length for the string is the best way to limit memory usage. It is good practice if you need a string of a certain size to set the length of a string, since the default length for a string variable changes depending on the amount of memory in the microcontroller (see above).

To set the length see the example below:

```
'Create buffer variables to store received messages as 16 bytes long
```

```
Dim OutBuffer As String * 16
```

## Variable Aliases

Some variables are aliases, which are used to refer to memory locations used by other variables. These are useful for joining predefined byte variables together to form word variables.

Aliases are not like pointers in many languages - they must always refer to the same variable or variables and cannot be changed.

## Casting

Casting changes the type of a variable or value. Placing the type that the value should be converted to in square brackets will tell the compiler to convert it. For example, this will cause two byte variables to be treated as word variables by the addition code:

```
Dim MyWord As Word  
MyWord = [word]ByteVar + AnotherByteVar
```

Why do this? If there are no casts, then GCBASIC will add the two values using the byte addition code, and then convert the result to a word to store in MyWord. Suppose that ByteVar is 150, and AnotherByteVar is 231. When added, this will come to 381 - which will overflow, leaving 125 in the result. However, when the cast is added, GCBASIC will treat

ByteVar as if it were a word, and so will use the word addition code. This will cause the correct result to be calculated.

Often, a cast will be used when calculating an average:

```
MyAverage = ([word]Value1 + Value2) / 2
```

It's also possible to cast the second value:

```
MyAverage = (Value1 + [word]Value2) / 2
```

The result will be exactly the same.

**For more help, see:**

[Declaring variables with DIM](#)

[Setting Variables](#)

Doing things to individual bits of variables

[SET](#)

[ROTATE](#)

Checking variables and doing different things based on their value:

[IF](#)

[DO](#)

[FOR](#)

[Conditions](#)

### Combining multiple instructions

It is possible to combine multiple instructions on a single line, by separating them with a colon. For example, this code:

```
Set PORTB.0 On
  Set PORTB.1 On
  Wait 1 sec
  Set PORTB.0 Off
  Set PORTB.0 Off
```

could also be written as:

```
Set PORTB.0 On: Set PORTB.1 On
  Wait 1 sec
  Set PORTB.0 Off: Set PORTB.0 Off
```

In most cases, it will make no difference if commands share a line or not. However, special care should be taken with If commands, as this code:

```
Set PORTB.0 Off
  Set PORTB.1 Off
  If Temp > 10 Then Set PORTB.0 On: Set PORTB.1 On
  Wait 1 s
```

Will be equivalent to this:

```
Set PORTB.0 Off
  Set PORTB.1 Off
  If Temp > 10 Then
    Set PORTB.0 On
    Set PORTB.1 On
  End If
  Wait 1 s
```

Also, the commands used to start and end subroutines, data tables and functions must be alone on a line. For example, this is WRONG:

```
Sub Something: Set PORTB.0 Off: End Sub
```

## Usage:

Adding comments to your GCB program is done with an apostrophe before the comment line. You can also comment out sections of code if you want just by placing an apostrophe at the beginning of each line. The SynGCB IDE has a feature to do this automatically.

## Example:

```
' The number of pins to flash
#define FlashPins 2
```

```
' You can create a header using an apostrophe before each line
' This is a great way to describe your program
' You can also use it to describe the hardware connections.
```

```
' You can place comments above the command or on the same line
Dir PORTB Out ' Initialise PORTB to all Outputs
```

```
'Main loop
do
    PORTB = 0      ' All Pins off
    Wait 1 S      ' Delay 1 second
    PORTB = 0xFF   ' All pins on
    Wait 1 s      ' Delay 1 second
Loop
```

## Syntax:

`var = ReadAD (port)`

## Command Availability:

Available on all PIC and AVR chips with an analog to digital converter module built in.

## Explanation:

ReadAD is a function that can be used to read the built-in analog to digital converter that many microcontroller chips include. *port* should be AN0, AN1, AN2, etc., up to the number of analog inputs available on the chip that is in use. Those familiar with AVR microcontrollers can also refer to the ports as ADC0, ADC1, etc. Refer to the datasheet for the microcontroller chip to find the number of ports available. (Note: it's perfectly acceptable to use ANx on AVR, or ADCx on PIC.)

Another function, ReadAD10, is almost identical to ReadAD. The only difference is that it returns a full 10 bit value in a word variable.

## Example:

```
#chip 16F819, 8
#config osc = int
```

```
'Set the input pin direction
Dir PORTA.0 In
```

```
'Loop to take readings until the EEPROM is full
For CurrentAddress = 0 to 255
```

```
    'Take a reading and log it
    EPWrite CurrentAddress, ReadAD(AN0)
```

```
    'Wait 10 minutes before getting another reading
    Wait 10 min
```

```
Next
```



**This command is obsolete.** There should be no need to call it. GCBASIC will automatically disable the A/D converter and set all pins to digital mode when starting the program, and after every use of the ReadAD function.  
It is recommended that this command be removed from all programs.

## Syntax:

EPRead *location*, *store*

## Command Availability:

Available on all PIC and AVR chips with EEPROM data memory.

## Explanation:

EPRead is used to read information from the EEPROM data storage that many microcontroller chips are equipped with. *location* represents the location to read data from, and varies from one chip to another. *store* is the variable in which to store the data after it has been read from EEPROM.

## Example:

```
'Program to turn a light on and off
'Will remember the last status
```

```
#chip tiny2313, 1
#define Button PORTB.0
#define Light PORTB.1
```

```
Dir Button In
Dir Light Out
```

```
'Load saved status
EPRead 0, LightStatus
```

```
If LightStatus = 0 Then
    Set Light Off
Else
    Set Light On
End If
```

```
Do

    'Wait for the button to be pressed
    Wait While Button = On
    Wait While Button = Off
```

```
    'Toggle value, record
    LightStatus = !LightStatus
    EPWrite 0, LightStatus
```

```
'Update light
    If LightStatus = 0 Then
        Set Light Off
    Else
        Set Light On
    End If
Loop
```

For more help, see [EPWrite](#)

## Syntax:

EPWrite *location*, *data*

## Command Availability:

Available on all PIC and AVR chips with EEPROM data memory.

## Explanation:

EPWrite is used to write information to the EEPROM data storage, so that it can be accessed later by a programmer on the PC, or by the EPRead command. *location* represents the location to read data from, and varies from one chip to another. *data* is the data that is to be written to the EEPROM, and can be a value or a variable.

## Example:

```
#chip 16F819, 8
#config osc = int
```

```
'Set the input pin direction
Dir PORTA.0 In
```

```
'Loop to take readings until the EEPROM is full
For CurrentAddress = 0 to 255
```

```
    'Take a reading and log it
    EPWrite CurrentAddress, ReadAD(AN0)
```

```
    'Wait 10 minutes before getting another reading
    Wait 10 min
```

```
Next
```

For more help, see [EPRead](#)

**Syntax:**

ProgramErase(*location*)

**Command Availability:**

Available on all PIC chips with self write capability. Not available on AVR at present.

**Explanation:**

ProgramErase erases information from the program memory on chips that support this feature. The largest value possible for *location* depends on the amount of program memory on the PIC, which is given on the datasheet.

This command must be called before writing to a block of memory. It is slow in comparison to other GCBASIC commands. Note that it erases memory in 32-byte blocks - see the relevant PIC datasheet for more information.

This is an advanced command which should only be used by advanced developers. Care must be taken with this command, as it can easily erase the program that is running on the PIC.

**For more help, see** [ProgramRead](#), [ProgramWrite](#)

**Syntax:**

ProgramRead (*location*, *store*)

**Command Availability:**

Available on all PIC chips with self write capability. Not available on AVR at present.

**Explanation:**

ProgramRead reads information from the program memory on chips that support this feature. *location* and *store* are both word variables, meaning that they can store values over 255.

The largest value possible for *location* depends on the amount of program memory on the PIC, which is given on the datasheet. *store* is 14 bits wide, and thus can store values up to 16383.

This is an advanced command which should only be used by advanced developers.

**Example:**

For more help, see [ProgramErase](#), [ProgramWrite](#)

**Syntax:**

ProgramWrite (*location*, *value*)

**Command Availability:**

Available on all PIC chips with self write capability. Not available on AVR at present.

**Explanation:**

ProgramWrite writes information to the program memory on chips that support this feature. *location* and *value* are both word variables.

The largest value possible for *location* depends on the amount of program memory on the PIC, which is given on the datasheet. *value* is 14 bits wide, and thus can store values up to 16383.

This is an advanced command which should only be used by advanced developers. ProgramErase must be used to clear a block of memory BEFORE ProgramWrite is called.

**Example:**

For more help, see [ProgramErase](#), [ProgramRead](#)

# Do

## Syntax:

Do [{While | Until} *condition*]

...

*program code*

....

<*condition*> *Exit Do*

...

Loop [{While | Until} *condition*]

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Do command will cause the code between the Do and the Loop to run repeatedly while *condition* is true or until *condition* is true, depending on whether While or Until has been specified.

Note that the While or Until and the condition can only be specified once, or not at all. If they are not specified, then the code will repeat endlessly.

Optionally, you can specify a condition to exit the Do-Loop immediately.

## Example #1:

```
'This code will flash a light until the button is pressed
#chip 12F629, 4
#config osc = int

#define BUTTON GPIO.3
#define LIGHT GPIO.5

Dir BUTTON In
Dir LIGHT Out

Do Until BUTTON = 1
    PulseOut LIGHT, 1 s
    Wait 1 s
Loop
```

## Example #2:

This code will also flash a light until the button is pressed. This example uses EXIT DO within a continuous loop.

```
#chip 12F629, 4
#config osc = int
```

```
#define BUTTON GPIO.3
    #define LIGHT GPIO.5

Dir BUTTON In
    Dir LIGHT Out

Do
    PulseOut LIGHT, 1 s
    Wait 1 s
    if BUTTON = 1 then EXIT DO
Loop
```

**For more help, see [Conditions](#)**



# End

## Syntax:

End

## Command Availability:

Available on all microcontrollers.

## Explanation:

When the End command is used, the program will immediately stop running. There are very few cases where this command is needed - generally, the program should be an endless loop.

## Example:

```
'This program will turn on the red light, but not the green light
Set RED On
End
Set GREEN On
```

## Syntax options:

Exit Sub | Exit Function | Exit Do | Exit For

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will make the program exit the routine it is currently in, as it would if it came to the end of the routine.

Applies to Subroutines, Functions, For-Next loops and Do-Loop loops.

## Example:

```
#chip tiny13, 1

#define SENSOR PORTB.0
#define BUZZER PORTB.1
#define LIGHT PORTB.2
Dir SENSOR In
Dir BUZZER Out
Dir LIGHT Out

Do
    Burglar
Loop

'Burglar Alarm subroutine
Sub Burglar
    If SENSOR = 0 Then
        Set BUZZER Off
        Set LIGHT Off
        Exit Sub
    End If
    Set BUZZER On
    Set LIGHT On
End Sub
```

For more help, see [Do](#), [For](#), [Sub](#), [Function](#)

## Syntax:

For *counter* = *start* To *end* [Step *increment*]

...

*program code*

<*condition*> Exit For

...

Next

## Command Availability:

Available on all microcontrollers.

## Explanation:

The For command is ideal for situations where a piece of code needs to be run a set number of times, and where it is necessary to keep track of how many times the code has run. When the For command is first executed, *counter* is set to *start*. Then, each successive time the program loops, *increment* is added to *counter*, until *counter* is equal to *end*. Then, the program continues beyond the Next.

Step and *increment* are optional. If Step is not specified, GCBASIC will increment *counter* by 1 each time the code is run.

The Exit For is optional and can used to exit the loop upon a specific condition.

## Example #1:

'This code will flash a green light 6 times.

```
#chip 16F88, 8
#config Osc = Int

#define LED PORTB.0
Dir LED Out

For LoopCounter = 1 to 6
    PulseOut Led, 1 s
    Wait 1 s
Next
```

## Example #2:

'This code will flash alternate LEDS until the switch is pressed.

```
#chip 16F88, 8
#config Osc = Int

#define LED1 PORTB.0
Dir LED1 Out
#define LED2 PORTB.2
Dir LED2 Out
```

```
#define SWITCH1 PORTA.0
    Dir SWITCH1 In

main:
    PulseOut LED1, 1 s
    For LoopCounterOut = 1 to 250
        PulseOut LED2, 4 Ms
        if switch = On then Exit For
    Next
    Set LED2 OFF
goto main
```

**See Also** [Repeat](#)

# Gosub

## Syntax:

Gosub *label*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Gosub command is used to jump to a label as a subroutine, in a similar way to Goto. The difference is that Return can then be used to return to the line of code after the Goto.

**Note:** Gosub should not be used if it can be avoided. It is not required to call a subroutine that has been defined using [Sub](#), just write the name of the subroutine.

## Example:

```
'This program will flash an LED on portb bit 0 and play a beep on  
'porta bit 4. until the robot is turned off.
```

```
#chip 16F628A, 4 'Change this to suit your circuit
```

```
#define SOUNDOUT PORTA.4  
#define LIGHT PORTB.0  
Dir LIGHT Out
```

```
Do  
    'Flash Light  
    PulseOut LIGHT, 1 s  
    Wait 1 s  
    'Beep  
    Gosub PlayBeep  
Loop
```

```
PlayBeep:  
    Tone 200, 10  
    Tone 100, 10  
    Return
```

# Goto

## Syntax:

`Goto label`

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Goto command will make the robot jump to the line specified, and continue running the program from there. The Goto command is mainly useful for exiting out of loops - if you need to create an infinite loop, use the Do command instead.

Be careful how you use Goto. If used too much, it can make programs very hard to read.

To define a label, put the name of the label alone on a line, with just a colon (:) after it.

## Example:

```
'This program will flash the light until the button is pressed  
'off. Notice the label named SWITCH_OFF.
```

```
#chip 16F628A, 4 'Change this line to suit your circuit
```

```
#define BUTTON PORTB.0  
#define LIGHT PORTB.1  
Dir BUTTON In  
Dir BUTTON Out
```

```
Do  
    PulseOut LIGHT, 500 ms  
    If BUTTON = 1 Then Goto SWITCH_OFF  
    Wait 500 ms  
    If BUTTON = 1 Then Goto SWITCH_OFF  
Loop
```

```
SWITCH_OFF:  
    Set LIGHT Off  
'Chip will enter low power mode when program ends
```

**Syntax:*****Short form:***

If *condition* Then *command*

***Long form:***

If *condition* Then

...

*program code*

...

End If

***Using Else:***

If *condition* Then

*code to run if true*

Else

*code to run if false*

End If

**Command Availability:**

Available on all microcontrollers.

**Explanation:**

The If command is the most common command used to make decisions. If *condition* is true, then *command* (short) or *program code* (long) will be run. If it is false, then the robot will skip to the code located on the next line (short) or after the End If (long form).

If Else is used, then the condition between If and Else will run if the condition is true, and the code between Else and End If will run if the condition is false.

**Note:**

ELSE must be on a separate line in the source code.

**Supported**

```
<instruction> ' is supported
```

```
ELSE
```

```
<instruction>
```

**Not Supported**

```
<instruction> ELSE ' is not supported but will compile
```

<instruction>

## Example:

'Turn a light on or off depending on a light sensor

```
#chip 12F683, 8
#config osc = int

#define LIGHT GPIO.1
#define SENSOR AN3
#define SENSOR_PORT GPIO.4

Dir LIGHT Out
Dir SENSOR_PORT In

Do
    If ReadAD(SENSOR) > 128 Then
        Set LIGHT Off
    Else
        Set LIGHT On
    End If
Loop
```

**For more help, see [Conditions](#)**



## Syntax:

IndCall *Address*

## Command Availability:

Available on all microcontrollers.

## Explanation:

IndCall provides a basic implementation of function pointers. *Address* is the program memory location of the subroutine that is to be called. There are two ways to specify this - either by providing a direct reference to the subroutine using the @ operator, or by specifying a word variable that contains the address.

This command is useful for callbacks. For example, a particular subroutine might read bytes from a serial connection, but different actions may need to be taken at different times. A different subroutine could be created for each action, and then the subroutine for the appropriate action could be passed to the serial connection reading routine each time it is called.

Note: Calling subroutines that have parameters using IndCall is not supported. Errors may occur. If data needs to be passed, use a variable instead.

## Example:

```
'Flash an LED using an indirect call
#chip 12F683
```

```
'Create a word variable, and set it to the memory location of the
'Blink subroutine.
Dim FlashingSub As Word
FlashingSub = @Blink
```

```
'Main loop
Do
    'Indirect call to subroutine at location FlashingSub
    IndCall FlashingSub
Loop
```

```
'LED flashing subroutine
Sub Blink
    PulseOut GPIO.0, 500 ms
    Wait 500 ms
End Sub
```

# Pause

## Syntax:

***Fixed Length Delay:***    Pause *time* ms

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Pause command will cause the program to wait for either a specified amount of time in milliseconds.

# Repeat

## Syntax:

Repeat *times*

...

*program code*

...

End Repeat

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Repeat command is ideal for situations where a piece of code needs to be run a set number of times. It uses less memory and runs faster than the For command, and should be used wherever it is not necessary to count how many times the code has run.

Repeat has a maximum repeat value of 65535.

## Example:

```
'This code will flash a green light 6 times.
```

```
#chip 16F88, 20
```

```
#define LED PORTB.0  
dir LED out
```

```
Repeat 6  
    PulseOut LED, 1 s  
    Wait 1 s  
End Repeat
```

**See Also** [FOR](#)

# Select

## Syntax:

```
Select Case var
  Case value1
    code1

  Case value2
    code2

  Case Else
    code3

End Select
```

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Select Case control structure is used to select and run a particular section of code, based on the value of *var*. If *var* equals *value1* then *code1* will be run. Once *code1* has run, the chip will jump to the End Select command and continue running the program. If none of the other conditions are true, then the code under the Case Else section will be run.

Case Else is optional, and the program will function correctly without it.

