BASIC MICRO STUDIO SYNTAX MANUAL

VERSION 1.0

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Discussion List

A web based discussion board is maintained at http://forums.basicmicro.com

Updates

In our continuing effort to provide the best and most innovative products, software updates are made available by contacting us at support@basicmicro.com or via our web site.

Introduction

You have now entered the exciting world of BasicATOMs. No other microcontroller on the market is as easy to learn yet still remains powerful enough to be under the hood of some of the most popular robots to be found on the internet. Some of the top rated Youtube robot videos are powered by a BasicATOM Pro.

What is the BasicATOM?

The BasicATOM and BasicATOM Pro modules are self contained micro computers. There power regulation, clock system and communication hardware are all built in. All you need to do is supply power and a connection to your computer. The Nano series is the core of the BasicATOM. Except it requires you to supply the power regulation and communication system. The clocking system is internal to the Nano series.

Programming Language

MBasic is the programming language which is used to program the BasicATOM series. MBasic is based on a subset of BASIC. In general is considered to be one of the most widely used language aside from C. The language it self has been around for years. It was the first product created by Microsoft in the early days for one of the first home built programmable computers called the Altair. The BasicATOM Pro does support C but the primary focus of this manual is centered around MBasic.

Software

Basic Micro Studio is the main piece of software that you will be using to write your code for any of the Basic Micro products such as a BasicATOMs or BasicATOM Pro. It is commonly referred to as an Integrated Development Environment or IDE for short. The IDE contains 3 main parts. A text editor for writing programs, a compiler to translate your program into something the microcontroller will understand and a loader to download your program to the microcontroller. There are several advance features that will greatly help in creating your program and are documented in this manual.

Resources

There are several additional resources available when learning MBasic. There are forums available at Basicmicro.com. The forums offer a search function and most answers to your questions can be found. There are additional forums available at lynxmotion.com.

Hardware

Hardware Introduction

Lets introduce the hardware. All modules are pin compatible and mostly code compatible. Nanos are not pin compatible with modules but are code compatible. As you move up in the line, the capabilities increase. Some features are not backward compatible. The BasicATOM Nano is the beginning of the scale with BasicATOM in the middle and BasicATOM Pro at the top of the scale in regards to performance and capabilities. Product datasheet available for download at Basicmicro.com.

Module Hardware Comparison

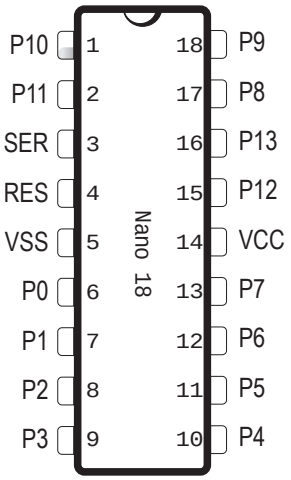
Description	Atom24	Atom28	Atom40	ProONE	Pro24	Pro28	Pro40
Temp Range	0 - 70 C	0 - 70 C	0 - 70 C	0 - 70 C	0 - 70 C	0 - 70 C	0 - 70 C
Flash	14K	14K	14K	32K	32K	32K	56K
RAM	0.3K	0.3K	0.3K	2.0K	2.0K	2.0K	4.0K
EEPROM	256 Bytes	256 Bytes	256 Bytes	0 Bytes	0 Bytes	4000 Bytes	4000 Bytes
I/O	16	20	32	16	8	20	32
A/D	4	4	8	4	4	8	8
Clock	20MHz	20Mhz	20Mhz	16Mhz	16Mhz	16Mhz	20Mhz
IPS	33,000	33,000	33,000	100,000	100,000	100,000	120,000
Floating Point	YES	YES	YES	YES	YES	YES	YES
32 Bit Hardware				YES	YES	YES	YES
32 Bit Software	YES	YES	YES	YES	YES	YES	YES
Floating Point	YES	YES	YES	YES	YES	YES	YES
UARTS	1	1	1	1	1	1	2
PWM Hardware	1	1	1	3	3	3	6

Chip Hardware Comparison

Description	Nano18	Nano28	Nano40	Nano28X	Nano40X
Temp Range	0 - 70 C	0 - 70 C	0 - 70 C	0 - 70 C	0 - 70 C
Flash	7K	14K	14K	14K	14K
RAM	0.3K	0.3K	0.3K	0.3K	0.3K
EEPROM	256 Bytes	256 Bytes	256 Bytes	256 Bytes	256 Bytes
I/O	15	24	35	16	20
A/D	7	11	11	4	4
Clock	8MHz	8MHz	8Mhz	20MHz	20Mhz
IPS	13,000	13,000	13,000	33,000	33,000
Floating Point	YES	YES	YES	YES	YES
32 Bit Hardware					
32 Bit Software	YES	YES	YES	YES	YES
Floating Point	YES	YES	YES	YES	YES
UARTS	1	1	1	1	1
PWM Hardware	1	1	1	1	1

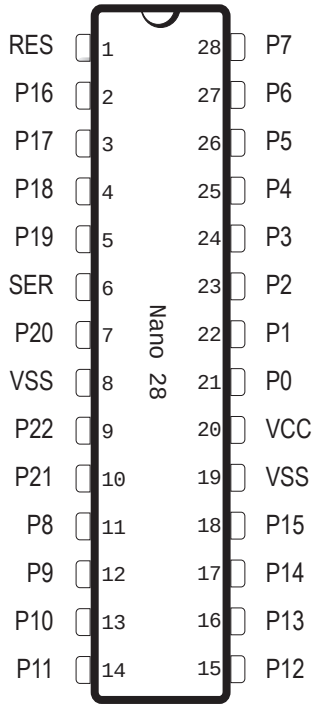
Nano 18

The BasicATOM Nano 18 is a programmable microcontroller. The Nano 28 requires a regulated 5VDC power source. It has 15 general purpose I/O, 7K of program memory, 300 Bytes of RAM, 256bytes of EEPROM and 6 Analog to Digital pins.



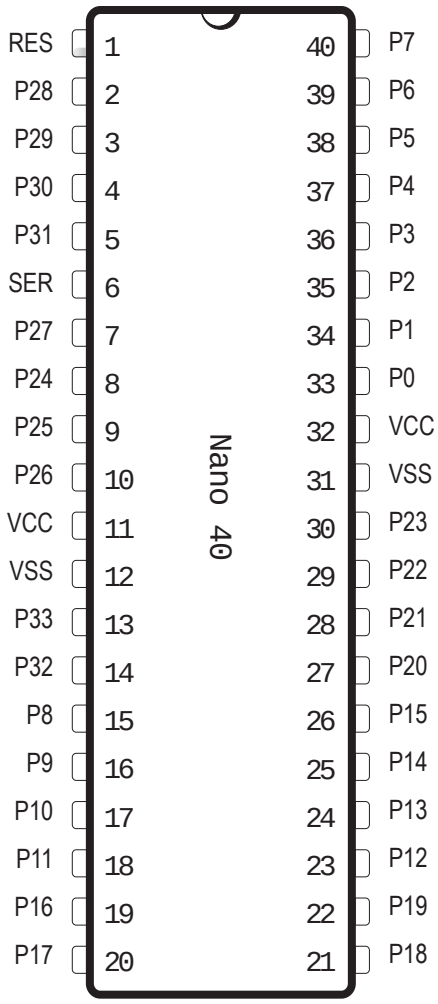
Nano 28

The BasicATOM Nano 28 is a programmable microcontroller. The Nano 28 requires a regulated 5VDC power source. It has 24 general purpose I/O, 14K of program memory, 300 Bytes of RAM, 256bytes of EEPROM and 11 Analog to Digital pins.



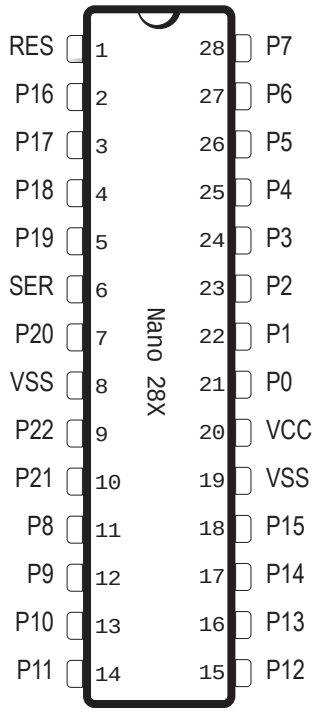
Nano 40

The BasicATOM Nano 40 is a programmable microcontroller. The Nano 40 requires a regulated 5VDC power source. It has 35 general purpose I/O, 14K of program memory, 300 Bytes of RAM, 256bytes of EEPROM and 14 Analog to Digital pins.



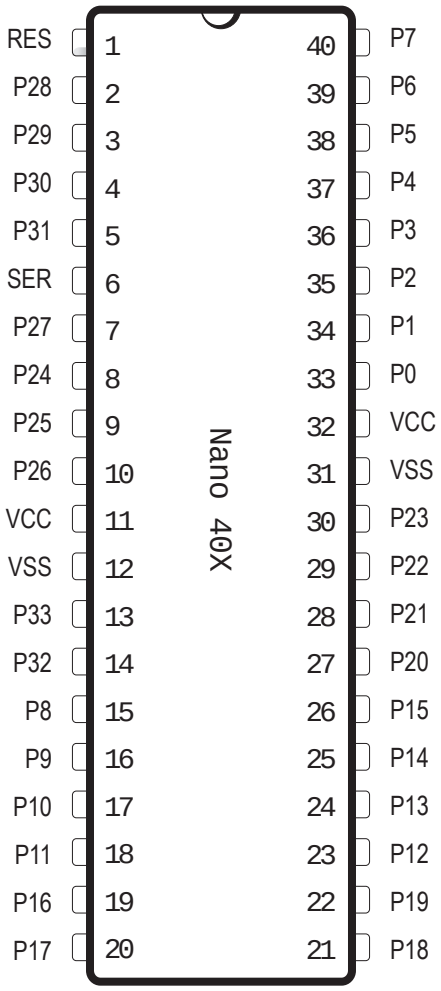
Nano 28X

The BasicATOM Nano 28X is a programmable microcontroller. The Nano 28X requires a regulated 5VDC power source and 20Mhz resonator. It has 22 general purpose I/O, 14K of program memory, 300 Bytes of RAM , 256bytes of EEPROM and 11 Analog to Digital pins.



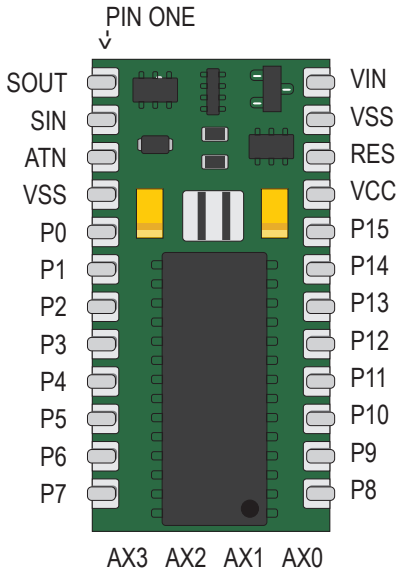
Nano 40X

The BasicATOM Nano 40X is a programmable microcontroller. The Nano 40X requires a regulated 5VDC power source and 20Mhz resonator. It has 33 general purpose I/O, 14K of program memory, 300 Bytes of RAM , 256bytes of EEPROM and 14 Analog to Digital pins.



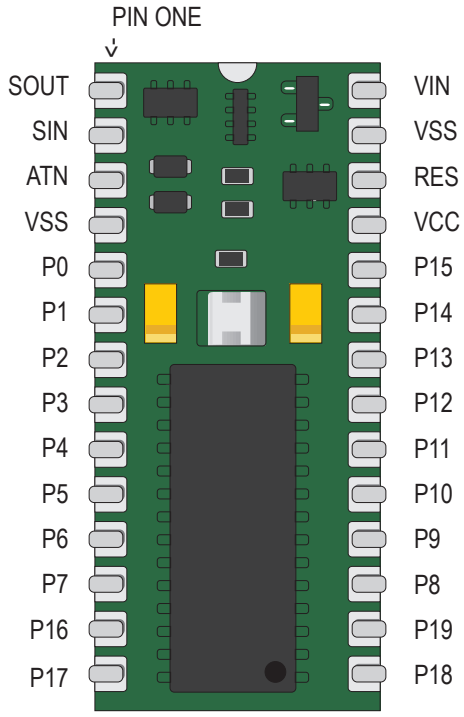
BasicATOM 24m

The BasicATOM 24m is a self contained microcontroller with all its support circuity built in. It has 16 general purpose I/O, 8K of program memory, 300 Bytes of RAM, 256bytes of EEPROM and 4 Analog to Digital pins labeled AX3, AX2, AX1 and AX0 on it underside.



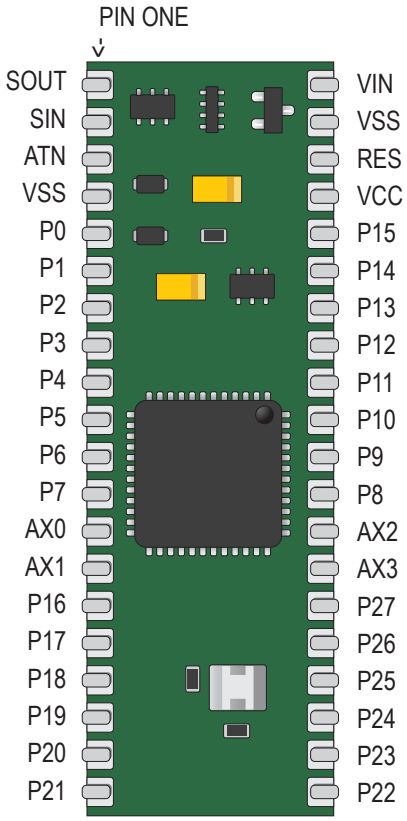
BasicATOM 28m

The BasicATOM 28m is a self contained microcontroller with all its support circuity built in. It has 20 general purpose I/O, 8K of program memory, 300 Bytes of RAM, 256bytes of EEPROM with 10 Analog to Digital pins.



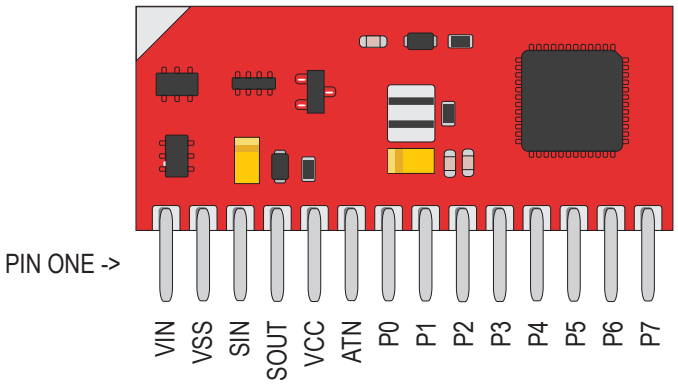
BasicATOM 40m

The BasicATOM 40m is a self contained microcontroller with all its support circuity built in. It has 32 general purpose I/O, 8K of program memory, 300 Bytes of RAM, 256bytes of EEPROM with 14 Analog to Digital pins.



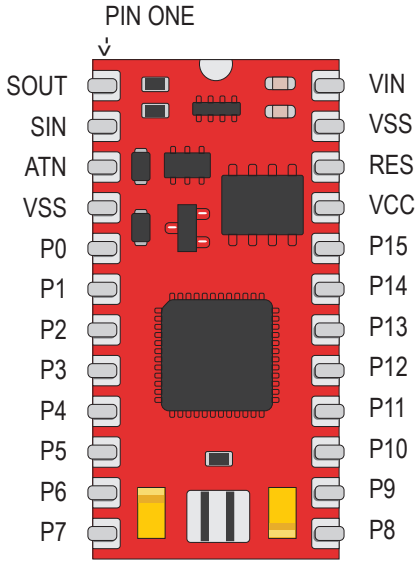
BasicATOM Pro ONEm

The BasicATOM Pro ONEm is a self contained microcontroller with all its support circuity built in. It has 8 general purpose I/O, 32K of program memory, 2K of RAM and 4 Analog to Digital pins.



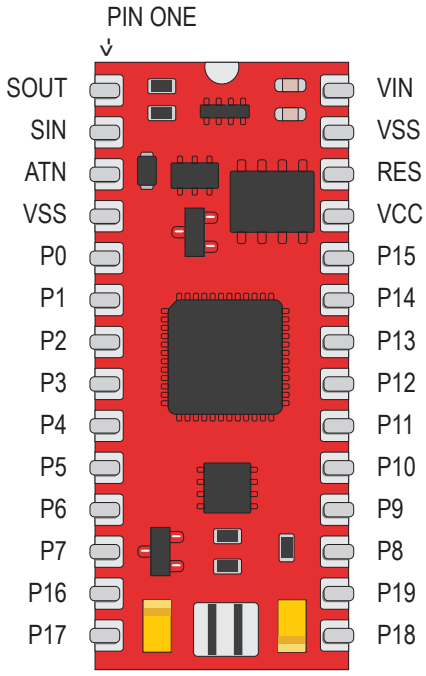
BasicATOM Pro 24m

The BasicATOM Pro 24m is a self contained microcontroller with all its support circuity built in. It has 16 general purpose I/O, 32K of program memory, 2K of RAM and 4 Analog to Digital pins.



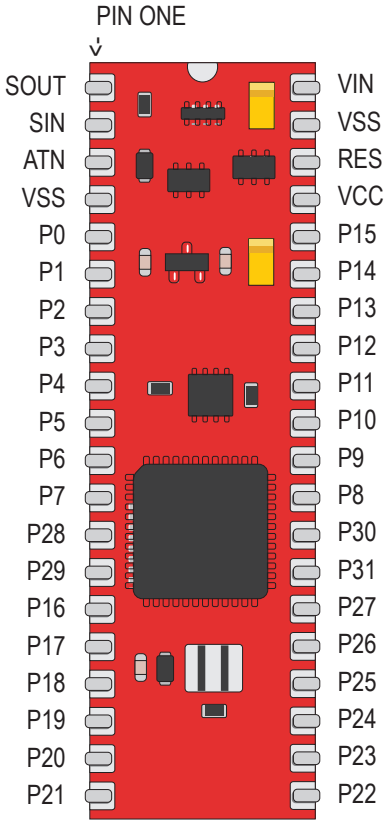
BasicATOM Pro 28m

The BasicATOM Pro 28m is a self contained microcontroller with all its support circuity built in. It has 20 general purpose I/O, 32K of program memory, 2K of RAM, 4K bytes of EEPROM and 8 Analog to Digital pins.



BasicATOM Pro 40m

The BasicATOM Pro 40m is a self contained microcontroller with all its support circuity built in. It has 32 general purpose I/O, 56K of program memory, 4K of RAM, 4K bytes of EEPROM and 8 Analog to Digital pins.



Quick Start Guide

The next few pages will go over setting up the hardware, software and creating your first program. This section is designed to teach you the basics of using the BasicATOM microcontroller line. If you are using the USB on the development board the drivers must be installed correctly first. See the development boards data sheet.

Equipment Requirements

- BasicATOM module
- USB Development Board or compatible
- PC running Windows XP or later
- USB cable

BasicATOM USB Development Board

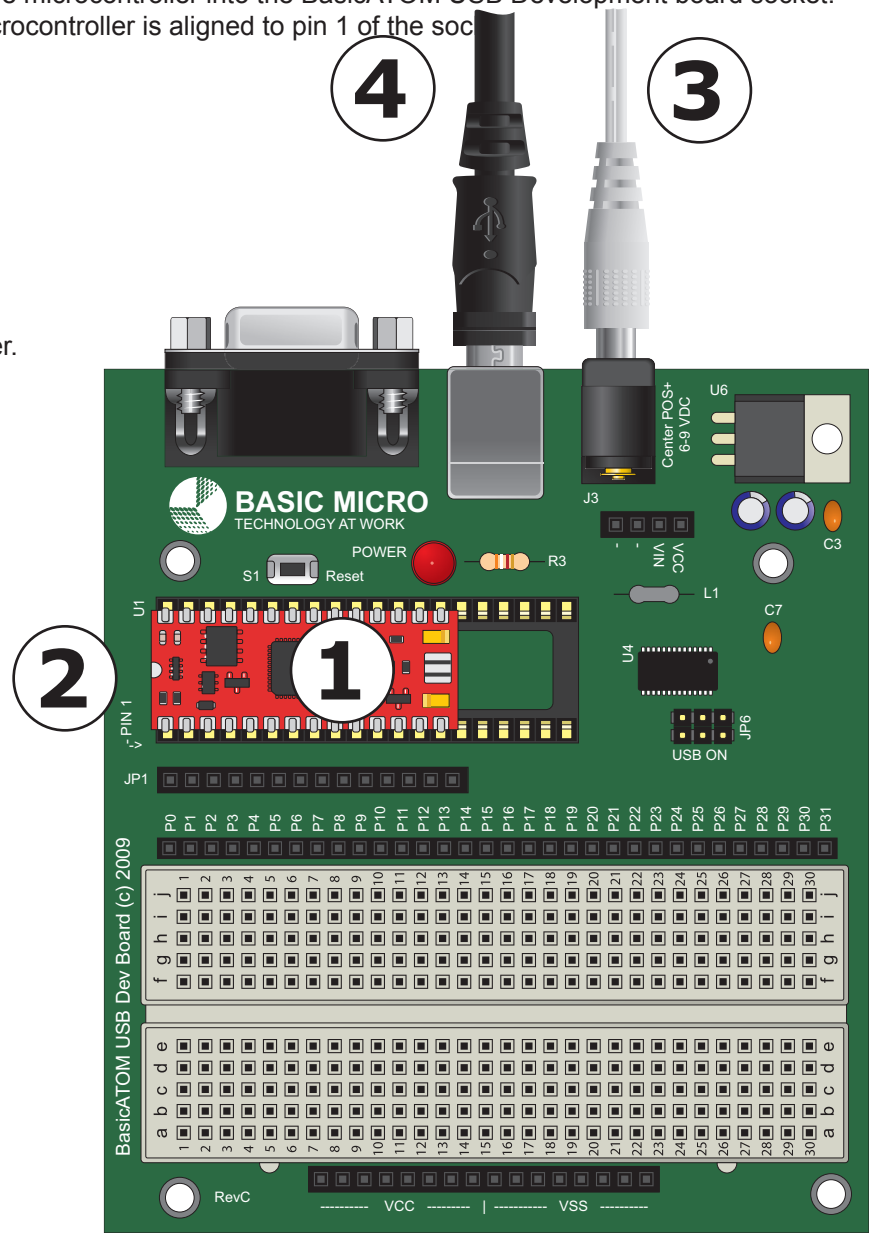
The first step is to insert the microcontroller into the BasicATOM USB Development board socket. Make sure pin 1 of the microcontroller is aligned to pin 1 of the soc

1. Insert the BasicATOM microcontroller.

2. Make sure pin 1 of the microcontroller is aligned to pin1 of the socket.

3. Connect a 6-9V 500mA center positive wall adapter.

4. Connect the B side of a USB 2.0 compliant cable.



Nano Development Board

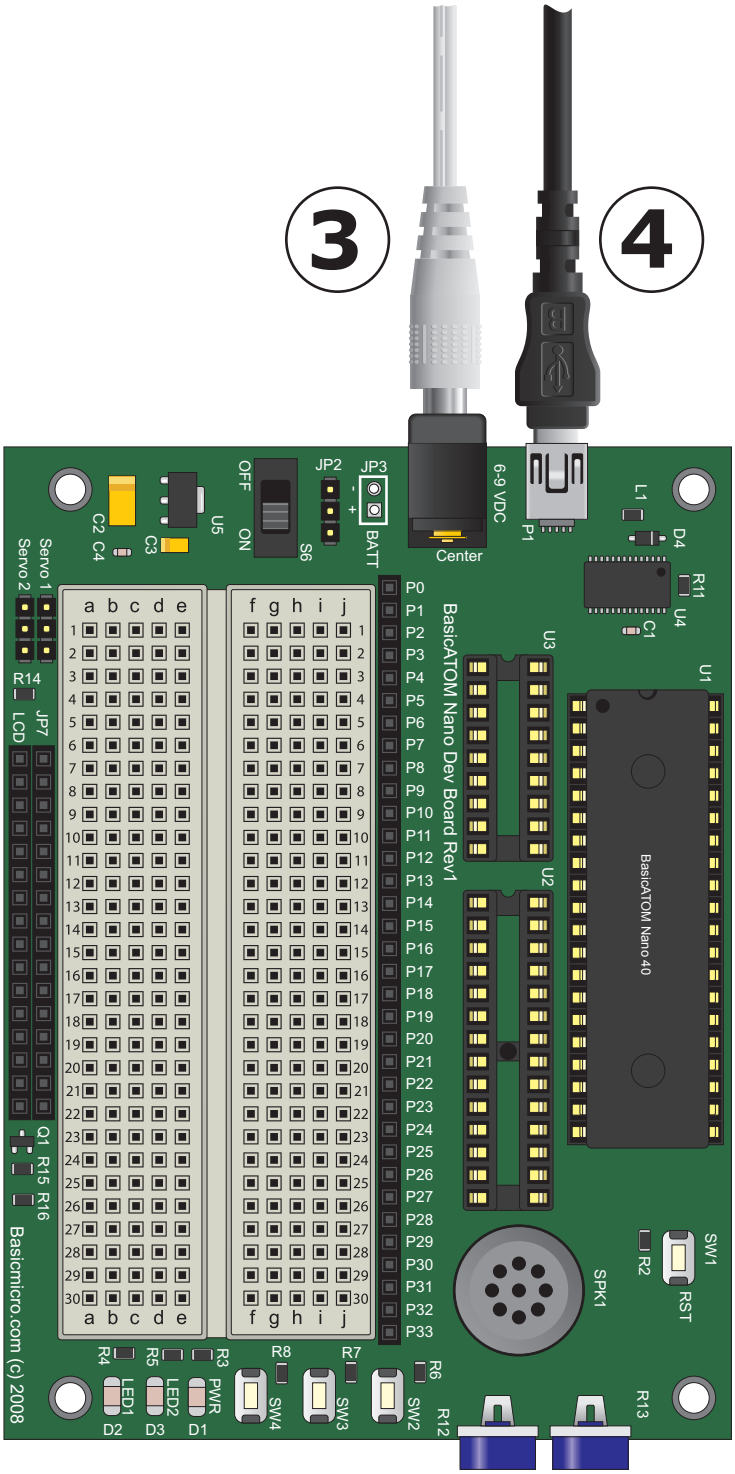
The first step is to insert the microcontroller into the Nano Development board socket. Make sure pin 1 of the microcontroller is aligned to pin 1 of the socket. If you are using the USB on the development board the drivers must be installed correctly first. See the development boards data sheet.

1. Insert the Nano microcontroller.

2. Make sure pin 1 of the microcontroller is aligned to pin1 of the socket.

3. Connect a 6-9V 500mA center positive wall adapter.

4. Connect the B side of a USB 2.0 compliant cable.



Quick Start

The first task before writing any program is installing and setting up Basic Micro Studio. Studio is the main piece of software that you will be using to develop your code for the BasicATOMs. It is commonly referred to as an Integrated Development Environment or IDE for short. The IDE contains 3 parts. A text editor for writing programs, a compiler to translate your program into something the microcontroller will understand and a loader to download your program to the microcontroller.

Equipment Requirements

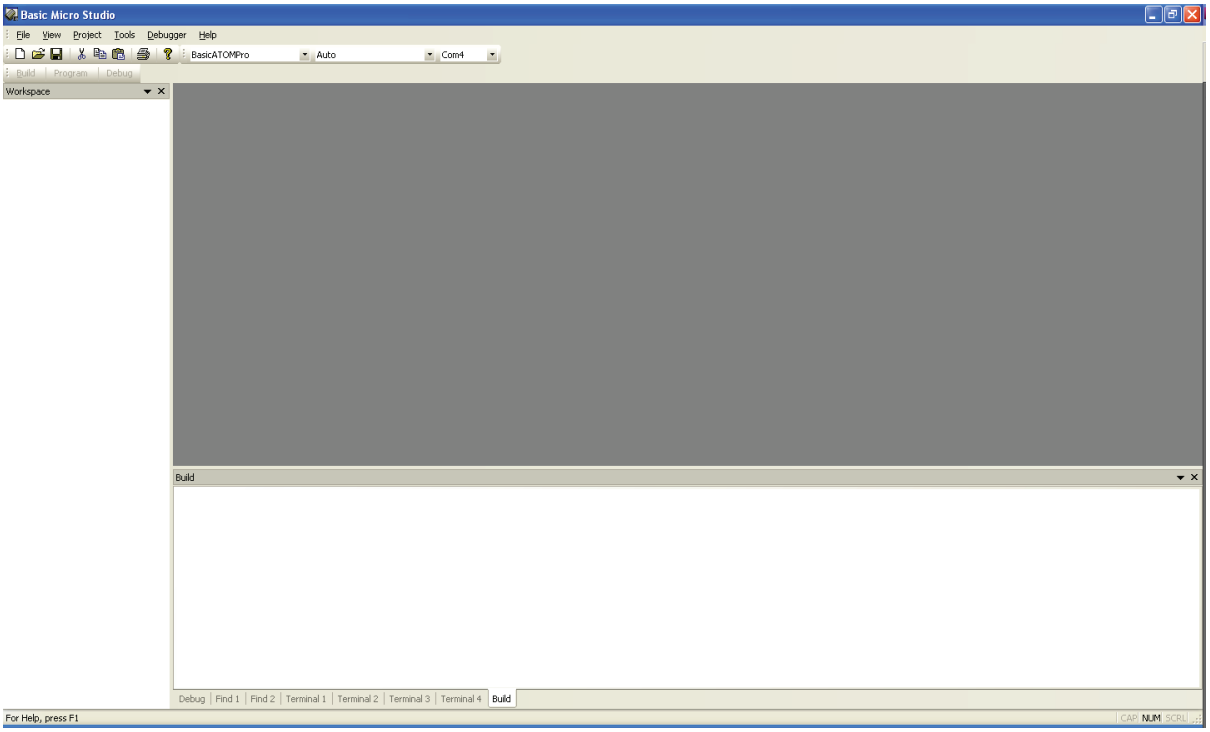
- Any BasicATOM module
- USB Development Board or compatible
- PC running Windows XP or later
- USB cable

Basic Micro Studio Installation

You can download Basic Micro Studio from the downloads section at Basicmicro.com. Before installing Studio make sure you are logged in as an Administrator. Start installing Studio by double clicking the installer icon. The installation process if fairly quick and painless. Once the installation is complete, start Studio from the Start Menu -> Programs -> Basic Micro -> Basic Micro Studio.

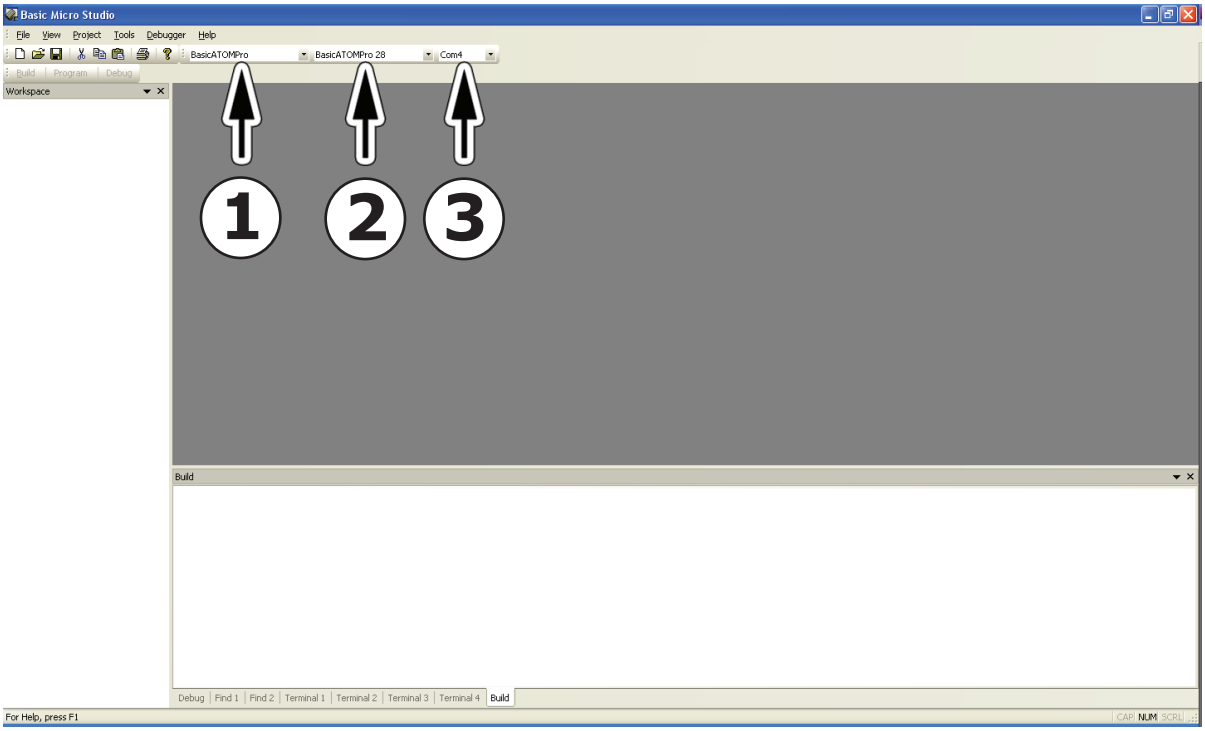
Overview

To begin lets get familiar with some of Studios features. The following screen is what you should see when first starting Basic Micro Studio.

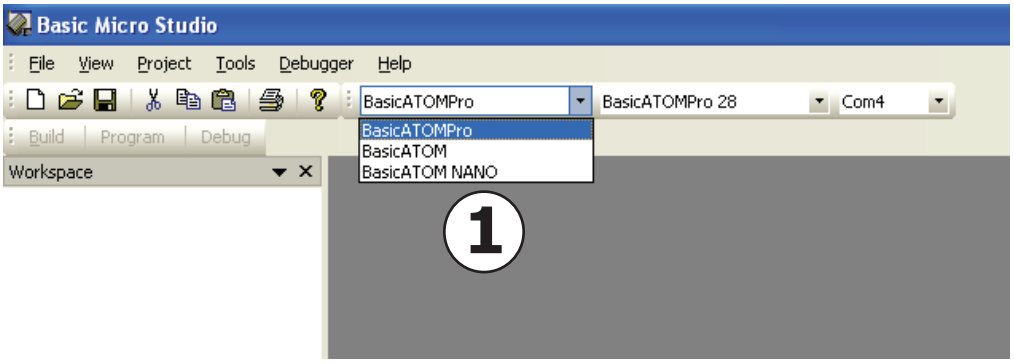


Studio Setup

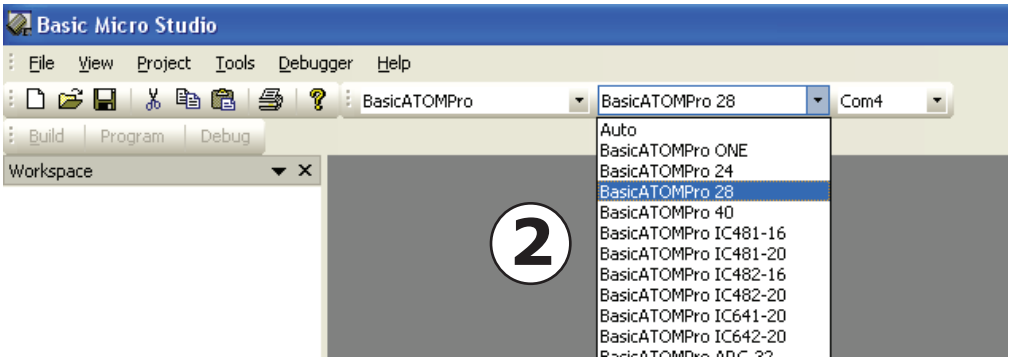
Before using Basic Micro Studio you must set the microcontroller that will be used. There are 3 drop down menus as shown below. The first sets the microcontroller family. The second sets the microcontroller type and the last sets what COM port the microcontroller is attached too.