If there is only one line of code after the Case, the code may look neater if the line is placed after the Case. This is shown below in the example, for cases 3, 4 and 5.

It is important to note that **only one section of code will be run** when using Select Case.

## Example:

```
'Program to read a value from a potentiometer, and display a
'different word based on the result
```

```
#chip 18F4550, 20
```

```
'LCD connection settings
#define LCD_IO 4
#define LCD_DB4 PORTD.4
#define LCD_DB5 PORTD.5
#define LCD_DB6 PORTD.6
#define LCD_DB7 PORTD.7
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
```

```
#define LCD_Enable PORTD.2
```

```
DIR PORTA.0 IN
```

```
Do
```

```
    Temp = ReadAD(AN0) / 20
```

```
    CLS
```

```
    Select Case Temp
```

```
        Case 0
```

```
            Print "None!"
```

```
        Case 1
```

```
            Print "One"
```

```
        Case 2
```

```
            Print "Two"
```

```
        Case 3: Print "Three"
```

```
        Case 4: Print "Four"
```

```
        Case 5: Print "Five"
```

```
        Case Else
```

```
            Print "A lot!"
```

```
    End Select
```

```
    Wait 250 ms
```

```
Loop
```

# Wait

**Syntax:**  
*Fixed Length Delay:*   Wait *time units*  
*Conditional Delay:*       Wait {While | Until} *condition*  
**Command Availability:**  
Available on all microcontrollers.

**Explanation:**  
The Wait command will cause the program to wait for either a specified amount of time (such as 1 second), or while/until a condition is true.

When using the fixed-length delay, there is a variety of units that are available:

Unit	Length of unit	Delay range
us	1 microsecond	1 us - 65535 us
10us	10 microseconds	10 us - 2.55 ms
ms	1 millisecond	1 ms - 65535 ms
10ms	10 milliseconds	10 ms - 2.55 s
s	1 second	1 s - 255 s
m	1 minute	1 min - 255 min
h	1 hour	1 hour - 255 hours

At one stage, GCBASIC variables could not hold more than 255. The 10us and 10ms units were added as a way to work around this limit. There is now no such limit (Wait 1000 ms will work for example), so these are not really needed. However, you may see them in some older examples or programs, and the 10us units are sometimes the shortest delay that will work accurately.

**Example:**

```
'This code will wait until a button is pressed, then it will flash  
'a light every half a second and produce a 440 Hz tone.  
  
#chip 16F819, 8  
#config osc = int  
  
#define BUTTON PORTB.0  
#define SPEAKER PORTB.1  
#define LIGHT PORTB.2  
Dir BUTTON In  
Dir SPEAKER Out  
Dir LIGHT Out
```

```
'Assumes Button switches on when pressed
  Wait Until BUTTON = 1
  Wait Until BUTTON = 0

Do
  'Flash the light
  Set LIGHT On
  Wait 500 ms
  Set LIGHT Off

  'Produce the tone
  '440 Hz = 880 changes = tone on for 1.14 ms
  Repeat 440
    PulseOut SPEAKER, 1140 us
    Wait 114 10us 'Wait for 114 x 10 us (1.14 ms)
  End Repeat
Loop
```

**For more help, see [Conditions](#)**

**Syntax:**

IntOff

**Command Availability:**

Available on PIC and AVR microcontrollers with interrupt support. Will be automatically removed on chips without interrupts.

**Explanation:**

IntOff is used to disable interrupts on the microcontroller. It should be used at the start of code which is timing-sensitive, and which would not function correctly if paused and restarted.

It is essential that IntOn is used to turn interrupts on again after the timing-sensitive code has finished running. If not, no interrupts will be handled.

IntOff will be removed from the program if no interrupts are used. It is recommended that IntOff be placed before all code that is timing sensitive, in case interrupts are implemented later.



**Syntax:**

IntOn

**Command Availability:**

Available on PIC and AVR microcontrollers with interrupt support. Will be automatically removed on chips without interrupts.

**Explanation:**

IntOn is used to enable interrupts on the microcontroller after IntOff has disabled them. It should be used at the end of code which is timing-sensitive.

IntOn will be removed from the program if no interrupts are used.

**Syntax:**

- On Interrupt *event* Call *handler*
- On Interrupt *event* Ignore

**Command Availability:**

Available on PIC and AVR microcontrollers with interrupt support.

**Explanation:**

On Interrupt will add code to call the subroutine *handler* whenever the interrupt *event* occurs. When Call is specified, GCBASIC will enable the interrupt, and call the interrupt handler when it occurs. When Ignore is specified, GCBASIC will disable the interrupt handler and prevent it from being called when the event occurs. If the event occurs while the handler is disabled, then the handler will be called as soon as it is re-enabled. The only way to prevent this from happening is to manually clear the flag bit for the interrupt.

There are many possible interrupt events that can occur, and the events vary greatly from chip to chip. GCBASIC will display an error if a given chip cannot support the specified event.

In some cases, On Interrupt will not be able to set or clear the interrupt flag and/or enable bits. If this is the case, GCBASIC will display a warning. You will need to consult the chip datasheet and use the Set command to manually set/clear the flag and enable bits, both at the start of the program and inside the interrupt handler subroutine.

If On Interrupt is used to handle an event, then the Interrupt subroutine will not be called for that event. However, it will still be called for any events not dealt with by On Interrupt.

**Events:**

GCBASIC supports the events shown on the table below. Some events are only implemented on a few specialised chips. Events in grey are supported by PICs and AVRs, events in blue are only supported by some PICs, and events in red are only supported by AVRs.

Note that GCBASIC doesn't fully support all of the hardware which can generate interrupts - some work may be required with various system variables to control the unsupported peripherals.

Event Name	Description
ADCReady	The analog/digital converter has finished a conversion
BatteryFail	The battery has failed in some way. This is only implemented on the ATmega406
CANActivity	CAN bus activity is taking place
CANBadMessage	A bad CAN message has been received
CANError	Some CAN error has occurred

CANHighWatermark	CAN high watermark reached
CANRx0Ready	New message present in buffer 0
CANRx1Ready	New message present in buffer 1
CANRx2Ready	New message present in buffer 2
CANRxReady	New message present
CANTransferComplete	Transfer of data has been completed
CANTx0Ready	Buffer 0 has been sent
CANTx1Ready	Buffer 1 has been sent
CANTx2Ready	Buffer 2 has been sent
CANTxReady	Sending has completed
CCADCAccReady	CC ADC accumulate conversion finished (ATmega406 only)
CCADCReady	CC ADC instantaneous conversion finished (ATmega406 only)
CCADCRegular	CC ADC regular conversion finished (ATmega406 only)
CCP1	The CCP1 module has captured an event
CCP2	The CCP2 module has captured an event
CCP3	The CCP3 module has captured an event
CCP4	The CCP4 module has captured an event
CCP5	The CCP5 module has captured an event
Comp0Change	The output of comparator 0 has changed
Comp1Change	The output of comparator 1 has changed
Comp2Change	The output of comparator 2 has changed
Crypto	The KEELOQ module has generated an interrupt
EEPROMReady	An EEPROM write has finished
Ethernet	The Ethernet module has generated an interrupt. This must be dealt with in the handler.
ExtInt0	External Interrupt pin 0 has been ed
ExtInt1	External Interrupt pin 1 has been ed
ExtInt2	External Interrupt pin 2 has been ed
ExtInt3	External Interrupt pin 3 has been ed
ExtInt4	External Interrupt pin 4 has been ed
ExtInt5	External Interrupt pin 5 has been ed
ExtInt6	External Interrupt pin 6 has been ed
ExtInt7	External Interrupt pin 7 has been ed
GPIOChange	The pins on port GPIO have changed
LCDReady	The LCD is about to draw a segment
LPWU	The Low Power Wake Up has been ed
OscillatorFail	The external oscillator has failed, and the PIC is running from an internal oscillator.
PinChange	Logic level of PCINT pin has changed
PinChange0	Logic level of PCINT0 pin has changed
PinChange1	Logic level of PCINT1 pin has changed
PinChange2	Logic level of PCINT2 pin has changed
PinChange3	Logic level of PCINT3 pin has changed
PinChange4	Logic level of PCINT4 pin has changed
PinChange5	Logic level of PCINT5 pin has changed
PinChange6	Logic level of PCINT6 pin has changed
PinChange7	Logic level of PCINT7 pin has changed
PMPReady	A Parallel Master Port read or write has finished
PORTAChange	The pins on port A have changed
PORTABChange	The pins on port A and/or B have changed
PORTBChange	The pins on port B have changed

PSC0Capture	The counter for Power Stage Controller 0 matches the value in a compare register, the value of the counter has been captured, or a synchronisation error has occurred
PSC0EndCycle	Power Stage Controller 0 has reached the end of its cycle
PSC1Capture	The counter for Power Stage Controller 1 matches the value in a compare register, the value of the counter has been captured, or a synchronisation error has occurred
PSC1EndCycle	Power Stage Controller 1 has reached the end of its cycle
PSC2Capture	The counter for Power Stage Controller 2 matches the value in a compare register, the value of the counter has been captured, or a synchronisation error has occurred
PSC2EndCycle	Power Stage Controller 2 has reached the end of its cycle
PSPReady	A Parallel Slave Port read or write has finished
PWMTimeBase	The PWM time base matches the PWM Time Base Period register (PTPER)
SPIReady	The SPI module has finished the previous transfer
SPMReady	A write to program memory by the spm instruction has finished
SPPReady	A SPP read or write has finished
SSP1Collision	SSP1 has detected a bus collision
SSP1Ready	The SSP/SSP1/MSSP1 module has finished sending or receiving
SSP2Collision	SSP2 has detected a bus collision
SSP2Ready	The SSP2/MSSP2 module has finished sending or receiving
Timer0Capture	An input event on the pin ICP0 has caused the value of Timer 0 to be captured in the ICR0 register
Timer0Match1	Timer 0 matches the Timer 0 output compare register A (OCR0A)
Timer0Match2	Timer 0 matches the Timer 0 output compare register B (OCR0B)
Timer0Overflow	Timer 0 has overflowed
Timer1Capture	An input event on the pin ICP1 has caused the value of Timer 1 to be captured in the ICR1 register
Timer1Error	The Timer 1 Fault Protection unit has been ed by an input on the INT0 pin
Timer1Match1	Timer 1 matches the Timer 1 output compare register A (OCR1A)
Timer1Match2	Timer 1 matches the Timer 1 output compare register B (OCR1B)
Timer1Match3	Timer 1 matches the Timer 1 output compare register C (OCR1C)
Timer1Match4	Timer 1 matches the Timer 1 output compare register D (OCR1D)
Timer1Overflow	Timer 1 has overflowed
Timer2Match1	Timer 2 matches the Timer 2 output compare register A (OCR2A)
Timer2Match2	Timer 2 matches the Timer 2 output compare register B (OCR2B)
Timer2Overflow	Timer 2 has overflowed
Timer3Capture	An input event on the pin ICP3 has caused the value of Timer 3 to be captured in the ICR3 register
Timer3Match1	Timer 3 matches the Timer 3 output compare register A (OCR3A)
Timer3Match2	Timer 3 matches the Timer 3 output compare register B (OCR3B)

Timer3Match3	Timer 3 matches the Timer 3 output compare register C (OCR3C)
Timer3Overflow	Timer 3 has overflowed
Timer4Capture	An input event on the pin ICP4 has caused the value of Timer 4 to be captured in the ICR4 register
Timer4Match1	Timer 4 matches the Timer 4 output compare register A (OCR4A)
Timer4Match2	Timer 4 matches the Timer 4 output compare register B (OCR4B)
Timer4Match3	Timer 4 matches the Timer 4 output compare register C (OCR4C)
Timer4Overflow	Timer 4 has overflowed
Timer5CAP1	An input on the CAP1 pin has caused the value of Timer 5 to be captured in CAP1BUF
Timer5CAP2	An input on the CAP2 pin has caused the value of Timer 5 to be captured in CAP2BUF
Timer5CAP3	An input on the CAP3 pin has caused the value of Timer 5 to be captured in CAP3BUF
Timer5Capture	An input event on the pin ICP5 has caused the value of Timer 5 to be captured in the ICR5 register
Timer5Match	Timer5 matches the PR5 register
Timer5Match1	Timer 5 matches the Timer 5 output compare register A (OCR5A)
Timer5Match2	Timer 5 matches the Timer 5 output compare register B (OCR5B)
Timer5Match3	Timer 5 matches the Timer 5 output compare register C (OCR5C)
Timer5Overflow	Timer 5 has overflowed
TWICConnect	The AVR has been connected to or disconnected from the TWI (I2C) bus
TWIRReady	The TWI has finished the previous transmission and is ready to send or receive more data
UsartRX1Ready	UART/USART 1 has received data
UsartRX2Ready	UART/USART 2 has received data
UsartRX3Ready	UART/USART 3 has received data
UsartRX4Ready	UART/USART 4 has received data
UsartTX1Ready	UART/USART 1 is ready to send data
UsartTX1Sent	UART/USART 1 has finished sending data
UsartTX2Ready	UART/USART 2 is ready to send data
UsartTX2Sent	UART/USART 2 has finished sending data
UsartTX3Ready	UART/USART 3 is ready to send data
UsartTX3Sent	UART/USART 3 has finished sending data
UsartTX4Ready	UART/USART 4 is ready to send data
UsartTX4Sent	UART/USART 4 has finished sending data
USBEndpoint	A USB endpoint has generated an interrupt
USB	The USB module has generated an interrupt. This must be dealt with in the handler.
USIOverflow	The USI counter has overflowed from 15 to 0
USIStart	The USI module has detected a start condition
VoltageFail	The input voltage has dropped too low
VoltageRegulator	An interrupt has been generated by the voltage regulator (ATmega16HVA only)
WakeUp	The Wake-Up timer has overflowed
WDT	An interrupt has been generated by the Watchdog Timer

## Example:

```
'This program increments a counter every time Timer1 overflows
#chip 16F877A, 20
```

```
'LCD connection settings
#define LCD_IO 4
#define LCD_DB4 PORTD.4
#define LCD_DB5 PORTD.5
#define LCD_DB6 PORTD.6
#define LCD_DB7 PORTD.7
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2
```

```
InitTimer1 Osc, PS1_1/8
  StartTimer 1
  CounterValue = 0
```

```
Wait 100 ms
  Print "Int Test"
```

```
On Interrupt Timer1Overflow Call IncCounter
```

```
Do
    CLS
    Print CounterValue
    Wait 100 ms
Loop
```

```
Sub IncCounter
    CounterValue ++
End Sub
```

**For more help, see** The [InitTimer0](#) article contains an example of using Timer 0 and On Interrupt to generate a Pulse Width Modulation signal to control a motor.

Introduction

The keypad routines allow for a program to read from a 4 x 4 matrix keypad. There are two ways that the keypad routines can be set up. One option is to connect the wires from the keypad in a particular order, and then to set the KeypadPort constant. The other option is to connect the keypad in whatever way is easiest, and then set the KEYPAD\_ROW\_x and KEYPAD\_COL\_x constants. The first option (setting KeypadPort) will generate slightly more efficient code.

Configuration using KEYPAD\_ROW\_x and KEYPAD\_COL\_x

These constants must be set:

Constant Name	Controls	Default Value
KEYPAD_ROW_1	The pin on the microcontroller that connects to the Row 1 pin on the keypad	N/A
KEYPAD_ROW_2	The pin on the microcontroller that connects to the Row 2 pin on the keypad	N/A
KEYPAD_ROW_3	The pin on the microcontroller that connects to the Row 3 pin on the keypad	N/A
KEYPAD_ROW_4	The pin on the microcontroller that connects to the Row 4 pin on the keypad	N/A
KEYPAD_COL_1	The pin on the microcontroller that connects to the Col 1 pin on the keypad	N/A
KEYPAD_COL_2	The pin on the microcontroller that connects to the Col 2 pin on the keypad	N/A
KEYPAD_COL_3	The pin on the microcontroller that connects to the Col 3 pin on the keypad	N/A
	The pin on the	

KEYPAD_COL_4	microcontroller that connects to the Col 4 pin on the keypad	N/A
--------------	--	-----

If using a 3 x 3 keypad, do not set the KEYPAD\_ROW\_4 or KEYPAD\_COL\_4 constants.

**Configuration using KeypadPort**

When setting up the keypad code using the KeypadPort constant, only KeypadPort needs to be set:

Constant Name	Controls	Default Value
KeypadPort	The port on the microcontroller chip that the keypad is connected to.	N/A

For this to work, the keypad must be connected as follows:

Microcontroller port pin	Keypad connector
0	Row 1
1	Row 2
2	Row 3
3	Row 4
4	Column 1
5	Column 2
6	Column 3
7	Column 4

Note: To use a 3 x 3 keypad in this mode, the pins on the microcontroller for any unused columns must be pulled up.



**Syntax:**  
`var = KeypadData`

**Command Availability:**  
Available on all microcontrollers.

**Explanation:**  
This function will return a value corresponding to the key that is pressed on the keypad. Note that if two or more keys are pressed, then only one value will be returned.  
`var` can have one of the following values:

Value	Constant Name	Key Pressed
0		0
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10	KEY_A	A
11	KEY_B	B
12	KEY_C	C
13	KEY_D	D
14	KEY_STAR	Asterisk/Star (*)
15	KEY_HASH	Hash (#)
255	KEY_NONE	None

**Example:**

```
'Program to show the value of the last pressed key on the LCD
#chip 18F4550, 20

'LCD connection settings
#define LCD_IO 4
#define LCD_DB4 PORTD.4
#define LCD_DB5 PORTD.5
#define LCD_DB6 PORTD.6
#define LCD_DB7 PORTD.7
#define LCD_RS PORTD.0
```

```
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2

'Keypad connection settings
#define KeypadPort PORTB

'Main loop
Do
    'Get key
    Temp = KeypadData

    'If a key is pressed, then display it
    If Temp <> KEY_NONE Then
        CLS
        Print Temp
        Wait 100 ms
    End If
Loop
```

**For more help, see [Relevant Constants](#)**

**Syntax:**  
*largevar* = KeypadRaw

**Command Availability:**  
Available on all microcontrollers.

**Explanation:**  
This function will return a 16 bit value, in which each bit corresponds to a key on the keypad. If the key is pressed its bit will hold 1, and if it is released its bit will contain a 0.