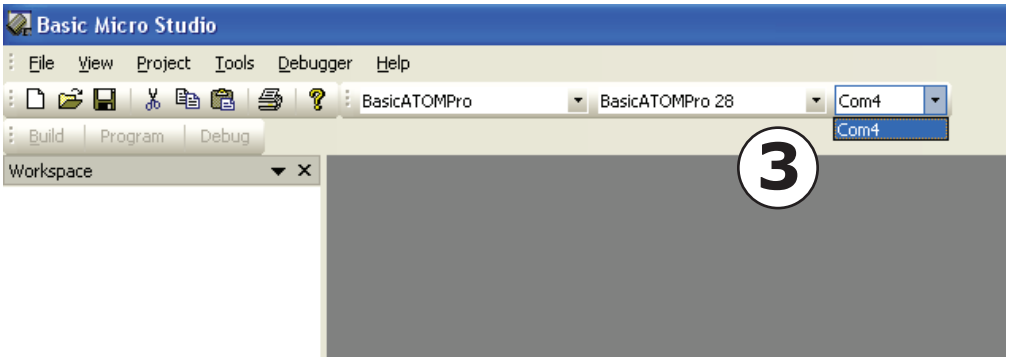
1. Microcontroller Family - is the main microcontroller family groups. BasicATOM Pro, BasicATOM Nano and BasicATOM. Choose the microcontroller family from drop down (1) as shown below:



2. Microcontroller Type - is the specific microcontroller such as BasicATOM Pro 24, BasicATOM 40 or BasicATOM Nano 18. Select the target module or chip you are using from the drop down menu Auto can be used if your unsure or Studio is having issues detecting the microcontroller. Choose the microcontroller type from drop down (2) as shown below:

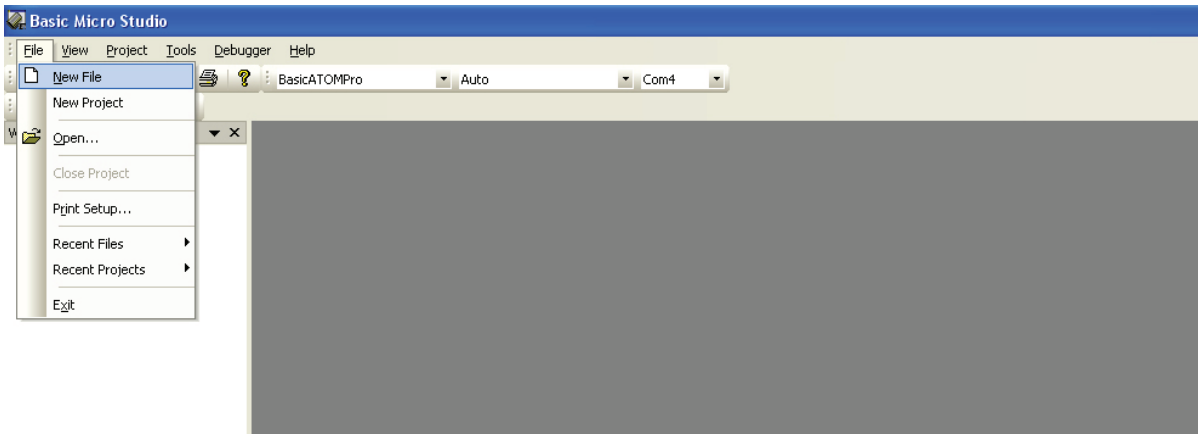


3. COM Port - is the communications port the device is attached to. This can be any port number from COM 1 to 255. Choose the COM ports from the drop down (3) as shown below:



First Program

The next step is to create your first program. You can do this by selecting File-> New File. Then name your file *first.bas*. Choose a location to save your first program.



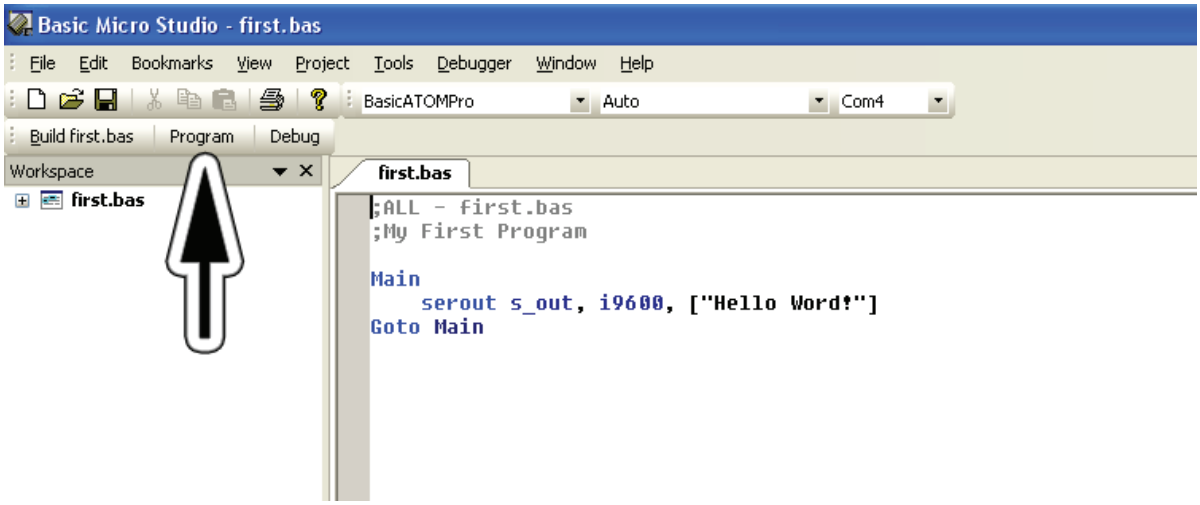
After you have created the file *first.bas*, type the following example code exactly as shown below. If you copy and paste the example code you will need to edit the quotes as they won't copy over properly.

```
;ALL - first.bas
;My First Program

Main
     serout s_out, i9600, [“Hello Word!”,13]
Goto Main
```

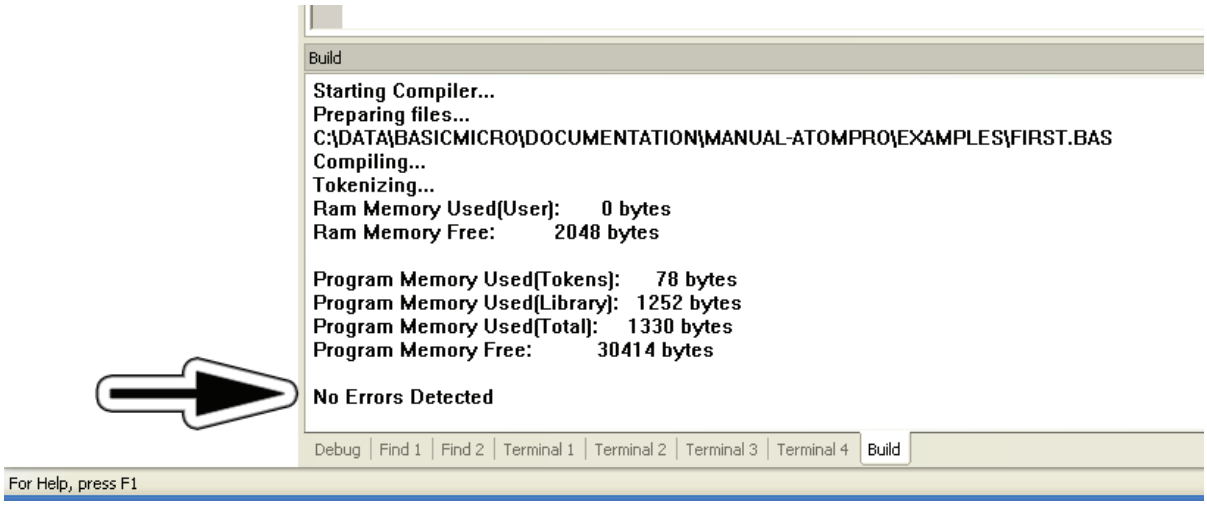
Downloading The Program

By this time you should have the microcontroller installed on the development board. Apply power and connect the USB cable to your PC. If Basic Micro Studio has trouble detecting your microcontroller make sure the USB drivers were installed correctly and the correct COM port is selected.

Make sure the correct family, type and COM port has been set properly. Once your ready click on the “Program” button shown by the arrow below.

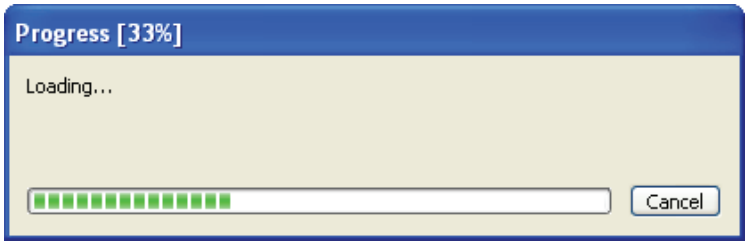


If the program is correct with no syntax errors and the microcontroller is detected you should see a message “No Errors Detected” at the bottom of the build window as shown below.



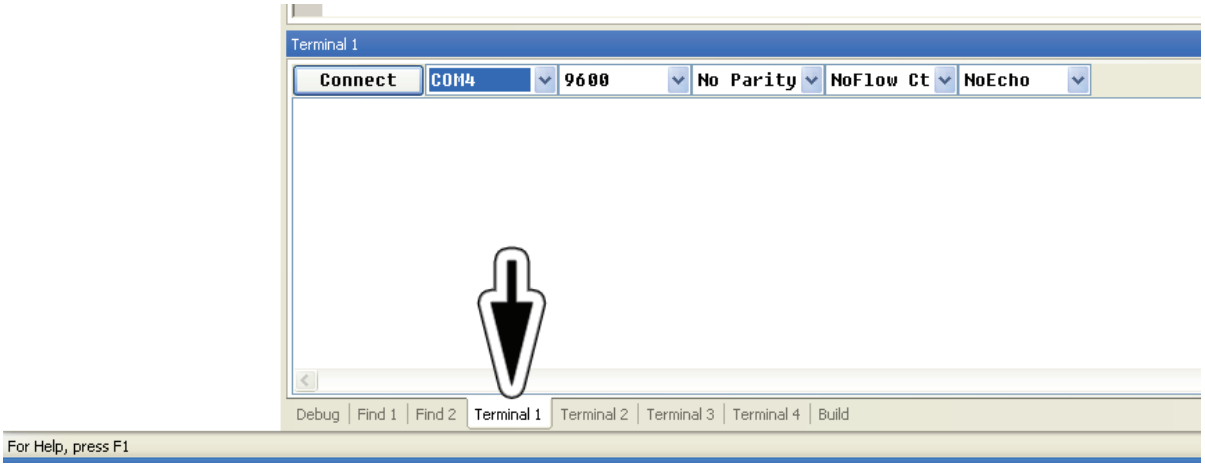
The Download Begins

After the microcontroller is detected and your program compiles without errors downloading will begin and you should see the progress dialog. Downloading the program can typically be 2 or 3 passes depending on what microcontroller family your using.



Terminal Window

You have successfully written and downloaded your first program. Now its time to see what it does. We will connect to your program using Studios built in terminal windows. After programming is complete, at the bottom of the IDE window there are several tabs. These tabs set what control is displayed. Click on “Terminal 1”.

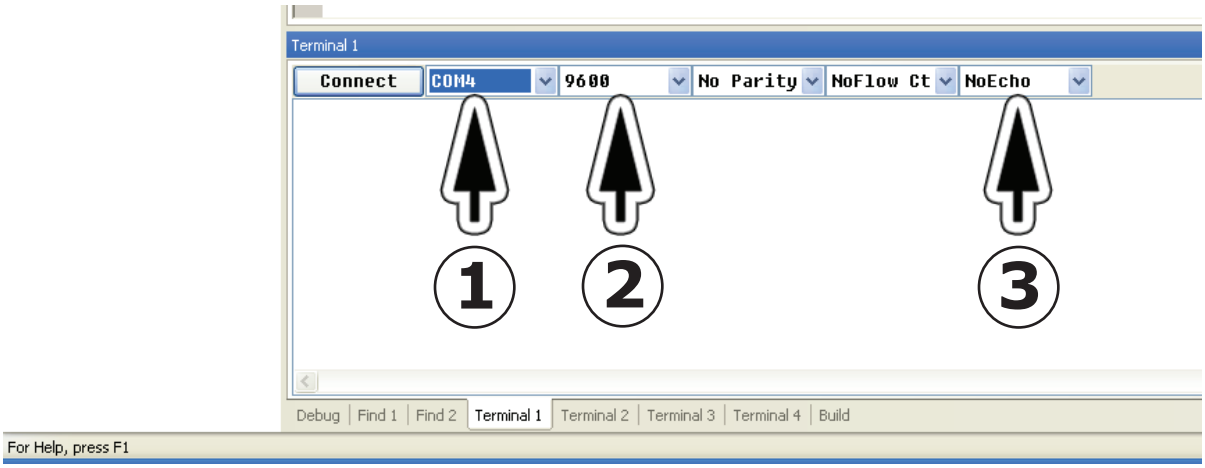


Terminal Window Setup

The next step is setting the terminal window to match the SEROUT / SERIN command parameters you used in your program.

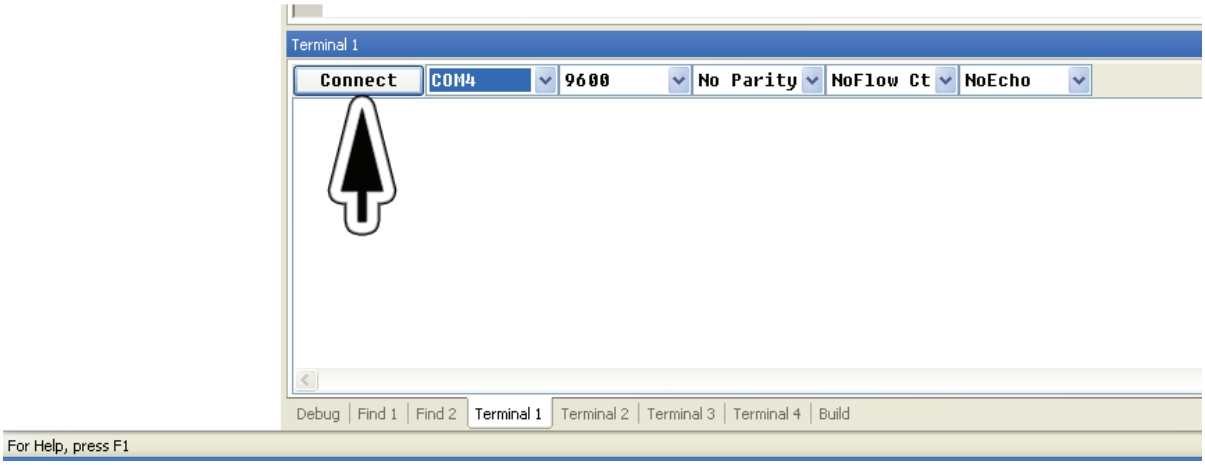
```
serout s_out, i9600, [“Hello Word!”,13]
```

First select the COM port (1). For this example you will use the same COM port as you used in the drop down box at the top of Studio. Next i9600 was used so our baud rate (2) should be set to 9600. Last, set NoEcho (3).

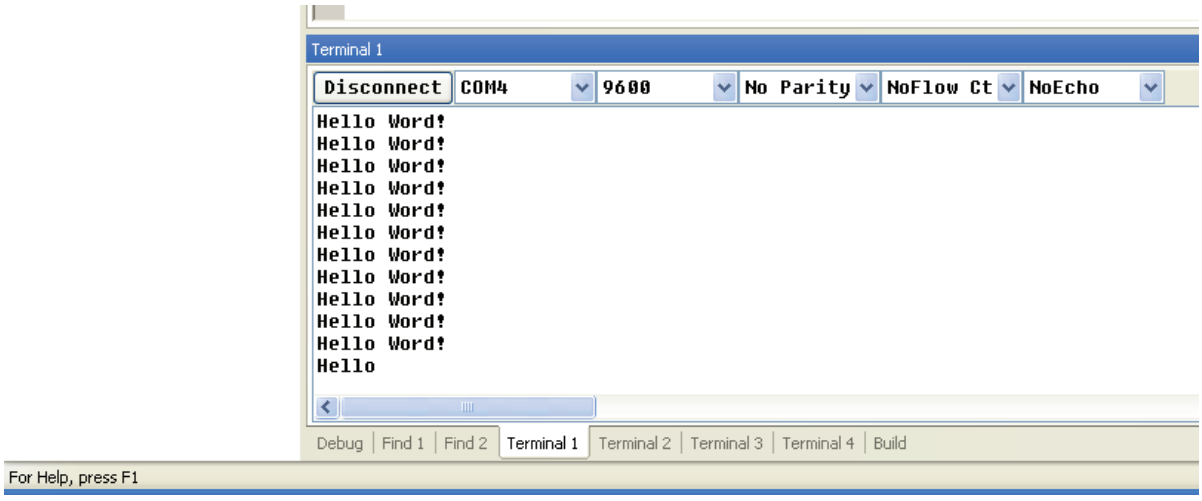


Terminal Window Connect

Once you have the terminal window set properly its time to connect to your program. Click the connect button.



Once the terminal window successfully connects to your program you should see “Hello World!” displayed in the terminal window. Since our first program is a simple loop it will print “Hello World!” forever or until you disconnect it.

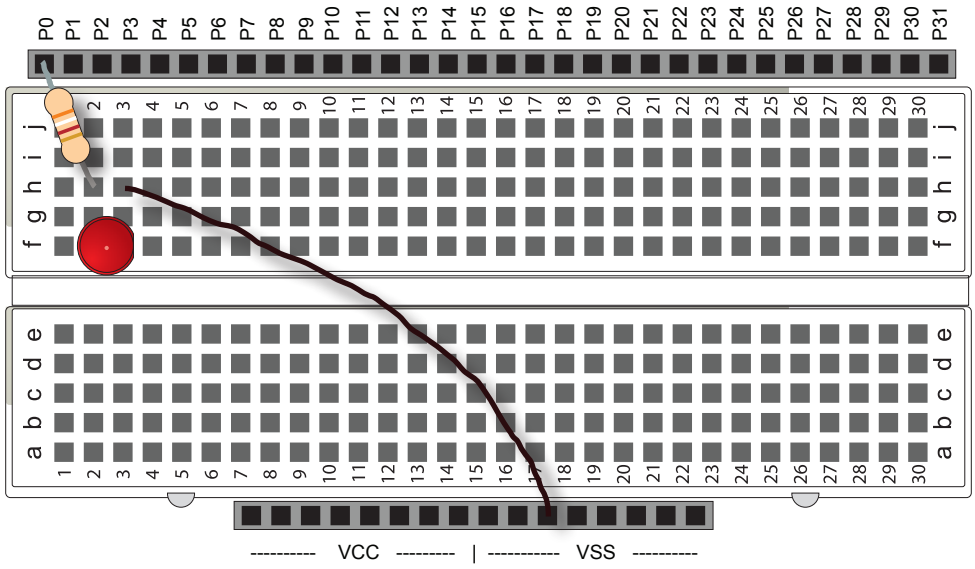


Congratulations

You have successfully created and downloaded your first program. Welcome to the exciting world of microcontrollers!

Blinking LED

Now that you know how to write a program and download it, lets make something we can see. Everyone likes a blinking LED. Connect a 390 Ohm resistor to P0. Connect an LED anode (+) to the resistor. Connect the other side of the led cathode (-) to VSS (GND) which is marked by the small flat spot on the LED.



The Program

Type or copy the below example exactly as shown. You can copy and paste the program into Studio. Once you have entered the program save it as *blink.bas*. Then download it to the BasicATOM as outline in the previous section of this manual.

```
;ALL - blink.bas
;My blinking LED program

Main
     High P0
     Pause 300
     Low P0
     Pause 300
Goto Main
```

Congratulations

You have successfully blinked your first LED! You can now officially consider yourself a programmer.

Variables

Variables

Variables are used to store values used in your program. The values stored typically will change during program run time. What was stored at the start of your program in a given variable can change by the time your program stops running.

To use a variables it must be defined in your program so Basic Micro Studio knows to set aside the required amount of space in RAM. The ATOM line is 32 bit so variables can be from 1 bit to 4,294,967,295. Typically most microcontroller systems are limited to 65,535 which is the maximum 16 Bit value you can store.

When creating a variable you specify what type of variable you will need in your program. You can define as many variables as you want. The only limit is the amount of RAM available which varies for each ATOM type.

Variable Types

Type	Bits	Value Range
Bit	1	1 or 0
Nib	4	0 to 15
Byte	8	0 to 255
Sbyte	16	-127 to +128
Word	16	0 to 65,535
Sword	32	-32,767 to +32,768
Long	32	0 to 4,294,967,295
Slong	32	-2,147,483,647 to +2,147,483,648
Float	32	± 2.0 EXP -126 to ± 2.0 EXP 127
Pointer	32	0 to 4,294,967,295

Location

Variables should be defined in the beginning of your program if you want access to the variable anywhere in your program. Variable defines are run time only. Meaning they space is not allocated in RAM until your program is running on the ATOM. You can define variables anywhere in your program but they will only be accessible after the section of code is ran that defines them.

Signed

Variables can be signed. This keeps track if the variable is a negative or positive number. This is useful in many applications. A simple example would be controlling a DC motor. A negative number can indicate one direction of spin, 0 can be stop and a positive value can be the opposite direction of spin using one variable. Signed variables are created using Sbyte, Sword and Slong

Defining Variables

Variables are defined with the statement VAR. You can declare your new variable as any type found in the Variable Types table. The syntax to define a variable is shown below.

Syntax:

```
VariableName VAR Type
```

Examples:

```
Red VAR Byte
Tick VAR Nib
Switch var Bit
Totals var Sword
```

Variable Names

Variables must start with a letter but can be any combination of letters and numbers including some symbols that are not in the reserved word list. You can name your variables almost anything. However its a good idea to name them something useful that you will remember and understand for debugging your program. Variable names can be up to 1,024 characters long. The only names you can not use for your variables is reserved words. These are words used by Studio for commands or other syntax based names (see the manual appendix for a complete reserved word list).

Example:

```
MotorSensor VAR Word
```

Aliases

Variables can be aliases. This is useful when creating a program for a processor with limited RAM (i.e. Basic Stamp). Using an aliases can help your code be more human readable without wasting RAM. If you have a variable that is only used in one particular section of code you can assign an aliases pointing to a variable that was defined earlier.

Example:

```
MotorDirection VAR Word
MaxCCSpeed VAR MotorDirection
MacCCWSpeed VAR MotorDirection.byte0
```

Variable Modifiers

Variable modifiers can be used when only part of a variables value is needed. Most communication formats such as serial or I2C are byte driven. If you have a word sized variable and you are sending data to such a device, you will need to send one byte at a time of the word variable. The word value can be split using an aliases with a modifier as shown below.

Example

```
MyData VAR Word
FirstByte VAR MyData.HighByte
SecondByte VAR MyData.LowByte
```

Variable Modifier Type

Modifier	Description
LowBit	Returns the low bit of a variable (least significant bit).
HighBit	Returns the high bit of a variable (most significant bit).
Bit*n*	Returns the *N*th bit of a variable. From 0 to 31 depending on variable size.
LowNib	Returns the low nibble (4 bits) of a variable (least significant nib).
HighNib	Returns the low nibble (4 bits) of a variable (most significant nib).
Nib*n*	Returns the *N*th nib (4 bits) of a variable. From 0 to 7 depending on variable size.
LowByte	Returns the low byte (8 bits) of a variable (least significant byte).
HighByte	Returns the high byte (8 bits) of a variable (most significant byte).
Byte*n*	Returns the *N*th byte of a variable. From 0 to 3 depending on variable size.
LowWord	Returns the low word (8 bits) of a variable (least significant word).
HighWord	Returns the high word (8 bits) of a variable (most significant word)
Word*n*	Returns the high or low word from a long. 0 or 1 can be used.

Variable Arrays

Variable arrays can be used to store several values using one variable name. A good use of variable arrays would be taking multiple readings from a temperature sensor and storing the samples in a variable named Temperature. The reads can later be averaged for a more accurate temperature. Studio only supports one dimensional arrays.

Example:

```
Temperature VAR Byte(5)
```

The example above creates 5 byte sized RAM locations for the variable temperature. Each location is indexed and referenced by using a numerical value. The range is based on the array size that was defined. In this case the array size is 5. So an index value of 0 to 4 can be used.

Example:

```
Temperature(0) = 255 ;loads first position
Temperature(1) = 255 ;loads second position
Temperature(2) = 255 ;loads third position
Temperature(3) = 255 ;loads fourth position
Temperature(4) = 255 ;loads fifth position

Temp = Temperature(0) ;Loads value from first position in the array
```

A common use of variable arrays is to store strings of ASCII based characters. This can be used to send an entire sentence of text to a byte driven device such as a computer terminal window.

Out of Range

When declaring variables, careful consideration should be given to the maximum value it will store. If a byte sized variable is declared but the result of some function is word sized then data will be lost. Basic Micro Studio has no way of knowing these possible conditions existing within your program. This situation has added some grey hair more times than most programmers will admit. So beware. Typically a beginner programmer will declare every variables as largest as they can. While this sounds good in theory, in practice you'll run out of RAM space quickly. Plus is makes for an inefficient programming style.

Constants

Constants

Constants are values defined that will never change. The assigned value is store in program memory and can not be changed. Constants are set during compile time by Studio. Constants are a convenient way to give a name to a numeric value. They are typically used to make a program more human readable. There are two types of constants. Normal constant define using CON and a floating point constant defined by FCON. You can use almost any name for a constant, except reserved words (see manual appendix).

Example:

```
LimitTravel CON 255
MaxSpeed FCON 6.50
```

Constant Tables

Tables are similar to arrays except tables only store constant values. You can store large strings of text in a constant table. Each position is accessed like arrays using an index number. Values assigned to a table are store in program memory and can not be changed during program run time. A common use for constant tables is building interactive menu systems. If the user selects *n* reply with string from table *n*. Constant tables are restricted to word boundaries if you have an odd number of bytes in a byte table an extra byte is added for padding.

Example:

Sentence ByteTable “Hello World!”

The above example byte table *Sentence* contains the sting *Hello World!*. Each character including the space is a byte in the table. *Sentence* contains 12 bytes. To access the bytes you would use an index value of 0 to 11.

Example:

```
Temp VAR Byte
Sentence ByteTable “Hello World!”

Temp = Sentence(0)
```

The variable *Temp* now is equal to the ASCII value *H* since index 0 is the first byte in the defined table.

Table Types

Type	Description
ByteTable	Each table index point is byte sized (8 bits).
WordTable	Each table index point is word sized (16 bits).
LongTable	Each table index point is long sized (32 bits).
FloatTable	Each table index point is floating point sized (32 bits).

Pins and Ports

Pin and Ports

Pins and ports is how your program will interfaces with the outside world. Pins can only be read as or set as high or low. In some cases pins are what is known as open drain which can be a low or floating.

Pins are accessed individually or by ports which are typically 8 pins groups. Pins names are treated as constants. However pins can be accessed like variable using pin variable names. Ports are accessed and handle just like variables.

Pin Constants

Pin names are defined with a “P”. The “P” stands for Pin followed by a pin number. The amount of pins and their names will vary depending on the processor your using. The first 8 pins of a BasicATOM are:

```
P0
P1
P2
P3
P4
P5
P6
P7
```

Pin names are only limited by the number of accessible pins on the processor your using. Pin names are normally used as an argument in most commands. A simple example would be:

```
High P0
Low P1
```

The high command will set P0 high. Which is Pin 0 of the processor your using. It is important to note pin names are treated as constants. An example of this is shown below. *Temp* which is a variable would be made to equal the ASCII value of P and 0:

```
Temp = P0
```

Pin Variables

Since pin names are constants it can be used in a logical expression since it would never change. Instead we use pin variables. Pin variables are important when your program needs to know something about the outside world. They can be used to determine the state of a pin or port. To make this expression from above work properly you would need to use the pin name variables:

Temp = IN0
Temp = OUT0

IN0 and OUT0 are pin variables. They both do the same thing and are hold overs for Basic Stamp compatibility. Using either IN or OUT will make the above expressions work. *Temp* will either equal 0 or 1 depending on the pin state when its read. However all pin and ports start off as inputs during power up. If the pin or port was last used by a command that set the pin or port to an output the above expression would not work with out first using a DIR statement.

The following table is a complete list of all the available pin and port variable names. Using the variable names, individual pins can be accessed or up to 32 pins can be accessed at one time. You will need to check the data sheet for the processor your using to determine how many pins are user accessible. Not all the pin or port variables will work on every processor the limitation being the amount of available pins.

Pin and Port Variable Names

Variable	Variable Size	Bits	Affected Pins
INL0	Long	32	P0 - P31
INL1	Long	32	P32 - P63
INW0	Word	16	P0 - P15
INW1	Word	16	P16 - P31
INW2	Word	16	P32 - P47
INW3	Word	16	P48 - P63
INB0	Byte	8	P0 - P7
INB1	Byte	8	P8 - P15
INB2	Byte	8	P16 - P23
INB3	Byte	8	P24 - P31
INB4	Byte	8	P32 - P39
INB5	Byte	8	P40 - P47
INB6	Byte	8	P48 - P55
INB7	Byte	8	P56 - P63
INN0	Nib	4	P0 - P3
INN1	Nib	4	P4 - P7
INN2	Nib	4	P8 - P11
INN3	Nib	4	P12 - P15
INN4	Nib	4	P16 - P19
INN5	Nib	4	P20 - P23
INN6	Nib	4	P24 - P27
INN7	Nib	4	P28 - P31
INN8	Nib	4	P32 - P35
INN9	Nib	4	P36 - P39
INNA	Nib	4	P40 - P43
INNB	Nib	4	P44 - P47
INNC	Nib	4	P48 - P51
INND	Nib	4	P52 - P55
INNE	Nib	4	P56 - P59
INNF	Nib	4	P60 - P63
IN	Bit	1	Any
OUT	Bit	1	Any

Direction Variables

The DIR variables are used to set pins and ports to inputs or outputs. All pins and ports are set to inputs by default on power up. When a pin or a port is used in a output command like High, the pin or port direction is set automatically. The pin is left in the last used state. If the command was an input the pin is set to an output. In the below example the value of *Temp* will never change regardless of the pins state:

```
High P0
Temp = IN0
```

This is due to the High command being an output command the pin being left in an output state. So it can not be read as an input until its changed. To fix this we use a DIR variable to change the pin to an input. The below program would now function correctly:

```
High P0
DIR0 = %0
Temp = IN0
```

Special attention must be paid to what module type you are using when utilizing the DIR variables. On the Nano and BasicATOM 0 represents an output state. The BasicATOM Pro is reverse where a 0 represents an input. The below table can be used to determine what zero means to the particular processor your using.

Input Output

Processor	Input	Output
Nano18	0	1
Nano28	0	1
Nano40	0	1
BasicATOM 24-M	0	1
BasicATOM 28-M	0	1
BasicATOM 40-M	0	1
BasicATOM Pro One-M	1	0
BasicATOM Pro 24-M	1	0
BasicATOM Pro 28-M	1	0
BasicATOM Pro 40-M	1	0

DIR Variables Names

Variable	Variable Size	Bits	Affected Pins
DIRE	Long	32	P0 - P31
DIRS	Word	16	P32 - P63
DIRES	Word	16	P0 - P15
DIRL	Byte	8	P16 - P31
DIRH	Byte	8	P32 - P47
DIREL	Byte	8	P48 - P63
DIREH	Byte	8	P0 - P7
DIRA	Nib	4	P8 - P15
DIRB	Nib	4	P16 - P23
DIRC	Nib	4	P24 - P31
DIRD	Nib	4	P32 - P39
DIREA	Nib	4	P40 - P47
DIREB	Nib	4	P48 - P55
DIREC	Nib	4	P56 - P63
DIRED	Nib	4	P0 - P3
DIR	Bit	1	P4 - P7

All bits in the direction variable your using must be set. You can use binary, decimal or hexadecimal values to represent what pins are being set as input or outputs. The following statements all mean the same things. Based on the BasicATOM Pro 28-M P0 will be set to an ouput:

```
DIR0 = %0         ;Binary
DIR0 = 0          ;Decimal
DIR0 = 0x00       ;Hexadecimal
```

Math

As with most BASIC implementations, Atom BASIC includes a full complement of math and comparison functions. Atom BASIC supports both 32 bit integer math both signed and unsigned. It also support floating point math signed or unsigned. By signing we mean denoting whether the resulting value is positive or negative. In most cases integer math is preferred. Floating math works very well within the BasicATOM series but is processor intensive. This should be remembered any time making a decision when creating programming math function. There are numerous cases where floating point math is required. Hence the flexibility of the BasicATOM when compared to other available processors.

Number Bases

Although all calculations are handled internally in binary, users can refer to numbers as decimal, hexadecimal or binary, whichever is most convenient for the programmer. For example, the number 2349 can be referred to as:

2349	Decimal
0x092D	Hexadecimal
%100100101101	Binary

Leading zeros are not required for hex or binary numbers, but may be used if desired. When using signed integers (sbyte, sword, slong) it's probably a good idea to stick to decimal notation to avoid confusion.

Math and Operators

Operators are what makes math work by performing a function. An example of an operator would be + (Addition), - (Subtraction), * (Multiplication) and / (Divide). All these symbols represent an operation to be performed. However the operators need something to do, so we add operands or better known as arguments. Math arguments are the values used in an expression.

In the following section you'll see the word "expression" used many times. This refers to something like 1+2 which is called an expression. The expression 1+2 has one operator (+) and two arguments(1, 2) or operands.

Operators

Operator	Description
-	Changes the value of an expression from positive to negative. Also used in subtraction.
ABS	Returns the absolute value of an expression.
SIN	Returns the sine of an expression.
COS	Returns the cosine of an expression.
DCD	Returns 2 to the power of an expression.
NCD	Returns the smallest power of 2 that is greater than the expression.
SQR	Returns the square root.
BIN2BCD	Converts expression from binary to packed binary code and decimal format.
BCD2BIN	Binary code and decimal format to a binary value.
RANDOM	Returns a random 32 bit number generated from a seed value.
-	Subtraction. Also used to sign an value.
+	Addition.
*	Multiplication.
/	Division.
**	Returns high 32 bits of a multiplication result.
*/	Fractional multiplication.
//	Remainder of Division.
MAX	Converts expression from binary to packed binary code and decimal format.
MIN	Binary code and decimal format to a binary value.
DIG	Returns a random 32 bit number generated from a seed value.
REV	Returns a random 32 bit number generated from a seed value.
<<	Shift left by specified amount.
>>	Shift right by specified amount.
&	Binary math AND.
|	Binary math OR.
^	Binary math XOR.
&/	Binary math AND NOT.
|/	Binary math OR NOT.
^/	Binary math XOR NOT.
=	Is equal to.
<>	Is not equal to.
<	Is less than.
>	Is greater than.
<=	Is less than or equal to.
>=	Is greater than or equal to.
AND	Logical AND.
OR	Logical OR.
XOR	Logical XOR.
NOT	Logical NOT.

Operator Precedence

All math functions have a precedence order. This simply mean each math function in an expression is calculated based on its precedence not based on the order in which it appears in the expression. This even holds true for math as it was taught in school. However the precedence of order may differ.

To solve the following equation 2+2*5/10 = 3 the ATOM would start with multiplication first since it has the higher precedence order. 2*5 will be calculated first which equals 10, then the divide 10 / 10 equals 1, then the addition of 2 which equals 3. The 2 was added last since it had the lowest precedence.

The multiply and divide operators have equal precedence, and both are higher precedence than addition and subtraction. Now you can change the order in which the math is performed by using parenthesis. This will force a specific order. Using parentheses, the following expression ((2+2)*5) /10 would yield a result of 2.