This table shows the key that each bit corresponds to:

Bit	Key Position (row, col)	Common Key Symbol
15	1,1	1
14	1,2	2
13	1,3	3
12	1,4	A
11	2,1	4
10	2,2	5
9	2,3	6
8	2,4	B
7	3,1	7
6	3,2	8
5	3,3	9
4	3,4	C
3	4,1	*
2	4,2	0
1	4,3	#
0	4,4	D

**Example:**

```
'Program to show the keypad status using LEDs
#chip 16F877A, 20

'Keypad connection settings
#define KeypadPort PORTB

'LEDs
#define LED1 PORTC
```

```
#define LED2 PORTD
Dir LED1 Out
Dir LED2 Out
```

```
'Declare a 16 bit variable for the key value
  Dim KeyStatus As Word
```

```
'Main loop
  Do
    'Get key
    KeyStatus = KeypadRaw

    'Display
    LED1 = KeyStatus_H 'High Byte
    LED2 = KeyStatus 'Low Byte
  Loop
```

**For more help, see [Relevant Constants](#)**

The GLCD commands are used to control a graphical Liquid Crystal Display based on the KS0108 driver chip. These are often 128x64 pixel displays. They can draw graphical elements by enabling or disabling pixels.

GCB makes this type of device easier to control with the commands for the GLCD.

## Setup:

You must include the glcd.h file at the top of your program. The file needs to be in brackets.

```
#include <GLCD.h>
```

## Defines:

There are several connections that must be defined to use the GLCD commands with a KS0108 display. The *I/O pin* is the pin on the PIC Microcontroller that is connected to that specific pin on the graphic LCD.

```
#define GLCD_RW I/O pin  'Read/Write pin connection
#define GLCD_RESET I/O pin  'Reset pin connection
#define GLCD_CS1 I/O pin  'CS1 pin connection
#define GLCD_CS2 I/O pin  'CS2 pin connection
#define GLCD_RS I/O pin    'RS pin connection
#define GLCD_ENABLE I/O pin  'Enable pin Connection
#define GLCD_DB0 I/O pin  'Data pin 0 Connection
#define GLCD_DB1 I/O pin  'Data pin 1 Connection
#define GLCD_DB2 I/O pin  'Data pin 2 Connection
#define GLCD_DB3 I/O pin  'Data pin 3 Connection
#define GLCD_DB4 I/O pin  'Data pin 4 Connection
#define GLCD_DB5 I/O pin  'Data pin 5 Connection
#define GLCD_DB6 I/O pin  'Data pin 6 Connection
#define GLCD_DB7 I/O pin  'Data pin 7 Connection
```

## Commands:

```
InitGLCD  'Initialize port pins
```

```
GLCDCLS  'Clear screen
```

```
GLCDPrint(In PrintLocX, In PrintLocY, PrintData As String)
```

```
GLCDDrawChar(In CharLocX, In CharLocY, In CharCode)
```

Box(In LineX1, In LineY1, In LineX2, In LineY2, Optional In LineColour = 1)

FilledBox(In LineX1, In LineY1, In LineX2, In LineY2, Optional In LineColour = 1)

Line(In LineX1, In LineY1, In LineX2, In LineY2, Optional In LineColour = 1)

PSet(In GLCDX, In GLCDY, In GLCDState)

GLCDWriteByte (In LCDByte)

GLCDReadByte

## Example:

This example shows how to drive a KS0108 based Graphic LCD module with the built in commands of Great Cow Basic. See [Graphic LCD](#) for details, this is an external web site.

```
;Chip Settings
#chip 16F886,16
'#config MCLRRE = on 'enable reset switch on CHIPINO
#include <chipino.h>
#include <GLCD.h>

;Defines (Constants)
#define GLCD_RW PORTB.1 'D9 to pin 5 of LCD
#define GLCD_RESET PORTB.5 'D13 to pin 17 of LCD
#define GLCD_CS1 PORTB.3 'D12 to actually since CS1, CS2 are backward
#define GLCD_CS2 PORTB.4 'D11 to actually since CS1, CS2 are backward
#define GLCD_RS PORTB.0 'D8 to pin 4 D/I pin on LCD
#define GLCD_ENABLE PORTB.2 'D10 to Pin 6 on LCD
#define GLCD_DB0 PORTC.7 'D0 to pin 7 on LCD
#define GLCD_DB1 PORTC.6 'D1 to pin 8 on LCD
#define GLCD_DB2 PORTC.5 'D2 to pin 9 on LCD
#define GLCD_DB3 PORTC.4 'D3 to pin 10 on LCD
#define GLCD_DB4 PORTC.3 'D4 to pin 11 on LCD
#define GLCD_DB5 PORTC.2 'D5 to pin 12 on LCD
#define GLCD_DB6 PORTC.1 'D6 to pin 13 on LCD
#define GLCD_DB7 PORTC.0 'D7 to pin 14 on LCD

InitGLCD
Start:
GLCDCLS
GLCDPrint 0,10,"Hello" 'Print Hello
wait 5 s
GLCDPrint 0,10, "ASCII #:" 'Print ASCII #:
Box 18,30,28,40 'Draw Box Around ASCII Character
for char = 15 to 129 'Print 0 through 9
GLCDPrint 17, 20 , Str(char)
GLCDdrawCHAR 20,30, char
wait 1 s
```

```
next
line 0,50,127,50           'Draw Line using line command
for xvar = 0 to 80         'draw line using Pset command
pset xvar,63,on           '
next                       '
Wait 10 s
Goto Start
```

**See also** [InitGLCD](#), [GLCDCLS](#), [GLCDDrawChar](#), [GLCDPrint](#), [GLCDReadByte](#), [GLCDWriteByte](#), [Pset](#)

# GLCDCLS

---

**Syntax:**

GLCDCLS

**Explanation:**

Clears the screen of a Graphic LCD.



### Syntax:

GLCDDrawChar(CharLocX, CharLocY, CharCode)

CharLocX is the X coordinate location for the character

CharLocY is the Y coordinate location for the character

CharCode is the ASCII number of the character to display. Can be decimal hex or binary.

### Explanation:

Displays an ASCII character at a specified X and Y location.

On a 128x64 Graphic LCD

X = 1 to 128

Y = 1 to 64

**Syntax:**

GLCDPrint(PrintLocX, PrintLocY, PrintData)

PrintLocX is the X coordinate location for the data

PrintLocY is the Y coordinate location for the data

PrintData is a String or String variable of the data to display

**Explanation:**

Prints string character(s) at a specified location on the GLCD screen.

On a 128x64 GLCD display

X is typically 0 to 128

Y is typically 0 to 64

**Syntax:**

GLCDWriteByte

**Explanation:**

Reads a byte of data from the Graphic LCD memory

# GLCDWriteByte

---

## Syntax:

GLCDWriteByte (LCDByte)

## Explanation:

Writes a byte of data to the Graphic LCD memory

**Syntax:**

Line(LineX1,LineY1, LineX2, LineY2, Optional LineColour = 1)

**Explanation:**

Draws a line on a graphic LCD from X1, Y1 location to X2,Y2 location. Must be horizontal or vertical. Diagonal will not work properly.

## Syntax:

InitGLCD

## Explanation:

This initializes the Graphical LCD for operation. Here are the steps it takes:

## Example:

```
'Set pin directions
```

```
Dir GLCD_RS Out
Dir GLCD_RW Out
Dir GLCD_ENABLE Out
Dir GLCD_CS1 Out
Dir GLCD_CS2 Out
Dir GLCD_RESET Out
```

```
'Reset
```

```
Set GLCD_RESET Off
Wait 1 ms
Set GLCD_RESET On
Wait 1 ms
```

```
'Select both chips
```

```
Set GLCD_CS1 On
Set GLCD_CS2 On
```

```
'Set on
```

```
Set GLCD_RS Off
GLCDWriteByte 63
```

```
'Set Z to 0
```

```
GLCDWriteByte 192
```

```
'Deselect chips
```

```
Set GLCD_CS1 Off
Set GLCD_CS2 Off
```

```
'Clear screen
```

```
GLCDCLS
```

**Syntax:**

PSet(GLCDX, GLCDY, GLCDState)

**Explanation:**

Sets or Clears a Pixel at the specified X, Y location. A one for GLCDState sets the pixel and a zero clears the pixel.

**Syntax:**

Box(LineX1,LineY1, LineX2, LineY2, Optional LineColour = 1)

**Explanation:**

Draws a box on a graphic LCD from the upper corner of X1, Y1 location to X2,Y2 location.

**See also** [FilledBox](#)



**Syntax:**

FilledBox(LineX1,LineY1, LineX2, LineY2, Optional LineColour = 1)

**Explanation:**

Draws a filled box on a graphic LCD from the upper corner of X1, Y1 location to X2,Y2 location.

**See also** [Box](#)

Introduction:

The routines in this section allow GCBASIC programs to interact with alphanumeric Liquid Crystal Displays based on the HD44780 IC. This covers most 16 x 2 and similar displays.

These routines allow the displays to be connected to the microcontroller in many different ways:

Connection Mode	Required Connections
0	None are required directly by the routines. However, the LCD routines must be provided with other subroutines which will handle the communication. This is useful for communicating with LCDs connected through RS232 or I2C.
2	Data and Clock lines. This mode is used when the LCD is connected through a 74LS174 shift register IC, as detailed at <a href="#">the Internet way back engine</a> .
4	R/W, RS, Enable and the highest 4 data lines (DB4 through DB7).
8	R/W, RS, Enable and all 8 data lines. The data lines must all be connected to the same I/O port, in sequential order. For example, DB0 to PORTB.0, DB1 to PORTB.1 and so on, with DB7 going to PORTB.7.

Using 0-bit mode:

To use 0-bit connection mode, a subroutine to write a byte to the LCD must be provided. Optionally, another subroutine to read a byte from the LCD can also be given. If there is no way to read from the LCD, then the LCD\_NO\_RW constant must be set.

In 0-bit mode, the LCD\_RS constant will be set automatically to a spare bit variable. The higher level LCD commands (such as Print and Locate) will set it, and the code responsible for writing to the LCD should read it and then set the RS pin on the LCD appropriately.

This code is an example of how to use 0-bit mode. It sends messages to another microcontroller, which has been programmed to read the messages and toggle the pins of an LCD appropriately:

```
#define LCD_IO 0
```

```
#define LCDWriteByte MySendToLCD
#define LCD_NO_RW
```

```
Sub MySendToLCD(In MyLCDByte)

    'Uses I2C
    'Sends an address byte (128)
    'Then a control byte, where bit 4 is the state of the RS pin
    'Then a data byte, which is sent to the LCD data pins.

    ControlByte = 0
    If LCD_RS = On Then ControlByte.4 = On

    I2CStart
    I2CSend 128
    I2CSend ControlByte
    I2CSend MyLCDByte
    I2CStop

    'Need to allow time for receiver of message to update LCD
    Wait 5 ms

End Sub
```

If the LCD was to be read, then LCDReadByte would be set to the name of a function that reads the LCD and returns the data byte from the LCD.

### Relevant Constants:

(Note: this section does not apply in 0 bit mode)

These constants are used to control settings for the Liquid Crystal Display routines included with GCBASIC. To set them, place a line in the main program file that uses #define to assign a value to the particular constant.

Some constants are used required for 4 and 8-bit modes, some are required for 4-bit mode, and some are used by 8-bit mode. When using 2-bit mode only three constants must be set - all others can be ignored. Check the "Modes" column to determine if you must set a constant.

Constant Name	Controls	Default Value	Modes
LCD_IO	The I/O mode. Can be 2, 4 or 8.	8	2, 4, 8
LCD_DB	The data pin used in 2-bit mode.	N/A - <i>Must be set</i>	2
LCD_CB	The clock pin used in 2- bit mode.	N/A - <i>Must be set</i>	2
LCD_RS	Specifies the output pin that is connected to Register Select on the LCD.	N/A - <i>Must be set</i>	4, 8

LCD_RW	Specifies the output pin that is connected to Read/Write on the LCD. The R/W pin can be disabled*.	N/A - <b><i>Must be set</i></b> (unless R/W is disabled)	4, 8
LCD_Enable	Specifies the output pin that is connected to Read/Write on the LCD.	N/A - <b><i>Must be set</i></b>	4, 8
LCD_DATA_PORT	Output port used to interface with LCD data bus	N/A - <b><i>Must be set</i></b>	8 only
LCD_DB4	Output pin used to interface with bit 4 of the LCD data bus	N/A - <b><i>Must be set</i></b>	4 only
LCD_DB5	Output pin used to interface with bit 5 of the LCD data bus	N/A - <b><i>Must be set</i></b>	4 only
LCD_DB6	Output pin used to interface with bit 6 of the LCD data bus	N/A - <b><i>Must be set</i></b>	4 only
LCD_DB7	Output pin used to interface with bit 7 of the LCD data bus	N/A - <b><i>Must be set</i></b>	4 only

\*The R/W pin can be disabled by setting the LCD\_NO\_RW constant. If this is done, there is no need for the R/W to be connected to the chip, and no need for the LCD\_RW constant to be set. Ensure that the R/W line on the LCD is connected to ground if not used!

## Syntax:

Print *string*

Print *byte*

Print *word*

Print *integer*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Print command will show the contents of a variable on the LCD. It can display string, word or byte variables.

## Example:

```
'A Light Meter program.

'General hardware configuration
#chip 16F877A, 20
#define LightSensor AN0

'LCD connection settings
#define LCD_IO 8
#define LCD_DATA_PORT PORTC
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2

CLS

Print "Light Meter:
Locate 1,2
Print "A GCBASIC Demo"
Wait 2 s

Do
    CLS
    Print "Light Level: "
    Print ReadAD(LightSensor)
    Wait 250 ms
Loop
```

For more help, see [Relevant Constants](#)

# Locate

## Syntax:

Locate *line, column*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Locate command is used to move the cursor on the LCD to the given location.

## Example:

```
'A Hello World program for GCBASIC.  
'Uses Locate to show "World" on the second line
```

```
'General hardware configuration  
#chip 16F877A, 20
```

```
'LCD connection settings  
#define LCD_IO 8  
#define LCD_DATA_PORT PORTC  
#define LCD_RS PORTD.0  
#define LCD_RW PORTD.1  
#define LCD_Enable PORTD.2
```

```
'Main routine  
Print "Hello"  
Locate 1, 5  
Print "World"
```

For more help, see [Relevant Constants](#)

# Put

## Syntax:

Put Line,Column, Character

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Put command writes the given ASCII character code to the location on the LCD.

## Example:

```
'A scrolling star for GCBASIC
```

```
'Misc Settings
```

```
#define SCROLL_DELAY 250 ms
```

```
'General hardware configuration
```

```
#chip 16F877A, 20
```

```
'LCD connection settings
```

```
#define LCD_IO 8
```

```
#define LCD_DATA_PORT PORTC
```

```
#define LCD_RS PORTD.0
```

```
#define LCD_RW PORTD.1
```

```
#define LCD_Enable PORTD.2
```

```
'Main routine
```

```
For StarPos = 0 To 16
```

```
  If StarPos = 0 Then
```

```
    Put 0, 16, 32
```

```
    Put 0, 0, 42
```

```
  Else
```

```
    Put 0, StarPos - 1, 32
```

```
    Put 0, StarPos, 42
```

```
  End If
```

```
  Wait SCROLL_DELAY
```

```
Next
```

For more help, see [Relevant Constants](#)

**Syntax:**

var = Get(Line, Column)

**Command Availability:**

Available on all microcontrollers, except if the LCD is connected using 2 bit mode.

**Explanation:**

The Get function reads the ASCII character code at a given location on the LCD.

For more help, see [Put](#), [Relevant Constants](#)



# CLS

## Syntax:

CLS

## Command Availability:

Available on all microcontrollers.

## Explanation:

The CLS command clears the contents of the LCD, and returns the cursor to the top left corner of the screen

## Example:

```
'A Flashing Hello World program for GCBASIC
```

```
'General hardware configuration
#chip 16F877A, 20
```

```
'LCD connection settings
#define LCD_IO 8
#define LCD_DATA_PORT PORTC
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2
```

```
'Main routine
Do
    Print "Hello World"
    Wait 1 sec
    CLS
    Wait 1 sec
Loop
```

For more help, see [Relevant Constants](#)

## Syntax:

LCDCreateChar *char*, *chardata*()

## Command Availability:

Available on all microcontrollers.

## Explanation:

The LCDCreateChar command is used to send a custom character to the LCD.

Each character on the LCD is made up from an 8 row by 5 column (5x8) matrix of pixels. The data to be sent to the LCD is composed of an 8 element array, where each element corresponds to a row. Inside each element, the 5 lowest bits make up the data for the corresponding row. When a bit is set a dot will be drawn at the matching location; when it is cleared, no dot will appear.

An array of more than 8 elements may be used, but only the first 8 will be read.

*char* is the ASCII value of the character to create. ASCII codes 0 through 7 are usually used to store custom characters.

*chardata()* is an array containing the data for the character.

## Example:

```
'This program draws a smiling face character

'General hardware configuration
#chip 16F877A, 20

'LCD connection settings
#define LCD_IO 8
#define LCD_DATA_PORT PORTC
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2

'Create an array to store the character until it is copied
Dim TempArray(8)

'Set the array to hold the character
'Binary has been used to improve the readability of the code, but is not essential
TempArray(1) = b'00011011'
TempArray(2) = b'00011011'
TempArray(3) = b'00000000'
TempArray(4) = b'00000100'
TempArray(5) = b'00000000'
TempArray(6) = b'00010001'
TempArray(7) = b'00010001'
TempArray(8) = b'00001110'
```

```
'Copy the character from the array to the LCD  
  LCDCreateChar 0, TempArray()
```

```
'Draw the custom character  
  LCDWriteChar 0
```

**For more help, see [LCDWriteChar](#), [Relevant Constants](#)**

## Syntax:

LCDHex *value*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The LCDHex command will show the specified value on the LCD, at the current cursor position. It will convert the byte it has been given into hexadecimal format.