Precedence Table

Order	Operation
1st	NOT, ABS, SIN, COS, - (NEG), DCD, NCD, SQR, RANDOM, TOINT, TOFLOAT, BIN2BCD, BCD2BIN, ~(Binary NOT), !(Binary NOT), NOT(Logical NOT), FSQRT, FSIN, FCOS, FTAN, FASIN, FACOS, FATAN, FATAN2, FSINH, FCOSH, FTANH, FATANH, FLN, FEXP
2nd	Rev, Dig
3rd	MAX, MIN
4th	*, **, */, /, //
5th	+, -
6th	<<, >>
7th	<, <=, =, >=, >, <>
8th	&, |, ^, &/, |/, ^/
9th	And, Or, Xor

- (Negative)

Signs an expression or argument as a negative value. The value will be signed and treated as such.

Example

```
Temp var Byte
Result var Byte
Temp = 1
Result = Temp + -1
```

Temp is first is set to equal 1. Then -1 is added. Which -1 is the signed integer. So *Result* now equals 0. Since 1 added to -1 equals 0.

ABS

The Absolute Value converts a signed number to its absolute value. The absolute value of a number is its a value that represents its difference from 0. The absolute value of -4 is 4. If the number is positive the result will always be the same number returned:

```
temp = abs(-1234)
temp = abs(1234)
```

The result will always be 1234 since the difference of 0 from -1234 is 1234.

SIN, COS

For use with integer arithmetic, some modifications to the way sine and cosine work have been made. For example, in floating point math, the expression:

ans = sin(angle)

where angle is 1 radian, would return a value of 0.841... for ans. In fact, the sine of an angle must always be a fractional value between -1 and 1. MBasic can't deal with fractional values so SIN and COS are made to work with integers.

Since we are dealing with binary integers, we divide the circle into 256 (rather than 360) parts. This means that a right angle is expressed as 64 units, rather than 90 degrees. When working with Studio angular units give you a precision of about 1.4 degrees.

The result of the SIN or COS function is a signed number in the range of –127 to +128. This number divided by 128 gives the fractional value of SIN or COS.

Example

In most "real world" applications, the angle does not need to be in degrees, nor the result be in decimal form. The following example shows a possible use of SIN with Studio values.

If a sensor returns the angle of a robotic control arm as a number from 0 to 64, where 0 is parallel and 64 is a right angle. We want to take action based on the sine of the angle.

```
      limit var byte
      angle var byte
loop
      (code that inputs the value of "angle")
      limit = sin angle
      if limit > 24 then first
      if limit > 48 then second
      goto loop
first
      code to warn of excessive angle
      goto loop
second
      code to shut down equipment
      etc...
```

This will warn the operator if the arm angle exceeds approximately 8 units (11.25 degrees) and shut down the equipment if the arm angle exceeds approximately 16 units (22.5 degrees). Most control examples don't need to work in actual degrees or decimal values of sine or cosine. To find the sine of a 60 degree angle, first convert the angle to MBasic units by multiplying by 256 and dividing by 360. For example:

angle = 60 * 256 / 360

will result in a value of 42. (It should actually be 42.667, which rounds to 43, but with integer arithmetic the decimal fraction is ignored, and the integer is not rounded up.) Then find the sine of this angle:

ans = sin angle

This will give a result of 109. Dividing this value by 128 will give the decimal value of 0.851 (compared to the correct floating point value which should be 0.866). You can't directly get the decimal value by doing this division within Studio Basic (you would get a result of 0). However, you could first multiply by 1000, then divide by 128 to get 851 as your result.

DCD

Similar to the “exp” function in some other BASIC implementations. Returns 2 to the power DCD.

Example
If the value of “num” is 7, then the following statement will return a value of 27, or 128.

```
answer = dcd num
```

Since the returned value increases exponentially, make sure your target variable (“result” in this case) is correctly defined to accommodate the largest value anticipated. If the target variable is too small, only the low order bits of the result will be stored.

NCD

This function returns the smallest power of 2 that is greater than the argument.

Example
If the value of “num” is 51, the following statement will return the value of 6. Since 25 = 32 and 26 = 64, 6 is the smallest power of 2 greater than 51.

```
answer = ncd num
```

SQR (Square Root)

Returns the integer portion of the square root of the argument. Increased precision can be obtained by multiplying the argument by an even power of 10, such as 100 or 10000.

Example 1

If the value of “num” is 64, the following statement will return the value of 8 (which is the square root of 64).

```
answer = sqr num
```

Example 2

If the value of “num” is 220, the following statement will return the value 14, which is the integer portion of 14.832..., the square root of 220.

```
answer = sqr num
```

Example 3

If more precision is required, multiply the argument by 100 or 10000. Using the example where “num” = 220 a value 148 is returned, which is 10 times the square root of 220.

```
answer = sqr (num * 100)
```

Alternately,

```
answer = sqr (num * 10000)
```

will return the value 1483, which is 100 times the square root of 220.

BIN2BCD, BCD2BIN

These commands let you convert back and forth between binary and “packed” binary coded decimal (BCD). A BCD number is one in which each decimal digit is represented by a 4 bit binary number (from 0 to 9). Packed BCD packs two 4 bit decimal digits in a single byte of memory.

For example, the decimal number 93 is represented in binary as:

Values	128	64	32	16	8	4	2	1
Binairy	0	1	0	1	1	1	0	1

The same number is expressed in packed BCD as:

Values	8	4	2	1	8	4	2	1
Binairy	1	0	0	1	0	0	1	1

Example
Assuming that “ans” is a byte variable and “num” has the decimal value of 93, the statement

```
answer = bin2bcd num
```

will set ans to a binary value of 10010011 (which is 93 in packed BCD).

RANDOM

Generates a 32 bit (Long) random number from the seed value. As with most random number generators, the random numbers generated will follow a predictable pattern, and each time the program is run the random number sequence will be the similar. The below code snippet will return a pseudo random set of numbers by re-seeding from the results:

```
seed var long

seed = 123456
seed = random seed
```

There are steps that can be taken to avoid repeating random number sequences. This is typically done using hardware based features. One common method is using an internal hardware timer for the seed value and asking the user to press a button at the beginning of a game. Each time the button is pressed the timer value will likely be different. Another method is reading an A/D pin that is left floating and near a noisy signal trace.

- (Subtraction)

Subtract a value from another value. The resulting number is not signed unless a signed variable is used. An example of subtraction:

```
time var byte
time = 100
time = time - 1
```

The variable time will now equal 99 since we subtracted 1 from 100.

+ (Addition)

Add one value to another value. The resulting number is not signed unless a signed variable is used. An example of addition:

```
time var byte
time = 100
time = time + 1
```

The variable time will now equal 101 since we added 1 to 100.

* (Multiplication)

Multiply one value by another value. The resulting number is not signed unless a signed variable is used. An example of addition:

```
time var byte
time = 100
time = time * 1
```

The variable time will now equal 100 since we multiplied 100 x 1.

/ (division)

Integer division discards fractional results. For example:

```
result = 76/7
```

will set the variable “result” to a value of 10. (The actual decimal result should be 10.857, but the decimal part is discarded, rounding is not done.) If your application requires fractional results you can use floating point numbers or the following solution.

Multiply the dividend by 10, 100, 1000 etc. before dividing. The result will gain extra digits of precision but must be interpreted correctly. Using the previous example we can gain three digits of precision as follows:

```
temp = dividend * 1000 ;dividend is now 76000
result = temp/7
```

Which sets “result” to a value of 10857.

** (Multiplication)

If two long variables or constants are multiplied, the result may exceed 32 bits. Normally, the multiply function will return the least significant (lowest) 32 bits. The ** function will, instead, return the most significant 32 bits.

```
time = 80000 ** 80000 ; result returns high 32 bits
```

The value of time would be equal to 0x1 which is the high 32 bits of the result 6,400,000,000.

*/ (fractional multiplication)

Fractional multiplication will multiply by a number with a fractional part. The multiplier must be a long value, and it is handled in a special fashion. The high 16 bits are the integer portion of the multiplier, the low 16 bits are the fractional part (expressed as a fraction of 65535). The result, of course, will be an integer; any fractional part is discarded (not rounded).

Example
Let us say we want to multiply the number 346 x 2.5. The multiplier must be constructed as follows: The high 16 bits will have a value of 2. We can do this with:

```
mult.highword = 2
```

The low 16 bits will have a value of half of 65535, or 32782, so:

```
mult.lowword = 32782
```

Then we do the fractional multiply:

```
a = 346 */ mult
```

which will give “a” the value 865. A similar procedure will let you multiply by any fraction; simply express that fraction with a denominator of 65535 as closely as possible.

Notice that half of 65535 is actually 32782.5; a number we can’t enter as the fractional part. This means that multiplication by exactly ½ is not possible. However, the difference is so small that it has no effect on the actual outcome of the integer result.

// (mod)

The mod function (short for “modulo”) returns the remainder after an integer division. So, for example, 13 modulo 5 is 3 (the remainder after dividing 13 by 5).

The mod function can be used to determine if a number is odd or even, as shown here:

```
x var word
     y var word
     (code that sets the value of x)
     y = x//2
     if y=0 goto even  ;zero indicates an even number
     if y=1 goto odd   ;one indicates an odd number
even
     (more code)
odd
     (more code)
```

Similarly, the mod function can be used to determine if a number is divisible by any other number.

MAX

The MAX function returns the smaller of two expressions. For example:

```
x var word
y var word
code to set value of y
x = y max 13
```

The example will set x to the value of y or 13, whichever is smaller. Think of this as “x equals y up to a maximum value of 13”.

MIN

The MIN function returns the larger of two expressions. For example:

```
x var word
y var word
code to set value of y
x = y min 9
```

The example will set y to the value of x or 9, whichever is larger. Think of this as “x equals y down to a minimum value of 9”.

DIG

The DIG (digit) function is used to isolate a single digit of a decimal number. For example:

```
x var word
y var byte
(code to set y)  ;say the result is y=17458
x = y dig 4      ;gives the 4th digit of y, which is 7
```

Digits are counted from the right, starting with 1. The DIG function will work with numbers in decimal format only. If you need to find a specific digit in a hex or binary number, use a variable modifier.

REV

The REV function works directly in binary, but the results may be expressed in any form. It is used to "reverse" the value of the low order bits of a number (i.e. change 0's to 1's and vice versa). Example:

```
x var byte
y var byte
x = %101110      ;this is decimal 46
y = x rev 3      ;gives g a value of %101001 or 41
```

<< (Shift Left)

The Shift Left operator shifts all the bits of a value to the left by a specified amount. Shifting left is the same as multiplying the value by 2 to the *n*th power. Bits shifted off the left end are lost. Zeros are added to the right for vacant bits. The example program will display the value of time before and after shifting left by 4. The results will be displayed in binary:

```
time var byte

serout sout, i9600,[bin time]
time = time << 4
serout sout, i9600,[bin time]
```

Important: The sign bit is not preserved so this function should not be used with signed numbers.

>> (Shift Right)

The Shift Right operator shifts all the bits of a value to the right by a specified amount. Shifting right is the same as dividing the value by 2 to the *n*th power. Bits shifted off the right end are lost. Zeros are added to the left for vacant bits. The example program will display the value of time before and after shifting right by 4. The results will be displayed in binary:

```
time var byte

serout sout, i9600,[bin time]
time = time >> 4
serout sout, i9600,[bin time]
```

Important: The sign bit is not preserved so this function should not normally be used with signed numbers.

& (AND)

The AND function is a logical operator and compares two values bit by bit. It sets the result to 1 if both matching bits are 1's. Or to 0 if either or both bits are 0's.

1 & 1 = 1
1 & 0 = 0
0 & 1 = 0
0 & 0 = 0

Value1	0	1	0	1	1	1	0	1
Value2	1	0	0	1	0	0	1	1
Result	1	0	0	1	0	0	0	1

One useful function for AND is to "mask" certain bits of a number. For example, if we are interested only in the low 4 bits of a number, and want to ignore the high 4 bits, we could AND the number with 00001111 as shown here:

Value1	0	1	0	1	1	1	0	1
Value2	0	0	0	0	1	1	1	1
Result	0	0	0	0	1	1	0	1

As you can see, the high 4 bits are now all set to 0's, regardless of their original state, but the low 4 bits retain their original state.

| (OR)

The OR function is a logical operator and compares two values bit by bit and sets the result to 1 if either or both of the matching bits are 1. Or to 0 if both bits are 0's.

1 | 1 = 1
1 | 0 = 1
0 | 1 = 1
0 | 0 = 0

Value1	0	1	0	1	1	1	0	1
Value2	1	0	0	1	0	0	1	1
Result	1	1	0	1	1	1	1	1

^ (Exclusive OR)

The Exclusive OR function is a logical operator and compares two values bit by bit and sets the result to a 1 if either but not both of the matching bits are 1. Or to 0 otherwise.

1 ^ 1 = 0
1 ^ 0 = 1
0 ^ 1 = 1
0 ^ 0 = 0

Value1	0	1	0	1	1	1	0	1
Value2	1	0	0	1	0	0	1	1
Result	1	1	0	0	1	1	1	0

&/ (AND NOT)

The AND NOT function is a logical operator and compares two values bit by bit and sets the result to a 1 if first bit is a 1 and the second bit is a 0. All other conditions will return a 0.

1 &/ 1 = 0
1 &/ 0 = 1
0 &/ 1 = 0
0 &/ 0 = 0

Value1	0	1	0	1	1	1	0	1
Value2	1	0	0	1	0	0	1	1
Result	0	1	0	0	1	1	0	0

|/ (OR NOT)

The OR NOT function is a logical operator and compares two values bit by bit and sets the result to a 1 if first bit is a 1 or the second bit is a 0. All other conditions will return a 0.

1 |/ 1 = 1
1 |/ 0 = 1
0 |/ 1 = 0
0 |/ 0 = 1

Value1	0	1	0	1	1	1	0	1
Value2	1	0	0	1	0	0	1	1
Result	0	1	1	1	1	1	0	1

^/ (XOR NOT)

The XOR NOT function is a logical operator and compares two values bit by bit and sets the result to a 1 if first bit is equal to the second bit. All other conditions will return a 0.

1 ^/ 1 = 1
1 ^/ 0 = 0
0 ^/ 1 = 0
0 ^/ 0 = 1

Value1	0	1	0	1	1	1	0	1
Value2	1	0	0	1	0	0	1	1
Result	0	0	1	1	0	0	0	1

= (Equal)

The Equal (=) is a logic operator and lets something be equal.

```
temp = temp + 1
```

The example code sets temp to equals its self plus 1.

<> (NOT Equal To)

The NOT Equal (<>) is a logic operator and compares if something is not equal to some value.

```
if temp <> 10 then
```

The conditional statement will check to see if temp is not equal to 10. If the value of temp is lower or greater the comparison returns false.

< (Less Than)

The Less Than (<) is a logic operator and compares if something is less than some value.

```
if temp < 10 then
```

The conditional statement will check to see if temp is less than 10. If the value of temp is lower the comparison returns true. Any value over a 10 will return a false.

> (Greater Than)

The Greater Than (>) is a logic operator and compares if something is greater than some value.

```
if temp > 10 then
```

The conditional statement will check to see if temp is greater than 10. If the value of temp is higher the comparison returns true. Any value from 0 to 9 will return false.

<= (Less Than or Equal To)

The Less Than or Equal To (<=) is a logic operator and compares if something is less than or equal to some value.

```
if temp <= 10 then
```

The conditional statement will check to see if temp is less than or equal to 10. If the value of temp is less than 10 or equal to 10 the comparison returns true. Any value from 11 and up will return a false.

>= (Greater Than or Equal To)

The Greater Than or Equal To (>=) is a logic operator and compares if something is greater than or equal to some value.

```
if temp >= 10 then
```

The conditional statement will check to see if temp is greater than or equal to 10. If the value of temp is greater than 10 or equal to 10 the comparison returns true. Any value from 0 to 9 will return a false.

AND

The AND operator is a logic comparison operator. It compares two conditions to make a single true or false statement. The AND operator will return a true only if both conditions are true. If one condition is false then a false is returned. The truth table demonstrates all combinations:

Condition 1	Condition 2	Result
True	True	True
True	False	False
False	True	False
False	False	False

The AND operator is used in decision making commands such as IF..THEN, DO..WHILE and so on. It differs from the & operator which is used in binary math functions. Example of the AND operator:

```
if minute = 10 AND hour = 1 then alarm
```

The conditional statement will check to see if both expressions are true before returning a true and jumping to the alarm label. If one of the expressions is not true a false is returned and the label is skipped. The IF..THEN only jumps to the label if the statement is true.

OR

The OR operator is a logic comparison operator. It compares two conditions to make a single true or false statement. The OR operator will return a true if one or both conditions are true. If both conditions are false then a false is returned. The truth table demonstrates all combinations:

Condition 1	Condition 2	Result
True	True	True
True	False	True
False	True	True
False	False	False

The OR operator is used in decision making commands such as IF..THEN, DO..WHILE and so on. It differs from the | operator which is used in binary math functions. Example of the OR operator:

```
if hour = 12 OR minute = 30 then ding
```

The conditional statement will check to see if either expressions is true before returning a true and jumping to the ding label. If both of the expressions are false the label is skipped. The IF..THEN only jumps to the label if the statement is true.

XOR

The XOR operator is a logic comparison operator. It compares two conditions to make a single true or false statement. The XOR operator will return a true if one but not both conditions are true. If both conditions are true or false then a false is returned. The truth table demonstrates all combinations:

Condition 1	Condition 2	Result
True	True	False
True	False	True
False	True	True
False	False	False

The XOR operator is used in decision making commands such as IF..THEN, DO..WHILE and so on. It differs from the ^ operator which is used in binary math functions. Example of the XOR operator:

```
if hour > 5 XOR hour = 5  then QuitTime
```

The conditional statement will check to see if either expressions is true before returning a true and jumping to the quittime label. If both of the expressions are false or true the label is skipped. The IF.. THEN only jumps to the label if the statement is true.

NOT

The NOT operator is a logic operator. It inverts a condition. When used true becomes false and false becomes true. The truth table demonstrates all combinations:

Condition	Result
True	False
False	True

The NOT operator is used in decision making commands such as IF..THEN, DO..WHILE and so on. Example of the NOT operator:

```
if hour = 5 then Quit_Time
if NOT hour < 5 then Over_Time
```

If hour is not equal to 5 the first conditional statement will skip quit_time. In the second conditional statement if hour is not less than 5 it jumps to the label over_time since the NOT operator inverted the result of the condition. The IF..THEN only jumps to the label if the statement is true.

Modifiers

Modifiers

In MBasic all values are received and store as binary. Modifiers were created for formatting the data used in commands that have input or output (SERIN / SEROUT). The modifiers are useful for formatting data being printed to a terminal window. All characters are represented in ASCII. Modifiers format the ASCII values to display properly based on the modifier used.

An example of a command modifier is formatting a decimal value. The decimal value 21 which is represented in binary as %00010101 would output to a terminal window as 9 separate ASCII characters. Not something that would be readable if printed to a terminal window. Instead to display the actual decimal value of the variable you would use the DEC modifier:

```
Temp Var Byte
Temp = 4

serout s_out, i9600, [DEC TEMP]
```

The code snippet above would display the value of temp which is set to 4. If the DEC modifier wasn't used a string of characters would be displayed representing the binary value. Several modifiers are input only modifiers such as WAIT which would cause a input command to wait until the received data matches a specified string.

Some modifiers have two variants. In SBIN the "S" stands for signed. Where in IBIN the "I" represents the indicated. The indicator is the symbol used to indicate the numeric type such as binary (%) or hexadecimal ($).

Modifiers can be used with the following commands:

Output Modifiers	Input Modifiers
DEBUG	DEBUGIN
I2CIN	I2COUT
OWIN	OWOUT
SERIN	SEROUT
HSERIN	HSEROUT
LCDREAD	LCDWRITE
READDM	WRITEDM
DTMFOUT	
DTMFOUT2	

Output modifiers can also be used to modify array variables:

```
string var byte(100)

string = "Hello World" ;string(0-10)="Hello World"
string = dec 1234567   ;string(0-6)="1234567"
string = ihex 0x3456   ;string(0-4)="$3456"
```

Modifiers

Name	Input	Output	Description
DEC	x	x	Decimal.
SDEC	x	x	Signed decimal.
HEX	x	x	Hexadecimal.
SHEX	x	x	Signed hexadecimal.
IHEX	x	x	Indicated ($) hexadecimal.
ISHEX	x	x	Signed and indicated ($) hexadecimal.
BIN	x	x	Binary.
SBIN	x	x	Signed binary.
IBIN	x	x	Indicated (%) binary.
ISBIN	x	x	Indicated (%) and signed binary.
REP		x	Repeat character *n* times.
REAL	x	x	Floating point number with decimal point.
STR	x	x	Read or write specified amount of characters and store in an array.
SKIP	x		Skip specified amount of characters.
WAIT	x		Wait for specified amount of characters.
WAITSTR	x		Compares specified amount of characters to array.

DEC

The DEC modifier formats stored values to decimal. The example will format *temp* so it prints as a decimal value in a terminal window. The output would display 4.

```
temp var byte
temp = 4

serout s_out, i9600, [DEC temp] ;prints 4
```

SDEC

The SDEC modifier formats values to a signed decimal. This means if a number is negative it will be lead by a - symbol. The example will format *temp* so it prints as a signed decimal value in a terminal window. The output would display a signed value of -4.

```
temp var sbyte
temp = -4

serout s_out, i9600, [SDEC temp] ;prints -4
```

HEX

The HEX modifier formats stored values to hexadecimal. The example will format *temp* so it prints as a hexadecimal value in a terminal window. The output would display 31 in hex (1F).

```
temp var byte
temp = 31

serout s_out, i9600, [HEX temp] ;prints 1F
```

SHEX

The SHEX modifier formats stored values to signed hexadecimal. The example will format the data in *temp* so it prints as a signed hexadecimal value in a terminal window. The output would display -31 as a signed hex value (-1F).

```
temp var sbyte
temp = -31

serout s_out, i9600, [SHEX temp] ;prints -1F
```

IHEX

The IHEX modifier will format a stored value to hexadecimal and add an indicator. The example will format the data in *temp* so it prints as a hexadecimal value with an indicator ($) in a terminal window. The output would display 31 as a signed hex value with its indicator ($-1F).

```
temp var byte
temp = 31

serout s_out, i9600, [ISHEX temp] ;prints $-1F
```

ISHEX

The ISHEX modifier formats stored values to a signed hexadecimal with indicator. The example will format the data in *temp* so it prints as signed hexadecimal value with an indicator ($) in a terminal window. The example would display -31 as a signed hex value with its indicator ($-1F).

```
temp var byte
temp = -31

serout s_out, i9600, [ISHEX temp]
```

BIN

The BIN modifier formats stored values to binary. The example will format *temp* so it prints as a binary value in a terminal window. The output would display 00011111.

```
temp var byte
temp = 31

serout s_out, i9600, [BIN temp] ;prints 00011111
```

SBIN

The SBIN modifier formats stored values to signed binary. The example will format the data in *temp* so it prints as a signed binary value in a terminal window. The output would display a signed binary value of -00011111.

```
temp var sbyte
temp = -31

serout s_out, i9600, [SBIN temp] ;prints -0001111
```

IBIN

The IBIN modifier will format a stored to value binary and add an indicator. The example will format the data in *temp* so it prints as a binary value with an indicator (%) in a terminal window. The output would display %000111.

```
temp var byte
temp = 31

serout s_out, i9600, [ISBIN temp] ;prints %0001111
```

ISBIN

The ISBIN modifier formats stored values to a signed binary with indicator. The example will format the data in *temp* so it prints as signed binary value with an indicator (%) in a terminal window. The example would display -31 as a signed binary value with its indicator (-%000111).

```
temp var sbyte
temp = -31

serout s_out, i9600, [ISBIN temp] ;prints %-000111
```

REP

The REP modifier will output the character *n* a specified number of times. The example will repeat the specified character “A” 10 times.

```
serout s_out, i9600, [REP “A”\10] ;prints A 10 times
```

REAL

The REAL modifier will converts a floating point value to ASCII characters, including sign and decimal point. The number after REAL specifies how many digits to display from the left of the decimal point. The number after *temp* specifies how many digits to the right of the decimal point.

```
temp var float
temp = 123.123
serout s_out, i9600, [REAL2 temp\2] ;prints 23.12
```

STR

The STR modifier will output *n* amount of characters (Hello World) from specified constant or variable array until the end of the array or until a specified end character is found (0). STR modifier can also be used to load data input a variable array.

```
temp var byte(20)
temp = “Hello world”,0

serout s_out,i9600,[str temp\20\0] ;output “Hello world”
```

SKIP

The SKIP modifier will skip *n* amount of characters.

```
serin s_in,i9600,[SKIP 10 temp] ;skip the first 10 values recevied
```

WAIT

The WAIT modifier will wait *n* amount of characters. The characters are always a string.

```
serin s_in,i9600,[WAIT “Hello World”] ;wait for “Hello world”
```

WAITSTR

The WAITSTR modifier will wait *n* amount of characters comparing them to an array. The characters are always a strings.

```
temp var byte(10)
temp = “hello”,0

serin s_in,i9600,[waitstr temp\5\0]
```

Command Reference

The following section outlines the syntax and general use of each command supported in MBasic. Not all commands support all Atom processors. Each command indicate what processors are supported with a simple “Supported” list. The supported processor list use abbreviations to indicate each processor family.

Supported List Abbreviations

Abbreviation	Description
BA	All BasicATOM modules and Nano X chips.
BAN	Only standard Nano chips.
BAP	BasicATOM Pro One, 24m and 28m modules.
BAP40	BasicATOM Pro 40m and ARC32.

Syntax

The syntax for each command is given in the command reference section. In addition Basic Micro Studio has built in syntax help. As a command is typed Basic Micro Studio will show the syntax for that command as its being typed.

ADIN

Syntax
adin pin, result

- **Pin** - is a variable or constant that specifies the pin to use for the analog reading. Must be analog capable pin.

- **Result** - is a variable used to store the analog results.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The ADIN command directly access the built-in analog hardware. The analog hardware can read any analog voltage from 0 to 5VDC. This will give 1024 positions. GND = 0 and 5V = 1023. Depending on the module type you are using the speed at which analog samples are performed varies. This is rates in samples per second. Each processors analog pins differ. See the table below.

Analog Capable Pins

Processor	Pins
Nano 18	P6 to P11
Nano 28	P0 to P5 and P16 to P20
Nano 40	P0 to P5 and P24 to P31
Atom 24m	AX0, AX1, AX3
Atom 28m	P16 to P19
Atom 40m	P24 to P31
AtomPro One	P0 to P3
AtomPro 24m	P0 to P3
AtomPro 28m	P0 to P3 and P16 to P19
AtomPro 40m	P0 to P3 and P28 to P31

Notes
1. The ADIN conversion must complete before the program will process the next command. This hap pens in the micro second range. The AD conversion typically takes around 8 micro seconds.
2. The ADIN command only works with pins that are analog capable.
3. The analog pins for each module or Nano are listed in its corresponding data sheet and differ from module to module.

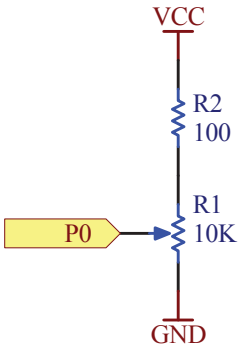
Examples

Run the example and connect to the terminal window at 9600. The ADIN command will read the analog pin P0 (AtomPro 28m) and print the result to the screen. Connect a potentiometer to P0 as shown in the schematic. You can connect any analog source and run the sample program.

```
;The analog pin number will change depending on module type

Pot var word

Main
     adin P0, pot ;read analog pin P0, load result into POT
     serout s_out, i9600, [0, "Analog Value = ", dec pot]
     Pause 50
Goto Main
```

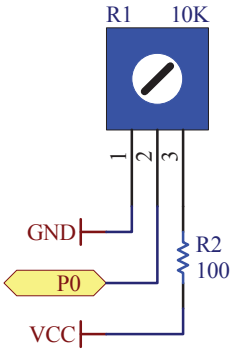
Schematic

The schematic is setup to use a potentiometer of 10K. Any value can be used. R2 the 100 ohm resistor is to prevent from shorting ground to power. Depending on what processor you are using you may need to change P0 to a different analog pin.



Schematic

This second schematic is basically the same as the first but shows an actually pot and how it would be wired up.R2 the 100 ohm resistor is to prevent from shorting ground to power. Depending on what processor you are using you may need to change P0 to a different analog pin.



ADIN16

Syntax
adin16 pin, result

- **Pin** - is a constant, variable or expression of an analog capable pin. See table from ADIN.
- **Result** - is a word sized variable where the analog to digital sample will be store.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
ADIN16 was create to generate a more accurate reading from the analog to digital hardware. The typical A/D reading has a value range of 0 to 1024. ADIN16 drastically improves this by is using an over sampling which results in a higher resolution A/D range. It sets up the A/D converter and stores the sum of 64 conversions in a result variable. The result variable will contain a 16 bit sum of all the conversions. This value can be used as a 16 bit resolution A/D reading which will be some what noisy. The noise can be cleaned up by right shifting the value to get to lower resolutions but with better readings that a standard A/D value.

Notes
1. 64 readings are taken which increase the time need to produce a result. Since the A/D is hardware base it has no affect on the processor as the conversion happens in the back ground.

Example
The following example will load the result into the variable temp then right shift it 4 times. This gives an A/D range of 0 to 4096 which is 4x better than a standard 0 to 1024 reading.

```
temp var word

main
     adin16 p0,temp
     temp = temp>>4 ;temp will hold a 12bit decimated A/D conversion
     serout s_out,i9600,["Conversion = ",dec temp,13]
     pause 100
goto main
```

Schematic
See ADIN.

BRANCH

Syntax
branch index, [label1, label2, label3]

- **Index** - is a variable, constant or expression. It is used to reference a label in a list.

- **Label -** is a list of constant labels that are jump points in a program

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The BRANCH command will jump to a label defined within the brackets. The label used for the jump is determined by the pointer *index*. The only limit to the amount of the labels within the brackets are program memory.

Notes
1. Labels are read from left to right with label1 as position 0.
2. If a label is specified in the BRANCH command and not used in the program, an error will result during compile.

Examples

Connect to the following program with the terminal window at 9600 baud. Enter a value from 0 to 4. The program will jump to the label specified by the value typed in. The BRANCH command is a great way to build a long conditional jump list based on some value range. User interactive menu systems are one idea.

```
;ALL - all_branch.bas

Index var word


Main
     Pause 1500
     serout s_out, i9600, [0, "Where should I jump to 0 to 4 ? -> "]
     Serin s_in, i9600, [dec Index]

     branch index, [label0, label1, label2, label3, label4]

Goto Main


Label0
     serout s_out, i9600, [13, "Label 0"]
     Goto Main

Label1
     serout s_out, i9600, [13, "Label 1"]
     Goto Main

Label2
     serout s_out, i9600, [13, "Label 2"]
     Goto Main

Label3
     serout s_out, i9600, [13, "Label 3"]
     Goto Main

Label4
     serout s_out, i9600, [13, "Label 4"]
     Goto Main
```

BUTTON

Syntax
button pin, downstate, delay, rate, workspace, targetstate, label

- **Pin** - is a variable or constant that specifies the pin to be used. The pin specified will be set to an input when the command runs.

- **Downstate** - is a variable or constant that specifies what state the pin should be to considered as a button press. High = 1 or Low = 0.

- **Delay** - is a byte sized variable or constant (0-255) that specifies the number of loops to execute before enter the auto repeat function (*rate*). Delay is the debounce function of the BUTTON com mand. If *delay* = 0 the command will run once with and *rate* is ignored. If *delay* = 255 the com mand will repeat 255 times but *rate* is ignored. Any value in between 1 - 254 will execute both debounce and *rate*.

- **Rate** - is a byte sized variable or constant (0-255) that specifies the number of loops to execute after delay has expired. This is the auto repeat function and only executes after delay has decre mented to 0.

- **Workspace** - is a byte sized variable (0-255) that is an internal counter that tracks how many times the command has been run. Internally its set by delay, then rate and is decremented each loop through the command. A unique workspace variable must be created for each BUTTON command used in the program.

- **Targetstate** - is a byte sized variable or constant and determines what state the button must be in before the BUTTON command will jump to the *label*. 1 = pressed and 0 = not pressed. If target state is set to 1 (Pressed), the command will jump to the label if the button is pressed. Otherwise the next line of code is executed.

- **Label** - is where the command will jump to based on targetstate. If targetstate = 0 (Not Pressed) then the jump to *label* is made when no button press is detected. If targetstate = 1 (Pressed) then the jump to *label* is made when a button press is detected.

Supported
- BA - Supported. X samples per second.
- BAN - Supported. X samples per second.
- BAP - Supported. X samples per second.
- BAP40 - Supported. X samples per second.

Description
The BUTTON command when ran will first look at downstate and determine if Pin must be high (1) or low (0) to consider a button is in a pressed state. After a button is determined pressed, the command loads the delay value into the workspace variable. Any time a mechanical switch or button is pressed there is a tiny vibration within the device. This vibration will appear to a microcontroller I/O pin as several on / off cycles. To eliminate this unwanted noise we debounce the press using a delay. Once the delay value it loaded into workspace the command will look at the targetstate and either jump to the label or move onto the next line of code. This is the first time the command has run.

The BUTTON command must be nested inside of a loop to perform properly. This is typically accomplished with a GOTO statement. If a button press has occurred, the BUTTON command will then look at the state of pin again. With each pass through decrementing workspace. This cycle is repeated for as many times as delay was set to. At the end of this cycle, if pin is still consider pressed the button command acts on a pressed state.

Notes

1. The BUTTON command is non blocking. Each run through it will either jump to label or allow pro gram execution to begin on the next line.
2. The BUTTON command automatically sets a pin to an input and will leave it in that state.

Examples

Connect to the following program with the terminal window set to 9600 baud. The BUTTON command is setup for an active low (Downstate = 0) on P0 and P1. Connect an active low button as shown in the below schematics. If a button press is detected on P0 or P1 its results are printed to the screen as “P0 = Pressed” or “P1 = Pressed”. Once a button press is no longer detect the program returns to the main loop.

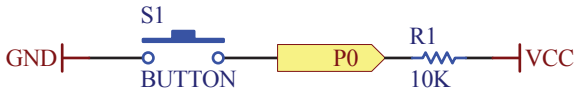
Targetstate is set to 1 (Pressed). When the command does not detect a press state the next line of code is ran. Which in this case is a SEROUT command used to clear [0] the terminal screen. If a button press is detect the BUTTON command will jump to label (pressed1, pressed2). Once at label, which button was pressed is printed to the screen.

```
;ALL - all_button.bas

Workspace1 var byte
Workspace2 var byte

;watch P0 and P1 for an active low button press.
;clear the screen if no button press is detected.
;if button is pressed jump to label and tell
;us about it.


Main
     button P0,0,80,40,workspace1,1,pressed1
     serout s_out, i9600, [0]

     button P1,0,80,40,workspace1,1,pressed2
     serout s_out, i9600, [0]

goto main

pressed1
     ;button press on P0 has been detected, print it to the sceen.
     serout s_out, i9600,[0,”P0 = Pressed”]
     pause 300
goto main

pressed2
     ;button press on P1 has been detected, print it to the sceen.
     serout s_out, i9600,[0,”P1 = Pressed”]
     pause 300
goto main
```

Schematics

The first schematic is consider an active low setup. This means the pin is pulled high and the switch is normally open. When the switch is pressed it shorts the pin to GND. The switch is now “active”.

Active Low



The second schematic is consider an active high setup. This means the pin is pulled low and the switch is normally open. When the switch is pressed it shorts the pin to VCC. The switch is now “active”.

Active High

CLEAR

Syntax
clear

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The clear command sets all user memory to zeros. This includes variables and any command which relies on user accessible memory. The CLEAR function is typically used in the beginning of a program to set all memory to a know state. In some situations CLEAR is used in place of several statements like variable = 0.

Notes
1. The CLEAR command will reset the buffers used in several hardware based commands such as HSERIAL and HSERVO. If the command is issued in the middle of program execution and data held in the buffers of these commands will be clear to all zeros.

Examples
Connect to the following program with the terminal window set to 9600 baud. The CLEAR command sets all variables and user memory to a known state before normal program execution begins. In some cases if your program is randomly restarted you would want to eliminate the potential for any random values left in user memory to interfere with normal operation. The following program demonstrates what happens to all defined variables after a CLEAR command is issued.

```
;ALL - all_clear.bas

Dog var byte
Cat var byte
Mop var byte
Top var byte

Dog = 1
Cat = 2
Mop = 3
Top = 4

Main
     pause 600
     serout s_out,i9600,[0,"Variables before CLEAR command: "]
     serout s_out,i9600,[13, "Dog = ", dec dog]
     serout s_out,i9600,[13, "Cat = ", dec cat]
     serout s_out,i9600,[13, "Mop = ", dec mop]
     serout s_out,i9600,[13, "Top = ", dec top]
     pause 1000

     CLEAR

     serout s_out,i9600,[13, 13, "Variables after CLEAR command: "]
     serout s_out,i9600,[13, "Dog = ", dec dog]
     serout s_out,i9600,[13, "Cat = ", dec cat]
     serout s_out,i9600,[13, "Mop = ", dec mop]
     serout s_out,i9600,[13, "Top = ", dec top]

End
```

COUNT

Syntax
count pin, time, cycles

- **Pin** - is a variable or constant that specifies which input pin to use. The pin is automatically set to input mode.
- **Time** - is a variable, constant or expression that specifies the amount of time to count *pin*.
- **Cycles** - is a variable in which the total count is stored.

Supported
- BA - Supported. Minimum pulse width 3.4us.
- BAN - Supported. Minimum pulse width 8.5us.
- BAP - Supported. Minimum pulse width 1.5us.
- BAP40 - Supported. Minimum pulse width 1.5us.

Description
The COUNT command is used to count low to high transition (0-1-0). It will count a low-high-low as 1 cycle. COUNT is a blocking command and will only count the *pin* for the specified time. The COUNT command can be used to calculate the speed of a motor from an optical encoder. Or it can be used to determine lower range frequencies.

Notes
1. Each module has a different minimum resolution, see supported chart.
2. Each module has a maximum speed it can count, see supported chart.
3. A cycle is considered a low-high-low transition.

Examples
Connect to the following program with the terminal window set to 9600 baud. Pull-up P0 with a 10K resistor. Use a jumper wire with one end connected to ground. Short P0 with the jumper wire. See how many cycles you create. Each loop through the COUNT command will count for 1 second. Then print the results to the terminal window. Repeating forever.

```
;ALL - all_count.bas

cycles     var Word
time var Word

;lets count the low-high-low transitions on P0 for 1 second
;save the results to the variable cycles, then print it to
;the terminal window. Pull-up P0 with a 10K resistor. Short
;P0 to ground with a small wire and see how many cycles you
;can create per loop.

time = 1000
cycles = 0

Main
     ;lets count the low-high-low transitions for a second
     count p0, time, cycles
     pause 500

     ;lets print the results to the terminal window
     serout s_out, i9600, ["Count = ", dec cycles,13]
goto main
```

DEBUG

Syntax
debug [{modifiers}data1,...,{modifiers}data2]

- **Data** - is a variable, constant or expression of data that will be display in the debug output window

- **Modifiers** - supports most all output modifiers. See Output Modifiers table below. For additional information regarding modifiers see the Modifier section of this manual.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Output Modifiers

Name	Description
DEC	Decimal.
SDEC	Signed decimal.
HEX	Hexadecimal.
SHEX	Signed hexadecimal.
IHEX	Indicated ($) hexadecimal.
ISHEX	Signed and indicated ($) hexadecimal.
BIN	Binary.
SBIN	Signed binary.
IBIN	Indicated (%) binary.
ISBIN	Indicated (%) and signed binary.
REP	Repeat character *n* times.
REAL	Floating point number with decimal point.
STR	Read specified amount of characters from an array.

Description
The DEBUG command is a simplified version of a SEROUT command. It works only to help debug a program. Once the DEBUG command is used the results will be printed to the debug window only when the target processor has been programmed using the Debug mode in Studio.

Notes

1. The debug command is only included in your final code when your program is compiled using the DEBUG function in Basic Micro Studio.

2. The debug output window expects all output to be in ASCII. If variables are output directly without modifiers, their values will be truncated to 8bits and interpreted by the terminal window as ASCII characters, which may give unexpected results.

3. On a BasicATOM Pro module debug supports a subset of the standard command output modifiers: DEC,HEX,BIN and REAL.

4. The Debug Output window accepts terminal window formatting commands.

Terminal Window Commands

Decimal Character	Command	Description
0	CLS	Clears the screen.
1	HOME	Moves cursor home.
3	MOVE LEFT	Moves cursor left.
4	MOVE RIGHT	Moves cursor right.
5	MOVE UP	Moves cursor up.
6	MOVE DOWN	Moves cursor down.
7	BELL	Make sound on PC.
8	BACK SPACE	Moves cursor back and delete.
9	HANDLE TAB	Add a standard tab.
10	LINEFEED	Move cursor to next line.
11	CLEAR RIGHT	Clear anything to the right of the cursor.
12	CLEAR DOWN	Clear anything below the cursor.
13	CARRIAGE RETURN	Move to the next line.

Example

The following example will out debug information to the debug window. The processor must be programmed using the Debug function of Basic Micro Studio.

```
value var long
fvalue var float

main
     value = value + 1
     fvalue = fvalue + 0.1

     debug ["Dec Value=",dec value," "]
     debug ["Hex Value=",hex value," "]
     debug ["Bin Value=",bin value," "]
     debug ["Real Value=",real fvalue,13]

goto main
```

DEBUGIN

Syntax
debugin [{modifiers}data1,...,{modifiers}data2]

- **Modifiers** - supports most all input modifiers. See Input Modifiers table below. For additional information regarding modifiers see the Modifier section of this manual.

- **Data** - is a variable where data sent from the debug window will be stored.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Input Modifiers

Name	Description
DEC	Decimal.
SDEC	Signed decimal.
HEX	Hexadecimal.
SHEX	Signed hexadecimal.
IHEX	Indicated ($) hexadecimal.
ISHEX	Signed and indicated ($) hexadecimal.
BIN	Binary.
SBIN	Signed binary.
IBIN	Indicated (%) binary.
ISBIN	Indicated (%) and signed binary.
REAL	Floating point number with decimal point.
STR	Read or write specified amount of characters and store in an array.
SKIP	Skip specified amount of characters.
WAIT	Wait for specified amount of characters.
WAITSTR	Compares specified amount of characters to array.

Description
Accepts keyboard input from the Debug Output window from Basic Micro Studio. The debug window is only available if the processor was programmed using the debug button. After a debug session is complete the processor needs to be reprogrammed using the normal program button otherwise it will not function properly.

Note
1. The DEBUGIN command is only included in your final code when your program is compiled using the DEBUG function in Basic Micro Studio.
2. In the absence of modifiers DEBUGIN assigns each keystroke to a single variable.
3. On a BasicATOM Pro processor DEBUGIN supports a subset of the standard input modifiers, DEC,HEX,BIN and REAL.

Example

The following example will send and receive data from the debug window. The processor must be programmed using the Debug function of Basic Micro Studio.

```
value var long
fvalue var float

debug [“Enter the starting integer value:”]
debugin [dec value]
debug [“Enter the starting real value:”]
debugin [real fvalue]

main
     value = value + 1
     fvalue = fvalue + 0.1

;output to Debug window using the DEC,HEX,BIN and REAL modifiers
     debug [“Dec Value=”,dec value,” “]
     debug [“Hex Value=”,hex value,” “]
     debug [“Bin Value=”,bin value,” “]
     debug [“Real Value=”,real fvalue,13]
goto main
```

DO - WHILE

Syntax
do
        program statements
while condition

- **Statements -** any group of commands to be run inside the loop.
- **Condition** - can be a variable or expression

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The DO - WHILE loop executes commands nested inside of it will some condition is true. The condition can be any variable or expression that is tested every loop until it is false.

Notes
1. In the programming world 0 is consider false. By default DO - WHILE will test this condition. If a stand alone variable is used for the test the loop will continue until its value equals 0.
2. DO - WHILE will always run at least once since the condition is checked last in the loop.
3. You can nest multiple DO - WHILE commands within each other. However you can not nest DO - WHILE with a WHILE - WEND together or the compiler will get the WHILE statements confused.

Example
Connect to the following program with the terminal window set to 9600 baud. The program will start counting up from 0 to 100. Once index reaches a value of 100 the condition is no longer true. The less than symbol < was used for the condition and 100 is no longer less than 100 making the condition false. Since DO - WHILE loops while a statement is true the program exits.

```
;ALL - all_do_while.bas

Index var word


Main
     Index = 0

     Do
     index = index + 1
     serout s_out, i9600,[0, "Counting: ", dec index]
     pause 75

     While index < 100 ;repeat until index is no longer less than 100

     serout s_out, i9600, [13,13, "Index = ", dec index]
     serout s_out, i9600, [13, "My condition is no longer true."]
     serout s_out, i9600, [13, "Index is no longer less than 100"]
End
```

Example

Connect to the following program with the terminal window set to 9600 baud. The program will start counting down from 100 until it equals 0. Once index = 0 the program will quit because the condition is no longer true since 0 = false. In programming 0 is always considered false. If a condition is tested and the results equal 0 then a false is returned.

```
;ALL - all_do_while2.bas

Index var word


Main
     Index = 100

     Do
     index = index - 1
     serout s_out, i9600,[0, "Counting: ", dec index]
     pause 75

     While index ;repeat until index is 0, which is a false expression

     serout s_out, i9600, [13,13, "Index = ", dec index]
     serout s_out, i9600, [13, "My condition is no longer true."]
     serout s_out, i9600, [13, "Index is now false"]
End
```

DTMFOUT

Syntax
dtmfout pin,{ontime,offtime,}[tone1, tone2]

- **Pin -** is a variable, constant or expression that specifies the I/O pin to use. The pin will be set to an output during tone generation. After tone generation is complete the pin will be set to an input.
- **Ontime -** is an optional variable, constant or expression that specifies the duration of each tone in milliseconds. If not specified, default is 200 ms.
- **Offtime -** is an optional variable, constant or expression that specifies the length of silence after each tone in milliseconds. If not specified, default is 50 ms.
- **Tone** - is a constant, variable or expression that specifies the tone to be generated. Tone can be any length. Valid value ranges are 0 to 15. See Tone table below.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Tone Table

Value	Pins
0 to 9	Digits 0 through 9
10	* (Star)
11	# (Pound)
12	A
13	B
14	C
15	D

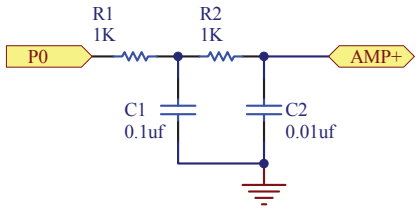
Description
DTMFOUT is used to generate the standard 16 tones for phone lines. It can also be used to control any radio device that supports DTMF tones. The tones are generated by mixing internally two sine waves that were created mathematically. The results are then internal used to control the duty cycle of a PWM signal. The resulting sound must be filtered to remove the digitization that is created when the tones are generated.

Notes
1. In order for the tones to be recognized by the receiving device the output must be filtered.

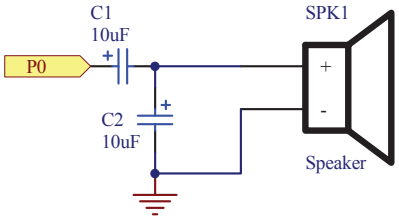
Schematic

There are a few ways to filter and interface devices to the processor used to create the DTMF tones. A speaker can be driven directly. A simple filter circuit can be used. Also shown is a method for connection the processor directly to a phone line.

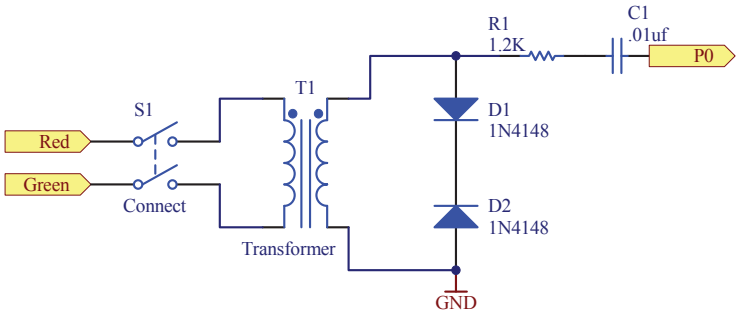
Passive Low Pass Filter



Direct Drive Speaker



Phone Line Interface



Example

The simple example program will dial out to Basic Micros main number using the phone line interface circuit.

```
main
     dtmfout p0,200,50,[8,0,0,5,3,5,9,1,6,1]
     pause 1000
goto main
```

DTMFOUT2

Syntax
dtmfout2 Lpin\Hpin,{ontime, offtime,}[tone1, tone2]

- **Lpin** - is a variable, constant or expression that specifies one of two I/O pins to used.
- **Hpin** - is a variable, constant or expression that specifies one of two I/O pins to used.
- **Ontime** - is an optional variable, constant or expression (0 – 65535) that specifies the duration of each tone in milliseconds. If not specified, default is 200 ms.
- **Offtime** - is a an optional variable, constant or expression (0 – 65535) that specifies the length of silence after each tone in milliseconds. If not specified, default is 50 ms.
- **Tone** - is a constant, variable or expression that specifies the tone to be generated. Tone can be any length. Valid value ranges are 0 to 15. See Tone table below.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

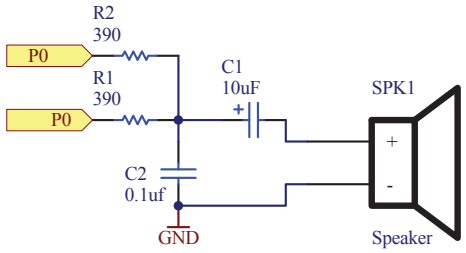
Tone Table

Value	Pins
0 to 9	Digits 0 through 9
10	* (Star)
11	# (Pound)
12	A
13	B
14	C
15	D

Description
DTMFOUT2 uses square waves instead of sine waves like DTMFOUT. This will create cleaner tones that need less filtering. DTMFOUT2 will generate the standard 16 tones for phone lines. It can also be used to control any radio device that supports DTMF tones. The tones are generated by created two square waves and out putting each on a separate pin. The results are then internal used to control the duty cycle of a PWM signal. The resulting sound should be filtered to remove the digitization that is created when the tones are generated.

Schematics

The schematic can be used to combine the two pins into one out put without shorting each other. The speaker can be replaced with a filter or phone line interfacing circuit.



Example

The simple example program will dial out to Basic Micros main number using the phone line interface circuit.

```
main
     dtmfout2  p0\p1,200,50,[8,0,0,5,3,5,9,1,6,1]
     pause 1000
goto main
```

END

Syntax
end

Supported
- BA - supported
- BAN - supported
- BAP - supported
- BAP40 - supported

Description
END stops program execution until a reset occurs. All I/O pins will remain in their last known state. Typically END is used at the very end of a program to halt all processes and cleanly shut down operation.

Example
The following example will only run once. The program will only restart if reset is pressed of the power is cycled.

```
value var long

serout s_out,i9600,[“This program just ends”,13]
serout s_out,i9600,[“Press reset to see it again.”,13]
end
```

EXCEPTION

Syntax
exception label

- **label** - is the label to continue execution from.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
Since Mbasic allows nested GOSUB...RETURN commands in some cases you may need to return to a specific label and clear the last GOSUB call. The EXCEPTION command will exit and return to the label specified, in doing so it will clear any return addresses from the stack.

Notes
1. Any RETURN data in your GOSUB loop will be lost.

Examples
The following example will print to the terminal window at 9600 baud. The EXCEPTION command is used to exit the second nested GOSUB and return to the label main

```
Mode var byte
Serout s_out,i9600,["Starting",13]

Main
     Serout s_out,i9600,["Main",13]
     Mode = mode + 1
     Gosub mysub1
     Serout s_out,i9600,["Returned from MySub1",13]
Goto main

Mysub1
     Serout s_out,i9600,["Entering MySub1",13]
     Gosub mysub2
     Serout s_out,i9600,["Returned from MySub2",13]
Return

Mysub2
     Serout s_out,i9600,["Entering MySub2",13]
     If(mode.bit0)then
     Serout s_out,i9600,["Exception back to Main",13]
     Exception main
Endif
Return
```

See Also:
GOSUB
RETURN

FATAN2

Syntax
fatan2 xval\yval,variable

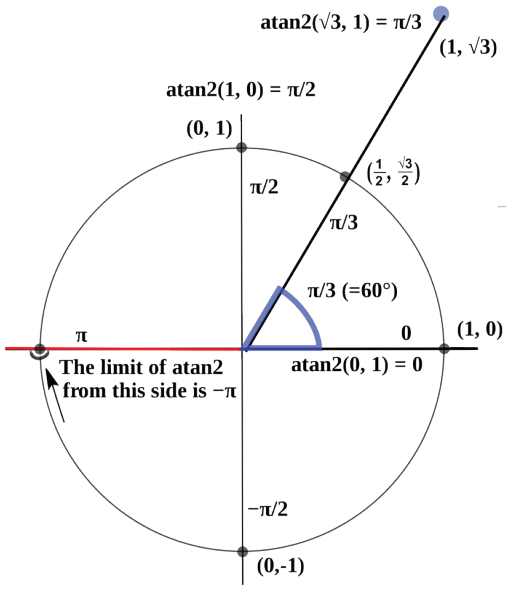
- **Xval** - is a variable, constant or expression that specifies the X coordinate in radians
- **Yval** - is a variable, constant or expression that specifies the Y coordinate in radians
- **Results** - is a variable the result will be stored in. This variable should be defined as a floating point variable.

Supported
- BA - Not Supported
- BAN - Not Supported
- BAP - Supported
- BAP40 - Supported

Description
FATAN2 calculates the four quadrant ArcTangent of the specified X and Y values given. FATAN2 can be used to calculate the angle in +/- 180 degrees based on an X / Y coordinate. All results are given in radians. This function is typically used when calculating Inverse Kinematics.

Example
The example calculates the solution for the graph shown. Where X = 1/2 and Y= √3/2 the result of FATAN2 would be 1.0471. To get the exact degree you would then take result (1.0471 x 180) / π = 60 ˚.

```
result var float

Main
     fatan2 0.886\0.5,result
     serout s_out,i9600,[real result,13]
     pause 100
goto Main
```



Source: ATAN2 Wikipedia

FOR...NEXT

Syntax

```
for countVal = startVal to finishVal {step increment}
   ...code...
next
```

- **CountVal** - a variable used to store the current count
- **StartVal** - the starting value to count from
- **FinishVal** - a value to count up or down to
- **Increment** - the value to increment the variable by through each loop

Supported

- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description

Repeats a block of instructions and increments a variable counter with a value specified each time through the loop. The FOR...NEXT loop will exit when the count value is no longer between start and finish.

Notes

1. When no step increment is defined the default increment value is 1.
2. When the increment is positive the start must be less than or equal to finish or the FOR..NEXT loop will be skipped entirely.
3. If the increment is negative the start value must be greater then or equal to finish or the FOR... NEXT loop will be skipped entirely.
4. If variable is modified by the instructions in the FOR...NEXT block the loop can be forced to exit early.

Example
The below example will print the results to a terminal window at 9600 baud. It will count up from 0 to 9 then exit.

```
value var long


main
     for value = 0 to 9
     pause = 1000
     serout s_out,i9600,["Value=",dec value,13]
next
end
```

Example
The below example will print the results to a terminal window at 9600 baud. It will count down from 0 to 9 then exit.

```
value var long

main
     for value = 9 to 0 step -1
     pause = 1000
     serout s_out,i9600,["Value=",dec value,13]
next
end
```

Example
The below example will print the results to a terminal window at 9600 baud. It will count up from 0 to 54 using 5 as the increment then exit.

```
value var long

main
     for value = 0 to 54 step 5
     pause = 1000
     serout s_out,i9600,["Value=",dec value,13]
next
end
```

FREQOUT

Syntax
freqout pin, duration, freq1{,freq2}

- **Pin** - is a variable, constant or expression that specifies the I/O pin to be used. This pin will be set to output mode during tone generation and left in that state after output is completed.
- **Duration** - is a variable, constant or expression that specifies the duration of the output tone in milliseconds.
- **Freq1** - is a variable, constant or expression that specifies the frequency in Hz of the first tone which can be between 0 – 32767Hz.
- **Freq2** - is an optional variable, constant or expression that specifies the frequency in Hz of the second tone which can be between 0 – 32767Hz.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
This command generates one or two tones that are output on a single I/O pin. The signal generated is a pulse width modulated signal. This command can be used to create music, tones or general output signals. The maximum supported range is limited to what is practical. There aren't many speakers or piezo devices on the market that will work well outside of 30Khz. Which is why MBasic is limited to a high of 32Khz.

Notes
1. The tones are generated mathematically and output as a pulse width modulated (PWM) signal. The signal must be converted to a sine wave (or a pair of sine waves) by passing it through an integrator which is a low pass filter.

Example
The code snippet will generate a 1000Hz tone for 5 seconds on P1.

```
freqout p1, 5000, 1000
```

Now let's generate two tones 1000Hz and 2000Hz for 5 seconds on P1.

```
freqout p1, 5000, 1000, 2000
```

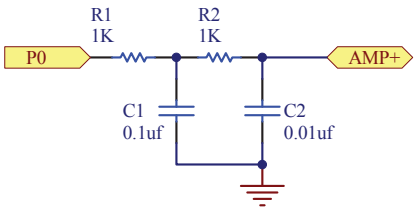
The next program will increment through several tones holding each for 3 seconds. Try adjusting the initial values tone1 and tone2 are set to. Each loop through the program tone1 will increment by 500 and tone2 will increment by 750.

```
tone1 var long
tone2 var long
clear

main
tone1 = tone1 + 500
tone2 = tone2 + 750
     freqout p0, 3000, tone1, tone2
Goto Main
```

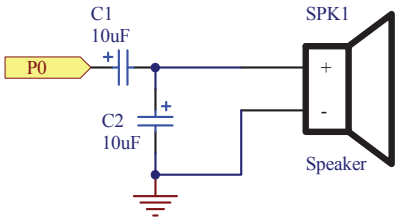
Schematics

The sine wave output from FREQOUT is generated using a high frequency PWM. The higher frequency need to be filtered to generate a cleaner tone. There are a number of way this can be accomplished. The following circuits are provided as examples. P1 is used but any specified pin can be connected.

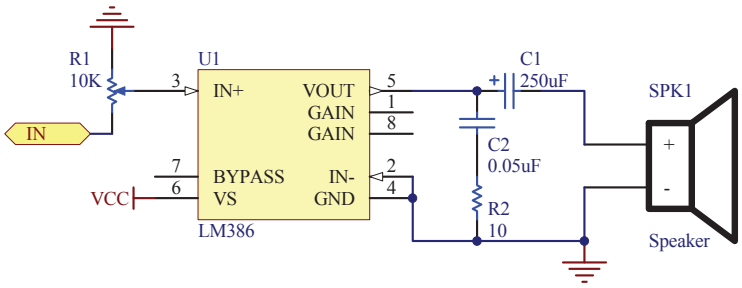
Passive Low Pass Filter



Direct Speaker



Simple Audio Amplifier



GOSUB

Syntax
gosub label{[argument1,...,argument2]}{,DataResult}

- **Label** - the go to label of the subroutine to be execute.
- **Argument** - is user defined arguments to send to the called subroutine. The only limit to the amount of arguments used is program memory.
- **DataResult** - is an optional variable to store the value returned from called subroutine.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The GOSUB command will jump to a specified label. After executing the code at the jump label a RETURN command is then used to return the program to the next command after the last called GOSUB.

If your familiar with some BASIC languages there is typically a limit to what is called nesting. This is where multiple GOSUB...RETURN statements are nested inside of each other. There is no limit to this with Studio.

GOSUB stores the address of the next command on the stack and jumps to the specified label. User specified arguments can be defined in the subroutine and a return value from the subroutine called can be stored in variable that is then loaded into the GOSUB DataResult argument.

Notes
1. Subroutines should exit via the RETURN command, which clears the saved address from the stack and returns to the command following the GOSUB. Do not use BRANCH or GOTO when exiting a subroutine.
2. User defined arguments must match the number of arguments defined at the subroutine. If they do not match, a stack overflow or underflow will happen.
3. If subroutines returns a value the GOSUB is not required to use it or specify a return value variable

Example

The below program will print the results to the terminal window at 9600 baud. The results will be 110. The GOSUB command has to arguments and includes DataResult variable. The values 10 and 100 are passed to the subroutine MyAdd. The values are then loaded into the variables *arg1* and *arg2*. Since RETURN can have an expression the variables *arg1* and *arg2* are added and returned to the variable *result*.

```
Result var long

Main
     Gosub myadd[10,100],result
     Serout s_out,i9600,["Result =",dec result]
End

Arg1 var long
Arg2 var long

MyAdd [arg1,arg2]
Return arg1+arg2
```

See Also

RETURN
EXCEPTION

GOTO

Syntax
goto label

- **Label** - is a label the program will jump to.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The GOTO command tells the program to jump to some label. You can use as any labels you want except reserved words and variables or constants defined in your program.

Notes
1. Can not use reserved words or variables.

Examples
Connect to the following program with the terminal window set to 9600 baud. The following program is a simple loop using GOTO that will repeat for ever.

```
;Demo Program - GOTO.bas

basic
     Pause 800
     serout s_out,i9600,[0, "Basic"]
     pause 800
     goto micro
     goto basic

micro
     serout s_out,i9600,[2, " Micro"]
     pause 800
     Goto rules
     goto basic

rules
     serout s_out,i9600,[2, " Rules!"]
     pause 800
     goto basic
```

HIGH

Syntax
high pin

- **PIN** - is a variable, constant or expression that specifies which pin to go high.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The HIGH command is an output command that will set a pin HIGH. All pins can be in 3 states. HIGH, LOW and FLOAT (input). The HIGH command will change any of these states to an output and set the pin HIGH (5VDC)

Notes
1. If a variable is used, the variables value will be directly translated into a pin. If the variable equals 0 then P0 will go high. If the value is out of range to the pins that are present nothing will happen. If you have 10 pins and the variable equals 11 then nothing will happen.

Examples
The following program is a simple loop using HIGH and LOW commands that will repeat for ever. If you connect an LED to P0 it will blink at half second intervals forever.

```
;ALL - all_high.bas

Main
     High p0
     Pause 500
     Low p0
     Pause 500
     Goto Main
```

HPWM

Syntax
hpwm pin,period,duty{,wait}

- **Pin** - hardware capable PWM pin number. See table below.
- **Period** - the time in clock cycles for a single pulse (high and low part).
- **Duty** - the time in clock cycles for the high side of the pulse.
- **Wait** - an optional boolean (true or false) argument that will cause the command to wait until the current pulse has finished before setting the new period and duty. This eliminates the possibility of a glitch in the pulses.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

HPWM Capable Pins

Processor	Pins
Nano 18	P3
Nano 28	P9 / P10
Nano 40	P9 / P10
Atom 24m	P9 / P10
Atom 28m	P9 / P10
Atom 40m	P9 / P10
AtomPro One	P4 / P5 / P6
AtomPro 24m	P10 / P11 / P12
AtomPro 28m	P10 / P11 / P12
AtomPro 40m	P9 / P10 / P11 / P13 / P14 / P15

Description
The HPWM command is generates a pulse width modulated signal. HPWM is based on internal hardware and is processor independent. Meaning it will run in the back ground while your program performs additional task. HPWM has several use some of which are generating an analog voltage, DC motor control, servo control or generating a frequency.

To create an analog voltage the pin is transitioned from high to low. During the transitions leaving the pin high for a certain amount of time versus low and then averaging the output will cause a voltage change. If the pin was high (5V) 50% of the time and then low (0V) the other 50% the voltage output would be around 2.5V. By adjusting how long the pin is high or low we can control the output voltage with a simple RC circuit.

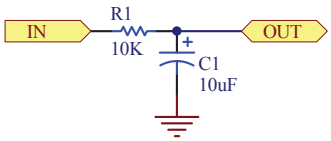
The number of high to low transitions is called the duty cycle. The higher the duty cycle the higher the overall output voltage would be. Period specifies how long a pulse is. A pulse is made up of one high to low transition. So the period specifies the frequency. When dealing with generating an along voltage using the RC circuit the duty and period will determine at what voltage and how much current the circuit can provide. The limiting factor being the processor its self.

Notes

1. Nano and BasicATOM processors the highest Period allowed is 16383
2. BasicATOM Pro processors the highest Period is 524287.

Schematic

The schematic is a simple RC filter. The resistor and capacitors values can be changed to affect the final output. The RC values shown on average at 50% Duty will generate 2.5V depending on load at the output of the circuit.

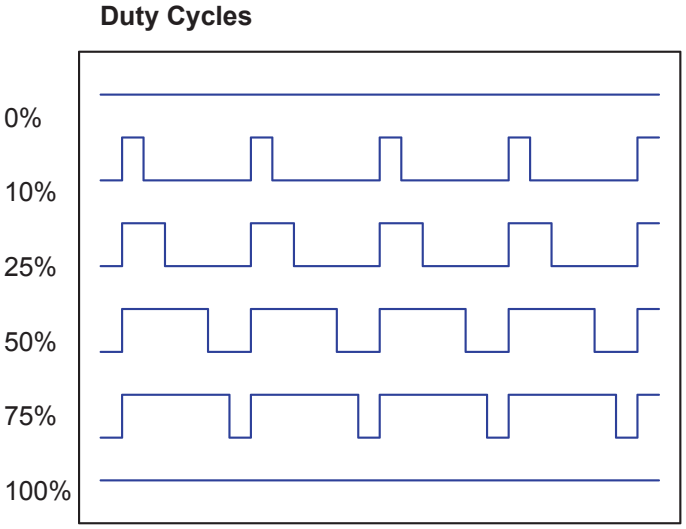


The code snippet will generate a 50% duty cycle. Which with no load will output 2.5V on the output side of our RC filter. Build the circuit, run this program and attach a volt meter probe to the output. Try adjusting the duty cycle to see the results.

```
hpwm p10, 10000, 5000
```

Duty Cycles

The following chart is what the signal would look like on an oscilloscope at specific duty cycles. This will give you an idea of what the duty cycles look like. You can see their on times. More on time would be mean more charge for our RC circuit which would increase its output voltage. At 0% duty cycle the pin is always low. At 100% duty cycle the pin is always high.



HSERIN

Syntax
hserin uart, {tlabel, timeout,}[{modifiers} InputData,{modifiers} InputData2]

- **UART** - is an optional argument on a 1 UART processor. It is a constant of 1 or 2 that specifics what UART to use. See HSERIAL Pin table below.
- **Tlabel** - is an optional label the program will execute from if the time out value is exceeded. Tlabel must be specified if a Timeout value is set.
- **Timeout** - is an optional constant, variable or expression that specifies the time in milliseconds to wait for data to be received.
- **Modifiers** - supports most all input modifiers. See Input Modifiers table below. For additional information regarding modifiers see the Modifier section of this manual.
- **InputData** - is a constant, variable or expression that incoming data will be stored. The only limit to the amount of InputData variables in the list is the amount of user ram on the processor. The incoming data can be formatted with optional input modifiers. See the Modifier section of this manual.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
HSERIN / HSEROUT use a special hardware feature called a UART. The UART allows the processor to perform other task while receiving or sending serial data. The hardware runs in the background and is processor independent. Data that is received, is stored in a buffer, regardless of what the processor is doing. The HSERIN / HSEROUT commands then retrieve this data from the buffer. Some processors have two UARTS that run independent of each other. The UART output is inverted. Which is setup to work with a RS232 circuit. Non inverted mode is not support. A simple inverter circuit could be used if needed. For all HSERIN / HSEROUT capable pins see the table below.

HSERIAL Capable Pins

Processor	HSEROUT (TX)	HSERIN (RX)	HSEROUT (TX2)	HSERIN (RX2)
Nano 18	P5	P2		
Nano 28	P14	P15		
Nano 40	P14	P15		
Atom 24m	P14	P15		
Atom 28m	P14	P15		
Atom 40m	P14	P15		
AtomPro One	S_OUT	S_IN		
AtomPro 24m	P15	P14		
AtomPro 28m	P15	P14		
AtomPro 40m	S_OUT	S_IN	P15	P14
ARC32	S_OUT	S_IN	P26	P38

SETHSERIAL

MBasic must create a buffer in memory for each UART and specify the baud rate for the UART. The directive SETHSERIAL sets the available parameters for the specified UART. This is only required once at the beginning of a program. There are two UARTs available on some processors. To set UART1 use SETHSERIAL1 and to set UART2 use SETHSERIAL2.

The SETHSERIAL1 directive is used to set UART1 as shown below.

```
sethserial1, baudrate {,databits, parity, stopbits} ;Set UART1
```

The SETHSERIAL2 directive is used to set UART1 as shown below.

```
sethserial2, baudrate {,databits, parity, stopbits} ;Set UART2
```

Baud Rate

SETHSERIAL is also used to set the baud rate for HSERIAL. The other arguments shown below are optional. They are typically set when attached to a proprietary device. Rarely would these be set when communicating to a PC.

- **Baudrate** - is a predefined value that specifies the transmit and receive rate. Different processors support different baud rate. See Supported Baud Rate table.
- **DataBits** - is an optional argument that defines how many bits are used. The default is 8. See Supported Options table.
- **Parity** - is an optional argument that sets what the parity bit is. No parity, even parity or odd parity are supported. The default is no parity (N). See Supported Options table.
- **Stopbits** - is an optional argument that specifies 1 or 2 stop bits in the serial format. The default is 1. See Options table.

Options

DataBits	Parity	StopBits
H8DATABITS	HNOPARITY	H1STOPBIT
H7DATABITS	HEVENPARITY	H2STOPBIT
	HODDPARITY	

Multiple UARTs

When two UARTS are available they can be setup independently of each other. The UARTS can be set to different or the same baud rates. The second UART is only available on some processors. See HSERIAL table. To setup both UARTS follow the example below:

```
sethserial1, H9600     ;Sets UART 1 to 9600 Baud
sethserial2, H38400    ;Sets UART 2 to 38400 Baud
```

Example

The following example is a loop back. Wire the TX pin to the RX pin. It will receive and send to its self to demonstrate how the buffer of the UARTS. Unlike normal SERIAL commands the HSERIAL commands do not need to be running to receive data. Its done in the background.

```
sethserial1 h57600

string var byte(20)
integer var long

main
     hserout [“Type a string upto 20 characters long and hit enter”,13]
     hserin [str string\20\13]
     hserout [“You string is: “,str string\20\13,13]

     hserout [“Type a decimal number and hit enter”,13]
     hserin [dec integer]
     hserout [“Your number is:”,dec integer,13]
     hserout [“Your number in Hexidecimal is:”,hex integer,13]
     hserout [“Your number in Bianry is:”,bin integer,13]

goto main
```

Supported Baud Rates

BAP	Error
H300	0.16%
H600	0.16%
H1200	0.16%
H2400	0.16%
H4800	0.16%
H7200	0.64%
H9600	0.16%
H12000	0.79%
H14400	0.79%
H16800	0.79%
H19200	0.16%
H21600	0.64%
H24000	0.79%
H26400	0.32%
H28800	2.12%
H31200	0.16%
H33600	0.79%
H36000	0.79%
H38400	0.16%
H40800	2.12%
H45600	0.32%
H50400	0.79%
H55200	0.64%
H62400	0.16%
H72000	0.79%
H81600	2.12%
H84000	0.79%
H98400	1.63%
H100800	0.79%
H55555	0.00%
H62500	0.00%
H71428	0.00%
H83333	0.00%
H100000	0.00%
H125000	0.00%
H166666	0.00%
H250000	0.00%
H500000	0.00%

BAP40	Error
H300	0.16%
H600	0.16%
H1200	0.16%
H2400	0.16%
H4800	0.16%
H7200	0.22%
H9600	0.16%
H12000	0.16%
H14400	0.94%
H16800	0.55%
H19200	1.36%
H21600	0.22%
H24000	0.16%
H26400	1.36%
H28800	1.36%
H31200	0.16%
H33600	2.10%
H36000	2.12%
H38400	1.73%
H40800	2.12%
H45600	2.10%
H48000	0.16%
H52800	1.36%
H57600	1.36%
H62400	0.16%
H69600	0.22%
H76800	1.73%
H79200	1.36%
H88800	0.55%
H91200	2.10%
H103200	0.94%
H105600	1.36%
H69444	0.00%
H78125	0.00%
H89285	0.00%
H104166	0.00%
H125000	0.00%
H156250	0.00%
H208333	0.00%
H312500	0.00%
H625000	0.00%

BA	Error
H2400	0.16%
H4800	0.16%
H7200	0.22%
H9600	0.16%
H12000	0.16%
H14400	0.22%
H16800	0.55%
H19200	0.16%
H21600	0.22%
H24000	0.16%
H26400	0.74%
H28800	0.94%
H31200	0.16%
H33600	0.55%
H36000	0.79%
H38400	1.36%
H57600	1.36%
H115200	1.36%

BAN	Error
H600	0.16%
H1200	0.16%
H2400	0.16%
H4800	0.16%
H7200	0.64%
H9600	0.16%
H12000	0.79%
H14400	0.79%
H16800	0.79%
H19200	0.16%
H21600	0.64%
H24000	0.79%
H26400	0.32%
H28800	2.12%
H31200	0.16%
H33600	0.79%
H36000	0.79%
H38400	0.16%

HSEROUT

Syntax
hserout [{modifiers}data1,...,{modifiers}data2]

- **Modifiers** - supports all output modifiers. See Input Modifiers table below. For additional information regarding modifiers see the Modifier section of this manual.