## Example:

```
'A program to count from 0 to FF on an LCD screen.
```

```
'General hardware configuration
#chip 16F877A, 20
```

```
'LCD connection settings
#define LCD_IO 8
#define LCD_DATA_PORT PORTC
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2
```

```
For Counter = 0 To 255
    CLS
    LCDHex Counter
    Wait 250 ms
Next
```

## Syntax:

LCDWriteChar *char*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The LCDWriteChar command will show the specified character on the LCD, at the current cursor position.

*char* is the ASCII value of the character to show. On most LCDs, characters 0 through 7 are user defined, and can be set using the LCDCreateChar command.

## Example:

```
'This program draws a smiling face character
```

```
'General hardware configuration
#chip 16F877A, 20
```

```
'LCD connection settings
#define LCD_IO 8
#define LCD_DATA_PORT PORTC
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2
```

```
'Create an array to store the character until it is copied
Dim TempArray(8)
```

```
'Set the array to hold the character
TempArray(1) = b'00011011'
TempArray(2) = b'00011011'
TempArray(3) = b'00000000'
TempArray(4) = b'00000100'
TempArray(5) = b'00000000'
TempArray(6) = b'00010001'
TempArray(7) = b'00010001'
TempArray(8) = b'00001110'
```

```
'Copy the character from the array to the LCD
LCDCreateChar 0, TempArray()
```

```
'Draw the custom character
LCDWriteChar 0
```

For more help, see [LCDCreateChar](#), [Relevant Constants](#)

Introduction:

The routines described in this chapter allow the generation of Pulse Width Modulation signals. These allow for the microcontroller to control the speed of a motor, or the brightness of a light. The routines can also be used to generate the appropriate frequency signal to drive an infrared LED for remote control applications.

The PWMOn, PWMOff and HPWM routines use the PWM generation module on the microcontroller. They will only work on some microcontrollers - see the article on each command for details. PWMOn and HPWM will cause the PWM module on the microcontroller to start generating the PWM signal, which will then continue to be generated until the PWMOff instruction is run.

PWMOut does not make use of any special hardware. However, a signal is only generated while the PWMOut command is running - when the program moves on to the next command, the signal will stop.

Relevant Constants:

These constants are used to control settings for the Pulse Width Modulation module of the PIC chip. To set them, place a line in the main program file that uses #define to assign a value to the particular constant.

Note that there are two sets of constants: one for Hardware PWM, and one for Software PWM. Hardware PWM requires a CCP module on the PIC chip - Software PWM has no requirements regarding the PIC.

Hardware PWM

These constants are only required for PWMOn. HPWM and PWMOff do not require any constants to operate.

Constant Name	Controls	Default Value
PWM_Freq	Specifies the output frequency of the PWM module in KHz.	38
PWM_Duty	Sets the duty cycle of the PWM module output. Given as percentage.	50

Hardware PWM is only available through the "CCP1" or "CCP" pin. This is a hardware limitation of PIC microcontrollers.

Software PWM

Constant Name	Controls	Default Value
	The PWM Period. The length of any	

PWM_Delay	<p>delay used will be multiplied by 255.</p> <p>If no value is specified, no delays will be inserted into the PWM routine.</p>	Not defined - no delay
PWM_Out $n$	<p>The port physical port on the PIC that corresponds to channel <math>n</math>. <math>n</math> can represent 1, 2, 3 or 4.</p>	Not Defined

More than 4 channels are possible, but for this the PWMOut routine in `include\lowlevel\stdbasic.h` must be altered.







## Syntax:

PWMOff

## Command Availability:

Only available on PIC microcontrollers with Capture/Compare/PWM (CCP) module.

## Explanation:

This command will disable the output of the PWM module on the PIC chip.

## Example:

```
'This program will enable a 76 Khz PWM signal, with a duty cycle  
'of 80%. It will emit the signal for 10 seconds, then stop.  
#define PWM_Freq 76  'Set frequency in KHz  
#define PWM_Duty 80  'Set duty cycle to 80 %  
PWMON                'Turn on the PWM  
WAIT 10 s            'Wait 10 seconds  
PWMOff               'Turn off the PWM
```

For more help, see [PWMON](#)

## Syntax:

PWMOn

## Command Availability:

Only available on PIC microcontrollers with Capture/Compare/PWM (CCP) module.

## Explanation:

This command will enable the output of the PWM module on the PIC chip.

## Example:

```
'This program will enable a 76 Khz PWM signal, with a duty cycle  
'of 80%. It will emit the signal for 10 seconds, then stop.  
#define PWM_Freq 76  'Set frequency in KHz  
#define PWM_Duty 80  'Set duty cycle to 80 %  
PWMOn               'Turn on the PWM  
WAIT 10 s           'Wait 10 seconds  
PWMOff              'Turn off the PWM
```

For more help, see [PWMOff](#)

**Syntax:**

HPWM *channel*, *frequency*, *duty cycle*

**Command Availability:**

Only available on PIC microcontrollers with Capture/Compare/PWM (CCP) module.

**Explanation:**

This command sets up the hardware PWM module of the PIC chip to generate a PWM waveform of the given frequency and duty cycle. Once this command is called, the PWM will be emitted until PWMOff is called. If you only need one particular frequency and duty cycle, you should use PWMOn and the constants PWM\_Freq and PWM\_Duty instead.

*channel* is 1 or 2, and corresponds to the pins CCP1 and CCP2 respectively. On chips with only one CCP port, pin CCP or CCP1 is always used, and *channel* is ignored. (It should be set to 1 anyway to allow for future upgrades to more powerful PIC chips.)

*frequency* sets the frequency of the PWM output. It is measured in KHz. The maximum value allowed is 255 KHz. The minimum value varies depending on the clock speed. 1 KHz is the minimum on chips 16 MHz or under and 2 KHz is the lowest possible on 20 MHz chips. In situations that do not require a specific PWM frequency, the PWM frequency should equal approximately 1 five-hundredth the clock speed of the PIC (ie 40 KHz on a 20 MHz chip, 16 KHz on an 8 MHz chip). This gives the best duty cycle resolution possible.

*duty cycle* specifies the desired duty cycle of the PWM signal, and ranges from 0 to 255 where 255 is 100% duty cycle.

**Example:**

```
'This program will alter the brightness of an LED using
'hardware PWM.
```

```
'Select chip model and speed
#chip 16F877A, 20
```

```
'Set the CCP1 pin to output mode
DIR PORTC.2 out
```

```
'Main code
do
```

```
    'Turn up brightness over 2.5 seconds
    For Bright = 1 to 255
        HPWM 1, 40, Bright
        wait 10 ms
```

```
    next
    'Turn down brightness over 2.5 seconds
    For Bright = 255 to 1
```

```
    HPWM 1, 40, Bright
    wait 10 ms
  next
loop
```

**For more help, see [PWMOff](#)**

Introduction:

These routines allow GCBASIC to generate pseudo-random numbers. The generator uses a 16 bit linear feedback shift register to produce pseudo-random numbers. The most significant 8 bits of the LFSR are used to provide an 8 bit random number.

When compiling a program, GCBASIC will generate an initial seed for the generator. However, this seed will be the same every time the program runs, so the sequence of numbers produced by a given program will always be the same. To work around this, there is a Randomize subroutine. It can be provided with a new seed for the generator (which will cause the generator to move to a different point in the sequence). Alternatively, Randomize can be set to obtain a seed from some other source such as a timer every time it is run.

Relevant Constants:

These constants are used to control settings for the tone generation routines. To set them, place a line in the main program file that uses #define to assign a value to the particular constant.

Constant Name	Controls	Default Value
RANDOMIZE_SEED	Source of the random seed if Randomize is called without a parameter	Timer0

# Random

## Syntax:

var = Random

## Command Availability:

Available on all microcontrollers

## Explanation:

The Random function will generate a pseudo-random number between 0 and 255 inclusive.

The numbers generated by Random will follow the same sequence every time, until Randomize is used.

## Example:

```
'Set chip model
#chip tiny2313, 1
```

```
'Use randomize, with the value on PORTD as the seed
Randomize PORTD
```

```
'Generate random numbers, and output on PORTB
Do
    PORTB = Random
    Wait 1 s
Loop
```

## Syntax:

Randomize

Randomize *seed*

## Command Availability:

Available on all microcontrollers

## Explanation:

Randomize is used to seed the pseudo random number generator, so that it will produce a different sequence of numbers each time it is used.

If no *seed* is specified, then the RANDOMIZE\_SEED constant will be used as the seed. If *seed* is specified, then it will be used to seed the generator.

It is important that the seed is different every time that Randomize is used. If the seed is always the same, then the sequence of numbers will always be the same. It is best to use a running timer, an input port, or the analog to digital converter as the source of the seed, since these will normally provide a different value each time the program runs.

## Example:

```
'Set chip model
#chip tiny2313, 1
```

```
'Use randomize, with the value on PORTD as the seed
Randomize PORTD
```

```
'Generate random numbers, and output on PORTB
Do
    PORTB = Random
    Wait 1 s
Loop
```



Introduction

The 7 segment display routines make it easier for GCBASIC programs to display numbers and letters on 7 segment LED displays.

There are two ways that the 7 segment display routines can be set up. One option is to connect the wires from the display/s in a particular order, and then to set the DisplayPort*n* and DispSelect*n* constants. The other option is to connect the display/s in whatever way is easiest, and then set the DISP\_SEG\_x and DISP\_SEL\_x constants. The first option (setting DisplayPort*x* and DispSelect*n*) will generate slightly more efficient code.

Configuration using DISP\_SEG\_x and DISP\_SEL\_x

When setting up the 7 segment code with DISP\_SEG\_x constants, these must be set:

Constant Name	Controls	Default Value
DISP_SEG_x	Controls the output pin used to control segment x of the displays. There are 7 of these constants, named DISP_SEG_A through DISP_SEG_G. One must be set for each segment.	N/A
DISP_SEG_DOT	Specifies the output pin used to control the decimal point on the displays.	N/A
DISP_SEL_x	The command used to select display <i>n</i> . Used to control addressing pins when several displays are multiplexed.	N/A

**Note:** Instead of setting DISP\_SEL\_x, it is possible to set DispSelect*n* and use these in conjunction with DISP\_SEG\_x.

Configuration using DisplayPort*n* and DispSelect*n*

To set the 7-Segment display routines supplied with GCBASIC using DisplayPort*n*, it is necessary to set these constants:

Constant Name	Controls	Default Value
	Controls the output	

DisplayPort $n$	port used to control display $n$ . $n$ is A, B, C or D, corresponding to displays 1, 2, 3 and 4, respectively.	N/A
DispSelect $n$	The command used to select display $n$ . Used to control addressing pins when several displays are multiplexed.	nop

To set up the routines in this way, the displays must be connected as follows:

Microcontroller port pin	Display Segment
0	A
1	B
2	C
3	D
4	E
5	F
6	G

# DisplayValue

## Syntax:

DisplayValue *display*, *data*

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will display the given value on a seven segment LED display. *display* is the number of the display to use, and *data* is the value between 0 and 9 to show

## Example:

```
'This program will count from 0 to 99 on two LED displays
#chip 16F819, 8
#config osc = int
```

```
#define DISP_SEG_A PORTB.0
#define DISP_SEG_B PORTB.1
#define DISP_SEG_C PORTB.2
#define DISP_SEG_D PORTB.3
#define DISP_SEG_E PORTB.4
#define DISP_SEG_F PORTB.5
#define DISP_SEG_G PORTB.6
```

```
#define DISP_SEL_1 PORTA.0
#define DISP_SEL_2 PORTA.1
```

Do

```
For Counter = 0 To 99
```

```
    'Get the 2 digits
    Number = Counter
    Num1 = 0
    If Number >= 10 Then
        Num1 = Number / 10
        'SysCalcTempX stores remainder after division
        Number = SysCalcTempX
    End If
    Num2 = Number
```

```
    'Show the digits
    'Each DisplayValue will erase the other (multiplexing)
    'So they must be called often enough that the flickering
    'cannot be seen.
    Repeat 500
        DisplayValue 1, Num1
        Wait 1 ms
        DisplayValue 2, Num2
        Wait 1 ms
    End Repeat
```

```
Next
```

```
Loop
```

For more help, see [Relevant Constants](#)

# DisplayChar

## Syntax:

DisplayChar (*display*, *character*)

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will display the given ASCII character on a seven segment LED display. *display* is the number of the display to use, and *character* is the ASCII character to show.

## Example:

```
'This program will show "Hello" on a LED display  
'The display should be connected to PORTB
```

```
#chip 16F877A, 20  
#define DisplayPortA PORTB  
  
Dim Message As String  
  Message = "Hello "  
  For Counter = 1 to 6  
    DisplayChar 1, Message(Counter)  
    Wait 250 ms  
  Next
```

For more help, see [Relevant Constants](#)

Introduction:

These routines allow the microcontroller to send and receive RS232 data. All functions are implemented using software, so no special hardware is required on the microcontroller. However, if the microcontroller has a hardware serial module (usually referred to as UART or USART), and the serial data lines are connected to the appropriate pins, the hardware routines should be used for smaller code, improved reliability and higher baud rates.

Relevant Constants:

These constants are used to control settings for the RS232 serial communication routines. To set them, place a line in the main program file that uses #define to assign a value to the particular constant.

Constant Name/s	Controls	Default Value
SendALow, SendBLow, SendCLow	These are used to define the commands used to send a low (0) bit on serial channels A, B and C respectively.	nop <b>(must be set)</b>
SendAHigh, SendBHigh, SendCHigh	These are used to define the commands used to send a high (1) bit on serial channels A, B and C respectively.	nop <b>(must be set)</b>
RecALow, RecBLow, RecCLow	The condition that is true when a low bit is being received	Sys232Temp.0 OFF <b>(must be set)</b>
RecAHigh, RecBHigh, RecCHigh	The condition that is true when a high bit is being received	Sys232Temp.0 ON <b>(must be set)</b>

## Syntax:

InitSer *channel, rate, start, data, stop, parity, invert*

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will set up the serial communications. The parameters are as follows:

- *channel* is 1, 2 or 3, and refers to the I/O ports that are used for communication.
- *rate* is the bit rate, which is given by the letter r and then the desired rate in bps. Acceptable units are r300, r600, r1200, r2400, r4800, r9600 and r19200.
- *start* gives the number of start bits, which is usually 1. To make the PIC wait for the start bit before proceeding with the receive, add 128 to *start*. (Note: it may be desirable to use the WaitForStart constant here.)
- *data* tells the program how many data bits are to be sent or received. In most situations this is 8, but it can range between 1 and 8, inclusive.
- *stop* is the number of stop bits. If *start* bit 7 is on, then this number will be ignored.
- *parity* refers to a system of error checking used by many devices. It can be odd (in which there must always be an odd number of high bits), even (where the number of high bits must always be even), or none (for systems that do not use parity).
- *invert* can be either "normal" or "invert". If it is "invert", then high bits will be changed to low, and low to high.

## Example:

Please refer to [SerSend](#) for an example of InitSer

For more help, see [Relevant Constants](#)

## Syntax:

SerSend *channel*, *data*

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will send a byte given by *data* using the RS232 channel referred to as *channel* according to the rules set using InitSer.

## Example:

'This program will send a byte using PORTB.2, the value of which depends on whether a button is pressed. This can be used with the 'example for SerReceive.

```
#chip 16F819, 8
#config Osc = Int

#define SendAHigh Set PORTB.2 ON
#define SendALow Set PORTB.2 OFF
#define Button PORTA.0

Dir Button In
Dir PORTB.2 Out

InitSer 1, r9600, 1+WaitForStart, 8, 1, none, normal
Do
    If Button = On Then Temp = 100
    If Button = Off Then Temp = 0
    SerSend 1, Temp
    Wait 100 ms
Loop
```

For more help, see [Relevant Constants](#), [InitSer](#)



# SerReceive

## Syntax:

SerReceive *channel*, *output*

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will read a byte from the RS232 channel given by *channel* according to the rules set using InitSer, and store the received byte in the variable *output*.

## Example:

```
'This program will read a byte from PORTB.2, and set the LED on if  
'the byte is more than 50. This can be used with the SerSend  
'example program.
```

```
#chip 16F88, 8  
#config Osc = Int
```

```
#define RecAHigh PORTB.2 ON  
#define RecALow PORTB.2 OFF  
#define LED PORTB.0
```

```
Dir PORTB.0 Out  
Dir PORTB.2 In
```

```
InitSer 1, r9600, 1 + WaitForStart, 8, 1, none, normal  
Do  
    SerReceive 1, Temp  
    If Temp <= 50 Then Set LED Off  
    If Temp > 50 Then Set LED On  
Loop
```

For more help, see [Relevant Constants](#), [InitSer](#)

## Syntax:

SerPrint *channel*, *value*

## Command Availability:

Available on all microcontrollers.

## Explanation:

SerPrint is used to send a value over the serial connection. *value* can be a string, word or byte - SerPrint is very similar to Print. *channel* is the serial connection to send data through.