- **Data** - is a variable where data sent from the debug window will be stored.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
HSERIN / HSEROUT use a special hardware feature called a UART. The UART allows the processor to perform other task while receiving or sending serial data. The hardware runs in the background and is processor independent. Data that is received, is stored in a buffer, regardless of what the processor is doing. The HSERIN / HSEROUT commands then retrieve this data from the buffer. Some processors have two UARTS that run independent of each other. The UART output is inverted. Which is setup to work with a RS232 circuit. Non inverted mode is not support. A simple inverter circuit could be used if needed. For all HSERIN / HSEROUT capable pins see the table below.

HSERIAL Capable Pins

Processor	HSEROUT (TX)	HSERIN (RX)	HSEROUT (TX2)	HSERIN (RX2)
Nano 18	P5	P2		
Nano 28	P14	P15		
Nano 40	P14	P15		
Atom 24m	P14	P15		
Atom 28m	P14	P15		
Atom 40m	P14	P15		
AtomPro One	S_OUT	S_IN		
AtomPro 24m	P15	P14		
AtomPro 28m	P15	P14		
AtomPro 40m	S_OUT	S_IN	P15	P14
ARC32	S_OUT	S_IN	P26	P38

Notes
Most of the information for HSEROUT would simply be duplicated from HSERIN. See HSERIN.

HSERVO

Syntax
hservo [pin\pos\spd, pin1\pos1\spd1]

- **Pin** - are constants, variables or expressions that specify the pin numbers connected to servos.
- **Pos** - are constants, variables or expressions that specify the desired positions for each of the specified servos (range –12000 to +12000).
- **Spd** - are constants, variables or expressions that specify the speed used to move each servo to its new position (default 255).

Supported
- BA - NOT Supported.
- BAN - NOT Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
HSERVO uses a back ground hardware system to control one or several servos at a time. HSERVO is a non blocking command. Program execution will continue as normal while the command is executed. HSERVO can control the position and the speed of up to 32 servos. Before using this command the ENABLEHSERVO compile time directive must be included in your program.

Notes
1. Analog servos may need to be deactivated. To accomplish this set its position to –24000 on the BAP 24 and BAP 28 modules and to -30000 on the BAP 40 module.
2. Each servo position should be initially set with a speed of 0(or no speed at all) the first time a given servo is positioned. If the speed argument is used on a servo that has not had it's initial position set the servo may behave erratically during the first HSERVO command.

Example
The example HSERVO program is a very basic program that will control 2 servos connected to P0 and P1 of the microcontroller you are using.

```
ENABLEHSERVO

hservo [p0\0,p1\0] ;set initial servo positions(centered)

main
     hservo [p0\1000\100,p1\-1000\100]
     pause 1000
     hservo [p0\-1000\100,p1\1000\100]
     pause 1000
goto main
```

HSERVO System
The HSERVO system has several supporting commands that can be used to control the interaction between the program and the servo. The following commands require the HSERVO system is loaded using the directive.

HSERVOWAIT
hservowait [pin#,pin#,pin#]

In come situations it may be necessary to wait for the HSERVO command to finish updating the servo position before program execution resumes. The HSERVOWAIT command is used to delay program execution until HSERVO has finished updating the servos specified.

Example
The example will pause program execution until servos attached to PO through P4 are finished being updated to new positions.

```
hservowait [p0,p1,p2,p3,p4]
```

HSERPOS
hservopos pin

To determine the last position a particular servo was set to using HSERVO the HSERPOS command is used. It will return the position last given to a specified servo. The value returned is the position the HSERVO system believes the servo is at. Typically there is no feedback from a servo for true position.

Example
The example sets a word sized variable and loads it with the last position used for a servo attached to P0.

```
temp var word
temp = hservopos p0
```

HSERVOIDLE
hservoidle pin

To determine if a servo is still being updated by HSERVO the HSERVOIDLE command is used. It will return a value of 0 if the servo specified is not idle. If the specified servo is still being updated a value not equal to 0 (0xFFFFFFFF)

Example
The example will update a servo on PO. The program will loop and report until the servo is idle.

```
hservo [p0\0]
pause 1000
hservo [p0\1000\100]

main
     if (hservoidle p0) then
     serout s_out,i9600,[“Servo P0 is not idle”,13]
     end
     endif
goto main
```

IF...THEN...ELSEIF...ELSE...ENDIF

Simple Syntax
if *expression* then label
if *expression* then goto label
if *expression* then gosub label

Extended Syntax
if *expression* then
  ...code...
endif

if *expression* then
  ...code...
else
  ...code...
endif

if *expression* then
  ...code...
elseif *expression*
  ...code...
endif

if *expression* then
  ...code...
elseif *expression*
  ...code...
else
  ...code...
endif

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
IF..THEN are the decision makers of MBasic. It evaluates a condition to determine if it is true. If you want to test the value of a variable against another variable or a known value you would use the IF.. THEN. When the results are true the code after THEN is executed. If it returns false the code after THEN will be ignored. A simple example would be to increment a variable in a loop and each time through the loop test if our variable equals 10. This lets us control how many times through the loop we want to run. We can also test if our variables is greater than, less than or even not equal too. Several math expressions can be used as the condition to test.

```
main
if temp = 10 then label
goto main
```

The above statement is looking for our variable temp to equal 10. If it is true then we will jump to label. If its not true then lets keep looping. Since there is nothing to make our variable equal to 10 this loop would run forever.

Notes
1. Multiple ELSEIF blocks may be used in a single IF...THEN block.
2. ELSE will only execute following code if no conditions were true.
3. ENDIF is required to close a block of conditionals.

Example
This first example demonstrates using the IF...THEN argument with a go to label. If something is true jump to the label after the THEN statement. Otherwise, if the condition is false execute the commands on the next line after the THEN statement. You can follow the program flow with a terminal window connected at 9600 baud.

```
value var long
value = 0

main
     value = value+1
     if value = 10 then reset

     ;display the value on the PC terminal window
     serout s_out,i9600,["Value=",dec value,13]
     pause 1000
goto main

reset
     value = 0
goto main
```

GOSUB Example
A GOSUB statement can be used after a THEN. When the condition is true a GOSUB will send the program to the GOSUB label. Eventually a RETURN statement is expected. This will return the program to the next line of code after the GOSUB statement was used. Its an easy way to create conditional branching in a main program loop. The program will increment value by 1 each loop through. Once value is equal to 10 the condition becomes true and the GOSUB label is executed. Which in turns resets value to 0 starting the process over. This program was design to be followed using a terminal window connected to it at 9600 baud. Follow the results until you understand the decision making process. Can you guess what the terminal window will show?

```
value var long
value = 0

main
     value = value+1
     if value = 10 then gosub reset

     ;display the value on the PC terminal window
     serout s_out,i9600,["Value=",dec value,13]
     pause 1000
goto main

reset
     value = 0
return
```

Advance Arguments

Now that we understand the basics of IF..THEN we can explore optional arguments. The optional arguments may not make sense at first. The next section will explain each with sample code that will display the result so you can follow along.

ENDIF Example

Not always will you want to jump to a label or GOSUB. In some cases you may want to run a block of code when the condition is true. MBasic can execute a command or commands directly after the THEN statement instead of jumping to a label. The ENDIF is used to tell MBasic run the following commands after THEN if the condition is true. So ENDIF literately mean what it says, lets end the IF. When the IF..THEN condition is false ENDIF tells MBasic to instead, run the commands after ENDIF. This simply resumes normal program operation. ENDIF is an easy way to execute a group of commands based on some condition returning true or completely skipping them if the condition is false. This program was design to be followed using a terminal window connected at 9600 baud. See if you can you guess the results?

```
value var long
value = 0

main
     value = value+1
     if value = 10 then
     value = 0
endif

     ;display the value on the PC terminal window
     serout s_out,i9600,["Value=",dec value,13]
     pause 1000
goto main
```

ELSEIF Example

In some cases you may want to test another condition or several conditions for true, which the ELSEIF lets MBasic test several conditions for true before executing a blocks of code. This is no real limit other than program memory on how many conditions can be tested in one IF..THEN argument. So now we understand how a true lets the next group of commands after the THEN statement be executed or skipped if the condition returns false. Now we want to check a second condition in the same IF..THEN argument. To do this we would use an ELSEIF statement after the group of commands that will be executed if the first condition returns true. This can be repeated as many times as you want. A simple example is shown.

```
if temp = 10 then
temp = 20
elseif temp = 20
temp = 10
endif
```

Assuming our variable temp equals 10 when the program starts, the first condition will return true. This causes the statements after THEN to be executed. Now our variable equals 20. The ELSEIF will now test the condition following it. Temp was set to 20 previously. This now means the ELSEIF condition would return true. The next statements are executed, setting temp back to 10. The ENDIF tells MBasic we are done with the decision making and resume normal program operating on the next line.

ELSEIF can be repeated several times with no real end. If ELSEIF returns a false MBasic will look for the next ELSEIF and test its condition until either the program is forced to jump out of the IF.. THEN or an ENDIF is found. The next program is an example of several ELSEIF with true conditions. The last ELSEIF will always return false causing the variable value to never reset to 0. The program will execute once since several of the ELSEIFs will be true at the beginning. But on the second loop through they will all be false since value is equal to 4. This program was design to be followed using a terminal window connected at 9600 baud. See if you can you guess the results?

```
value var long
value = 0

main
     if value = 0 then
     value = 1

     elseif value = 1
     value = 2

     elseif value = 2
     value = 3

     elseif value = 3
     value = 4

     elseif value = 10
     value = 0
endif

     ;display the value on the PC terminal window
     serout s_out,i9600,["Value=",dec value,13]
     pause 1000
goto main
```

ELSE

So we tested a bunch of conditions and everything was false which means the program will resume normal operation, skipping any code found enclosed with in the IF..THEN / ENDIF statements. Even though everything was false we may want to run one block of code before exiting the IF..THEN statements. We do this with ELSE. If everything is false, ELSE tells MBasic to go ahead and run these commands, but only if everything ELSE was false. It does exactly what it says, ELSE. This program was design to be followed using a terminal window connected at 9600 baud. See if you can you guess the results?

```
value var long
value = 0

main
     if value = 1 then
     value = 1

     elseif value = 2
     value = 2

     else
     value = 3

endif

     ;display the value on the PC terminal window
     serout s_out,i9600,[“Value=”,dec value,13]
     pause 1000
goto main
```

INPUT

Syntax
input pin

- **Pin** - is any expression, constant or variable that specifies an input capable pin to use.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
In order for a pin to “see” something from the outside world we need to set it as an input. When a pin is set as an input, it can be read as 1 (high) or 0 (low). All input based commands will automatically set the pins state and after execution leave the pin in an input state. During start up all pins are in an input state. Typically the INPUT statement would be used in the beginning of your program to set specific pins to known states.

Notes
1. On power up, all pins by default are inputs.

Example
Connect to the running program example below using the terminal window set to a baud rate of 9600. As the program runs it will print the state of pins 0 to the terminal window. P1 is then set high and the first report is P0 set as a 1 (high). Next command sets it to an input and P0 is now 0 (low). P1 is then set back to an output. Since its last known state was high it will return to this state when set to an output again so P0 will read 1 (high) again. See if you can follow the program flow to see when the pin state changes.

```
;Connect p0 to p1

Input p0
     High p1 ;Set P1 to an output and high
     Serout s_out,i9600,[“P0 state is “,dec IN0,13]
     Pause 1000

Input p1
     Serout s_out,i9600,[“P0 state is “,dec IN0,13]
     Pause 1000

;Set P1 high, will remember its last set state
Output p1
     Serout s_out,i9600,[“P0 state is “,dec IN0,13]
     Pause 1000
```

I2COUT

Syntax
i2cout sda, scl, controlbyte, [addressbyte1, addressbyte2, {modifiers}databytes]

- **SDA** - is a variable or constant that defines the serial data pin (SDA).
- **SCL** - is a variable or constant that defines the serial clock pin (SCL).
- **ControlByte** - is a byte sized variable or constant (0-255) that sets the device ID and the device address of the I2C device.
- **AddressByte1** - is a byte sized variable or constant (0-255) that specifies the address in a byte addressing i2c scheme. In word sized i2x addressing schemes it specifies high byte.
- **AddressByte2** - is a byte sized variable or constant (0-255) that specifies the low byte of a word sized i2x addressing scheme. *AddressByte2* can be ignored in a byte size address scheme.
- **Modifiers** - supports all output modifiers. See modifier section of this manual.
- **DataBytes** - is a list of byte sized variables or constant with optional modifiers that store the values to be written or sent to an attached I2C device. The only limit to the number of data bytes in one command is the device its self.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The I2COUT command is generic to all I2C devices and not specific to I2C EEPROMs. There are many I2C devices available as the I2C format is fairly popular. The *controlbyte* is used to indicate the device type and address (A0,A1,A2). The high nib (reading from left to right, first 4 bits in a byte) control the device type ID. An I2C EEPROM would be %1010. This information is typically found in the device data sheet. The next 3 bits represent A0, A1, A2 pins and if they are set high or low. The last bit can be ignored.

A *controlbyte* of %10100000 indicates a device type ID of 1010 for I2C EEPROM, The next 3 zeros indicate A0, A1 and A2 are tied to ground for address 000. The last bit is ignored.

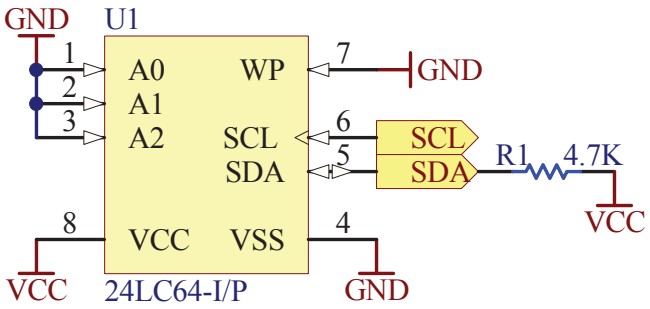
I2C devices can use byte addressing or word addressing. Refer to the device data sheet to determine which is used. If byte addressing is used you can ignore addressbyte2. If word sized addressing is used then both *addressbyte1* and *addressbyte2* are required. An 24LC01 EEPROM utilizes byte addressing and a 24LC32 uses word sized addressing.

Notes

1. To read or write any I2C device an I2COUT command must be used to specify the address.
2. I2C devices other than I2C EEPROM will have a different device type ID.
3. A0, A1 and A2 are the physical address pins. If only 1 device exist on the I2C buss, address pins are connected to GND.
4. More than one I2C device can be on the same SDA and SCL pins. Each device requires a unique address by changing A0,A1 and A2 pins.
5. Some I2C EEPROM internally use A0, A1 and A2 to change memory banks. Commonly 24LC04 (24C04) and 24LC08 (24C08).

Schematic

The schematic illustrates how to connect an I2C EEPROM for use with the sample code. A0,A1 and A2 are all tied to GND. This sets the device address to 000. WP is the write protect pin and can not be left floating. SCL is the clock pin and SDA is the data pin. For low speed EEPROM 10K pull-up resistor will work. However for faster I2C devices you may need to increase this value up to 1K.



Examples

Connect to the following program with the terminal window set to 9600 baud. The program will write to the first 10 bytes of a 24LC01 EEPROM using byte addressing. Each loop *databyte* is added by 7. The values that will be written are 0, 7, 14, 21, 28, 35, 42, 49, 56 and 63. The loop pauses so you can see the data being printed to the screen.

```
;ALL - all_i2c_byte.bas

;This program will write and read to the first
;10 locations of a 24LC01 I2C eeprom using
;byte address.

databyte var byte
address var byte

databyte = 0
address = 0

pause 500

main
     serout s_out, i9600, [13, "Writing:",13]

     for address = 0 to 9

     i2cout p0, p1, %10100000, [address, databyte]
     Serout s_out, i9600, [dec address, " = ", dec databyte, 13]
     databyte = databyte + 7
     pause 100
     Next

           databyte = 0
           address = 0
           pause 100
           serout s_out, i9600, [13, "Reading:",13]

     for address = 0 to 9

     i2cout p0, p1, %10100000, [address]
     i2cin p0,p1, %10100000, [databyte]
     serout s_out, i9600, [dec address, " = ", dec databyte, 13]
     pause 100
     next

     end
```

I2CIN

Syntax
i2cin sda, scl, controlbyte, [{modifiers}databyte1,...,{modifiers}databyte2]

- **SDA** - is a variable or constant that defines the serial data pin (SDA).
- **SCL** - is a variable or constant that defines the serial clock pin (SCL).
- **ControlByte** - is a byte sized variable or constant (0-255) that sets the device ID and the device address of the I2C device.
- **Modifiers** - readdm supports all input modifiers. See modifier section of this manual.
- **DataBytes** - is a list of byte sized variables or constant with optional modifiers that store the values read from an attached I2C device. The only limit to the number of data bytes in one command is the device its self.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The I2CIN command is generic to all I2C devices and not specific to I2C EEPROMs. There are many I2C devices available as the I2C format is fairly popular. The *controlbyte* is used to indicate the device type and address (A0,A1,A2). The high nib (reading from left to right, first 4 bits in a byte) control the device type ID. An I2C EEPROM would be %1010. This information is typically found in the device data sheet. The next 3 bits represent A0, A1, A2 pins and if they are set high or low. The last bit can be ignored.

A *controlbyte* of %10100000 indicates a device type ID of 1010 for an I2C EEPROM, The next 3 bits are set to zeros which indicates address pins A0, A1 and A2 are tied to ground for address 000. The last bit is ignored.

Notes
1. To read or write any I2C device an I2COUT command must be used to specify the address.
2. I2C devices other than I2C EEPROM will have a different device type ID.
3. A0, A1 and A2 are the physical address pins. Typically if only 1 device exist on the I2C buss the address pins are all tied to GND.
4. You can connect several I2C EEPROM together on the same SDA and SCL pins by changing the A0,A1 and A2 address pins.
5. Some I2C EEPROM internally use A0, A1 and A2 to change memory banks. Commonly 24LC04 (24C04) and 24LC08 (24C08).

Examples
See I2COUT.

Examples

Connect to the following program with the terminal window set to 9600 baud. This next example will write to the first 10 locations of a 24LC512 using word sized addressing. A*ddress* is set as a word sized variable. For the *address1* and *address2* we use a high and low byte pointer to load the address values from *address*. Each loop we add 7 to *databyte* which is what we are writing to the EEPROM. The values written are 0, 7, 14, 21, 28, 35, 42, 49, 56 and 63. The program will print to the terminal window what it is writing and then what is being read. If the values above are not returned then you have a bad EEPROM or you don't have something wired correctly (see schematic).

```
;ALL - all_i2c_word.bas

;This program will write and read to the first
;10 locations of a 24LC512 I2C eeprom using
;word addressing.

databyte var byte
address var Word

databyte = 0
address = 0

pause 500

main
     serout s_out, i9600, [13, "Writing:",13]

     for address = 0 to 9

     i2cout p0, p1, %10100000, [address.byte1, address.byte0, databyte]
     Serout s_out, i9600, [dec address, " = ", dec databyte, 13]
     databyte = databyte + 7
     pause 100
     Next

           databyte = 0
           address = 0
           pause 100
           serout s_out, i9600, [13, "Reading:",13]

     for address = 0 to 9

     i2cout p0, p1, %10100000, [address.byte1,address.byte0]
     i2cin p0,p1, %10100000, [databyte]
     serout s_out, i9600, [dec address, " = ", dec databyte, 13]
     pause 100
     next

     end
```

Examples

Connect to the following program with the terminal window set to 9600 baud. The 24LC08 has 4 pages of 255 bytes each. The example will write to the first 10 memory locations of all 4 pages then read back and print to the terminal window. Each page is accessed with A0,A1 and A2 internally. So the control bits change for each page.

```
;ALL - all_i2c_paging.bas

;This program will write and read to the first
;10 memory locations of all 4 pages of a 24LC08
;I2C eeprom using byte addressing.

databyte var byte
address var Byte

databyte = 10
address = 0

pause 500

main
     serout s_out, i9600, [13, "Writing:",13]

     for address = 0 to 9    ;increment through the first 10 locations

     i2cout p0, p1, %10100000, [address, databyte]   ;page 1
     i2cout p0, p1, %10100010, [address, databyte]   ;page 2
     i2cout p0, p1, %10100100, [address, databyte]   ;page 3
     i2cout p0, p1, %10100110, [address, databyte]   ;page 4

     ;lets see what we are writting to each address on each page
     serout s_out, i9600, ["Page 1 to 4-> ",dec address," = ",dec |
     databyte, 13]

     databyte = databyte + 10
     pause 100
     Next

           databyte = 0
           address = 0
           serout s_out, i9600, [13, "Reading:",13]

     for address = 0 to 9    ;increment through the first 10 locations

     i2cout p0, p1, %10100000, [address] ;page 1
     i2cin p0,p1, %10100000, [databyte]

     i2cout p0, p1, %10100010, [address] ;page 2
     i2cin p0,p1, %10100010, [databyte]

     i2cout p0, p1, %10100100, [address] ;page 3
     i2cin p0,p1, %10100100, [databyte]

     i2cout p0, p1, %10101100, [address] ;page 4
     i2cin p0,p1, %10101100, [databyte]

     ;lets read and print each address of each page.
     serout s_out, i9600, ["Page 1 to 4-> ",dec address," = ",dec |
     databyte, 13]

     pause 100
     next

     end
```

LCDINIT

Syntax
lcdinit RS\ E\ D7\ D6\ D5\ D4 {,RW}

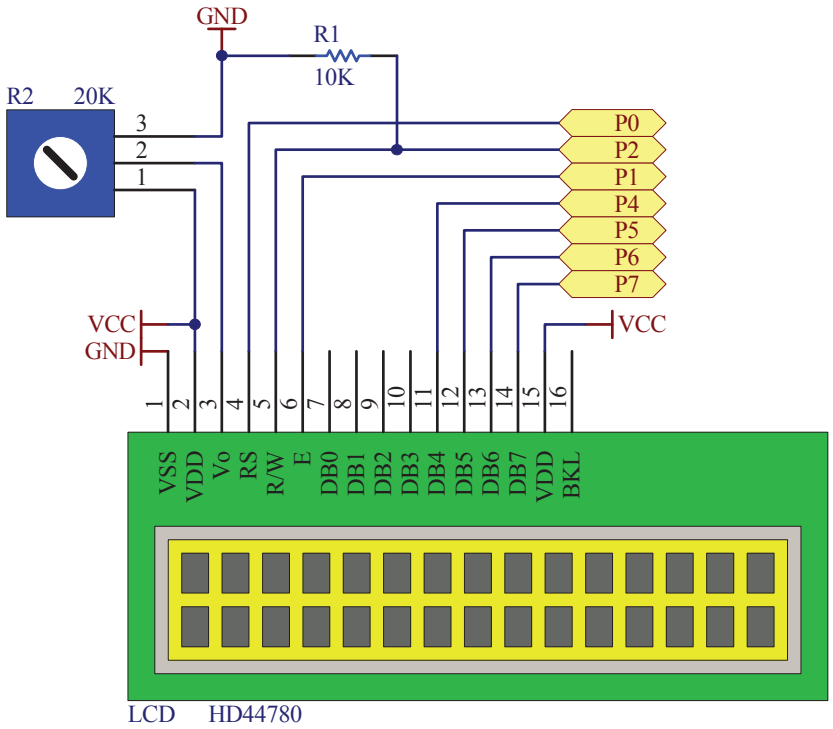
- **RS** - is any expression, constant or variable that specifies the I/O pin connected to the LCD's R/S pin.
- **E** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's enable pin.
- **D7** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 7 pin.
- **D6** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 6 pin.
- **D5** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 5 pin.
- **D4** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 4 pin.
- **RW** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's read or write enable pin.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
There are 3 LCD commands available in MBasic and are used to interface to a Hitachi HD44780 controller based LCD. This is probably one of the most common LCDs available. 1x16 all the way up to 4x40 size screens are supported. The HD44780 controller does require special initialization commands so the LCDINIT command was added to handle this automatically. The LCDINIT command is only needed once in a program, typically to the beginning of a program. The LCD does require some time to power up before running the LCDINIT command. A short pause placed before the LCDINIT command will handle any power up issues. Otherwise the LCDINIT command can be ran later in a program to provide the same power up time.

Schematic

The schematic shown is a common HD44780 wiring. 7 I/O pins are required to drive it in 4 bit mode. To control the screen contrast a 20K potentiometer R2 is used. Optionally the backlight can be controller by driving BKL to GND either hard wired or through a transistor circuit for optional software control.



Example

The following program allows the LCD time to power up with a short pause. The LCD is then initialized. After which “Hello World!” is printed to the screen using the LCDWRITE command.

```
;DEMO PROGRAM - LCDINIT.BAS

Pause 500
lcdinit p0\p1\p7\p6\p5\p4,p2
lcdwrite p0\p1\p7\p6\p5\p4,p2, [CLEARLCD,HOMELCD,SCR,TWOLINE,”Hello World”]
```

LCDWRITE

Syntax
lcdwrite RS\ E\ D7\ D6\ D5\ D4 {,RW}, [(modifiers} expression]

- **RS** - is any expression, constant or variable that specifies the I/O pin connected to the LCD's R/S pin.
- **E** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's enable pin.
- **D7** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 7 pin.
- **D6** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 6 pin.
- **D5** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 5 pin.
- **D4** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 4 pin.
- **RW** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's read or write enable pin.
- **Modifiers** - are any output modifiers as shown in the modifiers section of this manual.
- **Expression** - is any expression, constant or variable that specifies data to be displayed to the lcd screen. In addition screen locations can be specified (SCRRAM).

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The LCD commands are setup to work with the Hitachi HD44780 controller. This is probably one of the most common LCDs available. 1x16 all the way up to 4x40 size screens are supported. Before using the LCDWRITE command see LCDINIT command.

The LCDWRITE command is used to address the HD44780 ram. Depending on the display size there is one byte of screen ram for each display character. Most displays will include additional off screen ram. The off screen ram locations can be used to store characters that are then later shifted onto the screen. LCDWRITE includes several formatting and cursor control commands. These are used to position the cursor or set features on the HD44780 controller. The following table includes all the LCD commands MBasic supports.

LCD Command Table

Command	Value	Function
Lcdclear	$101	Clear display. Clears all on and off screen ram.
Lcdhome	$102	Return to home position.
Inccur	$104	Auto increment cursor (default).
Incscr	$105	Auto increment display.
Deccur	$106	Auto decrement cursor.
Decscr	$107	Auto decrement display.
Off	$108	Display, cursor and blink OFF.
Scr	$10C	Display ON, cursor and blink OFF.
Scrblk	$10D	Display and blink ON, cursor OFF.
Scrcur	$10E	Display and cursor ON, blink OFF.
Scrcurblk	$10F	Display, cursor and blink ON.
Curleft	$110	Move cursor left.
Currright	$114	Move cursor right.
Oneline	$120	Set display for 1 line LCDs.
Twoline	$128	Set display for 2 line LCDs.
Cgram | address	$140	Set CGRAM address for reading or writing.
Scrram | address	$180	Set display RAM address for reading or writing.

LCD Commands

The LCD commands are used to setup the display. This is done if the first LCDWRITE command issued. It only needs to be done once unless something is needs to be changed the next time the LCDWRITE command is used. If your using a 2x16 LCD display you would need to issue the Twoline command. One of the SCR commands are required to turn the display on. Otherwise data will be written to the DDRAM but not displayed. The following code snippet turns the screen on, clears it and moves the cursor to home before printing “Hello World!”.

```
;DEMO PROGRAM - LCDINIT.BAS

Pause 500
lcdinit p0\p1\p7\p6\p5\p4,p2
lcdwrite p0\p1\p7\p6\p5\p4,p2, [CLEARLCD,HOMELCD,SCR,TWOLINE,”Hello World”]
```

LCD DDRAM

The HD44780 uses DDRAM to store ASCII characters. The one HD44780 control can handle up to 4x20 ram locations. This means one controller can drive up to a 4x20 screen. A 4x40 display would use to HD44780 controllers. With this in mind a 1x16 or 2x16 screen still has all the ram locations to make up a 4x20 display. Only certain locations will actually print to the display while the unused can be written to an characters can be stored for later shifting into the display area. The diagrams below illustrate how the memory map (DDRAM) is handled for each display.

2x16 LCD Memory Map

The HD44780 controller has the same memory locations regardless of display size. Displays that are smaller than the amount of DDRAM available will allow writes and reads to off screen locations. The 2x16 display uses only 0-15 and 64-79 for on screen. As you can see the memory locations are not in order. This is due to how the HD44780 controller was designed.

0	1	2	3	4	5	6	7	8	9	0	11	12	13	14	15	16	17	18	19
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103

4x20 LCD Memory Map

The HD44780 controller has the same memory locations regardless of display size. The 4x20 display uses all the memory locations to display on the screen. Again you can see memory address locations are not in order.

0	1	2	3	4	5	6	7	8	9	0	11	12	13	14	15	16	17	18	19
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103

Cursor Positioning

The cursor is set to the position the screen is being written to. The cursor can be positioned any where in the 80 locations. With this control the cursor can be moved around the screen and individual characters can be changed or erased at will. Characters can also be loaded into the off screen memory and then shifted onto the display area.

This following code snippet is setup to work with the schematic shown for LCDINIT. It moves the cursor to the home position and clears the memory. Returning the cursor home with LCDHOME does not clear the memory. The LCDCLEAR command is used in conjunction with sending the cursor home:

```
lcdwrite p0\p1\p7\p6\p5\p4,p2,[lcdclear,lcdhome]
```

The next line will print an ASCII “A” to an off screen location on a 2x16 LCD Display using the screen ram command with an address. If you look at the 2x16 memory map you will see location 16 is off screen:

```
lcdwrite p0\p1\p7\p6\p5\p4,p2,[scrram+16, “A”]
```

Custom Characters

Most HD44780 controllers provides room for 8 user definable characters. They are ASCII values 0 to 7. The programmable characters are 5x8 pixels. There are 8 bytes for each custom character. The bytes are arranged in a grid to define the new character. The custom characters can be used to make sprites that can then be used to form larger characters that are made up of multiple locations and spread across more than one display line. The first 3 bits are ignored (7-5). Only bits 4-0 are used to define the character. An on pixel is express with a 1 and off is 0.

Bits ->	4	3	2	1	0	Binary	Hex	Decimal
Byte 0						00000000	00	00
Byte 1		■		■		00001010	0A	10
Byte 2		■		■		00001010	0A	10
Byte 3		■		■		00001010	0A	10
Byte 4						00000000	00	00
Byte 5	■				■	00010001	11	17
Byte 6		■	■	■		00001110	0E	14
Byte 7						00000000	00	00

Example

To write and display the custom character shown above you would use the LCDWRITE command with the CGRAM function. The following code snippet will write and display the custom character shown above on a 2x16 LCD display. Connect LCD as shown for LCDINIT.

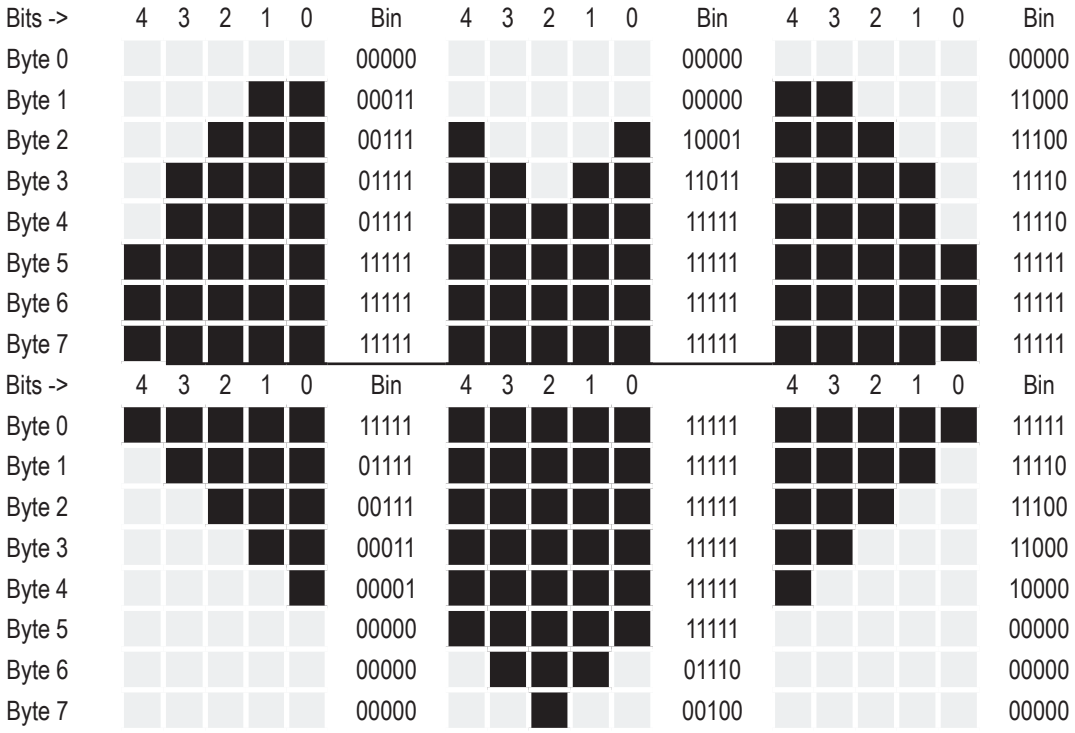
```
lcdinit p0\p1\p7\p6\p5\p4

lcdwrite p0\p1\p7\p6\p5\p4,[cgram+0,0x00,0x0A,0x0A,0x0A,0x00,0x11,0x0E,0x00,scrram+0]
```

The sample code below will clear the screen and starting from home print “Hello Word!” with our newly created custom character shown above.

```
lcdinit p0\p1\p7\p6\p5\p4

;create custom character
lcdwrite p0\p1\p7\p6\p5\p4,[cgram+0,0x00,0x0A,0x0A,0x0A,0x00,0x11,0x0E,0x00,scrr
am+0]

;clear screen, home cursor, print “Hello World!” and custom character
lcdwrite p0\p1\p7\p6\p5\p4,[lcdclear,lcdhome,”Hello World! “,0]
```

Custom Shapes

Custom characters can be created and used as sprites to form large graphics. The following example will display a 2 line 3 character wide heart in the middle of a 2x16 LCD display. Experiments see what creative characters and sprites you can come up with. The leading 3 zeros have been left off the binary value due to space constraints. When creating the custom characters you will need to add the 3 leading zeros. See example code.



Example

The following program will load all 6 custom characters and display them on a 2x16 LCD display using the schematics shown for LCDINIT. The program uses the hex values which can be generated by converting from binary to hex.

```
lcdinit p0\p1\p2\p3\p4\p5

;create custom heart character
lcdwrite p0\p1\p2\p3\p4\p5,[cgram+0,0x00,0x03,0x07,0x0F,0x0F,0x1F,0x1F,0x1F]
lcdwrite p0\p1\p2\p3\p4\p5,[0x00,0x00,0x11,0x1B,0x1F,0x1F,0x1F,0x1F]
lcdwrite p0\p1\p2\p3\p4\p5,[0x00,0x18,0x1C,0x1E,0x1E,0x1F,0x1F,0x1F]
lcdwrite p0\p1\p2\p3\p4\p5,[0x1F,0x0F,0x07,0x03,0x01,0x00,0x00,0x00]
lcdwrite p0\p1\p2\p3\p4\p5,[0x1F,0x1F,0x1F,0x1F,0x1F,0x1F,0x0E,0x04]
lcdwrite p0\p1\p2\p3\p4\p5,[0x1F,0x1E,0x1C,0x18,0x10,0x00,0x00,0x00,scrram+0]

lcdwrite p0\p1\p2\p3\p4\p5,[TWOLINE,SCR,0,1,2,scrram+0x40,3,4,5]

end
```

LCDREAD

Syntax
lcdread RS\ E\ D7\ D6\ D5\ D4 {,RW}, {cgram+} address, [{modifiers} expression]

- **RS** - is any expression, constant or variable that specifies the I/O pin connected to the LCD's R/S pin.
- **E** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's enable pin.
- **D7** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 7 pin.
- **D6** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 6 pin.
- **D5** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 5 pin.
- **D4** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's data bit 4 pin.
- **RW** - is any expression, constant or variable that specifies an I/O pin connected to the LCD's read or write enable pin.
- **Cgram** - LCDREAD defaults to reading screen ram. CGRAM is an optional argument which specifies custom character ram (CGRAM). If CGRAM is used the LCDREAD command will return data store in the CGRAM and not SCRRAM.
- **Address** - specifys what
- **Modifiers** - are any output modifiers as shown in the modifiers section of this manual. They are used to format the out going data (Hex, Bin, Dec and so on).
- **Expression** - is any expression, constant or variable that specifies data to be displayed to the lcd screen.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The LCD commands are setup to work with the Hitachi HD44780 controller. This is probably one of the most common text LCDs available. 1x16 all the way up to 4x40 size screens are supported. Before using the LCDREAD command see LCDINIT command.

The LCDREAD command is used to read the memory addresses of the HD44780 ram. The ram memory map is standard across LCD display sizes. The only difference being what values are actual display ram and what values are off screen ram. This is outlined in the LCDWRITE section of this manual under the memory map tables. The LCDREAD command can access both screen ram and the custom character area (CGRAM).

Example
If your running a large menu system and some of the information is generated on the fly the LCDREAD command can be used to retrieve screen data to determine what is being displayed. It can also be used to temporarily store data in the off screen ram. The following program will read the first location of screen ram on a 2x16 LCD display.

```
character var byte

lcdinit p0\p1\p7\p6\p5\p4,p2

lcdread p0\p1\p7\p6\p5\p4,p2,0,[character]
serout s_out, i9600,[character,13]
```

The next program will read the CGRAM where custom characters are created. Since it takes 8 bytes to define 1 custom character we will need to read all 8 bytes in and create a variable array to do so. After reading the first custom character location the program will display the results to a terminal window connected at 9600 baud.

```
cch var byte(8)

lcdinit p0\p1\p2\p3\p4\p5,p6

lcdread p0\p1\p2\p3\p4\p5,p6,cgram+0,[cch( 0 ),cch( 1 ),cch( 2 ),cch( 3 ),|
cch( 4 ),cch( 5 ),cch( 6 ),cch( 7 )]

serout s_out,i9600,[hex cch( 0 )," ",hex cch( 1 )," ",hex cch( 2 )," ",|
hex cch( 3 )," ",hex cch( 4 )," ",hex cch( 5 )," ",hex cch( 6 )," ",hex cch( 7 )]

end
```

LOOKDOWN

Syntax
lookdown value,{operator,} [list],target

- **Value** - is a variable or constant that will be used to compare to the *list*.
- **Operator** - is the comparison operator which defines how *value* is applied to *list*. If no operator is given the default operator is equals (=). Comparison operates are =, <, >, <>, >=, <=.
- **List** - is any combination of variables, constants or expressions that will be used to compare against. Variables can be any type variable including floating, signed, longs.
- **Target** - is where the result of a comparison are store. The index position of a match from *list*, is loaded into *target*.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The LOOKDOWN command checks through a list of variables or constants looking for the first match to *value* using the comparison operator. Each item in *list* is indexed starting from 0. If you have 10 variable or constants in the list then the expected results will be from 0 to 9.

Notes
1. The LOOKDOWN command will stop on the first result that is true. If there is a possibility that two or more *values* in *list* will return true the LOOKDOWN command returns the first match.
2. The fist item in *list* has an index value of 0. If the first item is true in *list*, a 0 is returned.
3. If no results are true then *target* is left unchanged.

Examples

The LOOKDOWN command can be used to determine the relevance of an unknown value by comparing it to a known list of known values. An example would be determining a range of something such as low, medium or high.

Connect to the following program with the terminal window set to 9600 baud. The DEC modifier was used to convert the variable to real numbers. If the value 1 is sent, the program will return 1:Low. Since we used the comparison operator less than (<) and equals (=), 1 is less than and not equal to anything in the list. Type 100 in the terminal window and press enter. 100: Low is returned since 100 is equal to something in the list. If 101 was sent 101: Medium would be returned. 101 is greater than 100 and less than 512. A good programming technique is coding to anticipate errors or unexpected results. Try sending a value of 1025.

```
Value      Var   Long
Target     Var   Long

Main
     Value = 0
     Target = 3

     Serin S_IN, i9600, [DEC Value]

     LOOKDOWN value, <=, [100, 512, 1024], target
     IF target = 0 Then
          Serout S_OUT, i9600, [0, DEC value, " : Low",13]
     ENDIF
     IF target = 1 Then
          Serout S_OUT, i9600, [0, DEC value, " : Medium",13]
     ENDIF
     IF target = 2 Then
          Serout S_OUT, i9600, [0, DEC value, " : High",13]
     ENDIF
     IF target = 3 Then
          Serout S_OUT, i9600, [0, DEC value, " : Out of range",13]
     ENDIF

     Goto Main   ;Repeat forever
```

LOOKUP

Syntax
lookup index,[list],target

- **Index** - is a variable, constant or expression that will be used to select a position in *list*.
- **List** - is any combination of variables, constants or expressions. Variables can be any type of variable including floating, signed, longs.
- **Target** - is the variable where the value returned from *list* is stored.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The LOOKUP command use the *index* value to locate a value from *list* and load it into *target*. Each item in *list* is indexed starting from 0. If you have 10 variable or constants in *list* then *index* can be a value from 0 to 9.

Notes
1. The fist item in *list* has an index value of 0.
2. If *index* has a value that does match a position in *list* then *target* is left unchanged.

Examples
Connect to the following program with the terminal window set to 9600 baud. Enter a value from 0 to 8. The number received will be stored in *index*. The LOOKUP command will then use this number and move to that position in the list. The results are loaded into *target*. In the program there are 9 values in *list*. Since the first position is 0, only 0 to 8 are valid input commands. Any other values will leave *target* unchanged. For an example of LOOKUP in use see SOUND command example.

```
;ALL - all_lookup.bas

Index var Word
Target var Word

Main
     Index = 0
     Target = 0

     serout s_out, i9600,[1, "Type a value from 0 to 8: "]
     Serin s_in, i9600,[dec Index]

     lookup Index,[10,20,30,40,50,60,70,80,90],Target

     serout s_out, i9600,[0, 13, 13, "Index Position= ", dec Index]
     serout s_out, i9600,[13, "Result= ", dec Target,13]

Goto Main
```

Constant strings can also be used. The following program will print out one character per loop. Since there is 18 characters we use a for next loop to increment through the LOOKUP *list*.

```
;ALL - all_lookup2.bas

index var word
target var byte


main
     serout s_out,i9600,[0]
     for index = 0 to 17
           lookup index,[“Basic Micro Rules!”],target
           serout s_out,i9600,[target]
           pause 100
     next
     goto main
```

LOW

Syntax
low pin

- **Pin** - is a variable or constant that specifies which pin to go high.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The LOW command is an output command that will set a pin LOW. All pins can be in 3 states. HIGH, LOW and FLOAT (input). The LOW command will change any of these states to an output and set the pin LOW (GND)

Notes
1. If a variable is used, the variables value will be directly translated into a pin. If the variable equals zero then P0 will go low. If the value is out of range to the pins that are present nothing will hap pen. If you have 10 pins and the variable equals 11 then nothing will happen.

Examples
The following program is a simple loop using HIGH and LOW commands that will repeat for ever. Connect an LED from P0 to P7. They will blink in sequence, repeating forever.

```
Pins var byte

Main
     Pins = 0
     For Pins = 0 to 7
           High Pins
           Pause 200
           Low Pins
           Pause 200
     Next
     Goto Main
```

NAP

Syntax
nap period

- **Period** - is a variable, constant or expression that determines the duration of nap. Valid range is 0 to 7.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Nap Period

Nap Value	Time
0	18ms
1	36ms
2	72ms
3	144ms
4	288ms
5	576ms
6	1152ms
7	2304ms

Notes
1. The period can vary slightly with temperature, supply voltage and manufacturing tolerances.
2. The Atom Pro will immediately wake up from a nap if an interrupt occurs.
3. The NAP command does not affect internal registers so your program will continue executing when the time expires.

Description
The NAP command executes the processor's internal sleep mode for a specified time (Period). Power consumption is reduced in sleep mode. NAP is a simplified version of the SLEEP command. NAP is an easy way to conserver power on battery powered application when the processor is idle. The AtomPro can conserve power until an outside trigger occurs (Interrupt) to wake the device.

Example
The following example will put the processor in a lower power state for 2,304 milliseconds.

```
main
     serout s_out, i9600, ["Going to NAP"
     nap 7
     serout s_out, i9600, ["I'm wake!"]
goto main
```

OWIN

Syntax
owin pin,mode,{FailLabel,} [{modifiers}InData, {modifiers}InData1]

- **Pin** - is a variable, constant or expression that specifies the pin used for 1-wire data transfer.
- **Mode** - is a variable, constant or expression the specifies the data transfer mode as described in the table below.
- **FailLabel** - is a label the program will jump to if communications fails (No Chip present).
- **InData** - is a list of variables with optional modifiers to store incoming data from an attached 1-wire device.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Modes

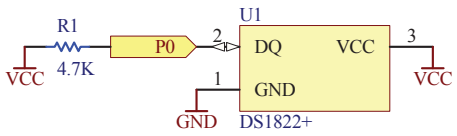
Mode	Reset	Byte / Bit	Speed
0	None	Byte	Low
1	Before Data	Byte	Low
2	After Data	Byte	Low
3	Before and After	Byte	Low
4	None	Bit	Low
5	Before Data	Bit	Low

Description
The 1-wire protocol was developed by Maxim (Dallas Semiconductor). It is a 1 wire asynchronous serial protocol that does not require a clock. Most 1-wire devices can optionally be powered from the data line. This is known as parasitic power. This means the device is powered from a extended data high (1) state on its data pin. A high (1) state is held briefly to charge a small internal capacitor. One wire is setup to have a single master device which communications with one or more 1-wire devices over a single data line. This network is dubbed a “MicroLan”. The master initiates and controls all activities on the 1-wire bus.

Notes
1. The 1-wire parts use CMOS/TTL logic levels with open collector outputs. The data line requires a 4.7K pull-up.

Schematics

The following schematic shows how to wire up a DS1822+ temperature device.



Example

This example shows how to read the temperature sensor DS1822+. The commands used for each 1-wire device will differ. To find the list of supported commands for the device being used see the device data sheet. Wire up the DS1822+ as shown in the schematics. Load the program below and connect using Studio terminal window at 9600 baud. The program will update the current temperature reading from the 1-wire part. Place your fingers on the device and watch the temperature reading increase.

```
temp var word
convert var float
counter var byte

main
     owout P0,1,main,[$cc,$44]

wait
     owin P0,0,[temp]
     if temp = 0 then wait
     owout P0,1,main,[$cc,$be]
     owin P0,0,[temp.byte0,temp.byte1]
     convert = tofloat temp / 2.0
     serout s_out,i9600,["Temperature = ",real convert," C",13]
goto main
```

If your only using one device on the MicroLan then you can send a command to skip the unique ID. Using mode 1 (byte mode, low speed, and reset before data) we send the command $CC (Skip ROM) which sets the DS1822+ to accept commands regardless of its unique ID code. The next command is $44 (Convert Temperature) which initiates the temperature conversion and stores the result in the DS1822's scratch pad memory.

Using mode 0 (byte mode, low speed, and no reset) we read back the conversion status. While a conversion is in progress the read will be a 0. When data is ready it changes to a 1. The example program will loop until a conversion is finished.

Command $CC is sent, then $BE (Read Scratch pad) which tells the DS1822 to send the two bytes from its scratch pad on the next read. The the two bytes from the DS1820's scratch pad are read and stores them in the variable temp. The program makes use of the variable modifiers byte0 and byte1 to load the word variable temp with the low and high bytes of the temperature.

The program then converts the temperature to floating point format and divides by 2.0 because the DS1822+'s output is in 0.5°C steps. The result is then sent to a terminal window set to 9600 baud.

OWOUT

Syntax
owout pin,mode,{NCLabel,}[Data1..Data2]

- **Pin** - is a variable, constant or expression that specifies the pin used for 1-wire data transfer.
- **Mode** - is a variable, constant or expression the specifies the data transfer mode as described in the table below.
- **FailLabel** - is a label the program will jump to if communications fails (No Chip present).
- **Data1..Data2** - is a variable, constant or expressions that specifies the data to be send to the 1-wire device.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Modes

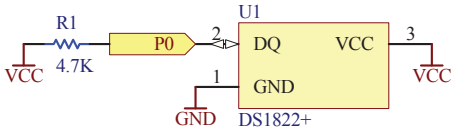
Mode	Reset	Byte / Bit	Speed
0	None	Byte	Low
1	Before Data	Byte	Low
2	After Data	Byte	Low
3	Before and After	Byte	Low
4	None	Bit	Low
5	Before Data	Bit	Low

Description
The information here is duplicated from OWIN. The 1-wire protocol was developed by Maxim (Dallas Semiconductor). It is a 1 wire asynchronous serial protocol that does not require a clock. Most 1-wire devices can optionally be powered from the data line. This is known as parasitic power. This means the device is powered from a extended data high (1) state on its data pin. A high (1) state is held briefly to charge a small internal capacitor. One wire is setup to have a single master device which communications with one or more 1-wire devices over a single data line. This network is dubbed a “MicroLan”. The master initiates and controls all activities on the 1-wire bus.

Notes
1. The 1-wire parts use CMOS/TTL logic levels with open collector outputs. The data line requires a 4.7K pull-up.

Schematics

The following schematic shows how to wire up a DS1822+ temperature device.



Example

This example shows how to read the temperature sensor DS1822+. The commands used for each 1-wire device will differ. To find the list of supported commands for the device being used see the device data sheet. Wire up the DS1822+ as shown in the schematics. Load the program below and connect using Studio terminal window at 9600 baud. The program will update the current temperature reading from the 1-wire part. Place your fingers on the device and watch the temperature reading increase.

```
temp var word
convert var float
counter var byte

main
     owout P0,1,main,[$cc,$44]

wait
     owin P0,0,[temp]
     if temp = 0 then wait
     owout P0,1,main,[$cc,$be]
     owin P0,0,[temp.byte0,temp.byte1]
     convert = tofloat temp / 2.0
     serout s_out,i9600,["Temperature = ",real convert," C",13]
goto main
```

If your only using one device on the MicroLan then you can send a command to skip the unique ID. Using mode 1 (byte mode, low speed, and reset before data) we send the command $CC (Skip ROM) which sets the DS1822+ to accept commands regardless of its unique ID code. The next command is $44 (Convert Temperature) which initiates the temperature conversion and stores the result in the DS1822's scratch pad memory.

Using mode 0 (byte mode, low speed, and no reset) we read back the conversion status. While a conversion is in progress the read will be a 0. When data is ready it changes to a 1. The example program will loop until a conversion is finished.

Command $CC is sent, then $BE (Read Scratch pad) which tells the DS1822 to send the two bytes from its scratch pad on the next read. The the two bytes from the DS1820's scratch pad are read and stores them in the variable temp. The program makes use of the variable modifiers byte0 and byte1 to load the word variable temp with the low and high bytes of the temperature.

The program then converts the temperature to floating point format and divides by 2.0 because the DS1822+'s output is in 0.5°C steps. The result is then sent to a terminal window set to 9600 baud.

OUTPUT

Syntax
output pin

- **Pin** - is a variable, constant or expression that specifies an output capable pin to use.

Supported
- BA - supported
- BAN - supported
- BAP - supported
- BAP40 - supported

Description
In order for a pin to control something in the outside world we need to set it as an output. When a pin is set as an output, only then can we specify whether it is high (1) or low (0). All output based commands will automatically set the pins state. But during start up all pins are in an input state and after an input command is ran the pin is left in an input state. The OUTPUT command can be used to set a pin as an output. Typically the OUTPUT statement would be used in the beginning of your program to set specific pins to known states.

Notes
1. On power, all pins by default are inputs.

Example
Connect to the running program example below using the terminal window set to a baud rate of 9600. As the program runs it will print the state of pins 0 to the terminal window. P1 is then set high and the first report is P0 set as a 1 (high). Next command sets it to an input and P0 is now 0 (low). P1 is then set back to an output. Since its last known state was high it will return to this state when set to an output again so P0 will read 1 (high) again. See if you can follow the program flow to see when the pin state changes.

```
;Connect p0 to p1

Input p0
     High p1 ;Set P1 to an output and high
     Serout s_out,i9600,["P0 state is ",dec IN0,13]
     Pause 1000

Input p1
     Serout s_out,i9600,["P0 state is ",dec IN0,13]
     Pause 1000

;Set P1 high, will remember its last set state
Output p1
     Serout s_out,i9600,["P0 state is ",dec IN0,13]
     Pause 1000
```

PAUSE

Syntax
pause time

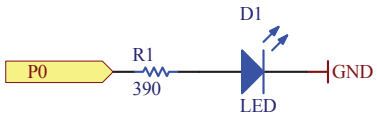
- **Time** - is a variable, constant or expression that specifies number of milliseconds to wait.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The PAUSE command is used to create a predetermined delay in a program. The amount of delay is specified in milliseconds. There are 1000 milliseconds in 1 second. So if a value of 500 is used for time, it would be a half second. If 1000 is used for time, the program would wait 1 second.

Notes
1. PAUSE is fairly accurate. However over time the count will be off. This will vary from processor to processor. The Nano uses an internal clock which is less accurate than the external clocks used on the modules. Therefore the error rate would be higher with the Nano.

Schematic
Connect a LED as shown below. You can substitute the resistor for anything from 330 ohms to 470 ohms.



Example
The following program will blink an led at approximately once second intervals forever or until power is removed. To increase the speed at which the LED blinks chance both PAUSE time values from 1000 to something smaller.

```
;Wire LED to P0

Main
     High P0
     Pause 1000
     Low P0
     Pause 1000
Goto Main
```

PAUSEUS

Syntax
pauseus time

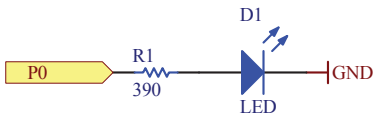
- **Time** - is a variable, constant or expression that specifies the number of half microseconds to wait.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The PAUSEUS command is used to create a predetermined delay in a program. The amount of delay is specified in microseconds. The PAUSEUS command differs from the PAUSE command in that is uses half microsecond increments. There are 1000 microseconds in 1 millisecond. So a value of 1,000,000 would wait a full second. The PAUSEUS command is used when high resolution delays are required.

Notes
1. PAUSEUS is fairly accurate. However over time the count will be off. This will vary from processor to processor. The Nano uses an internal clock which is less accurate than the external clocks used on the modules. Therefore the error rate would be higher with the Nano.

Schematic
Connect a LED as shown below. You can substitute the resistor for anything from 330 ohms to 470 ohms.



Example
The following program will blink an led at approximately once second intervals forever or until power is removed. To increase the speed at which the LED blinks chance both PAUSEUS time values from 1000000 to something smaller.

```
;Wire LED to P0

Main
     High P0
     Pause 1000000
     Low P0
     Pause 1000000
Goto Main
```

PAUSECLK

Syntax
pauseclk time

- **Time** - is a variable, constant or expression that specifies the number of clock cycles to wait.

Supported
- BA - Supported with timing differences.
- BAN - Supported with timing differences.
- BAP - Supported with timing differences.
- BAP40 - Supported with timing differences.

Description
The PAUSECLK command is used to create a high resolution delay in a program. The delay is specified in clock cycles. The PAUSECLK command differs from the PAUSE and PAUSEUS commands in that is uses clock cycles. The clock cycle across processor lines are different so the same value on one processor applied to another one will change the delay. The PAUSECLK command can be used in generating precise timing signals.

Notes
1. The Nano processors runs at 8Mhz internally. It takes 4 clock cycles to complete one instruction. So it runs at 1/4 clock cycles. One millisecond is equal to 2000 clock cycles on the Nano.
2. The BasicATOM processors runs at 20Mhz. It takes 4 clock cycles to complete one instruction. So it runs at 1/4 clock cycles. One millisecond is equal to 5000 clock cycles on the ATOM.
3. The ATOM Pro runs at 16Mhz. Where the BasicATOM Pro 40 runs at 20Mhz. One millisecond is equal to 16000 on the ATOM Pro and 20000 on the ATOM Pro 40.

Example
The program below will function slightly differently depending on what processor your using. Separate programs have been provided to demonstrate a one seconding timing on all 4 different processors. The program will print to the terminal window set at 9600 baud. To test the examples only load the portion that corresponds to the processor your using.

```
;Nano pauseclk example

     Serout s_out,i9600,[“Starting”,13]
     Pauseclk 2000000
     Serout s_out,i9600,[“One second later”]
     End


;Atom pauseclk example

     Serout s_out,i9600,[“Starting”,13]
     Pauseclk 5000000
     Serout s_out,i9600,[“One second later”]
     End
```

```
;AtomPro pauseclk example

     Serout s_out,i9600,[“Starting”,13]
     Pauseclk 16000000
     Serout s_out,i9600,[“One second later”]
     End


;AtomPro40 pauseclk example

     Serout s_out,i9600,[“Starting”,13]
     Pauseclk 20000000
     Serout s_out,i9600,[“One second later”]
     End
```

PULSIN

Syntax
pulsin pin, direction, {Tlabel, Timeout,} result

- **Pin** - is variable, constant or expression that specifies the pin to be used for the input pulse.
- **Direction** - is variable, constant or expression (0 or 1) that specifies the pulse direction start. If direction is set to 0 a high state will trigger the timer. If direction is set to a 1 a low state will trigger the timer.
- **Tlabel** - is an optional argument that specifies a label the program will jump to if a timeout occurs. If no Tlabel or Timeout value is specified the command will wait about 32ms for a pulse to occur. If no pulse occurs a result of 0 is returned and program execution will resume.
- **Timeout** - is variable, constant or expression that specifies the number of microseconds for a time out. Timeout is a 32-bit integer value (0 - 4,294,967,295). Timeout is measured in 0.5 microsecond intervals. A timeout of 1000 microseconds would be entered as 2000.
- **Result** - is a variable that stores the pulse duration in 0.5 microseconds increments. If the result variable specified is too small only the least significant bits will be stored. If no pulse is detected within the time out value the result will be set to 0. See the table below for the minimum time resolution of each processor.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Resolution

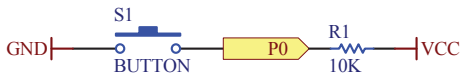
Processor	Time
BA	1.4us
BAN	3.5us
BAP	1.5us
BAP40	1.5us

Description
PULSIN will measure the time from edge to edge of the pulse. It will start the count on a high to low transition or a low to high transition depending on what direction is set to. PULSIN measures the width of the pulse. PULSIN can be used to measure a servo signal or how long a button was press. PULSIN is a blocking command that will wait for 32ms until a pulse is detected. If no pulse is detected the command returns a 0 and continues program execution.

Notes
1. Each processor has a differ minimum resolution of time. After the minimum resolution all time values are added by 0.5us increments.
2. The value stored in result is in 0.5us increments. If 1000 is returned this represents 500us.

Schematics

Connect a momentary switch as shown below. R1 can be a 10K or a 4.7K resistor.



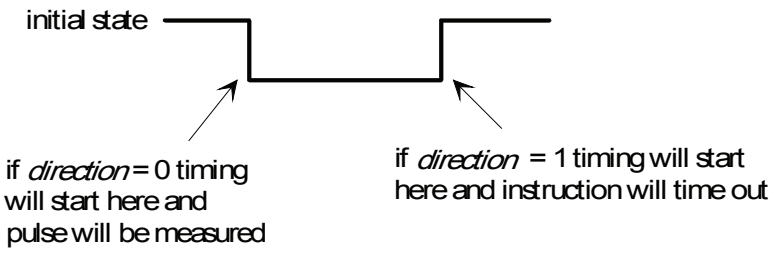
Examples

The example program will time how long a button is pressed, displaying the results to a terminal window at 9600 baud. The direction is set to 0 since our initial state will be high from the pull-up resistor.

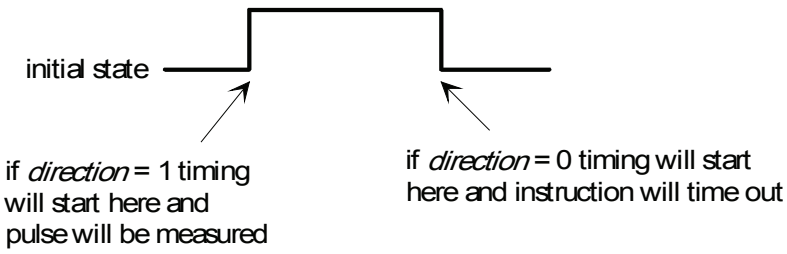
```
temp var long

main
     pulsin p40,1,main,2000000,temp
     serout s_out,i9600,[dec temp,13]
     pause 100
goto main
```

The direction 0 or 1 is important. If it is not set correctly the results will not be accurate. If the initial state is missed PULSIN may not time any pulse. Or time a second pulse as one pulse skewing the results. The two pulses below illustrate this point.

Initial State 1 (Direction 0)



Initial State 0 (Direction 1)



PULSOUT

Syntax
pulsout pin, time

- **Pin** - is a variable, constant or expression that specifies the pin to read a pulse.

- **Time** - is a variable, constant or expression that specifies the duration of the pulse. Time is measured in 0.5 microseconds increments. The smallest unit of time differs for each processor family. See Time Units table.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Time Units

Processor	Time
BA	5us
BAN	12us
BAP	3us
BAP40	2.5us

Description
PULSOUT toggles the pin state from high to low to equal one pulses. You can use the high or low commands to set the initial state of the pin, which controls the polarity of the pulse. The pin will remain in the last known state after the PULSOUT command has ran. This allows successive use of the PULSOUT command to produce pulses of the same polarity.

Notes
1. Each processor has a differ minimum resolution of time. After the minimum resolution all time values are added by 0.5us increments.
2. Temperature will effect the pulse. The affect is greater the closer to the minimum resolution increments.

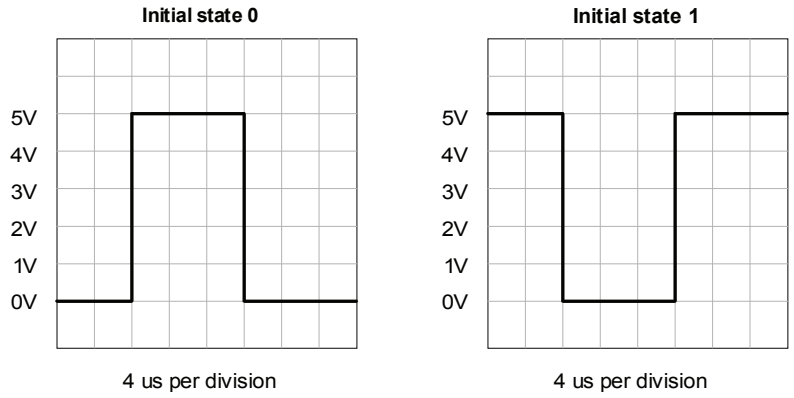
Examples

The example program will produce a pulse to that shown below for an initial state of 0. If the “low p0” is changed to “high p0” the pulse will be similar to that shown for initial state of 1.

The pulse will vary slightly. This will be due to the temperature and other factors such as components values used to build the BasicATOM or BasicATOM Pro. The closer the desired pulse is to the minimum resolution the more noticeable the effect. Large values so no loss.

```
time var word

time=120   ; 0.5us increments, pulse width = 60

main
     low p0
     pulsout p0, time
goto main
```

Pulse Initial states



PWM

Syntax
pwm pin, period, duty, cycles

- **Pin** - is a variable, constant or expression that specifies the pin to use.
- **Period** - is a variable, constant or expression that specifies the period of the pulse width signal in clock cycles.
- **Duty** - is a variable, constant or expression that specifies the period of the duty cycle pulse width signal in clock cycles.
- **Duration** - is a variable, constant or expression that specifies the number of pulses to output.

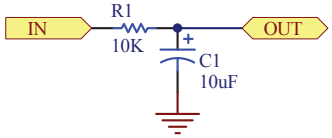
Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The PWM command generates a pulse width modulated signal. PWM has several use some of which are generating an analog voltage, DC motor control, servo control or generating a frequency.

To create an analog voltage the pin is switched from high to low. During the transitions leaving the pin high for a certain amount of time versus low and then averaging the output will cause a voltage change. If the pin was high (5V) 50% of the time and then low (0V) the other 50% the voltage output would be around 2.5V. By adjusting how long the pin is high or low we can control the output voltage with a simple RC circuit.

The number of high to low transitions is called the duty cycle. The higher the duty cycle the higher the overall output voltage would be. Period specifies how long a pulse is. A pulse is made up of one high to low transition. So the period specifies the frequency. When dealing with generating an along voltage using the RC circuit the duty and period will determine at what voltage and how much current the circuit can provide. The limiting factor being the processor its self.

Schematic
The schematic is a simple RC filter. The resistor and capacitors values can be changed to affect the final output. The RC values shown on average at 50% Duty will generate 2.5V depending on load at the output of the circuit.

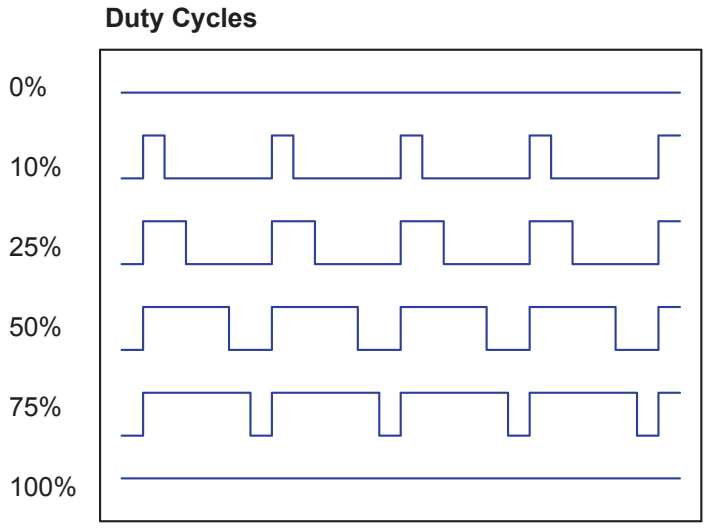


The code snippet will generate a 50% duty cycle. Which with no load will output 2.5V on the output side of our RC filter. Build the circuit, run this program and attach a volt meter probe to the output. Try adjusting the duty cycle to see the results.

```
pwm p0,1000,500,1000
```

Duty Cycles

The following chart is what the signal would look like on an oscilloscope at specific duty cycles. This will give you an idea of what the duty cycles look like. You can see their on times. More on time would be mean more charge for our RC circuit which would increase its output voltage. At 0% duty cycle the pin is always low. At 100% duty cycle the pin is always high.



RCTIME

Syntax
rctime pin,state,{tlabel,timeout,}result

- **Pin** - is a variable, constant or expression that specifies the pin to use.
- **State** - is a variable, constant or expression (1 or 0) that specifies the state which will end the timing period.
- **Tlabel** - is an optional argument that specifies a label the program will jump to if no transition occurs. If Tlabel and timeout are not specified, RCTIME will wait 32ms for a transition to occur. If no transitions occurs 0 is returned and program execution will resume.
- **Timeout** - is variable, constant or expression that specifies the number of microseconds for a time out. Timeout is measured in 0.5 microsecond intervals. A timeout of 1000 microseconds would be entered as 2000.
- **Result** - is a variable that stores the pulse duration in 1.5 microseconds increments. If the result variable specified is too small only the least significant bits will be stored. If no pulse is detected within the time out value the result will be set to 0. See the table below for the minimum time resolution of each processor.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Time Units

Processor	Time
BA	4.2us
BAN	10.5us
BAP	4.5us
BAP40	4.5us

Description
RCTIME is typically used to measure the charge and or discharge time of a resistor / capacitors circuit. It can also be used in precise triggered timing measurements like ultra sonic sensors. When using RCTIME with an R/C circuit it can measure the amount of time the capacitor takes to discharge. RCTIME is a blocking command and will wait 32ms for a transition to occur before continue program execution.

Notes
1. RCTIME can only measure up to its maximum value with is 4,294,967,295.
2. Each processor has a minimum measure resolution. The example program is timed for the BAP.
3. Analog should be measured using the ADin command.

Schematic

The schematic can use any value capacitor. Two different values are shown. The resistor must be a 10K in order for the sample program to work properly.

Example

The example program will measure the discharge rate of a capacitor and determine is value. This is possible since we use a known resistor value of 10K. RCTME can also be used to calculate a resistor or a potentiometer value by using a known capacitance and changed the formula used to calculate RC. The pin is first set to an output and high. The small pause allows the capacitor time to fully charge. The RCTime command will then count how long it takes for the capacitor to discharge through a 10K resistor. When the capacitor voltage level falls below the TTL threshold of a logical 0, RCTIME will return the result.

```
capacitance var float
results var long

main
     pause 320 ;charge for 1 second
     rctime P0, 0, NoTime, 2000000, results ;result is time in .5us
     high P0
     capacitance = TOFLOAT(results) / 12800.0
     serout s_out, i9600, ["Time = ",dec results/2,"us ", real
capacitance\3,"uF", 13]
goto main

NoTime
     serout s_out, i9600, ["RCTIME timed out!", 13]
goto main
```

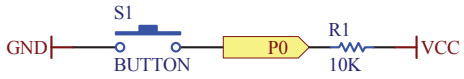
The program sets P0 to output, high state, and then waits one second for the capacitor to charge fully. The RCTIME command then changes P0 to an input and waits for a low state, which occurs when the capacitor discharges to about 0.8V. The time, in microseconds, is stored in the results variable.

The resistance is then calculated using the formula: resistance = results/(1.83 * capacitance) However, to accommodate the integer arithmetic, the 1.83 and capacitance are each multiplied by 100 (giving 183 and 2, respectively), so the numerator must be multiplied by 10000 to compensate.

If you see the RCTIME timeout error message, then the capacitor is too large for the program or you have something wired wrong.

Example

The next example is a small game that can be played by connecting a button as show to P0. Its a timed press. See how fast you can get. Use the button schematic shown with the following example program to play the game.




```
temp var long

main
      if IN0=0 then
            serout s_out,i9600,["Please release the button to continue.",13]
      endif
            while IN0=0
            wend

      serout s_out,i9600,["Get ready",13]
      pause 1000

      serout s_out,i9600,["Get set",13]
      pause 1000

      serout s_out,i9600,["GO!!!",13]
      rctime p0,0,timeout,200000000,temp

      serout s_out,i9600,["Your time was:",real TOFLOAT(temp)/2000000.0\4," seconds",13]
      pause 2000

goto main

timeout
      serout s_out,i9600,["You waited too long. Starting over.",13]
      goto main
```

READ

Syntax
read address, databyte

- **Address** - is a byte sized variable or constant that specifies what address to read the on board eeprom from.