SerPrint will not send any new line characters. If the chip is sending to a terminal, these commands should follow every SerPrint:

SerSend *channel*, 13

SerSend *channel*, 10

## Example:

```
'This program will display any values received over the serial
'connection. If "pot" is received, the value of the analog sensor
'will be sent.
```

```
'Chip settings
```

```
#chip 18F2525, 8
#config Osc = Int
```

```
'LCD settings
```

```
#define LCD_IO 4
#define LCD_RS PORTC.7
#define LCD_RW PORTC.6
#define LCD_Enable PORTC.5
#define LCD_DB4 PORTC.4
#define LCD_DB5 PORTC.3
#define LCD_DB6 PORTC.2
#define LCD_DB7 PORTC.1
```

```
'Serial settings
```

```
#define SerInPort PORTB.6
#define SerOutPort PORTB.7
```

```
#define SendAHigh Set SerOutPort Off
#define SendALow Set SerOutPort On
#define RecAHigh SerInPort Off
#define RecALow SerInPort On
```

```
'Potentiometer
```

```
#define POT_PORT PORTA.0
#define POT_AN AN0
```

```
'Set pin directions
```

```
Dir SerOutPort Out
Dir SerInPort In
Dir POT_PORT In
```

```
'Create buffer variables to store received messages
```

```
Dim Buffer As String
Dim OldBuffer As String
BufferSize = 0
```

```
'Set up serial connection
```

```
InitSer 1, r9600, 1 + WaitForStart, 8, 1, none, invert
```

```
'Show test messages
```

```
Print "Serial Tester"
Wait 1 s
SerPrint 1, "GCBASIC RS232 Test"
SerSend 1, 13
SerSend 1, 10
Wait 1 s
```

```
'Main loop
```

```
Do
```

```
    'Get a byte from the terminal
    SerReceive 1, Temp
```

```
    'If Enter key was pressed, deal with buffer contents
```

```
    If Temp = 13 Then
        Buffer(0) = BufferSize
```

```
        'Try to execute commands in buffer
```

```
        If Not ExecCommand (Buffer) Then
```

```
            'Show message on bottom line, last message on top.
```

```
            CLS
```

```
            Print OldBuffer
```

```
            Locate 1, 0
```

```
            Print Buffer
```

```
            'Store the message for next time
```

```
            OldBuffer = Buffer
```

```
        End If
```

```
        BufferSize = 0
```

```
    End If
```

```
    'Backspace code, delete last character in buffer
```

```
    If Temp = 8 Then
```

```
        If BufferSize > 0 Then BufferSize -= 1
```

```
    End If
```

```
    'Received ASCII code between 32 and 127, add to buffer
```

```
    If Temp >= 32 And Temp <= 127 Then
```

```
        BufferSize += 1
```

```
        Buffer(BufferSize) = Temp
```

```
    End If
```

```
Loop
```

```
'Takes a sensor reading and sends it to terminal
```

```
Sub SendSensorReading
```

```
    SerPrint 1, "Sensor Reading: "
```

```
    SerPrint 1, ReadAD10(POT_AN)
```

```
    SerSend 1, 13
```

```
    SerSend 1, 10
```

```
End Sub
```

```
'Will check the buffer for a command
'If command found, run it and return true
'If not, return false
Function ExecCommand (CmdIn As String)
    ExecCommand = False
    'If received command is "pot", show potentiometer value
    If CmdIn = "pot" Then
        SendSensorReading
        ExecCommand = True
    End If
End Function
```

**For more help, see [Relevant Constants](#)**

Introduction

These subroutines allow GCBASIC programs to communicate more easily using RS232.

These hardware-based routines are intended for use on microcontrollers with built in RS232 modules - normally referred to in datasheets as USART or UART modules. To use these, the RS232 data lines must be connected to the pins on the microcontroller used by the serial module. If the RS232 lines are connected elsewhere, or the microcontroller has no RS232 module, then the software based routines must be used.

Relevant Constants

These constants affect the operation of the hardware RS232 routines:

Constant Name	Controls	Default Value
USART_BAUD_RATE	Baud rate (in bps) for the routines to operate at.	N/A
USART_BLOCKING	If set, this constant will cause the USART routines to delay until data can be sent or received. If not set, then the data will be buffered and send by the hardware when possible.	Not set

## Syntax:

HSerPrint *value*

## Command Availability:

Available on all microcontrollers with a USART or UART module.

## Explanation:

SerPrint is used to send a value over the serial connection. *value* can be a string, word or byte - SerPrint is very similar to Print. *channel* is the serial connection to send data through.

SerPrint will not send any new line characters. If the chip is sending to a terminal, these commands should follow every SerPrint:

SerSend *channel*, 13

SerSend *channel*, 10

## Example:

```
'This program will display any values received over the serial
'connection. If "pot" is received, the value of the analog sensor
'will be sent.
'Note: This has been adapted from the SerPrint example.
```

```
'Chip settings
#chip 18F2525, 8
#config Osc = Int

'LCD settings
#define LCD_IO 4
#define LCD_RS PORTC.7
#define LCD_RW PORTC.6
#define LCD_Enable PORTC.5
#define LCD_DB4 PORTC.4
#define LCD_DB5 PORTC.3
#define LCD_DB6 PORTC.2
#define LCD_DB7 PORTC.1

'USART settings
#define USART_BAUD_RATE 9600

'Potentiometer
#define POT_PORT PORTA.0
#define POT_AN AN0

'Set pin directions
Dir SerOutPort Out
Dir SerInPort In
Dir POT_PORT In
```

```

'Create buffer variables to store received messages
Dim Buffer As String
Dim OldBuffer As String
BufferSize = 0

'Show test messages
Print "Serial Tester"
Wait 1 s
HSerPrint "GCBASIC RS232 Test"
HSerSend 13
HSerSend 10
Wait 1 s

'Main loop
Do
    'Get a byte from the terminal
    HSerReceive Temp

    'If Enter key was pressed, deal with buffer contents
    If Temp = 13 Then
        Buffer(0) = BufferSize

        'Try to execute commands in buffer
        If Not ExecCommand (Buffer) Then
            'Show message on bottom line, last message on top.
            CLS
            Print OldBuffer
            Locate 1, 0
            Print Buffer
            'Store the message for next time
            OldBuffer = Buffer
        End If

        BufferSize = 0
    End If
    'Backspace code, delete last character in buffer
    If Temp = 8 Then
        If BufferSize > 0 Then BufferSize -= 1
    End If
    'Received ASCII code between 32 and 127, add to buffer
    If Temp >= 32 And Temp <= 127 Then
        BufferSize += 1
        Buffer(BufferSize) = Temp
    End If
Loop

'Takes a sensor reading and sends it to terminal
Sub SendSensorReading
    HSerPrint "Sensor Reading: "
    HSerPrint ReadAD10(POT_AN)
    HSerSend 13
    HSerSend 10
End Sub

'Will check the buffer for a command
'If command found, run it and return true
'If not, return false
Function ExecCommand (CmdIn As String)
    ExecCommand = False
    'If received command is "pot", show potentiometer value

```

```
    If CmdIn = "pot" Then
        SendSensorReading
        ExecCommand = True
    End If
End Function
```



# HSerReceive

## Syntax:

***Used as subroutine:***

HSerReceive *output*

***Used as function:***

*output* = HSerReceive

## Command Availability:

Available on all microcontrollers with a USART or UART module.

## Explanation:

This command will read a byte from the hardware RS232 module. It can be used either as a subroutine or as a function. If used as a subroutine, a variable must be supplied to store the received value in. If used as a function, it will return the received value.

## Example:

'This program will read a value from the USART, and display it on PORTB.

```
#chip 16F877A, 20
```

```
'USART settings
```

```
  #define USART_BAUD_RATE 9600
```

```
'Set PORTB to input
```

```
  Dir PORTB Out
```

```
'Set USART receive pin to input
```

```
  Dir PORTC.7 In
```

```
'Main loop
```

```
  Do
```

```
    'Get and display value
```

```
    'If there is no new data, HSerReceive will return old value.
```

```
    HSerReceive PORTB
```

```
    'Could also write:
```

```
    'PORTB = HSerReceive
```

```
  Loop
```

# HSerSend

## Syntax:

HSerSend *data*

## Command Availability:

Available on all microcontrollers with a USART or UART module.

## Explanation:

This command will send a byte given by *data* using the hardware RS232 module.

## Example:

```
'This program will send the status of PORTB through the hardware  
'serial module.
```

```
#chip 16F877A, 20
```

```
'USART settings  
#define USART_BAUD_RATE 9600
```

```
'Set PORTB to input  
Dir PORTB In  
'Set USART transmit pin to output  
Dir PORTC.6 Out
```

```
'Main loop  
Do  
    'Send PORTB value through USART  
    HSerSend PORTB  
    'Short delay for receiver to process message  
    Wait 10 ms  
Loop
```

Introduction

These routines make it easier to communicate with a PS/2 device, particularly a keyboard.

Relevant Constants

These constants affect the operation of the PS/2 routines:

Constant Name	Controls	Default Value
PS2Data	Pin connected to PS/2 data line	N/A
PS2Clock	Pin connected to PS/2 clock line.	N/A
PS2_DELAY	This constant can be set to a delay, such as 10 ms. If set, a delay will be added at the end of every byte sent or received.	Not set

# INKEY

**Syntax:**  
*output* = INKEY

**Command Availability:**  
Available on all microcontrollers.

**Explanation:**  
The INKEY function will read the last pressed key from a PS/2 keyboard, and return an ASCII value corresponding to the key. If no key is pressed, then INKEY will return 0.

It will also monitor Caps Lock, Num Lock and Scroll Lock keys, and update the status LEDs as appropriate.

**Example:**

```
'A program to accept messages from a standard PS/2 keyboard
'Any keys pressed will be shown on an LCD screen.

'Hardware settings
  #chip 18F4620, 20

'LCD connection settings
  #define LCD_IO 4
  #define LCD_DB4 PORTD.4
  #define LCD_DB5 PORTD.5
  #define LCD_DB6 PORTD.6
  #define LCD_DB7 PORTD.7
  #define LCD_RS PORTD.0
  #define LCD_RW PORTD.1
  #define LCD_Enable PORTD.2

'PS/2 connection settings
  #define PS2Clock PORTC.1
  #define PS2Data PORTC.0
  #define PS2_DELAY 10 ms

'Set up key log
  Dim KeyLog(32)
  DataCount = 0
  KeyLog(1) = 32

Main:
  'Read the last pressed key
  KeyIn = INKEY
  'If no key pressed, try reading again
  If KeyIn = 0 Then Goto Main

  'Escape pressed - clear message
  If KeyIn = 27 Then
    DataCount = 0
    For DataPos = 1 to 32
      KeyLog(DataPos) = 32
```

```
        Next
        Goto DisplayData
    End If
```

```
'Backspace pressed - delete last character
If KeyIn = 8 Then
    If DataCount = 0 Then Goto Main
    KeyLog(DataCount) = 32
    DataCount = DataCount - 1
    Goto DisplayData
End If
```

```
'Otherwise, add the character to the buffer
If KeyIn >= 31 And KeyIn <= 127 Then
    DataCount = DataCount + 1
    KeyLog(DataCount) = KeyIn
End If
```

```
DisplayData:
'Display key buffer
'LCDWriteChar is used instead of Print for greater control
CLS
For DataPos = 1 to DataCount
    If DataPos = 17 then Locate 1, 0
    LCDWriteChar KeyLog(DataPos)
Next
Goto Main
```

# PS2SetKBLeds

## Syntax:

PS2SetKBLeds (*LedStatus*)

## Command Availability:

Available on all microcontrollers.

## Explanation:

This routine will turn the status LEDs on a keyboard on or off. *LedStatus* is a variable, of which the lower 3 bits correspond to the 3 LEDs. Bit 0 is for Scroll Lock, bit 1 controls Num Lock and bit 2 controls Caps Lock.

Note that this routine does not alter the status variables within the INKEY routine - so even if the Caps Lock LED is turned on, Caps Lock will stay off.

## Example:

```
'A spinning LED program for a keyboard
'Will flash Num Lock, then Caps Lock, then Scroll Lock.
```

```
'Hardware settings
#chip 16F88, 8
```

```
#define PS2Clock PORTB.2
#define PS2Data PORTB.3
#define PS2_DELAY 10 ms
```

```
'Main Loop
Do
```

```
    'Turn on only Num Lock (bit 1)
    PS2SetKBLeds b'00000010'
    Wait 250 ms
```

```
    'Turn on only Caps Lock (bit 2)
    PS2SetKBLeds b'00000100'
    Wait 250 ms
```

```
    'Turn on only Scroll Lock (bit 0)
    PS2SetKBLeds b'00000001'
    Wait 250 ms
```

```
Loop
```

**Syntax:**

*output* = PS2ReadByte

**Command Availability:**

Available on all microcontrollers.

**Explanation:**

PS2ReadByte will read a byte from the PS/2 bus. It will return the byte, or 0 if no data was returned by the PS/2 device.

The PS/2 bus will normally be held in the inhibit state. PS2ReadByte will uninhibit the bus for 25 ms. If a response is received, it will be read. Then, the bus will be placed back in the inhibit state.

**Example:**

For an example, please refer to the INKEY function in the ps2.h file.

**Syntax:**

PS2WriteByte *data*

**Command Availability:**

Available on all microcontrollers.

**Explanation:**

PS2WriteByte will send a byte to a PS/2 device. Once the byte has been written, the PS/2 bus will be placed in the inhibit state.

**Example:**

For an example, please refer to the PS2SetKBLeds function in the ps2.h file.



# SPIMode

**Syntax:**  
SPIMode *Mode*

**Command Availability:**  
Available on PIC microcontrollers with Synchronous Serial Port (SSP) module.

**Explanation:**  
SPIMode sets the mode of the SPI module within the PIC chip. These are the possible SPI Modes:

Mode Name	Description
MasterSlow	Master mode, SPI clock is 1/64 of the frequency of the PIC.
Master	Master mode, SPI clock is 1/16 of the frequency of the PIC.
MasterFast	Master mode, SPI clock is 1/4 of the frequency of the PIC.
Slave	Slave mode
SlaveSS	Slave mode, with the Slave Select pin enabled.

**See Also** [SPITransfer](#)

## Syntax:

SPITransfer *tx*, *rx*

## Command Availability:

Available on PIC microcontrollers with Synchronous Serial Port (SSP) module.

## Explanation:

This command simultaneously sends and receives a byte of data using the SPI protocol. It behaves differently depending on whether the PIC has been set to act as a master or a slave.

When operating as a master, SPITransfer will initiate a transfer. The data in *tx* will be sent to the slave, whilst the byte that is buffered in the slave will be read into *rx*.

In slave mode, the SPITransfer command will pause the program until a transfer is initiated by the master. At this point, it will send the data in *tx* whilst reading the transmission from the master into the *rx* variable.

## Example:

There are two example programs for this command - one to run on the slave PIC, and one on the master. A reading is taken from a sensor on the slave, and sent across to the master which shows the data on its LCD screen.

### **Slave Program:**

```
'Select chip model and configuration
#chip 16F88, 20
#config MCLR_OFF
```

```
'Set directions of SPI pins
dir PORTB.2 out
dir PORTB.1 in
dir PORTB.4 in
'Set direction of analogue pin
dir PORTA.0 in
```

```
'Set SPI mode to slave
SPIMode Slave
```

```
'Allow other PIC to initialise LCD
Wait 1 sec
```

```
'Main loop - takes a reading, and then waits to send it across.
do
'Note that rx is 0 - this is because no data is to be received.
SPITransfer ReadAD(AN0), 0
loop
```

### **Master Program:**

```
'General hardware configuration
#chip 16F877A, 20
```

```
'LCD connection settings
#define LCD_IO 8
#define LCD_DATA_PORT PORTC
#define LCD_RS PORTD.0
#define LCD_RW PORTD.1
#define LCD_Enable PORTD.2
```

```
'Set SPI pin directions
dir PORTC.5 out
dir PORTC.4 in
dir PORTC.3 out
```

```
'Set SPI Mode to master, with fast clock
SPIMode MasterFast
```

```
'Main Loop
do
'Read a byte from the slave
'No data to send, so tx is 0
SPITransfer 0, Temp
```

```
'Display data
if Temp > 0 then
CLS
Print "Light: "
LCDInt Temp
Temp = 0
end if
```

```
'Wait to allow time for the LCD to show the given value
wait 100 ms
loop
```

Introduction:

These routines allow GCBASIC programs to send and receive I2C messages. They can be configured to act as master or slave, and the speed can also be altered. No hardware I2C module is required for these routines - all communication is handled in software. However, these routines will not work on 12-bit instruction PICs (10F, 12F5xx and 16F5xx chips).

Relevant Constants:

These constants control the setup of the software I2C routines.

Constant	Controls	Default Value
I2C_MODE	Mode of I2C routines (Master or Slave)	Master
I2C_DATA	Pin on microcontroller connected to I2C data	N/A
I2C_CLOCK	Pin on microcontroller connected to I2C clock	N/A
I2C_BIT_DELAY	Time for a bit (used for acknowledge detection)	2 us
I2C_CLOCK_DELAY	Time for clock pulse to remain high	1 us
I2C_END_DELAY	Time between clock pulses	1 us
I2C_USE_TIMEOUT	Set to true if slave mode I2C routines should stop waiting for the master and exit after a timeout occurs.	Not Set
I2C_DISABLE_INTERRUPTS	Disable interrupts during I2C routines. Important when an i2C clock is part of your solution	Only available in GCB compiler post 1/2014

**Example:**

This example examines the IC2 devices and displays on a terminal. This code will require adaption but the code shows an approach to discover the IC2 devices.

```
' change the processor
#chip 16F1825,32
#config Osc = intOSC, MCLRE_OFF
#include "..\outputserial.h"

' Define I2C settings - CHANGE PORTS
#define I2C_MODE Master
#define I2C_DATA PORTC.5
#define I2C_CLOCK PORTC.4
#define I2C_DISABLE_INTERRUPTS ON

' THIS CONFIG OF THE SERIAL PORT WORKS WITH max232 THEN TO PC
#define SendAHigh Set PORTC.3 Off
#define SendALow Set PORTC.3 ON
Dir PORTC.3 Out
#define SerSendDelayms 10
'Set up serial connection
InitSer 1, r9600, 1+128, 8, 1, none, INVERT
wait SerSendDelayms ms

ANSIERASESCREEN_SW
ANSI_SW ( 0,0)
SerPrint 1, "Started: "
wait SerSendDelayms ms
SerPrint 1, "Searching I2C address space: v0.82"
sersend 1, ( 10)
sersend 1, ( 13)

dim deviceID as byte

for deviceID = 0 to 255
    I2CStart
    I2CSend ( deviceID )
    i2cstop

    if I2CSendState = ACK then
        SerPrint 1, "____"
        SerPrint 1, "ID : 0x"
        SerPrint 1, hex(deviceID)
        SerPrint 1, " (d"
        SerPrint 1, Str(deviceID)
        SerPrint 1, ") - "
        SerSend 1, 9
        SerPrint 1, "I2C Port ": Sersend 1, I2CSendState:          sersend 1, (
10):sersend 1, ( 13)
    end if
```

```
next
SerPrint 1, "End of Device Search": sersend 1, ( 10):sersend 1, ( 13)
END
```

# I2CACKPOLL

## Syntax:

I2CAckpoll ( I2C\_device\_address )

## Command Availability:

Only available in GCB I2C.h with release after 1/2014

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

## Explanation:

Should only be used when I2C routines are operating in Master mode, this command will look for a specific I2C device on the I2C bus.