- **DataByte** - is a byte sized variable (0-255) which stores the data returned from the on board EEPROM.

Supported
- BA - supported
- BAN - supported
- BAP - supported
- BAP40 - supported

Description
All modules except the BasicATOM Pro 24 come with built in eeprom. The READ / WRITE commands were created to access the built in memory. READ will read a signal byte from the built in eeprom at the address specified in the command.

Notes
1. The AtomPro24 does not have built in eeprom. An external 32kbit or larger eeprom can be added. Connect the eeprom SCL pin to P10 and the eeprom SDA pin to P11. Add a 10k ohm pull up resis tor to P11. On the eeprom connect A0,A1 and A2 the address pins to ground.
2. READ will only read one byte at a time. To read multiple locations a simple loop can be used or see READDM.

Example
The example program will write the string “Hello” starting at the first location to the on board eeprom. Next, it will read the eeprom locations 0 to 10 and print the contents to the terminal window.

```
index var byte
char var byte

write 0,”H”
write 1,”e”
write 2,”l”
write 3,”l”
write 4,”o”

for index = 0 to 10
     read index,char
     serout s_out,i9600,[char]
next
end
```

READDM

Syntax
readdm address,[{modifiers}databyte1,...,{modifiers}databyte2]

- **Address** - the starting address of the onboard eeprom to read from.
- **DataByte** - is a list of variables with optional modifiers in which data read from the eeprom will be stored in.
- **Modifiers** - are used in the command syntax to format data. Refer to the modifier section of this manual. All input modifiers are supported.

Supported
- BA - supported
- BAN - supported
- BAP - supported
- BAP40 - supported

Description
The READDM differs from the READ command in that it auto increments to the next read address. It can be ran once and read multiple bytes from the onboard eeprom using only a starting address. READDM will continue to read based on how many variables are specified. Modifiers can be used to format the data or add functionality to the command. See table above.

Notes
1. The AtomPro24 does not have built in eeprom. An external 32kbit or larger eeprom can be added. Connect the eeprom SCL pin to P10 and the eeprom SDA pin to P11. A 10k ohm pull up resistor is required on P11. Ground the eeproms A0,A1 and A2 address pins.
2. The ReadDM command differs from the Read command in that auto increments the address. It can read multiple bytes each time it is executed. The Read command can only read one byte each time it is executed.

Example
The example program will first write the string “Hello” using *Writedm* to the on board eeprom. Next, it will read the eeprom locations starting from 0 using *Readdm*. It will continue to read starting at location 0 until all specified databytes are loaded. Run the program once, then comment out the *Writedm*
command. The on board eeprom will retain all the data last written to it.

```
;Program will not work with BasicATOM Pro 24.


writedm 0,[“Hello world”]

readloop
     index var byte
     string var byte(11)
     readdm index,[str string\11]
     serout s_out,i9600,[str string\11]
end
```

REPEAT - UNTIL

Syntax
repeat
        program statements
until condition

- **Statements -** any group of commands to be run inside the loop.
- **Condition** - can be a variable or expression

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The REPEAT - UNTIL loop executes commands nested inside of it until some condition is false. This is the opposite of DO - WHILE and WHILE - WEND. The condition can be any variable or expression and is tested every loop until true.

Notes
1. In the programming world 0 is consider false. By default REPEAT - UNTIL will test this condition. If a stand alone variable is used for the test, the loop will continue until its value NOT equal to 0.
2. WHILE - WEND checks the condition first. If the condition is false the WHILE - WEND statements and all program code nested within them will not run.
3. You can nest multiple REPEAT - UNTIL commands within each other. You can nest DO - WHILE or WHILE - WEND with in a REPEAT - UNTIL loop but not both DO - WHILE and WHILE - WEND.

Example
Connect to the following program with the terminal window set to 9600 baud. The program will start counting up from 0 to 100. Once index reaches a value of 101 the condition is no longer false. The greater than symbol > was used for the condition and 101 is now greater than 100 making the condition true. Since REPEAT - UNTIL loops while a statement is false the program exits.

```
;ALL - all_repeat_until.bas

Index var word


Main
     Index = 0

     Repeat
     index = index + 1

     ;lets print the value index
     serout s_out, i9600,[0, "Couting: ", dec index]
     pause 75

     Until index > 100 ;run until index is greater than 100

     serout s_out, i9600, [13,13, "Index = ", dec index]
     serout s_out, i9600, [13, "My condition is no longer false."]
     serout s_out, i9600, [13, "Index is now greater than 100"]
End
```

RETURN

Syntax
return {DataResult}

- **DataResult** - an optional value to return to the gosub statement. Can be an expression, constant or variable.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
RETURN removes from the stack the address stored by GOSUB, and resumes program execution on the line following the calling GOSUB command. A return value may optionally be returned to the calling GOSUB.

The GOSUB command will jump to a specified label. After executing the code at the jump label a RETURN command is then used to return the program to the next command after the last called GOSUB.

If your familiar with some BASIC languages there is typically a limit to what is called nesting. This is where multiple GOSUB...RETURN statements are nested inside of each other. There is no limit to this with Studio.

GOSUB stores the address of the next command on the stack and jumps to the specified label. User specified arguments can be defined in the subroutine and a return value from the subroutine called can be stored in variable that is then loaded into the GOSUB DataResult argument.

Notes
1. Subroutines should exit via the RETURN command, which clears the saved address from the stack and returns to the command following the GOSUB. Do not use BRANCH or GOTO when exiting a subroutine.
2. User defined arguments must match the number of arguments defined at the subroutine. If they do not match, a stack overflow or underflow will happen.
3. If subroutines returns a value the GOSUB is not required to use it or specify a return value variable

Example
The below program will print the results to the terminal window at 9600 baud. The results will be 110. The GOSUB command has to arguments and includes DataResult variable. The values 10 and 100 are passed to the subroutine MyAdd. The values are then loaded into the variables *arg1* and *arg2*. Since RETURN can have an expression the variables *arg1* and *arg2* are added and returned to the variable *result*.

```
Result var long

Main
     Gosub myadd[10,100],result
     Serout s_out,i9600,["Result =",dec result]
End

Arg1 var long
Arg2 var long

MyAdd [arg1,arg2]
Return arg1+arg2
```

See Also:
GOSUB
EXCEPTION

REVERSE

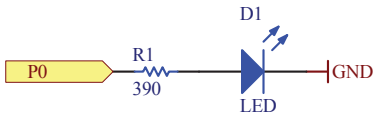
Syntax
reverse pin

- **Pin** - is any expression, constant or variable that specifies a pin to use.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
REVERSE will switch the input/output direction of a pin. If pin was an input it would reverse to an output. If the pin was an output it would reverse to an input. A pins state determines whether it can be read or set. To read a pin and determine if it has a high (1) or low (0) signal applied to it, the pin must be set to an input. A pin can only be set to high (1) or low (0) if the pin is in an output state.

Schematic
Connect a LED as shown below. You can substitute the resistor for anything from 330 ohms to 470 ohms.



Example
The program turn the LED on using the High command which is an output command. Then the LED will turn off using the Reverse command which changes P0 from an output to an input. When P0 is an input the internal circuitry is disconnected and the pin can no longer supply the 5V need to illuminate the LED.

```
Loop
     High p0
     Pause 500
     Reverse p0
     Pause 500
Goto Loop
```

SERIN

Syntax
serin rxpin{\fpin},baudmode,{plabel,}{timeout,tlabel,}[{modifiers} InputData]

- **Rxpin** - is a variable, constant or expression that specifies the receive data pin. This pin will switch to input mode and remain in that state at the end of the command.
- **\fpin** - is an optional variable, constant or expression that specifies a pin for flow control (the "\" is required). Flow control is used primarily with PC COM ports and conforms to RS232 serial port specifications. The flow control pin will switch to output mode and remain in that state at the end of the command.
- **Baudmode** - is a 32 bit variable, constant or expression that specifies how fast to receive data and in what format. Several predefined baud modes are available however custom modes are allowed. See the baud mode table for predefined modes.
- **Plabel** - is an optional label. The program will jump to plabel if parity is used and there was a parity error.
- **Timeout** - is an optional 32 bit variable, constant or expression that specifies the time to wait for incoming data. The value is measured in 0.5 microsecond increments If data does not arrive within this time, the program will jump to tlabel.
- **Tlabel** - is an optional label the program will jump to if a *timeout* is specified and has occurred.
- **InputData** - is a list of variables or constants that tell SERIN what to do with incoming data. The incoming data can be formatted with optional input modifiers. See the Modifier section of this manual.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SERIN command is designed to work with the RS232 serial specifications. The command is bit banged, which means they are created in software running on the processor. When SERIN is ran the processor can not do anything but receive data.

RS232 is a simple communication format supported by the PC and is referred to as a COM port. The COM port can send and receive data simultaneously with each being a separate circuit that works in only one direction. Each circuit can function independently to transmit and received data at the same time. This means the COM port is full duplex. The SERIN command is not capable of full duplex since it is software based.

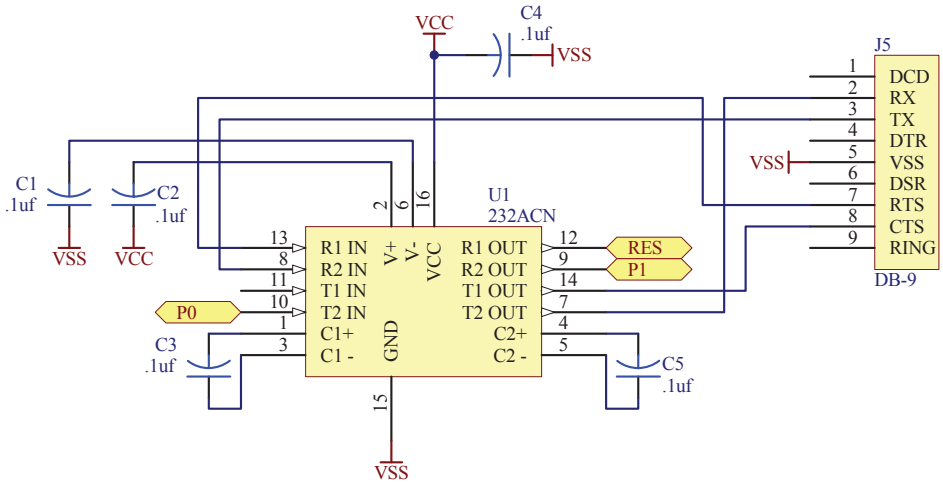
A 12 volt system was develop work over long wire lengths and electrically noisy environments. The low state (0) is defined by +3 to +12 volts while a high state (1) is defined by a -3 to -12 volts. Modern computer equipment ignores the negative level and accepts a zero voltage level as a 1. This means circuits powered by 5V are capable of driving RS232 circuits directly, however, the overall range that the RS232 signal may be transmitted and received is dramatically reduced.

All of the Basic Micro modules have specific pins meant to interface directly to a RS232 COM port on any device. These pins are labeled SIN / SOUT and have a circuit to handle the -12V and +12V signals. The SERIN / SEROUT commands will work with any pin. However connecting a standard I/O pin directly to a 12V circuit would damage the I/O.

The Nano and BasicATOM Chips require a translation circuit like the one shown below. This circuit uses a standard IC that is made to interface to RS232 COM ports. Mostly commonly a PC COM port. Most of the development boards meant for these chips will either have an RS232 translation circuit like the one below or will have a USB translation circuit. The Nano USB programmer can also be used as a simple USB translation circuit to any of the pins for communication.

Schematic

The schematic is a standard circuit for RS232 interface. It uses a MAX232A version. This version requires only .1uf caps. A cheaper alternate to the MAX232A is a HIN232ACN. The RES pin should be connected to the reset (RES) pin of the micro. The T2IN connected to P0 will be the receive (RX) pin. The R2OUT pin connected to P1 is the transmit (TX) pin. The circuit below or one like it should be used when interfacing generic I/O pins to a PC COM port.



Baud Modes

The baud modes define how SERIN / SEROUT operate. There are two parts to a predefined baud mode. The first part indicates the mode in which to receive or send the data. The second part defines the rate (speed) the data is sent or received. An example would be n9600. The N being the mode and the 9600 being the speed.

The two main modes supported are non inverted (N) and inverted (I). Inverted (I) is typically required when a translation circuit is used since the signal will be inverted. When the SIN / SOUT pins are used inverted will typically be used. If a standard I/O pin is used with no translation circuit non inverted (N) is typically used. Inverted or non inverted modes default to 8 bits, no parity bit and 1 stop bit. This means 8 bits of data will be sent or received without parity and with 1 stop bit which indicates the end of the 8 bits.

Parity

Parity is used to determine if there was a communication error. If parity is set using a predefine mode like IE (Inverted, even parity, 7 data bits) then the *plabel* is required. If an error is detected the command will exit and jump to *plabel*. The parity system is very rudimentary but in some situations is a better than nothing approach. The parity works by truncating the 8 data bits to 7 bits (0 to 127 for printable text characters). Even parity simple looks for an even amount of 1s received in the 8 bits.

Since the data is truncated to 7 bits the 8th bit is used to ensure there is always an even number of 1s. If the value being sent has three 1s in it, then the 8th bit is set to a 1 to make the total number of ones four which is even. If there were only two 1s in the value being sent then the 8th bit would be 0 since two 1s would be an even amount.

Supported Modes

Mode	Description
I	Inverted.
N	Non Inverted.
IE	Inverted, Even Parity.
NE	Non Inverted, Even Parity.
IO	Inverted, Open Drain.
NO	Non Inverted, Open Drain.
IEO	Inverted, Even Parity, Open Drain.
NEO	Non Inverted, Even Parity, Open Drain.

Baud Rates

The rate determines how fast the data is transmitted. A fairly standard speed is 9600. This means 9,600 bits per second will be sent or received. There are several predefined speeds. However custom ones can be created. Custom speeds allow SERIN / SEROUT to work with just about any RS232 devices. On occasion you do find devices you may want to interface with that support odd ball speeds. MBasic can easily support these by defining your own baud modes.

There are some limits with the SERIN / SEROUT commands. There is allot going on when SERIN is ran, so the max speed at which they can receive or send serial data is limited. The Nano is limited to a maximum speed of 38400. The BasicATOM Pro can handle up to 57600.

The predefined modes are listed below. The are used in combination with the predefined modes. An example would be n9600, i38400, ieo1200 and so on.

Predefined Baud Rates

Predefined Rate	Predefined Rate
300	16800
600	19200
1200	21600
2400	24000
4800	28800
7200	31200
9600	33600
12000	38400
14400	57600*

Limitations

The Nano maximum baud mode is 38400. The BasicATOM and BasicATOM Pro support up to 57600. These are standard PC COM port baud rates. Since the SERIN command is software based it will not exit unless the data it is waiting for is received or the *timeout* option is specified. The *timeout* option will wait the time specified and then jump to the timeout label.

Modifiers

The SERIN command will store the ASCII value of a character received. If a capital "A" is received a value of 65 is stored. Since the value is stored as binary it can be read back in decimal, hexadecimal or binary. Any character received is store as the ASCII equivalent value. Characters are case sensitive. "A" will have a different value from "a". See the ASCII table in this manual. In some cases you may want to send or receive hexadecimal values or raw binary. Modifiers allow you to format the data.

Input Modifiers

Name	Description
DEC	Decimal.
SDEC	Signed decimal.
HEX	Hexadecimal.
SHEX	Signed hexadecimal.
IHEX	Indicated ($) hexadecimal.
ISHEX	Signed and indicated ($) hexadecimal.
BIN	Binary.
SBIN	Signed binary.
IBIN	Indicated (%) binary.
ISBIN	Indicated (%) and signed binary.
REAL	Floating point number with decimal point.
STR	Read specified amount of characters and store in an array.
SKIP	Skip specified amount of characters.
WAIT	Wait for specified amount of characters.
WAITSTR	Compares specified amount of characters to array.

The DEC/Hex/BIN modifiers will store all incoming numeric values as their binary equivalents. However the DEC/HEX/BIN modifiers will ignore all preceding non-numeral character data and the commands will exit on the first non-numeral character received after it received numeral characters. The example below will read in one byte and store it in MyData. If a "1A" is received the command stores a "1" and exits when it receives the "A" since we only were looking for a number. If an "AA" was sent it would ignore both and continue to wait for numeral characters.

```
MyData var byte
serin p0, i9600, [DEC MyData]
```

In some case you may want to wait for a specific string of text. This is done with the WAIT modifier. This example will wait until the exact string of characters, "TEXT", is received. The quotes designate ASCII characters. One or more characters can be specified.

```
MyData var byte
serin p0, i9600, [WAIT ("TEXT")]
```

In other cases you may want to ignore most of the incoming data and receive only a specific value in a sequence. The SKIP modifier will allow you to ignore as much incoming data as specified before reading a value. The example will skip the first 3 values received and exit on the 4th value. If the word “TEXT” is sent the character “T” would be stored in MyData.

```
MyData var byte
serin p0, i9600, [SKIP 3 MyData]
```

For an example of how all input modifiers work see the modifier section of this manual. The modifiers work the same regardless of what command they are used in.

Notes

1. The Nano maximum baud rate is 38400.
2. BasicATOM and BasicATOM Pro maximum baud rate is 57600.
3. When SERIN is running the processor can not do anything else. If SERIN is not running and data is received it will be ignored.

Examples

This example is meant to work with a Basic Micro development board using the SIN / SOUT pins. This setup requires no wiring it use the default configuration. Simply power up the board and plug in the USB or Serial port.

The following program will return the ASCII value in decimal and hexadecimal of any character you send to it. Once you have the program loaded connect to it with the terminal window built into Studio. Connect using 9600 baud. Type the capital letter “A” in and you should receive a hex value of 0x41 and a decimal value of 65.

```
temp var byte

main
     serin s_in,i9600,[temp]
     serout s_out,i9600,[0,temp,” = Hex:0x”,hex2 temp\2,” Dec:“,dec temp]
goto main
```

SEROUT

Syntax
serout txpin{\fpin},baudmode,{pace,}{timeout,tlabel,}[{modifiers} OutputData]

- **Txpin** - is a variable, constant or expression that specifies the transmit data pin. This pin will switch to output mode and remain in that state at the end of the command.

- **\fpin** - is an optional variable, constant or expression that specifies a pin for flow control (the "\" is required). Flow control is used primarily with PC COM ports and conforms to RS232 serial port specifications. The flow control pin will switch to input mode and remain in that state at the end of the command.

- **Baudmode** - is a 32 bit variable, constant or expression that specifies how fast to receive data and in what format. Several predefined baud modes are available however custom modes are allowed. See the baud mode table for predefined modes.

- **Pace** - is an optional variable, constant or expression that specifies the length of an added pause in between transmitting bytes. Pace can not be used with Timeout and Fpin. Pace is expressed in .5us increments.

- **Timeout** - is an optional 32 bit variable, constant or expression that specifies the time to wait for Fpin before jumping to Tlabel. The value is measured in 0.5 microsecond increments If Fpin does not grant permission to send within this time, the program will jump to tlabel.

- **Tlabel** - is an optional label the program will jump to if Fpin and *timeout* are given and the amount of time specified has elapsed.

- **OutputData -** is a list of variables or constants that tell SERIN what to do with incoming data. The incoming data can be formatted with modifiers. See the Modifier section of this manual.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SEROUT command is designed to work with the RS232 serial specifications. The command is bit banged, which means they are created in software running on the processor. When SEROUT is ran the processor can not do anything but transmit data.

RS232 is a simple communication format supported by the PC and is referred to as a COM port. The COM port can send and receive data simultaneously with each being a separate circuit that works in only one direction. Each circuit can function independently to transmit and received data at the same time. This means the COM port is full duplex. The SEROUT command is not capable of full duplex since it is software based.

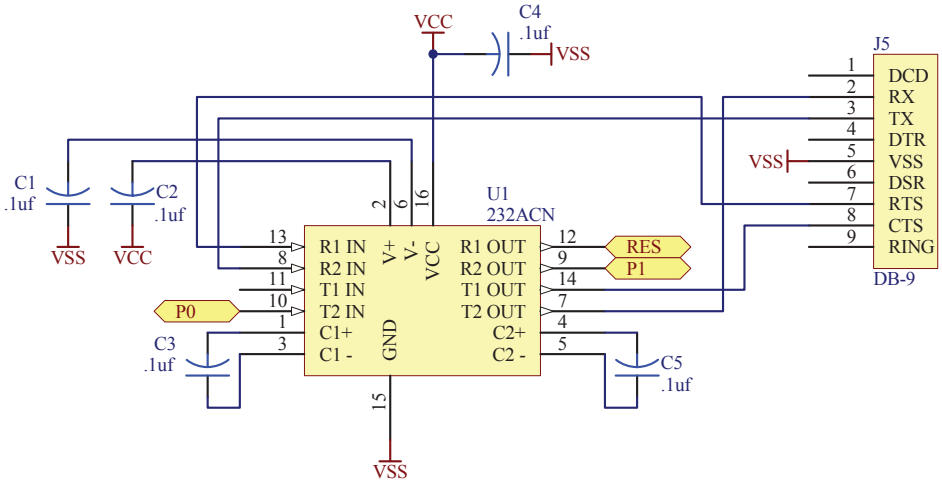
A 12 volt system was develop work over long wire lengths and electrically noisy environments. The low state (0) is defined by +3 to +12 volts while a high state (1) is defined by a -3 to -12 volts. Modern computer equipment ignores the negative level and accepts a zero voltage level as a 1. This means circuits powered by 5V are capable of driving RS232 circuits directly, however, the overall range that the RS232 signal may be transmitted and received is dramatically reduced.

All of the Basic Micro modules have specific pins meant to interface directly to a RS232 COM port on any device. These pins are labeled SIN / SOUT and have a circuit to handle the -12V and +12V signals. The SERIN / SEROUT commands will work with any pin. However connecting a standard I/O pin directly to a 12V circuit would damage the I/O.

The Nano and BasicATOM Chips require a translation circuit like the one shown below. This circuit uses a standard IC that is made to interface to RS232 COM ports. Mostly commonly a PC COM port. Most of the development boards meant for these chips will either have an RS232 translation circuit like the one below or will have a USB translation circuit. The Nano USB programmer can also be used as a simple USB translation circuit to any of the pins for communication.

Schematic

The schematic is a standard circuit for RS232 interface. It uses a MAX232A version. This version requires only .1uf caps. A cheaper alternate to the MAX232A is a HIN232ACN. The RES pin should be connected to the reset (RES) pin of the micro. The T2IN connected to P0 will be the receive (RX) pin. The R2OUT pin connected to P1 is the transmit (TX) pin. The circuit below or one like it should be used when interfacing generic I/O pins to a PC COM port.



Baud Modes

The baud modes define how SERIN / SEROUT operate. There are two parts to a predefined baud mode. The first part indicates the mode in which to receive or send the data. The second part defines the rate (speed) the data is sent or received. An example would be n9600. The N being the mode and the 9600 being the speed.

The two main modes supported are non inverted (N) and inverted (I). Inverted (I) is typically required when a translation circuit is used since the signal will be inverted. When the SIN / SOUT pins are used inverted will typically be used. If a standard I/O pin is used with no translation circuit non inverted (N) is typically used. Inverted or non inverted modes default to 8 bits, no parity bit and 1 stop bit. This means 8 bits of data will be sent or received without parity and with 1 stop bit which indicates the end of the 8 bits.

Parity

Parity is used to determine if there was a communication error. If parity is set using a predefine mode like IE (Inverted, even parity, 7 data bits) then the *plabel* is required. If an error is detected the command will exit and jump to *plabel*. The parity system is very rudimentary but in some situations is a better than nothing approach. The parity works by truncating the 8 data bits to 7 bits (0 to 127 for printable text characters). Even parity simple looks for an even amount of 1s received in the 8 bits.

Since the data is truncated to 7 bits the 8th bit is used to ensure there is always an even number of 1s. If the value being sent has three 1s in it, then the 8th bit is set to a 1 to make the total number of ones four which is even. If there were only two 1s in the value being sent then the 8th bit would be 0 since two 1s would be an even amount.

Supported Modes

Mode	Description
I	Inverted.
N	Non Inverted.
IE	Inverted, Even Parity.
NE	Non Inverted, Even Parity.
IO	Inverted, Open Drain.
NO	Non Inverted, Open Drain.
IEO	Inverted, Even Parity, Open Drain.
NEO	Non Inverted, Even Parity, Open Drain.

Baud Rates

The rate determines how fast the data is transmitted. A fairly standard speed is 9600. This means 9,600 bits per second will be sent or received. There are several predefined speeds. However custom ones can be created. Custom speeds allow SERIN / SEROUT to work with just about any RS232 devices. On occasion you do find devices you may want to interface with that support odd ball speeds. MBasic can easily support these by defining your own baud modes.

There are some limits with the SERIN / SEROUT commands. There is allot going on when SERIN is ran, so the max speed at which they can receive or send serial data is limited. The Nano is limited to a maximum speed of 38400. The BasicATOM Pro can handle up to 57600.

The predefined modes are listed below. The are used in combination with the predefined modes. An example would be n9600, i38400, ieo1200 and so on.

Predefined Baud Rates

Predefined Rate	Predefined Rate
300	16800
600	19200
1200	21600
2400	24000
4800	28800
7200	31200
9600	33600
12000	38400
14400	57600*

Limitations
The Nano maximum baud mode is 38400. The BasicATOM and BasicATOM Pro support up to 57600. These are standard PC COM port baud rates.

Modifiers
In some cases you may want to send or receive hexadecimal values or raw binary. Modifiers allow you to format the data.

Output Modifiers

Name	Description
DEC	Decimal.
SDEC	Signed decimal.
HEX	Hexadecimal.
SHEX	Signed hexadecimal.
IHEX	Indicated ($) hexadecimal.
ISHEX	Signed and indicated ($) hexadecimal.
BIN	Binary.
SBIN	Signed binary.
IBIN	Indicated (%) binary.
ISBIN	Indicated (%) and signed binary.
REP	Repeat character *n* times.
REAL	Floating point number with decimal point.
STR	Read specified amount of characters from an array.

Terminal Window
Basic Micro Studio has 4 built in terminal windows. The windows support formatting commands. These commands control the cursor positioning and other functions. The example shown will clear the screen and move the cursor to the home position before the word “Test” is printed.

```
serout s_out, i9600, [0,”Test”]
```

Terminal Window Commands

Decimal Character	Command	Description
0	CLS	Clears the screen.
1	HOME	Moves cursor home.
3	MOVE LEFT	Moves cursor left.
4	MOVE RIGHT	Moves cursor right.
5	MOVE UP	Moves cursor up.
6	MOVE DOWN	Moves cursor down.
7	BELL	Make sound on PC.
8	BACK SPACE	Moves cursor back and delete.
9	HANDLE TAB	Add a standard tab.
10	LINEFEED	Move cursor to next line.
11	CLEAR RIGHT	Clear anything to the right of the cursor.
12	CLEAR DOWN	Clear anything below the cursor.
13	CARRIAGE RETURN	Move to the next line.

Notes
1. The Nano maximum baud rate is 38400.
2. BasicATOM and BasicATOM Pro maximum baud rate is 57600.
3. When SEROUT is running the processor can not do anything else.

Examples
This example is meant to work with a Basic Micro development board using the SIN / SOUT pins. This setup requires no wiring it use the default configuration. Simply power up the board and plug in the USB or Serial port.

The following program will return the ASCII value in decimal and hexadecimal of any character you send to it. Once you have the program loaded connect to it with the terminal window built into Studio. Connect using 9600 baud. Type the capital letter “A” in and you should receive a hex value of 0x41 and a decimal value of 65.

```
temp var byte

main
     serin s_in,i9600,[temp]
     serout s_out,i9600,[0,temp,” = Hex:0x”,hex2 temp\2,” Dec:“,dec temp]
goto main
```

Examples
This example shows how to use the string modifier. We setup an array, load it with the text string “Hello World”. The SEROUT command with the string modifier will increment through the variable array and send the character from each position in the array. Connect to this program with the terminal window at 9600 baud to see the results.

```
string var byte(20)

string = “Hello World”,0

main
     serout s_out,i9600,[str string\20\0,13]
goto main
```

SERVO

Syntax
servo pin,pos{,repeat}

- **Pin** - is a variable, constant or expression that indicates what processor pin to use.
- **Pos** - is a variable, constant or expression that indicates servo position. The value used must be signed to indicate left or right swing. Valid real world ranges are +/- 3000 with 0 being center. The ranges will vary from servo to servo.
- **Repeat** - is a variable, constant or expression that is optional and specifies how many times a pulse is repeated before exiting the command. A repeat value of 0 is a special case and will only wait until the high side of the pulse is finished before resuming normal program execution.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SERVO commands will generate pulses to control a standard R/C hobby servo. The range is -3000 to +3000. Most servos will run from -2200 to +2200. Center is typically 0. The command is a blocking command and will wait until the pulse is finished.

The repeat argument can be used drive up to 6 servos by setting it to 0. The time it takes to update 6 SERVO commands in a row with repeat = 0 is about 18ms. Leaving time for the program to perform additional tasks.

Notes
1. Setting the repeat argument to 0 means this servo command will output 1 pulse and continue on to the next command without waiting for the low part of the pulse to finish
2. Setting the repeat argument to 1 or more will cause the SERVO command to output the pulse 20 times the value repeat is set to. Repeat = 20 would generate 400 pulses.

Examples
The program demonstrates how to update more than one servo at a time using the optional repeat argument. Setting the first repeat to 0 will allow the second SERVO command to run while the first is still updating. Setting the second SERVO command to a repeat 1 one provides enough time for both servo to finish updating.

```
pos var sword

main
     for pos = -500 to 500

     servo p0,pos,0
     servo p1,-pos,1
     next

     for pos = -500 to 500
           servo p0,-pos,0
           servo p1,pos,1
     next
     goto main
```

SHIFTIN

Syntax
shiftin dpin,cpin,mode,[InputData{\bits}, InputData1{\bits}]

- **Dpin -** is a variable, constant or expression that specifies the Data input pin. This pin will switch to an input pin.
- **Cpin -** is a variable, constant or expression that specifies the Clock output pin. This pin will switch to an output.
- **Mode -** is a value (0 to 7) or a predefined constant that sets the incoming data conditions.
- **InputData -** is a variable where incoming data is stored. The only limit to the amount of variables that can be used is the available ram on the processor being used.
- **Bits -** is an optional entry (1 – 32) defining the number of bits that will be written to each variable in the list. The default is 8 bits. Some devices will send back more than 8 bits or interleave from 8 to 16 bits. The optional bits argument allows the number of bits to be defined that will be stored in each variable in the list.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SHIFTIN and SHIFTOUT commands can send or received data from synchronous serial devices like an SPI device. Synchronous serial differs from asynchronous (SERIN / SEROUT) in that there is a clock line. This clock line is used to time the data bits sent or received. There are several settings which make the SHIFTIN / SHIFTOUT commands flexible enough to work with most any synchronous serial device.

The following tables provides all supported modes and maximum speed in kilo bits per second that each processor family can handle. There are 8 modes. The first 4 modes (0-3) are standard modes. The second set of 4 modes (4-7) are basically duplicates of the first 4 modes but for high speed operation.

Modes

Mode	Value	Description
MSBPRE	0	Sample bits msb first, before clock pulse.
LSBPRE	1	Sample bits lsb first, before clock pulse.
MSBPOST	2	Sample bits msb first, after clock pulse.
LSBPOST	3	Sample bits lsb first, after a clock pulse.
FASTMSBPRE	4	Faster sampling, msb first, before clock pulse
FASTLSBPRE	5	Faster sampling, lsb first, before clock pulse
FASTMSBPOST	6	Faster sampling, msb first, after clock pulse
FASTLSBPOST	7	Faster sampling, lsb first, after clock pulse

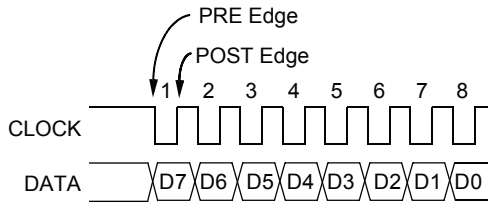
Speeds

Processor	Mode 0-4	Mode 5-7
BA	50 Kbps	100 Kbps
BAN	20 Kbps	40 Kbps
BAP	100 Kbps	380 Kbps
BAP40	400 Kbps	400 Kbps
ARC32	400 Kbps	400 Kbps

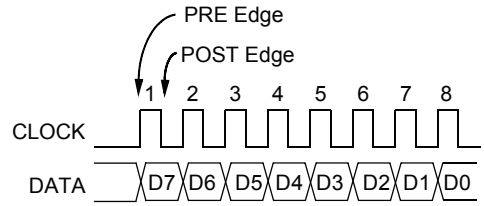
All SPI devices fall into 4 main transmission modes. They are specific to the timings of the writing and reading of data. The write and read of data at the first edge of the clock pulse is PRE. The second edge of the clock pulse is POST. The PRE and POST edge of the clock will change depending on whether the clock starts high(1) or low(0).

Most SPI device data sheets will indication if they are PRE, POST, MSB or LSB. However in some case the data sheet might not be clear. So first we must determine if the data is read PRE or POST clock edge. In almost all cases data can be written and read on the rising and falling edge of the clock signal. Looking at the timing diagrams below the clock can start from one of two states high(1) or low(0). The rising or falling edge of the clock does not matter in SPI only the edge its self. The diagrams below illustrate the PRE and POST edge based on a high(1) or low(0) clock start.

High(1) Clock Start



Low(0) Clock Start



The diagrams for clock start show the data in both cases being written on the POST edge of the clock. The next thing to determine is the bit order. Which from the diagrams starts with bit 7 (D7) and ends with bit 0 (D0), this is MSB (Most Significant Bit First). If the byte order were reversed and bit 0 (D0) was first with bit 7 (D7) last that would be LSB (Least Significant Bit First)

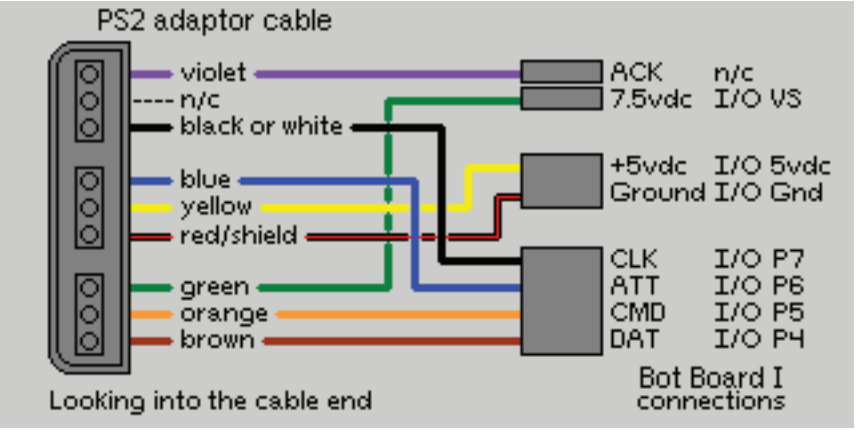
Notes

1. SHIFTIN and SHIFTOUT only work as a master device, the clock pin will always be an output for both SHIFTIN and SHIFTOUT.

Schematics

The wiring diagram below illustrates how to connect a PS2 controller for the given example program. The connector shown is a standard PS2 cable that can be made or purchased from Lynxmotion. The DAT pin requires a10K pull-up resistor to work properly.

PS2 Wiring Diagram



Examples

The example program on the following pages can be copied and pasted into Studio. However you must watch for the header and page number from being copied with it. Copy the first page into a new bas file then copy and past the second page into the same file.