This set a global variable I2CAckPollState that can be inspected in your calling routine.

## Example:

```
.....
' ACK polling removes the need to for the 24xxxxx device to have a 5ms write time
I2CACKPOLL( eeprom_device )
' You check the exit state, see I2CAckPollState
.....
```

# I2CReceive

## Syntax:

I2CReceive *data*

I2CReceive *data*, *ack*

## Command Availability:

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

## Explanation:

The I2CReceive command will send *data* through the I2C connection. If *ack* is TRUE, or no value is given for *ack*, then I2CReceive will send an ack.

If in master mode, I2CReceive will read the data immediately. If in slave mode, I2CReceive will wait for the master to send the data before reading.

## Example:

```
'This program reads an I2C register and sets an LED if it is over 100.  
'It will read from address 83, register 1.
```

```
'Chip settings  
#chip 18F2620, 8  
  
'I2C settings  
#define I2C_MODE Master  
#define I2C_DATA PORTC.0  
#define I2C_CLOCK PORTC.1  
  
'Misc settings  
#define LED PORTB.0  
  
'Main loop  
Do  
    'Send start  
    I2CStart  
  
    'Request value  
    I2CSend 83  
    I2CSend 1  
  
    'Read value  
    I2CReceive ValueIn  
  
    'Send stop  
    I2CStop  
  
    'Turn on LED if received value > 100  
    Set LED Off  
    If ValueIn > 100 Then Set LED On  
  
    'Delay
```



Wait 20 ms

Loop

# I2CRESET

## Syntax:

I2CReset

## Command Availability:

Only available in GCB I2C.h with release after 1/2014

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

## Explanation:

This will attempt a reset of the I2C by changing the state of the I2C bus.

## Example:

```
.....  
I2CReset  
.....
```

**Syntax:**  
I2CRestart

**Command Availability:**  
Only available in GCB I2C.h with release after 1/2014

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

**Explanation:**  
If the I2C routines are operating in Master mode, this command will send a start and restart condition in a single command.

**Example:**

```
.....  
I2CRESTART  
.....
```

# I2CSend

## Syntax:

I2CSend *data*

I2CSend *data*, *ack*

## Command Availability:

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

## Explanation:

The I2CSend command will send *data* through the I2C connection. If *ack* is TRUE, or no value is given for *ack*, then I2CSend will wait for an Ack from the receiver before continuing.

If in master mode, I2CSend will send the data immediately. If in slave mode, I2CSend will wait for the master to request the data before sending.

## Example:

```
'This program will act as an I2C analog to digital converter
'When data is requested from address 83, registers 0 through
'3, it will return the value of AN0 through AN3.
```

```
'Chip model
#chip 16F88, 8

'I2C settings
#define I2C_MODE Slave
#define I2C_CLOCK PORTB.0
#define I2C_DATA PORTB.1

#define I2C_DISABLE_INTERRUPTS ON

'Main loop
Do
    'Wait for start condition
    I2CStart

    'Get address
    I2CReceive Address
    If Address = 83 Then
        'If address was this device's address, respond
        I2CReceive Register

        OutValue = ReadAD(Register)
        I2CSend OutValue
    End If

    I2CStop

    Wait 5 ms
Loop
```

# I2CSlaveDeviceReceive

## Syntax:

I2CSlaveDeviceReceive ( this\_devices\_address, current\_device\_address\_on\_bus, [optional ACK|NACK] )

## Command Availability

Only available in GCB I2C.h with release after 1/2014

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

Slave Mode only.

## Explanation:

This instruction inspects the i2C and scans for I2C request for 'this' device. The instruction essentially ensure that the request on the i2c bus is for 'this' slave device.

This returns the current I2C device that is being addressed on the I2C bus.

## Example:

' This example receives data from a Picaxe PIC only when it is 'this' device. 'This' device responds with the value of the AD port.

```
,  
' Reads a byte from the I2C bus, and this device will send an ACK if this device is  
being addressed.
```

' Assumes CHIP and SERIAL PORT etc. etc. are operational prior this code

```
' This device ID as a SLAVE @ 0x7e  
thisI2CSlavedevice = 0b01111110
```

```
Counter = 0  
Do
```

```
    OutValue = ReadAD(0 )
```

```
    'Wait for start condition  
    I2CStart
```

```
    ' Ensures the request is for this device
```

```
        I2CSlaveDeviceReceive thisI2CSlavedevice, readDeviceAddress, TRUE
```

```
    if readDeviceAddress = thisI2CSlavedevice then
```

```
        counter++
```

```
        I2CReceive PicaxeTimeInSeconds, TRUE
```

```
        I2CStart
```

```
        I2CReceive Read_DeviceAddress, TRUE
```

```
    I2CSend (readDeviceAddress, TRUE)
```

```
        ' Send back the data received
```

```
        I2CSend (PicaxeTimeInSeconds, TRUE)
```

```

        ' Send the read address
        I2CSend (TimeinSeconds, TRUE)
        ' Send a counter
        I2CSend (Counter, TRUE)
        ' Send AD value
        I2CSend (OutValue, TRUE)
    End if
    I2CStop
    SerPrint 1, "Time in Seconds Received "
    SerPrint 1, str(TimeinSeconds)
    SerSend 1, 9
    SerPrint 1, "Pot Value "
    SerPrint 1, str(OutValue)
    SerPrint 1, 13
    SerPrint 1, 10
Loop

```

.....

**For more help, see [I2CReceive](#)**

**Syntax:**

I2CStart

**Command Availability:**

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

**Explanation:**

If the I2C routines are operating in Master mode, this command will send a start condition. If routines are in Slave mode, it will pause the program until a start condition is sent by the master. It should be placed at the start of every I2C transmission.

If interrupt handling is enabled, this command will disable it.

**Example:**

Please see [I2CSend](#) and [I2CReceive](#) for an example.

## I2CStartOccurred

### Syntax:

I2CStartOccurred

### Command Availability:

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

### Explanation:

Check if a start condition has occurred since the last run of this function

Only used in slave mode.

If interrupt handling is enabled, this command will disable it.

### Example:

Please see [I2CSend](#) and [I2CReceive](#) for an example.



**Syntax:**

I2CStop

**Command Availability:**

Available on all microcontrollers except 12 bit instruction PICs (10F, 12F5xx, 16F5xx chips)

**Explanation:**

When in Master mode, this command will send an I2C stop condition, and re-enable interrupts if I2CStart disabled them. In Slave mode, it will re- enable interrupts.

I2CStop should be called at the end of every I2C transmission.

**Example:**

Please see [I2CSend](#) and [I2CReceive](#) for an example.

Introduction:

These routines generate tones of a given frequency and duration.  
**Note:** If an exact frequency is required, or a smaller program is needed, these routines should not be used. Instead, you should use code like this:

```
Repeat count
    PulseOut SoundOut, period us
    Wait period us
End Repeat
```

Set *count* and *period* to the appropriate values:

- *period* to 1000000 / desired frequency / 2
- *count* to desired duration / *period*.

Relevant Constants:

These constants are used to control settings for the tone generation routines. To set them, place a line in the main program file that uses #define to assign a value to the particular constant.

Constant Name	Controls	Default Value
SoundOut	The output pin to produce sound on	N/A - <b><i>Must be set</i></b>

# Tone

## Syntax:

Tone *Frequency*, *Duration*

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will produce the specified tone for the specified duration. *Frequency* is measured in Hz, and *Duration* is in 10 ms units.

Please note that this command may not produce the exact frequency specified. While it is accurate enough for error beeps and small pieces of monophonic music, it should not be used for anything that requires a highly precise frequency.

## Example:

```
'Sample program to produce a constant A note (440 Hz)
'on PORTB bit 1.
#chip 16F877A, 20
#define SoundOut PORTB.1
```

```
Do
    Tone 440, 1000
Loop
```

For more help, see [Relevant Constants](#)

## Syntax:

ShortTone Frequency, Duration

## Command Availability:

Available on all microcontrollers.

## Explanation:

This command will produce the specified tone for the specified duration. Frequency is measured in units of 10 Hz, and Duration is in 1 ms units.

Please note that this command may not produce the exact frequency specified. While it is accurate enough for error beeps and small pieces of monophonic music, it should not be used for anything that requires a highly precise frequency.

## Example:

```
'Sample program to produce a tone on PORTB bit 1, based on the  
'reading of an LDR on AN0 (usually PORTA bit 0).
```

```
#chip 16F88, 20  
#define SoundOut PORTB.1  
  
Dir PORTA.0 In  
  
Do  
    ShortTone ReadAD(AN0), 100  
Loop
```

For more help, see [Relevant Constants](#)

## Timer Overview

---

Several functions are provided to read the current timer value. They are:

- Timer0
- Timer1
- Timer2
- Timer3
- Timer4
- Timer5

Not all of these functions are available on all chips. For example, if a chip only has 3 timers, then only Timer0, Timer1 and Timer2 will be available. Timer0 and Timer2 return byte values, while Timer1, Timer3, Timer4 and Timer5 will return words.

Please refer to the datasheet for your microcontroller to determine the number and size of the timers available.

## Syntax:

InitTimer0 *source*, *prescaler*

## Command Availability:

Available on all microcontrollers with a Timer 0 module.

## Explanation:

InitTimer0 will set up timer 0, according to the settings given. *source* can be Osc or Ext.

On a PIC microcontroller, *prescaler* can be one of the following settings:

- PS0\_2
- PS0\_4
- PS0\_8
- PS0\_16
- PS0\_32
- PS0\_64
- PS0\_128
- PS0\_256

These correspond to a prescaler of between 1/2 and 1/256 the oscillator speed. The prescaler will apply to either the oscillator or the external clock input.

On an AVR microcontroller, *prescaler* can be one of these settings:

- PS\_1
- PS\_8
- PS\_64
- PS\_256
- PS\_1024

These correspond to a prescaler of between 1/1 and 1/1024 times the original input frequency. On the AVR, the prescaler will only apply when the timer is driven from the internal oscillator - the prescaler has no effect on the external clock pulse.

When the timer overflows from 255 to 0, a Timer0Overflow interrupt will be generated. This can be used in conjunction with On Interrupt to run a section of code periodically.

## Example:

```
'This code will use Timer 0 and On Interrupt to generate a Pulse  
'Width Modulation signal, that will allow the speed of a motor to  
'be easily controlled.
```

```
#chip 16F88, 8  
#config osc = int
```

```
#define MOTOR PORTB.0
```

```
'Call the initialisation routine
```

```
InitMotorControl
```

```
'Main routine
```

```
Do
    'Increase speed to full over 2.5 seconds
    For Speed = 0 to 100
        MotorSpeed = Speed
        Wait 25 ms
    Next
    'Hold speed
    Wait 1 s
    'Decrease speed to zero over 2.5 seconds
    For Speed = 100 to 0
        MotorSpeed = Speed
        Wait 25 ms
    Next
    'Hold speed
    Wait 1 s
Loop
```

```
'Setup routine
```

```
Sub InitMotorControl
    'Clear variables
    MotorSpeed = 0
    PWMCounter = 0

    'Add a handler for the interrupt
    On Interrupt Timer0Overflow Call PWMHandler

    'Set up the timer
    InitTimer0 Osc, PS0_1/2
    'Timer 0 starts automatically on a PIC
End Sub
```

```
'PWM sub
```

```
'This will be called when Timer 0 overflows
Sub PWMHandler
    If MotorSpeed > PWMCounter Then
        Set MOTOR On
    Else
        Set MOTOR Off
    End If
    PWMCounter += 1
    If PWMCounter = 100 Then PWMCounter = 0
End Sub
```

## Syntax:

InitTimer1 *source*, *prescaler*

## Command Availability:

Available on all microcontrollers with a Timer 1 module.

## Explanation:

InitTimer1 will set up timer 1, according to the settings given. *source* can be Osc , Ext or ExtOsc (ExtOsc is only available on PIC microcontrollers). On a PIC, *prescaler* can be one of the following settings:

- PS1\_1
- PS1\_2
- PS1\_4
- PS1\_8

On an AVR chip, the following options are available for *prescaler*:

- PS\_1
- PS\_8
- PS\_64
- PS\_256
- PS\_1024

## Example:

```
'This example will measure that time that a switch stays on for
#chip 16F819, 20
#define Switch PORTA.0
```

```
Dir Switch In
    DataCount = 0
    InitTimer Osc, PS1_8
```

```
Dim TimerValue As Word
```

```
Do
```

```
    ClearTimer 1
    Wait Until Switch = On
    StartTimer 1
    Wait Until Switch = Off
    StopTimer 1
```

```
    'Read the timer
    TimerValue = Timer1
```

```
    'Log the timer value
    EPWrite(DataCount, TimerValue_H)
    EPWrite(DataCount + 1, TimerValue)
    DataCount += 2
```

```
Loop
```



**Syntax:**

StartTimer *TimerNo*

**Command Availability:**

Available on all PIC and AVR microcontrollers with built in timer modules.

**Explanation:**

StartTimer is used to start the specified timer. Note that it cannot be used to start Timer 0 on a PIC - this timer always runs.

**Example:**

Please refer to the [InitTimer1](#) article for an example.

**Syntax:**

ClearTimer *TimerNo*

**Command Availability:**

Available on all PIC and AVR microcontrollers with built in timer modules.

**Explanation:**

ClearTimer is used to clear the specified timer.

**Example:**

Please refer to the [InitTimer1](#) article for an example.

**Syntax:**

StopTimer *TimerNo*

**Command Availability:**

Available on all PIC and AVR microcontrollers with built in timer modules.

**Explanation:**

StopTimer is used to stop the specified timer. Note that it cannot be used to stop Timer 0 on a PIC - this timer always runs.

**Example:**

Please refer to the [InitTimer1](#) article for an example.

## Reading Timers

---

Several functions are provided to read the current timer value. They are:

- Timer0
- Timer1
- Timer2
- Timer3
- Timer4
- Timer5

Not all of these functions are available on all chips. For example, if a chip only has 3 timers, then only Timer0, Timer1 and Timer2 will be available. Timer0 and Timer2 return byte values, while Timer1, Timer3, Timer4 and Timer5 will return words.

Please refer to the datasheet for your microcontroller to determine the number and size of the timers available.

# Using Variables

## Variables

Using and accessing bytes within word and long numbers etc may be required when you are creating your solution. This can be done with some ease.

You can access the bytes within word and longs variables using the following as a guide using the Suffixes `_H`, `_U` and `_E`

```
Dim workvariable as word
workvariable = 21845
Dim lowb as byte
Dim highb as byte
Dim upperb as byte
Dim lastb as byte
```

```
lowb      = workvariable
highb     = workvariable_H
upperb    = workvariable_U
lastb     = workvariable_E
```

To further explain, where

```
Dim rB as Byte
Dim sW as Word
Dim sW as Word
```

To extract the bytes from a WORD of 16 bits use the Suffix `_H`

```
'To use the bits 7-0 [lower byte] in the Word variable sW
rB = sW
```

```
'For bits 15-8 [upper byte] in the Word variable sW, use sw_H
rB = sW_H
```

To extract the bytes from a LONG of 32 bits use the Suffixes `_H`, `_U` and `_E`, where

```
Dim rB as Byte
Dim sW as Word
Dim tL as Long
```

```
` For bits 7-0 [lowest byte #0] in Long variable tL
rB = tL
```

```
` For bits 15-8 [lower middle byte #1] in Long variable tL
rB = tL_H
```

```
` For bits 23-16 [upper middle byte #2] in Long variable tL
rB = tL_U
```

```
` For bits 31-24 [highest byte #3] in Long variable tL
```

```
rB = tL_E
```

To extract nibbles from the variable rB

```
lower_nibble = rB & 0x0F  
upper_nibble = (rB & 0xF0) / 16
```

## Variables

Within Great Cow Basic you can use regular variable assignments. But, you can also use C like maths assignments. The following methods are also supported.

```
GLCDPrintLoc += 6
CharCode -= 15
CharCode++
CharCode---
```

Within Great Cow Basic you can define constants, see [Constants](#). Please note what is and what is not support with respect to assigning numbers to constants. An example program examines what is supported.

```
#chip 16F88, 4
#config Osc = INT, MCLRE_OFF
```

```
' All these work
#define Test0 b'11111111'
#define Test1 0b11111111
#define Test2 0B11111111
#define Test3 255
#define Test4 0xFF
#define Test5 0xff
#define Test6 0Xff
```

```
# Proof
dir porta Out
```

```
porta = test0
porta = test1
porta = test2
porta = test3
porta = test4
porta = test5
porta = test6
```

You can assigned values/numbers with all the methods shown above (for constants and variables) but please be aware that you must Use '0' not '00'. One zero equates to zero and two zeros will give you an unassigned variable.

## Constants

A few critical constants are defined within Great Cow Basic , you can use this constants. They include:

```
#define ON 1
#define OFF 0
#define TRUE 255
#define FALSE 0
```

Dim has two uses, both of which involve large variables. It can be used to define arrays, and to declare variables larger than 1 byte.

**Syntax:**

**For Variables > 1 byte:**

Dim *variable* [, *variable2* [, *variable3*]] [*As type*] [*Alias othervar* [, *othervar2*]] [*At location*]

**For Arrays:**

Dim *array*(*size*) [*At location*]

**Command Availability:**

Available on all microcontrollers.

**Explanation:**

The Dim variable command is used to inform GCBASIC of variables that are larger than 1 byte, or to create alternate names for other variables.

The Dim array command also sets up array variables. When using it for this, *size* must be a constant value up to 80.

*type* specifies the type of variable that is to be created. Different variable types can hold values over different ranges, and use different amounts of RAM. See the [Variables](#) article for more information.

When multiple variables are included on the one line, GCBASIC will set them all to the type that is specified at the end of the line. If there is no type specified, then GCBASIC will make the variable a byte.

Alias creates a variable using the same memory location as one or more other variables. It is mainly used internally in GCBASIC to treat system variables as a word. For example, this command is used to create a word variable, made up from the two memory locations used to store the result of an A/D conversion:

A variable can be placed at a specific location in the data memory of the chip using the At option. *location* will be used whether it is a valid location or not, but a warning will be generated if GCBASIC has already allocated the memory, or if the memory does not appear to be valid. This can be used for peripherals that have multi byte buffers in RAM.

Dim ADResult As Word Alias ADRESH, ADRESL

**Example:**

```
'This program will set up an array, and a word variable
```



```
dim DataList(10)
    dim Reading as word

Reading = 21978
    DataList(1) = 15

dim stringvariable as string
```

**For more help, see:**

The [SerPrint](#) article uses Dim to create string variables and [Variables](#) for more details in creating and managing strings lengths.

### Syntax:

BcdToDec\_GCB ( ByteVariable )

### Command Availability:

Only available in GCB compiler post 1/2014

Available on all microcontrollers.

Support Bytes only.

### Explanation:

Converts numbers from Binary Coded Decimal format to decimal.

GCB from Feb 2014 has this function built.

But, you can easily add it with this function below. Just add this to your GCB program and then call it when you need it.

### Example:

```
Function BcdToDec(va) as byte
    BcdToDec=(va/16)*10+va%16
End Function
```

Also see [DecToBcd\\_GCB](#)

**Syntax:**

DectoBcd\_GCB ( ByteVariable )

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers.

Support Bytes only.

**Explanation:**

Converts numbers from Decimal to Binary Coded Decimal format.

GCB from Feb 2014 has this function built.

But, you can easily add it with this function below. Just add this to your GCB program and then call it when you need it.

**Example:**

```
Function DecToBcd(va) as Byte
    DecToBcd=(va/10)*16+va%10
End Function
```

**Also se** [BcdToDec\\_GCB](#)

# Rotate

**Syntax:**  
Rotate *variable* {Left | Right} [Simple]

**Command Availability:**  
Available on all microcontrollers.

**Explanation:**

The Rotate command will rotate *variable* one bit in a specified direction. The bit shifted will be placed in the Carry bit of the Status register (STATUS.C). STATUS.C acts as a ninth bit of the variable that is being rotated.

When a variable is **rotated right**, the bit in the STATUS.C location is placed into the MSB of the variable being rotated, and the LSB of the variable is placed into STATUS.C location.

When **rotated left** the opposite occurs. The MSB of the variable is shifted to the STATUS.C bit and the LSB of the variable will contain what was previously in the STATUS.C bit location.

This table shows the operation of the Rotate Left command

Command	<i>variable</i>	STATUS.C
Values at start:	b'01110011'	0
Rotate Left	b'11100110'	0
Rotate Left again	b'11001100'	1
Rotate Left third time	b'10011001'	1

As you may notice the STATUS.C bit added a 0 to the rotation. So this will take 9 shifts left to get back to the original value.

## SIMPLE option

Many times you want to rotate the variable around like the STATUS.C bit wasn't there so the MSB of the variable fills the LSB of the variable on Rotate Left or the LSB fills the MSB on Rotate Right. That is where the SIMPLE option comes in. It adds a hidden step that shifts the STATUS.C bit twice so the bit moves from one end of the variable to the other.

Command	<i>variable</i>	STATUS.C
Values at start:	b'01110011'	0
Rotate Left	b'11100110'	0
Rotate Left again	b'11001101'	1
Rotate Left third time	b'10011011'	1

(\*) Known as SREG bit C, or simply C flag on AVR.

### Example:

```
'This program will use Rotate to show a chasing LED.  
'8 LEDs should be connected to PORTB, one on each pin.
```

```
#chip 16F819, 8  
#config osc = int  
  
'Set port direction  
Dir PORTB Out  
  
'Set initial state of port (bits 0 and 4 on)  
PORTB = b'00010001'  
  
'Chase  
Do  
    Rotate PORTB Right Simple  
    Wait 250 ms  
Loop
```

# Set

## Syntax:

Set *variable.bit* {On | Off}

## Command Availability:

Available on all microcontrollers.

## Explanation:

The purpose of the Set command is to turn individuals bits on and off. The Set command is most useful for controlling output ports, but can also be used to set variables.

Often when controlling output ports, Set is used in conjunction with constants. This makes it easier to adapt the program for a new circuit later.

## Example:

```
'Blink LED sample program for GCBASIC
'Controls an LED on PORTB bit 0.
```

```
'Set chip model and config options
#chip 16F84A, 20
```

```
'Set a constant to represent the output port
#define LED PORTB.0
```

```
'Set pin direction
Dir LED Out
```

```
'Main routine
Do
    Set LED On
    Wait 1 sec
    Set LED OFF
    Wait 1 sec
Loop
```

## Syntax:

*Variable = data*

## Explanation:

*Variable* will be set to *data*. *Data* can be either a fixed value (such as 157), another variable, or a sum.

If *data* is a fixed value, it must be an integer between 0 and 255 inclusive.

If *data* is a calculation, then it may have any of the following operands:

- + (add)
- - (subtract, or negate if there is no value before it)
- \* (multiply)
- / (divide)
- % (modulo)
- & (and)
- | (or)
- # (xor)
- ! (not)
- = (equal)
- <> (not equal)
- < (less than)
- > (greater than)
- <= (less than or equal)
- >= (more than or equal)

The final 6 operands are for checking conditions. They will return FALSE (0) if the condition is false, or TRUE (255) if the condition is true.

The And, Or, Xor and Not operators function both as bitwise and logical operators.

GCBASIC understands order of operations. If multiple operands are present, they will be processed in this order:

1. Brackets
2. Unary operations (not and negate)
3. Multiply/Divide/Modulo
4. Add/Subtract
5. Conditional operators
6. And/Or/Xor

There are several modes in which variables can be set. GCBASIC will automatically use a different mode for each calculation, depending on the type of variable being set. If a byte

variable is being set, byte mode will be used; if a word variable is being set, word mode will be used. If a byte is being set but the calculation involves numbers larger than 255, word mode can be used by adding [WORD] to the start of one of the values in the calculation. This is known as casting - refer to the [Variables](#) article for more information.

If you prefer, you can add "LET" to the start of the line. It will not alter the execution of the program, but is included for those who are used to including it in other BASIC dialects.

### Example:

```
'This program is to illustrate the setting of variables.
Chipmunk = 46      'Sets the variable Chipmunk to 46
Animal = Chipmunk  'Sets the variable Animal to the value of the variable
Chipmunk
Bear = 2 + 3 * 5    'Sets the variable Bear to the result of 2 + 3 * 5, 17.
Sheep = (2 + 3) * 5 'Sets the variable Sheep to the result of (2 + 3) * 5, 25.
Animal = 2 * Bear   'Sets the variable Animal to twice the value of Bear.

LargeVar = 321      'LargeVar must be set as a word - see DIM.
Temp = LargeVar / [WORD]5 'Note the use of [WORD] to ensure that the calculation is
performed correctly
```



# SWAP

## Syntax:

SWAP Swap( VariableA, VariableB)

## Command Availability:

Available on all microcontrollers.

Support Bytes and Words only.

## Explanation:

A function that swaps (or exchanges) one byte or word for another. SWAP support the use of byte and word variables.

# SWAP4

## Syntax:

SWAP4 ( VariableA)

## Command Availability:

Available on all microcontrollers.

Support Bytes only.

## Explanation:

A function that swaps (or exchanges) nibbles (or the 8 bits of a byte in nibbles).

## Example:

```
dim ByteVariable as Byte
```

```
' Set variable to 0x12  
ByteVariable = 0x12
```

```
ByteVariable = Swap4( ByteVariable )
```

```
HSerPrint hex(ByteVariable)
```

```
' Would return 0x21
```

## Syntax:

`bytevar = ASC(string, [position] )`

## Command Availability:

Available on all microcontrollers

## Explanation:

Only available in GCB compiler post 1/2014

Returns the character code of the character at the specified position in a string.

ASC returns the character code of a particular character in the string. If the string is an ANSI string, the returned value will be in the range of 0 to 255. This function DOES NOT support UNICODE.

The optional position parameter determines which character is to be checked. The first character is one, the second two, etc. If the position parameter is missing, the first character is presumed.

CHR is the natural complement of ASC. CHR produces a one-character string corresponding to its ASCII

## Restrictions:

If the string passed is null (zero-length) or the position is zero or greater than the length of the string the returned value will be 0.

## Example:

### Syntax

```
charpos = ASC( "ABCD" ): ' Returns 65
```

```
charpos = ASC( "ABCD", 2 ): ' Returns 66
```

For more help, see [Chr](#)

**Syntax:**

*stringvar* = BYTETOBIN( *bytevar* )

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers

**Explanation:**

The ByteToBin function creates a string of a ANSI (8-byte) characters. The function converts a number to a string consisting of ones and zeros that represents the binary value.

Supports BYTE variables only. For WORD variables use WordToBin

**Example:****Syntax**

```
string = ByteToBin( 1 ): ' Returns "00000001"
```

```
string = ByteToBin( 254 ): ' Returns "11111110"
```

**For more help, see** [WordToBin](#)

**Syntax:**

*stringvar* = CHR( *bytevar* )

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers

**Explanation:**

The CHR function creates a string of a ANSI (1-byte) character.

ASC is the natural complement of CHR.

**Example:**

```
string = CHR( 65 ): ' Returns "A"
```

```
string = CHR( 66 ): ' Returns "B"
```

**For more help, see [Asc](#)**

## Syntax:

*stringvar* = Hex(*number*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The Hex function will convert a number into hexadecimal format. The input *number* should be a byte variable, or a fixed number between 0 and 255 inclusive. After running the function, the string variable *stringvar* will contain a 2 digit hexadecimal number.

## Example:

```
'Set chip model
#chip 16F1936

'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING

'Send EEPROM data over serial connection
'Uses Hex to display as hexadecimal
For CurrentLocation = 0 to 255
  'Send location
  HSerPrint Hex(CurrentLocation)
  HSerPrint ":"
  'Read byte and send
  EPRead CurrentLocation, CurrByte
  HSerPrint Hex(CurrByte)
  'Send carriage return/line feed
  HSerPrintCRLF
Next
```

When using the functions HEX() do not leave space between the function call and the left brace. You will get a compiler error that is meaningless.

```
' use this, note this is no space between the HEX and the left brace!
HEX(number_variable)
' do not use, note the space!
HEX (number_variable)
```

**See Also** [Str.](#) [Val](#)

## Syntax:

*location* = Instr(*source*, *find*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The Instr function will search one string to find the location of another string within it. *source* is the string to search inside, and *find* is the string to find. The function will return the location of *find* within *source*, or 0 if *source* does not contain *find*.

## Example:

```
'Set chip model
#chip 16F1936
```

```
'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING
```

```
'Fill a string with a message
Dim TestData As String
TestData = "Hello, world!"
```

```
'Display the location of "world" within the string
'Will return 8, because "w" in world is the 8th character
'of "Hello, world!"
HSerPrint Instr(TestData, "world")
HSerPrintCRLF
```

```
'Display the location of "planet" within the string
'Will display 0, because "planet" does not occur inside
'the string "Hello, world!"
HSerPrint Instr(TestData, "planet")
HSerPrintCRLF
```

## Syntax:

*output* = LCase(*source*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The LCase function will convert all of the letters in the string *source* to lower case, and return the result.

## Example:

```
'Set chip model
#chip 16F1936
```

```
'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING
```

```
'Fill a string with a message
Dim TestData As String
TestData = "Hello, world!"
```

```
'Display the string in lower case
'Will display "hello, world!"
HSerPrint LCase(TestData)
HSerPrintCRLF
```

**See Also** [UCase](#)



## Syntax:

*output* = Left(*source*, *count*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The Left function will extract the leftmost *count* characters from the input string *source*, and return them in a new string.

## Example:

```
'Set chip model
#chip 16F1936
```

```
'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING
```

```
'Fill a string with a message
Dim TestData As String
TestData = "Hello, world!"
```

```
'Display the leftmost 5 characters
'Will display "Hello"
HSerPrint Left(TestData, 5)
HSerPrintCRLF
```

**See Also** [Mid](#), [Right](#)

## Syntax:

*output* = Len( string )

## Command Availability:

Only available in GCB compiler post 1/2014

Available on all microcontrollers

## Explanation:

The LEN function returns an byte value which is the length of a phrase or a sentence, including the empty spaces. The format is:

```
target_byte_variable = Len("Phrase")
```

or another example. This code will loop through the for-next loop 12 times as determined by the length of the string:

```
' create a test string of 12 characters

dim teststring as string * 12

teststring = "0123456789AB"

for loopthrustring = 1 to len(teststring)
  hserprint mid(teststring, loopthrustring , 1)
next
```

**Syntax:**

*stringvar* = LTRIM(*stringvar*)

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers

**Explanation:**

The LTRIM function will trim the 7-bit ASCII space character (value 32) from the LEFT hand side of a string.

Use LTRIM on text that you have received from another source that may have irregular spacing at the left hand end of the string.

**See Also** [Trim](#), [Rtrim](#)

## Syntax:

*output* = Mid(*source*, *start*, *count*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The Mid function is used to extract characters from the middle of a string variable. *source* is the variable to extract from, *start* is the position of the first character to extract, and *count* is the number of characters to extract. If *count* is not specified, all characters from *start* to the end of the source string will be returned.

## Example:

```
'Set chip model
#chip 16F1936

'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING

'Fill a string with a message
Dim TestData As String
TestData = "The cat sat on the mat"

'Extract "cat". The c is at position 5, and 3 letters are needed
HSerPrint "The animal is a "
HSerPrint Mid(TestData, 5, 3)

'Extract the action. "sat" starts at position 9.
HSerPrint "The animal "
HSerPrint Mid(TestData, 9)
HSerPrintCRLF
```

**See Also** [Left](#), [Right](#)

## Syntax:

*output* = Right(*source*, *count*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The Right function will extract the rightmost *count* characters from the input string *source*, and return them in a new string.

## Example:

```
'Set chip model
#chip 16F1936
```

```
'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING
```

```
'Fill a string with a message
Dim TestData As String
TestData = "Hello, world!"
```

```
'Display the rightmost 6 characters
'Will display "world!"
HSerPrint Right(TestData, 6)
HSerPrintCRLF
```

**See Also** [Left](#), [Mid](#)

**Syntax:**

*stringvar* = RTRIM(*stringvar*)

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers

**Explanation:**

The RTRIM function will trim the 7-bit ASCII space character (value 32) from the RIGHT hand side of a string.

Use RTRIM on text that you have received from another source that may have irregular spacing at the right hand end of the string.

**See Also** [Trim](#), [Ltrim](#)

**Syntax:**

```
stringvar = Str(number)
```

**Command Availability:**

Available on all microcontrollers

**Explanation:**

The Str function will convert a number into string. *number* can be any byte or word variable, or a fixed number between 0 and 65535 inclusive. The string variable *stringvar* will contain the same number, represented as a string.

This function is especially useful if a number needs to be added to the end of a string, or if a custom data sending routine has been created but only supports the output of string variables.

**Example:**

```
'Set chip model
#chip 16F1936

'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING

'Take an A/D reading
SensorReading = ReadAD(AN0)

'Create a string variable
Dim OutVar As String

'Fill string with sensor reading
OutVar = Str(SensorReading)

'Send
HSerPrint OutVar
HSerPrintCRLF
```

When using the functions STR() do not leave space between the function call and the left brace. You will get a compiler error that is meaningless.

```
' use this, note this is no space between the STR and the left brace!
STR(number_variable)
' do not use, note the space!
STR (number_variable)
```

**See Also** [Hex](#), [Val](#)

**Syntax:**

*stringvar* = TRIM(*stringvar*)

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers

**Explanation:**

The TRIM function will trim the 7-bit ASCII space character (value 32) from text.

TRIM removes all spaces from text except for single spaces between words. Use TRIM on text that you have received from another source that may have irregular spacing at the left or right hand ends of the string.

**See Also** [Ltrim](#), [Rtrim](#)



# UCase

## Syntax:

*output* = UCase(*source*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The UCase function will convert all of the letters in the string *source* to upper case, and return the result.

## Example:

```
'Set chip model
#chip 16F1936
```

```
'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING
```

```
'Fill a string with a message
Dim TestData As String
TestData = "Hello, world!"
```

```
'Display the string in upper case
'Will display "HELLO, WORLD!"
HSerPrint UCase(TestData)
HSerPrintCRLF
```

**See Also** [LCase](#)

## Syntax:

var = Val(*string*)

## Command Availability:

Available on all microcontrollers

## Explanation:

The Val function will extract a number from a string variable, and store it in a word variable. One potential use is reading numbers that are sent in ASCII format over a serial connection.

## Example:

```
'Program for an RS232 controlled dimmer
'Set chip model
#chip 16F1936

'Set up hardware serial connection
#define USART_BAUD_RATE 9600
#define USART_BLOCKING

'Set pin directions for USART and PWM

'Variable for output level
Dim OutputLevel As Word

'Variables for received bytes
Dim DataIn As String
DataInCount = 0

'Main Loop
Do
    'Get serial byte
    Wait Until USARTHasData
    HSerReceive InByte

    'Process latest byte
    'Enter key?
    If InByte = 13 Then
        'Convert output level to numeric variable
        OutputLevel = Val(DataIn)

        'Output
        HPWM 1, 32, OutputLevel

    'Clear output buffer for next command
    DataIn = ""
    DataInCount = 0
    End If

    'Number?
    If InByte >= 48 and InByte <= 57 Then
```

```
        'Add to end of DataIn string
        DataInCount += 1
        DataIn(DataInCount) = InByte
        DataIn(0) = DataInCount
    End If
Loop
```

**See Also** [Hex](#), [Str](#)

**Syntax:**

*stringvar* = WORDTOBIN( *bytevar* )

**Command Availability:**

Only available in GCB compiler post 1/2014

Available on all microcontrollers

**Explanation:**

The ByteToBin function creates a string of a ANSI (8-byte) characters. The function converts a number to a string consisting of ones and zeros that represents the binary value.

**Example:**

```
string = WordToBin( 1 ): ' Returns "0000000000000001"
```

```
string = WordToBin( 37654 ): ' Returns "1001001100010110"
```

**For more help, see** [ByteToBin](#)

**Syntax:**

Dir *port.bit* {In | Out} (*Individual Form*)

Dir *port* {In | Out | *DirectionByte*} (*Entire Port Form*)

**Command Availability:**

Available on all microcontrollers. However, some low end PIC microcontrollers (10F, 12F5x and 16F5x chips) will only accept the entire port form.

**Explanation:**

The Dir command is used to set the direction of the ports of the microcontroller chip. The individual form sets the direction of one pin at a time, whereas the entire port form will set all bits in a port.

In the individual form, specify the port and bit (ie. PORTB.4), then the direction, which is either In or Out.

The entire port form is similar to the TRIS instruction offered by some PIC chips. To use it, give the name of the port (ie. PORTA), and then a byte is to be written into the TRIS variable. *This form of the command is for those who are familiar with the PIC chip's internal architecture.*

**WARNING:** Entire port form will work differently on AVR when a value other than IN or OUT is used! AVR chips use 0 to indicate in and 1 to indicate out, whereas PICs use 0 for out and 1 for in. When IN and OUT are used there are no compatibility issues.

**Example:**

```
'This program sets PORTA bits 0 and 1 to in, and the rest to out.
'It also sets all of PORTB to output, except for B1.
'Individual form is used for PORTA:
DIR PORTA.0 IN
DIR PORTA.1 IN
DIR PORTA.2 OUT
DIR PORTA.3 OUT
DIR PORTA.4 OUT
DIR PORTA.5 OUT
DIR PORTA.6 OUT
DIR PORTA.7 OUT
'Entire port form used for B:
DIR PORTB b'00000010'
```

```
'Entire port form used for C:
DIR PORTC IN
```

## Syntax:

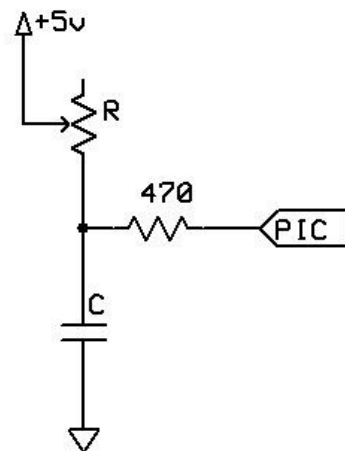
*Pot pin, output*

## Command Availability:

Available on all microcontrollers.

## Explanation:

Pot makes it possible to measure an analog resistance with a digital port, with the addition of a small capacitor. This is the required circuit:



The command works by using the microcontroller pin to discharge the capacitor, then measuring the time taken for the capacitor to charge again through the resistor.

The value for the capacitor must be adjusted depending on the size of the variable resistor. The charging time needs to be approximately 2.5 ms when the resistor is at its maximum value. For a typical 50 k potentiometer or LDR, a 50 nf capacitor is required.

This command should be used carefully. Each time it is inserted, 20 words of program memory are used on the chip, which as a rough guide is more than 15 times the size of the Set command.

*pin* is the port connected to the circuit. The direction of the pin will be dealt with by the Pot command.

*output* is the name of the variable that will receive the value.

## Example:

```
'This program will beep whenever a shadow is detected
'A potentiometer is used to adjust the threshold
```

```
#chip 16F628A, 4
#config INTOSC_OSC_NOCLKOUT
```

```
#define ADJUST PORTB.0
```

```
#define LDR PORTB.1
#define SoundOut PORTB.2
```

```
Dir SoundOut Out
```

```
Do
    Pot ADJUST, Threshold
    Pot LDR, LightLevel
    If LightLevel > Threshold Then
        Tone 1000, 100
    End If
Loop
```

**See Also** [http://www.cvs1.uklinux.net/cgi-bin/calculators/time\\_const.cgi](http://www.cvs1.uklinux.net/cgi-bin/calculators/time_const.cgi) (Useful for calculating capacitor value. Not associated with GCBASIC.)

## Syntax:

PulseOut *pin, time units*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The PulseOut command will set the specified pin high, wait for the specified amount of time, and then set the pin low again. The pin is specified in the same way as it is for the Set command, and the time is the same as for the Wait command.

## Example:

```
'This program flashes an LED on GPIO.0 using PulseOut
#chip 12F629, 4
#config INTRC_OSC_NOCLKOUT
```

```
Dir GPIO.0 Out
Do
    PulseOut GPIO.0, 1 sec 'Turn LED on for 1 sec
    Wait 1 sec 'Wait 1 sec with LED off
Loop
```



## Syntax:

*OutputVariable* = Peek (*location*)

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Peek function is used to read information from the on-chip RAM of the microcontroller.

*location* is a word variable that gives the address to read. The exact range of valid values varies from chip to chip.

This command should not normally be used, as it will make the porting of code to another chip very difficult.

## Example #1 :

```
'This program will read and check a value from PORTA
'Will only work on some PICs
Temp = PEEK(5)
IF Temp.2 ON THEN SET green ON
IF Temp.2 OFF THEN SET red ON
```

## Example #1

```
'      This prosub subroutine will toggle the pin state.
'      You must change the parameters for your chip.
'      Use as show in examples below.
'
'      Toggle @PORTE, 2 ' equates to RE1
'      Wait 100 ms
'      Toggle @PORTE, 2
'      Wait 100 ms
```

```
Sub Toggle ( In DestPort As word, In DestBit )
    Poke DestPort, Peek(DestPort) xor DestBit
End sub
```

See Also [Poke](#)

# Poke

## Syntax:

Poke (*location*, *value*)

## Command Availability:

Available on all microcontrollers.

## Explanation:

The Poke command is used to write information to the on-chip RAM of the microcontroller.

*location* is a word variable that gives the address to write. The exact range of valid values varies from chip to chip.

*value* is the data to write to the location.

This command should not normally be used, as it will make the porting of code to another chip very difficult.

## Example #1:

```
'This program will set all of the PORTB pins high
POKE (6, 255)
```

## Example #2:

```
;Chip Settings
#chip 16F88
```

Do Forever

```
FlashPin @PORTB, 8
Wait 1 s
```

Loop

```
Sub FlashPin (In DestVar As word, In DestBit)
```

```
Poke DestVar, Peek(DestVar) Or DestBit
Wait 1 s
```

```
Poke DestVar, Peek(DestVar) And Not DestBit
```

```
End Sub
```

Using @ before the name of a variable (including a special function register) will give you the address of that variable, which can then be stored in a word variable and used by Peek and Poke to indirectly access the location.

See Also [Peek](#)

# ReadTable

## Syntax:

ReadTable *TableName*, *Item*, *Output*

## Command Availability:

Available on all microcontrollers.

## Explanation:

The ReadTable command is used to read information from lookup tables. *TableName* is the name of the table that is to be read, *Item* is the line of the table to read, and *Output* is the variable to write the retrieved value in to.

*Item* is 1 for the first line of the table, 2 for the second, and so on. Item 0 gives the size of the table. Care must be taken to ensure that the program is not told to read beyond the end of the table, or strange effects will be observed.

The type of *Output* should match the type of data stored in the table. For example, if the table contains Word values then *Output* should be a Word variable. If the type does not match, GCBASIC will attempt to convert the value.

## Example:

```
'Chip Settings
#chip 16F88, 20
```

```
'Hardware Settings
#define LED PORTB.0
Dir LED Out
```

```
'Main Routine
ReadTable TimesTwelve, 4, Temp
Set LED Off
If Temp = 48 Then Set LED On
```

```
'Lookup table named "TimesTwelve"
Table TimesTwelve
12
24
36
48
60
72
84
96
108
120
132
144
End Table
```

For more help, see [Lookup Tables](#)

**Syntax:**

```
integer_variable = ABS( integer_variable )
```

**Command Availability:**

Available on all microcontrollers

**Explanation:**

The ABS function will computes the absolute value of a integer number therefore in the range of -32678 to 32768.

**Example:**

```
absolute_value = Abs( -127 ): ' Will return 127  
absolute_value = Abs( 127 ): ' Will return 127 also.  :-)
```

# Average

## Syntax:

```
integer_variable = Average( byte_variable1 , byte_variable2 )
```

## Command Availability:

Available on all microcontrollers

## Explanation:

A function that returns the average of two numbers. This only supports byte variables.  
Provides a very fast way to calculate the average of two 8 bit numbers.

## Example:

```
average_value = Average( 8 ,4 ): ' Will return 6
```

# #chip

## Syntax:

`#chip model, speed`

## Explanation:

The `#chip` directive is used to specify the chip model and speed that GCBASIC must compile for. *model* is the model of the microcontroller chip - something along the lines of "16F819". *speed* is the speed of the chip in MHz, and is required for the delay and PWM routines.

If *speed* is omitted, GCBASIC will use the highest clock speed that the internal oscillator can support. If the chip does not have an internal oscillator, then GCBASIC will assume that the chip is being run at its maximum possible clock speed using an external crystal.

When using an AVR, there is not need to specify "AT" before the name.

## Examples:

```
#chip 12F509, 4
#chip 18F4550, 48
#chip 16F88, 0.125
#chip tiny2313, 1
#chip mega8, 16
```

## #config

---

### Syntax:

`#config option1, option2, ... , optionn`

### Explanation:

The `#config` directive is used to specify configuration options for the chip. There is a detailed explanation of `#config` in the Configuration section of help.

**See Also** [Configuration](#)



# #define

---

## Syntax:

#define *Find Replace*

## Explanation:

#define will search through the program for *Find*, and replace it with the value given for *Replace*.

**See Also** [Defines](#)

# #if

## Syntax:

**#if** *Condition*

...

**#endif**

## Explanation:

The **#if** directive is used to prevent a section of code from compiling unless *Condition* is true.

*Condition* has the same syntax as the condition in a normal GCBASIC if command. The only difference is that it uses constants instead of variables.

## Example:

```
'This program will pulse an adjustable number of pins on PORTB
'The number of pins is controlled by the FlashPins constant
#chip 16F88, 8
```

```
'The number of pins to flash
#define FlashPins 2
```

```
'Initialise
Dir PORTB Out
```

```
'Main loop
Do
    #if FlashPins >= 1
        PulseOut PORTB.0, 250 ms
    #endif
    #if FlashPins >= 2
        PulseOut PORTB.1, 250 ms
    #endif
    #if FlashPins >= 3
        PulseOut PORTB.2, 250 ms
    #endif
    #if FlashPins >= 4
        PulseOut PORTB.3, 250 ms
    #endif
Loop
```

# #ifdef

## Syntax:

```
#ifdef Constant | Constant Value | Var(VariableName)
```

```
...
```

```
#endif
```

## Explanation:

The `#ifdef` directive is used to selectively enable sections of code. There are several ways in which it can be used:

- Checking if a constant is defined
- Checking if a constant is defined and has a particular value
- Checking if a system variable exists
- Checking if a system bit has been defined

The advantage of using `#ifdef` rather than an equivalent series of IF statements is the amount of code that is downloaded to the chip. `#ifdef` controls what code is compiled and downloaded, IF controls what is run once on the chip. `#ifdef` should be used whenever the value of a constant is to be checked.

GCBASIC also supports the `#ifndef` directive - this is the opposite of the `#ifdef` directive - it will remove code that `#ifdef` leaves, and vice versa.

*(Note: The code in the following sections will not compile, as it is missing `#chip` directives and DIR commands. It is intended to act as an example only.)*

## Enabling code if a constant is defined

### Syntax Example:

```
#define Blink1

#ifdef Blink1
    PulseOut PORTB.0, 1 sec
    Wait 1 sec
#endif
#ifdef Blink2
    PulseOut PORTB.1, 1 sec
    Wait 1 sec
#endif
```

This code will pulse PORTB.0, but not PORTB.1. This is because Blink1 has been defined, but Blink2 has not. If the line

```
#define Blink2
```

was added at the start of the program, then both pins would be pulsed. The value of the constant defined is not important and can be left off of the `#define`.

## ***Enabling code if a constant is defined and has a given value***

### ***Syntax Example:***

```
#define PinsToFlash 2

#ifdef PinsToFlash 1,2,3
    PulseOut PORTB.0, 1 sec
#endif
#ifdef PinsToFlash 2,3
    PulseOut PORTB.1, 1 sec
#endif
#ifdef PinsToFlash 3
    PulseOut PORTB.2, 1 sec
#endif
```

This program uses a constant called PinsToFlash that controls how many lights are pulsed. PORTB.0 is pulsed when PinsToFlash is equal to 1, 2 or 3, PORTB.1 is pulsed when PinsToFlash equals 2 or 3, and PORTB.2 is flashed when PinsToFlash is 3.

## ***Enabling code if a system variable is defined***

### ***Syntax Example:***

```
#ifdef NoVar(ANSEL)
    SET ADCON1.PCFG3 OFF
    SET ADCON1.PCFG2 ON
    SET ADCON1.PCFG1 ON
    SET ADCON1.PCFG0 OFF
#endif
#ifdef Var(ANSEL)
    ANSEL = 0
#endif
```

The above section of code has been copied directly from a-d.h. It is used to disable the A/D function of pins, so that they can be used as standard digital I/O ports. If ANSEL is not declared as a system variable for a particular chip, then the program uses ADCON1 to control the port modes. If ANSEL is defined, then the chip is newer and its ports can be set to digital by clearing ANSEL.

## ***Enabling code if a system bit is defined***

Similar to above, except with Bit and NoBit in the place of Var and NoVar respectively.

**See Also** [Defines](#), [#define](#)

# #ifndef

## Syntax:

```
#ifndef Constant | Constant Value | Var(VariableName)
```

```
...
```

```
#endif
```

## Explanation:

The `#ifndef` directive is used to selectively enable sections of code. It is the opposite of the `#ifdef` directive - it will delete code in cases where `#ifdef` would leave it, and will leave code where `#ifdef` would delete it.

**See** the [#ifdef](#) article for more information.

# #include

## Syntax:

`#include filename`

## Explanation:

`#include` tells GCBASIC to open up another file, read all of the subroutines and constants from it, and then copy them into the current program.

There are two forms of include - absolute, and relative.

Absolute is used to refer to files in the C:\Program Files\GCBASIC\include directory. The name of the file is specified in between < and > symbols. For instance, to include the file "srf04.h", the directive is:

```
#include <srf04.h>
```

Relative is used to read files in the same folder as the currently selected program. Filenames are given enclosed in quotation marks, such as:

```
#include "mycode.h"
```

where mycode.h is the name of the file that is to be read.

It is not essential that the include file name ends in .h - the important thing is that the name given to GCBASIC is the exact name of the file to be included.

Those who are familiar with `#include` in assembly or C should bear in mind that `#include` in GCBASIC works differently to `#include` in most other languages - code is not inserted at the location of the `#include`, but rather at the end of the current program.

# #script

## Syntax:

```
#script
  [scriptcommand1]
  [scriptcommand2]
  ...
  [scriptcommandn]
#endscript
```

## Explanation:

The #script block is used to create small sections of code which GCBASIC runs during compilation. A detail explanation and example are included in the Scripts article.

**See Also** [Scripts](#)

# #startup

---

## Syntax:

#startup *SubName*

## Explanation:

#startup is used in include files to automatically insert initialization routines. If a define or subroutine from the file is used in the program, then the specified subroutine will be called.

There are some limitations on this directive. It may only occur once within a file, and no parameters can be specified for the subroutine that is to be called.



**This directive is obsolete.** GCBASIC can now determine the amount of memory on a chip automatically, and will ignore the #mem directive. It is recommended that this directive is removed from all programs.

Problem		Common Causes	More Assistance
Cannot compile a program	There is an error in the program. Is Great Cow BASIC complaining about a particular line of code?		GCBASIC Forums
	Great Cow BASIC has not been installed correctly - reinstall it.		GCBASIC Forums
	There is a bug in Great Cow BASIC		Post on the forums, or send an email with your program attached to <a href="mailto:w_cholmondeley@users.sourceforge.net">w_cholmondeley@users.sourceforge.net</a>
A program compiles and downloads fine, but will not run	Oscillator not selected.		<a href="#">Configuration</a>

# Changes

**Release v0.9e this is not a GA Release**  
**Updates to this Help are as follows:**

**Jan 14**

New item(s)

- Len
- Asc
- Chr
- Trim
- Ltrim
- Rtrim
- Swap4
- Swap
- Abs
- Average
- Trim
- Ltrim
- Rtrim
- Wordtobin
- Bytetobin
- GLCD
- DectoBCD
- BCDtoDec
- Using variables
- More on constants and variables
- Acknowledgements

Changes to

- Str
- Hex
- Poke
- Else
- Readtable
- Exit (was exitsub)
- Command line parameters
- Frequently asked questions

Fixed typos.  
Updated REPEAT maximum repeat value.  
Updated most pages for layout.  
Fixed links to external pages.