After the program is loaded connect to it with the terminal window at 38400 baud. The program will display on the screen what control is being pressed from the PS2 controller and how hard. All buttons on most PS2 controllers have analog sensors that sense how hard a button is being pressed. These result will be displayed to the terminal window. Connect the PS2 controller as shown in the above wiring diagram. Don't forget the 10K pull-up resistor on the DAT pin.

```
;[PS2 Controller Constants]
DAT                             con P0          ;PS2 Controller DAT (Brown)
CMD                             con P1          ;PS2 controller CMD (Orange)
ATT                             con P2          ;PS2 Controller SEL (Blue)
CLK                             con P3          ;PS2 Controller CLK (White)

PadMode                         con $79
;-----------------------------------------------------------------

;[Ps2 Controller Variables]
DualShock                       var Byte(18)
LastButton                      var Byte(2)
DS2Mode                         var Byte
PS2Index                        var byte
;-----------------------------------------------------------------

main
      gosub ControlInput[dualshock(16),dualshock(17)]

      serout s_out,i38400,[0,"  DPad-Left: ",bin1 dualshock(0).bit7\1," ",dec dualshock(7),13]
      serout s_out,i38400,["  DPad-Down: ",bin1 dualshock(0).bit6\1," ",dec dualshock(9),13]
      serout s_out,i38400,[" DPad-Right: ",bin1 dualshock(0).bit5\1," ",dec dualshock(6),13]
      serout s_out,i38400,["    DPad-Up: ",bin1 dualshock(0).bit4\1," ",dec dualshock(8),13]

      serout s_out,i38400,["Right XAxis: ",sdec 128-dualshock(2),13]
      serout s_out,i38400,["Right YAxis: ",sdec 128-dualshock(3),13]
      serout s_out,i38400,[" Left XAxis: ",sdec 128-dualshock(4),13]
      serout s_out,i38400,[" Left YAxis: ",sdec 128-dualshock(5),13]

      serout s_out,i38400,["      Start: ",bin1 dualshock(0).bit3\1,13]
      serout s_out,i38400,["  RAxis(R3): ",bin1 dualshock(0).bit2\1,13]
      serout s_out,i38400,["  LAxis(L3): ",bin1 dualshock(0).bit1\1,13]
      serout s_out,i38400,["     Select: ",bin1 dualshock(0).bit0\1,13]

      serout s_out,i38400,["     Square: ",bin1 dualshock(1).bit7\1," ",dec dualshock(13),13]
      serout s_out,i38400,["      Cross: ",bin1 dualshock(1).bit6\1," ",dec dualshock(12),13]
      serout s_out,i38400,["     Circle: ",bin1 dualshock(1).bit5\1," ",dec dualshock(11),13]
      serout s_out,i38400,["   Triangle: ",bin1 dualshock(1).bit4\1," ",dec dualshock(10),13]

      serout s_out,i38400,["         R1: ",bin1 dualshock(1).bit3\1," ",dec dualshock(15),13]
      serout s_out,i38400,["         L1: ",bin1 dualshock(1).bit2\1," ",dec dualshock(14),13]
      serout s_out,i38400,["         R2: ",bin1 dualshock(1).bit1\1," ",dec dualshock(17),13]
      serout s_out,i38400,["         L2: ",bin1 dualshock(1).bit0\1," ",dec dualshock(16),13]

      pause 100

      goto main

ps2_motorww var byte
ps2_motoryy var byte
ControlInput [ps2_motorww,ps2_motoryy]
      high CLK
ControlInput_Retry
      LastButton(0) = DualShock(1)
      LastButton(1) = DualShock(2)
      low ATT
      shiftout CMD,CLK,FASTLSBPRE,[$1\8]
      shiftin DAT,CLK,FASTLSBPOST,[DS2Mode\8]
      high ATT
      pause 1

      if DS2Mode <> PadMode THEN
              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$1\8,$43\8,$0\8,$1\8,$0\8] ;enter config mode
              high ATT
              pause 1

              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$01\8,$44\8,$00\8,$01\8,$03\8,$00\8,$00\8,$00\8,$00\8]
```

```
;set and lock analog mode
              high ATT
              pause 1

              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$01\8,$4D\8,$00\8,$00\8,$01\8,$FF\8,$FF\8,$FF\8,$FF\8]
;Enable Vibration motors
              high ATT
              pause 1

              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$01\8,$4F\8,$00\8,$FF\8,$FF\8,$03\8,$00\8,$00\8,$00\8]
;set 18byte reply
              high ATT
              pause 1

              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$01\8,$43\8,$00\8,$00\8,$5A\8,$5A\8,$5A\8,$5A\8,$5A\8]
;exit config mode
              high ATT
              pause 1

              DualShock(1) = 255,255

              goto ControlInput_Retry
      else

              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$1\8,$42\8, $00\8]
              shiftin DAT,CLK,FASTLSBPOST,[DualShock(0)\8, DualShock(1)\8]
              high ATT
              low ATT
              shiftout CMD,CLK,FASTLSBPRE,[$1\8,$42\8, $00\8,ps2_motorww\8,ps2_motoryy\8]
              shiftin DAT,CLK,FASTLSBPOST,[DualShock(2)\8, DualShock(3)\8, DualShock(4)\8,
DualShock(5)\8, |
                              DualShock(6)\8, DualShock(7)\8, DualShock(8)\8, DualShock(9)\8, |
                              DualShock(10)\8, DualShock(11)\8, DualShock(12)\8, DualShock(13)\8, |
                              DualShock(14)\8, DualShock(15)\8, DualShock(16)\8, DualShock(17)\8]
              high ATT
      endif

return
;-----------------------------------------------------------------------
```

SHIFTOUT

Syntax
shiftout dpin,cpin,mode,[OutputData{\bits}, OutputData1{\bits}]

- **Dpin -** is a variable, constant or expression that specifies the Data input pin. This pin will switch to an input pin.
- **Cpin -** is a variable, constant or expression that specifies the Clock output pin. This pin will switch to an output.
- **Mode -** is a value (0 to 7) or a predefined constant that sets the incoming data conditions.
- **OutputData -** is a variable, constant or expression that specifies the data to be sent. The only limit to the amount of data is the available ram on the processor being used.
- **Bits -** is an optional entry (1 – 32) defining the number of bits that will be sent.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SHIFTIN and SHIFTOUT commands can send or received data from synchronous serial devices like an SPI device. Synchronous serial differs from asynchronous (SERIN / SEROUT) in that there is a clock line. This clock line is used to time the data bits sent or received. There are several settings which make the SHIFTIN / SHIFTOUT commands flexible enough to work with most any synchronous serial device.

The following tables provides all supported modes and maximum speed in kilo bits per second that each processor family can handle. There are 8 modes. The first 4 modes (0-3) are standard modes. The second set of 4 modes (4-7) are basically duplicates of the first 4 modes but for high speed operation.

Modes

Mode	Value	Description
MSBPRE	0	Sample bits msb first, before clock pulse.
LSBPRE	1	Sample bits lsb first, before clock pulse.
MSBPOST	2	Sample bits msb first, after clock pulse.
LSBPOST	3	Sample bits lsb first, after a clock pulse.
FASTMSBPRE	4	Faster sampling, msb first, before clock pulse
FASTLSBPRE	5	Faster sampling, lsb first, before clock pulse
FASTMSBPOST	6	Faster sampling, msb first, after clock pulse
FASTLSBPOST	7	Faster sampling, lsb first, after clock pulse

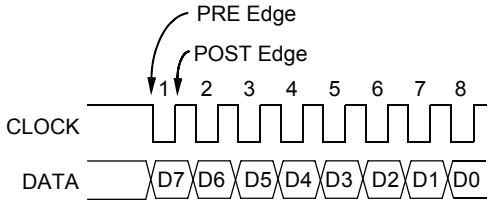
Speeds

Processor	Mode 0-4	Mode 5-7
BA	50 Kbps	100 Kbps
BAN	20 Kbps	40 Kbps
BAP	100 Kbps	380 Kbps
BAP40	400 Kbps	400 Kbps
ARC32	400 Kbps	400 Kbps

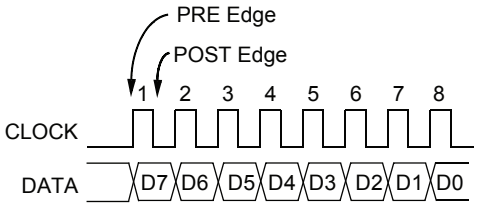
All SPI devices fall into 4 main transmission modes. They are specific to the timings of the writing and reading of data. The write and read of data at the first edge of the clock pulse is PRE. The second edge of the clock pulse is POST. The PRE and POST edge of the clock will change depending on whether the clock starts high(1) or low(0).

Most SPI device data sheets will indication if they are PRE, POST, MSB or LSB. However in some case the data sheet might not be clear. So first we must determine if the data is read PRE or POST clock edge. In almost all cases data can be written and read on the rising and falling edge of the clock signal. Looking at the timing diagrams below the clock can start from one of two states high(1) or low(0). The rising or falling edge of the clock does not matter in SPI only the edge its self. The diagrams below illustrate the PRE and POST edge based on a high(1) or low(0) clock start.

High(1) Clock Start



Low(0) Clock Start



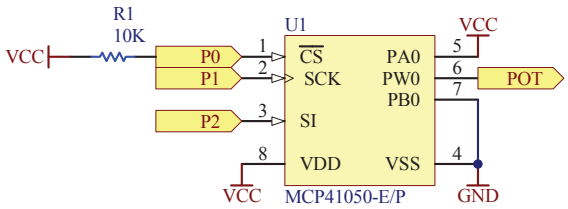
The diagrams for clock start show the data in both cases being written on the POST edge of the clock. The next thing to determine is the bit order. Which from the diagrams starts with bit 7 (D7) and ends with bit 0 (D0), this is MSB (Most Significant Bit First). If the byte order were reversed and bit 0 (D0) was first with bit 7 (D7) last that would be LSB (Least Significant Bit First)

Notes

1. SHIFTIN and SHIFTOUT only work as a master device, the clock pin will always be an output for both SHIFTIN and SHIFTOUT.

Schematics

The digital potentiometer is controlled by SHIFTOUT command using SPI communications. The 10K pull-up resistor on CS is require to disable the part when its in an idle state. P1 is connected to the clock pin and P2 is connected to the serial data input pin.



Examples

The following example will cycle the digital potentiometer from 0K to 50K. Connect the potentiometer as shown above and run the example code. Connect a multimeter to ground and the PW0 / POT pin on the digital potentiometer. As the code cycles the pot the multimeter reading will corollate.

```
cs con p0
clk con p1
si con p2

temp var byte
temp = 0

high clk
main
     temp = temp + 1
     low cs
     shiftout si,clk,MSBPRE,[(0x11<<8) | temp\16]
     high cs
     pause 25
goto main
```

SLEEP

Syntax
sleep time

- **Time** - is a variable, constant or expression that specifies the amount of time to sleep.

Supported
- BA - Supported with 1 second timings.
- BAN - Supported with 1 second timings.
- BAP - Supported with 1ms timings.
- BAP40 - Supported with 1ms timings.

Description
The SLEEP command is similar to the NAP command. It use the same behind the scene method to put the processor in a lower power state. SLEEP however supports timings in increments of 1. The BasicATOM and Nano supports 1 second timings. The BasicATOM Pro and BasicATOM Pro 40 support 1 millisecond timing increments.

Notes
1. BasicATOM and Nano support 1 second timing increments.
2. BasicATOM Pro and BasicATOM Pro 40 support 1 millisecond timings.

Example
The example program shown will sleep for 1 minute on a BasicATOM and Nano. Increase 60 to 6000 to sleep for the same time on the BasicATOM Pro and BasicATOM Pro 40 .

```
main
     serout s_out, i9600, [“Going to Sleep”]
     sleep 60 ;change to 6000 for ATOM Pro
     serout s_out, i9600, [“I’m awake!”]
goto main
```

SOUND

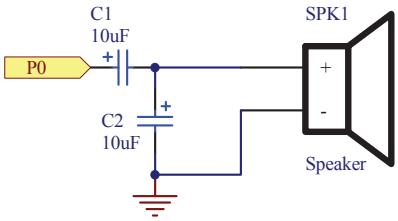
Syntax
sound pin, [duration\note, duration\note]

- **Pin -** is a variable or constant that specifies the pin used to generate the sounds on.
- **Duration** - is a variable, constant or expression that specifies how long to play the note following the backslash (\). Duration is in milliseconds.
- **Note** - is a variable constant or expression that specifies the frequency to generate in Hz. Notes and their durations can be a list separated by commas and only limited to the amount of user ram available.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SOUND command generates a square wave output. It can drive a small piezo speaker without amplification. To increase the volume output add a low pass filter such as a 10uf capacitor in-line.

Schematic
The schematic outlines a simple method of connecting a piezo speaker. The 10uf capacitor is typically an electrolytic but can be a tantalum. You can experiment by omitting the capacitor when a song is being played to see the difference it makes.



Example

Connect a piezo speaker to P0. The speakers GND should be connected to GND and the positive side connected through a 10uf capacitor to P0 (See schematic). The following program will play “Mary Had a Little Lamb” looping forever. The constant table in the program is setup to correctly create a given note. This makes writing the song easier since its now human readable. See what songs you can make.

```
;ALL - all_sound.bas


;The below table defines all the notes needed.
;It asigns the numeric value to an easily readable
;constant to make the song easier to create.

AH con 440*2 ;assigns a value for the note and octave
AS con 466*2 ;the note is 466*2 = A sharp second octave
BH con 494*2
CH con 523*2
CS con 554*2
DH con 587*2
DS con 622*2
EH con 659*2
FH con 698*2
FS con 740*2
GH con 784*2
GS con 831*2

;A lookup table is used to load the notes into the sound command.
;With a FOR/NEXT loop to increment through the note table in lookup.
;A slight pause is added to prevent the notes from overlapping. The
;loop will repeat forever.

Position var byte
Note var long

playsong
     for Position = 0 to 33
           lookup Position,[CS,BH,AH,BH,CS,0,CS,0,CS,BH,0,BH,0,BH,0,CS,|
                 EH, 0, EH,CS,BH,AH,BH,CS,0,CS,0,CS,BH,0,BH,CS,BH,AH],Note
           if Note then
                 sound p0,[300\Note]
           else
                 pause 10
           endif
     next
     pause 5000
     goto playsong
```

SOUND2

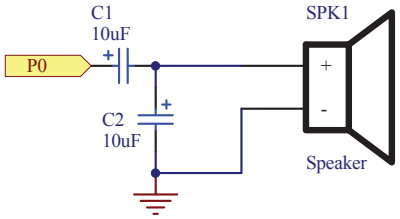
Syntax
sound2 pin1\pin2,[duration\note1\note2]

- **Pin -** is a variable, constant or expression that specifies the first pin used for generating note1 on.
- **Pin -** is a variable, constant or expression that specifies the first pin used for generating note2 on.
- **Duration** - is a variable, constant or expression that specifies how long to play the note (following the \). Duration is in milliseconds.
- **Note1** - is a variable constant or expression that specifies the first frequency to generate in Hz. Notes and their durations can be a list separated by commas and only limited to the amount of user ram available.
- **Note2** - is a variable constant or expression that specifies the second frequency to generate in Hz. Notes and their durations can be a list separated by commas and only limited to the amount of user ram available.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SOUND2 command generates two square waves. One wave is output on a unique pin. It can drive a small piezo speaker without amplification. To increase the volume output add a low pass filter such as a 10uf capacitor in-line.

Schematic
The schematic outlines a simple method of connecting a piezo speaker. The 10uf capacitor is typically an electrolytic but can be a tantalum. You can experiment by omitting the capacitor when a song is being played to see the difference it makes.



Examples
The following example will generate a two tone sound from P0 and P1. To connect a speaker see the circuits shown for SOUND.

```
main
     sound2 p0,p1,[500\500\1000,500\600\900]
goto main
```

STOP

Syntax
stop

Supported
- BA - supported
- BAN - supported
- BAP - supported
- BAP40 - supported

Description
Stops program execution until a reset occurs. All I/O pins will remain in their last known state. Typically STOP is used at the very end of a program to halt all processes and cleanly shut down operation. STOP works the same as END.

Example
The following example will only run once. The program will only restart if reset is pressed of the power is cycled.

```
value var long

     serout s_out,i9600,["This program just stops.",13]
     serout s_out,i9600,["Press reset to see it again.",13]
stop
```

SWAP

Syntax
swap variable1, variable2

- **Variable** - is any variable defined in the program.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The SWAP command is a coinvent way to switch the value of one variable with another.

Notes
1. SWAP will truncate a value if it is larger than the destination variable is setup for. If a WORD value is loaded into a BYTE variable it will truncate and load the low byte of the WORD.

Examples
Connect to the following program with the terminal window set to 9600 baud. Variable1 and variable2 values will be printed to the screen. The variables are then printed again, after the SWAP command is issued. You can see values of the variables have been swapped.

```
;ALL - all_swap.bas

Variable1 var word
Variable2 var word

Variable1 = 256
Variable2 = 512

Main
     Pause 500
     Serout s_out, i9600, [0, "Variable1 = ", dec variable1, 13]
     Serout s_out, i9600, ["Variable2 = ", dec variable2,13 ]

     Pause 1000
     Serout s_out, i9600, [13, "Swapping Variables", 13]
     Pause 1000

     swap variable1, variable2 ;lets swap var1 with var2

     ;Lets see what happened
     Serout s_out, i9600, [13, "Variable1 = ", dec variable1, 13]
     Serout s_out, i9600, ["Variable2 = ", dec variable2]

End
```

TOGGLE

Syntax
toggle pin

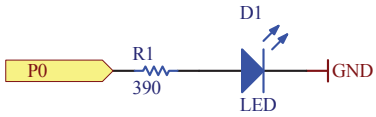
- **Pin** - is any expression, constant or variable that specifies an I/O pin to use.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
TOGGLE configures a pin as an output and toggles it's state from low (0) to high (1) or high (1) to low (0). The TOGGLE command is not like the REVERSE command since TOGGLE only deals with the output state of the pin low or high.

Notes
1. All pins on power up are inputs by default with a default output state of low if made outputs.

Schematic
Connect a LED as shown below. You can substitute the resistor for anything from 330 ohms to 470 ohms.



Example
The following program demonstrates another way to blink an LED attached to pin 0. The TOGGLE command changes the state of the pin from low as defined by LOW P0 to a high since it “toggles” the pin state.

```
;Wire an LED to P0

Low p0

Main
     Toggle p0
     Pause 500
Goto main
```

WHILE - WEND

Syntax

```
while condition
        program statements
wend
```

- **Condition** - can be a variable or expression
- **Statements -** any group of commands to be run inside the loop.

Supported

- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description

The WHILE - WEND loop executes commands nested inside of it will some condition is true. The condition is tested before the WHILE - WEND loop is ran. This is opposite of DO - WHILE which will test the condition for true after running once. The condition can be any variable or expression and is tested every loop until false. A simple example would be using the WHILE - WEND loop to test the state of an input pin. If the pin is low go do something until pin is high.

Notes

1. In the programming world 0 is consider false. By default WHILE - WEND will test this condition. If a stand alone variable is used for the test the loop will continue until its value equals 0.
2. WHILE - WEND checks the condition first. If the condition is false the WHILE - WEND statements and all program code nested within them will not run.
3. You can nest multiple WHILE - WEND commands within each other. However you can not nest DO - WHILE with a WHILE - WEND together or the compiler will get the WHILE statements con fused.

Example

Connect to the following program with the terminal window set to 9600 baud. The program will start counting up from 0 to 100. Once index reaches a value of 100 the condition is no longer true. The less than symbol < was used for the condition and 100 is no longer less than 100 making the condition false. Since WHILE - WEND loops if a statement is true the program exits.

```
;ALL - all_while_wend2.bas

Index var word

Main
     Index = 0

     While Index < 100 ;run until no longer less than 100
     index = index + 1

     ;print the value of index
     serout s_out, i9600,[0, "Couting: ", dec index]
     pause 75

     wend

     serout s_out, i9600, [13,13, "Index = ", dec index]
     serout s_out, i9600, [13, "My condition is no longer true."]
     serout s_out, i9600, [13, "Index is no longer less than 100"]
End
```

WRITE

Syntax
write address,data

- **Address** - address of eeprom to store data

- **Data** - is a byte value that will be written to the address specified. It can be an expression, constant or variable.

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
All modules except the BasicATOM Pro 24 come with built in eeprom. The READ / WRITE commands were created to access the built in memory. WRITE will write a signal byte to the built in eeprom at the address specified in the command.

Notes
1. The AtomPro24 does not have built in eeprom. An external 32kbit or larger eeprom can be added. Connect the eeprom SCL pin to P10 and the eeprom SDA pin to P11. A 10k ohm pull up resistor is required on P11. Ground the eeproms A0,A1 and A2 address pins.

Example
The example program will write the string “Hello” starting at the first location to the built in memory. Next, it will read built in memory locations 0 through 10 and print the contents to the terminal window.

```
index var byte
char var byte

write 0,”H”
write 1,”e”
write 2,”l”
write 3,”l”
write 4,”o”

for index = 0 to 10
     read index,char
     serout s_out,i9600,[char]
next
end
```

WRITEDM

Syntax
write address,[{modifiers}data1,...,{modifiers}data2]

- **Address**s - memory location to start the write at. Can be an expression, constant or variable.
- **Data** - a list of values and optional modifiers that will be stored in the built in eeprom. Values larger than a byte will be truncated to a byte.
- **Modifiers** - are used in the command syntax to format data. Refer to the modifier section of this manual. All output modifiers are supported

Supported
- BA - Supported.
- BAN - Supported.
- BAP - Supported.
- BAP40 - Supported.

Description
The READDM differs from the READ command in that its auto incrementing. It can be ran once and read multiple bytes from the onboard eeprom using only a starting address. READDM will continue to read based on how many variables are specified. Modifiers can be used to format the data or add functionality to the command. See table above.

Notes
1. The AtomPro24 does not have built in eeprom. An external 32kbit or larger eeprom can be added. Connect the eeprom SCL pin to P10 and the eeprom SDA pin to P11. A 10k ohm pull up resistor is required on P11. Ground the eeproms A0,A1 and A2 address pins.
2. The WriteDM command differs from the Write command in that auto increments the address. It can write multiple bytes each time it is executed. The Write command can only write one byte each time it is executed.

Example:
The program will write “Hello World” to the on board eeprom starting at location 0. Then using the ReadDM command will read the on board eeprom starting at location 0 then print the results to the terminal window using 9600 baud.

```
writedm 0,[“Hello world”]

index var byte
string var byte(11)

     readdm index,[str string\11]
     serout s_out,i9600,[str string\11]
end
```

Interrupts

Interrupts

While the program is executing it is possible to interrupt this execution to handle another event. The events can be things like a pin changing from high to low or low to high. Other events can be received data or timer count down or count up. There are several types of interrupts. The interrupt system is an advance feature of MBasic and should only be explored by an advance users. A basic understanding of interrupts and there limitations is required to utilize them properly.

ONINTERRUPT

oninterrupt interrupt, handler

- **Interrupt** - one of the listed interrupt types. See Interrupt Types table.
- **Handler** - the interrupt handler label to jump to when the interrupt triggers.

This is a directive to the compiler to specify the label to jump to when a specific interrupt triggers. The interrupt handler label must use RESUME to exit the interrupt handler.

ONASMINTERRUPT

onasminterrupt interrupt, handler

- **Interrupt** - one of the listed interrupt types. See Interrupt Types table.
- **Handler** - the assembly interrupt handler label to jump to when the interrupt triggers.

This is a directive to the compiler to specify the label to jump to when a specific interrupt triggers. The assembly interrupt handler must use the RTE assembly command to exit the interrupt handler.

ENABLE

enable {interrupt}

- **Interrupt** - an optional argument of one of the listed interrupt types. See Interrupt Types table.

Enables one or all interrupts. When used with no arguments the global interrupt enable flag is set. When used with an interrupt argument, that interrupt's enable flag is set. Only when both the global interrupt flag and specific interrupt flag are set will that interrupt be allowed to trigger.

DISABLE

disable {interrupt}

- **Interrupt** - an optional argument of one of the listed interrupt types. See Interrupt Types table.

Disables one or all interrupts. When used with no arguments the global interrupt enable flag is cleared.When used with an interrupt argument, that interrupt's enable flag is cleared. If either the global interrupt flag or the specific interrupt flag is cleared the interrupt will not trigger.

RESUME
resume

This command is used to exit the Basic interrupt handler and return to the point in your program where execution was interrupted due to an interrupt trigger.

Interrupt Example
The following example uses Time V and creates a counter that will blink an led every second regardless of what the program is doing. This is a very simple way to create a back ground task that can easily indicate the device is still running.

```
;calculates the number of interrupts per 1/100th of a second
;as a floating point constant.


interval fcon MHZ/100/256/128

counter var float
counter = 0.0

milliseconds var long
milliseconds = 0

TCRV0 = 0x03     ;Sets Timer V to count once every 128 OSC clocks
TCRV1 = 0x01


;Tells the processor where to jump to when the timer V
;overflow interrupt triggers.

ONINTERRUPT TIMERVINT_OVF,handler

ENABLE TIMERVINT_OVF   ;enables the timer V overflow interrupt
ENABLE                 ;enables interrupts in general

main
     if(milliseconds >= 500)then
           toggle p0
           milliseconds = milliseconds - 500
     endif
     goto main

handler
     ;this interrupt is executed once per 256*128 clock cycles

     counter = counter + 1.0
     if(counter>interval)then
           counter=counter-interval
           milliseconds = milliseconds + 10
     endif
     resume
```

Interrupt Types

There are several types of interrupts availabe on the BasicATOM Pro processors. The following tables list all the types available in MBasic. The types of interrupts will trigger based on different events. The processor at the heart of the BasicATOM Pro is an H8Tiny. The following chart details what is available. Information on how to utilize the interrupt can be found in the H8Tiny hardware manuals.

Interrupt Table

Interrupt	Description	Renesas Hardware Manual Pages
IRQ0INT	Irq0 pin interrupt	
IRQ1INT	Irq1 pin interrupt	
IRQ2INT	Irq2 pin interrupt	
IRQ3INT	Irq3 pin interrupt	
WKPINT_0	WKP0 pin onchange interrupt	
WKPINT_1	WKP1 pin onchange interrupt	
WKPINT_2	WKP2 pin onchange interrupt	
WKPINT_3	WKP3 pin onchange interrupt	
WKPINT_4	WKP4 pin onchange interrupt	
WKPINT_5	WKP5 pin onchange interrupt	
TIMERVINT_OVF	TimerV overflow interrupt	
TIMERVINT_CMEB	TimerV compare match A int	
TIMERVINT_CMEA	TimerV compare match B int	
SCI3INT_TDRE	Transmit Data Register Empty interrupt	
SCI3INT_RDRF	Read Data Register Full interrupt	
SCI3INT_TEND	Transmit End interrupt	
SCI3INT_OER	Overflow Error interrupt	
SCI3INT_FER	Frame Error interrupt	
SCI3INT_PER	Parity Error interrupt	
IICINT	I2C interrupt	
ADINT	Analog conversion complete int	
HSERIALINT_TDRE	Transmit Data Register Empty interrupt	
HSERIALINT_RDRF	Read Data Register Full interrupt	
HSERIALINT_TEND	Transmit End interrupt	
HSERIALINT_OER	Overflow Error interrupt	
HSERIALINT_FER	Frame Error interrupt	
HSERIALINT_PER	Parity Error interrupt.98	
HSERVOINT	Servo Handler interrupt.	
HSERVOINT_IDLE#	Servo Idle interrupt. Replace # with servo number.	

BAP 24/28 Only Interrupt Types

Interrupt	Description	Renesas Hardware Manual Pages
TIMERAINT	Overflow interrupt	
TIMERWINT_OVF	Overflow interrupt	
TIMERWINT_IMIEA	Capture/Compare Match A int	
TIMERWINT_IMIEB	Capture/Compare Match B int	
TIMERWINT_IMIEC	Capture/Compare Match C int	
TIMERWINT_IMIED	Capture/Compare Match D int	

BAP40 Only Interrupt Types

Interrupts	Description	Renesas Hardware Manual Pages
RTCINT	Real time clock interrupt	
TIMERZ0INT_OVF	Overflow interrupt	
TIMERZ0INT_IMIEA	Capture/Compare Match A int	
TIMERZ0INT_IMIEB	Capture/Compare Match B int	
TIMERZ0INT_IMIEC	Capture/Compare Match C int	
TIMERZ0INT_IMIED	Capture/Compare Match D int	
TIMERZ1INT_UDF	Underflow interrupt	
TIMERZ1INT_OVF	Overflow interrupt	
TIMERZ1INT_IMIEA	Capture/Compare Match A int	
TIMERZ1INT_IMIEB	Capture/Compare Match B int	
TIMERZ1INT_IMIEC	Capture/Compare Match C int	
TIMERZ1INT_IMIED	Capture/Compare Match D int	
TIMERB1INT	Overflow interrupt	
SCI3_2INT_TDRE	Transmit Data Register Empty interrupt	
SCI3_2INT_RDRF	Read Data Register Full interrupt	
SCI3_2INT_TEND	Transmit End interrupt	
SCI3_2INT_OER	Overflow Error interrupt	
SCI3_2INT_FER	Frame Error interrupt	
SCI3_2INT_PER	Parity Error interrupt	
HSERIAL2INT_TDRE	Transmit Data Register Empty interrupt	
HSERIAL2INT_RDRF	Read Data Register Full interrupt	
HSERIAL2INT_TEND	Transmit End interrupt	
HSERIAL2INT_OER	Overflow Error interrupt	
HSERIAL2INT_FER	Frame Error interrupt	
HSERIAL2INT_PER	Parity Error interrupt.	

Basic Stamp Conversion

Basic Stamp Conversion

The following section covers some of the differences you need to be aware of when porting over from a Basic Stamp. Several commands will have speed differences. The speed difference can cause timing issues with your program. Simply making changes to the arguments for those commands will solve most porting issues. The following is a list of compiled notes we have collect from customers and our own experiences when porting programs from the Basic Stamp.

Timings
On average most timing critical commands will execute considerably faster. In some cases you may need to add pauses in between commands if you have timing critical functions.

Math
MBasic treats math correctly signed or unsigned. So normal math rules apply.

AUXIO
The AUXIO command has no MBasic equivilant since all I/O are available at all time. No banking of pins is required.

IN / OUT / DIR
On the Basic Stamp IN / OUT / DIR variables only support up to 16 I/Os. MBasic has pin variables for all pins including the AtomPro 40 pin module.

BRANCH
The BRANCH command in Mbasic has no label limits. In PBasic its 255 max.

BUTTON
The BUTTON command is functionally the same.

COMPARE
The COMPARE command has no MBsic equivalent. RCTIME and or hardware analog functions can be used as a possible alternate.

CONFIGPIN
The CONFIGPIN command has no MBasic equivalent. Pull-ups can be added to a existing circuit.

COUNT
The COUNT command is the same but can be 32bits on the AtomPro. Duration is in clock cycles.

DATA
The DATA command has no MBasic equivalent. Data can be loaded to the on board eeprom using a serial command.

DEBUG / DEBUGIN
The debug commands are very different. They uses the same syntax as SEROUT / SERIN inside the brackets.

DO
The DO loop command is similar to MBasic DO..WHILE, WHILE..WEND or REPEAT..UNTIL.

DTMFOUT
The DTMFOUT command on time and off time are 1ms on all modules/processors.

EEPROM
The EEPROM command has no MBasic equivalent. A serial command can be used to preload on board eeprom data.

END
The END command simply halts the processor in Mbasic.

EXIT
The EXIT command has no MBasic equivalent. To exit form a loop add an exit label to the loop.

```
    do
       ...doing stuff...
       if wanttoexit then goto loopexit
    while 1
loopexit:
```

FOR...NEXT
The FOR..NEXT loop functions the same.

FREQOUT
The FREQOUT command is similar but the duration is in milliseconds in MBasic. Freq1 and Freq1 are in Hz.

GET
The GET command has no MBasic equivalent. An alternate method is to define variables to use and access directly instead.

GOSUB
The GOSUB command is functionally the same except MBasic supports calling subroutines with arguments. There is no limit on the number of total GOSUBS. Nested GOSUBS are only limited by the total stack memory available.

GOTO
The GOTO command functions the same.

HIGH
The HIGH command functions the same.

I2CIN - I2COUT
The I2C commands in MBasic are generic and will work with any I2C device. We've removed the eeprom address argument and a I2COUT command is used to send the address when talking to an eeprom. I2CIN data rates are 70kbps on the AtomPro 24, 28 and ONE. 87kbps on the BasicAtom Pro 40 and ARC32.

IF..THEN
The IF..THEN commands are mostly the same except MBasic doesn't support IF Condition(s) THEN Statement(s) { ELSE Statement(s) } directly. To do this you have to do this:

IF Condition(s) THEN : Statement(s) { : ELSE Statement(s) } : ENDIF

You have to add the ":" because that makes the compiler see a new line. There is no max nested limit There is no max ELSEIF limit.

INPUT
The INPUT command functions the same.

IOTERM
The IOTERM command has no MBasic equivalent. There is no need to switch between pin banks on the Atom.

LCDCMD
The LCD commands function differently. LCDCMD is replaced with LCDWRITE to send LCD commands. To send a command with LCDWrite send 0x100 + commmand number. See LCDWRITE and LCDREAD command section of this manual.

LCDIN
The BS2 LCDIN command is replaced with the MBasic LCDREAD.

LCDOUT
The BS2 LCDOUT command is replaced with the MBasic LCDWRITE.

LET
The LET command is supported with the use of modifiers or loading array variables with a single command.

```
let myarray = 1,2,3,4,5,6.
```

LOOKDOWN
The LOOKDOWN command syntax is similar to the BS2. No entry limit. MBasic LOOKDOWN supports 32bit expressions and values .

LOOKUP
The LOOKUP command syntax is similar to the BS2. No entry limit. MBasic LOOKDOWN supports 32bit expressions and values .

LOW
The LOW command functions the same.

MAINIO
The MAINIO command has no MBasic equivalent and is not required because all pins are directly accessible.

NAP
The NAP command is the same for the Nano and Atom. Nap on AtomPro is same as SLEEP on BS2.

ON
The ON command has no MBasic equivalent. Here is the way to get the same functionality.

```
main
gosub branchsub

goto main

branchsub
     branch index,[label1,label2,label3,label4]
     ..do default stuff..
     return

label1
..do stuff..
return

label2
..do stuff..
return

label3
..do stuff..
return

label4
..do stuff..
return
```

OUTPUT
The OUTPUT command functions the same.

OWIN - OWOUT
The One Wire commands functions the same except Mbasic supports a no connection label. Used to jump if 1-wire devices is not connected. Mbasic only supports normal speed.

PAUSE
The PAUSE command will run at the same speed since its arguments are based on time. If your using PAUSE in a loop you may need to increase the value used for PAUSE since the loop will execute faster.

POLLIN
The POLLIN command has no MBasic equivalent. However the functionality can be replicated in code due to the speed on the Atom processors. Optionally Interrupts can be used.

POLLMODE
The POLLMODE command has no MBasic equivalent. However the functionality can be replicated in code due to the speed on the Atom processors. Optionally Interrupts can be used.

POLLOUT
The POLLOUT command has no MBasic equivalent. However the functionality can be replicated in code due to the speed on the Atom processors. Optionally Interrupts can be used.

POLLRUN
The POLLRUN command has no MBasic equivalent. However the functionality can be replicated in code due to the speed on the Atom processors. Optionally Interrupts can be used.

POLLWAIT
The POLLWAIT command has no MBasic equivalent. However the functionality can be replicated in code due to the speed on the Atom processors. Optionally Interrupts can be used.

POT
The POT command is replaced by RCTIME. Which provides the same functionality. ADIN would be a better choice in most cases.

PULSIN..PULSOUT
The pulse commands functions the same. Units are in .5us with 32bit range or about 35 minutes max pulsewidth(when setting the time out to the maximum). Default time out is 65536 units or ~32ms.

PUT
The PUT command has no MBasic equivalent. The same functionality is available by using standard user defined variables instead.

PWM
The PWM command for MBasic has an additional argument for the period. Use a period of 256 in Mbasic to duplicate the BS2 PWM command. Units are .5us. With a period of 256 cycles are .1285ms

RANDOM
The RANDOM command in MBasic is a function. eg temp = random seed. MBasic will produce a 32bit random number.

RCTIME
The RCTIME command is functionally the same. Units are .5us. The maximum range is 32bits. Default time out is 65536 or approximately 32ms.

READ
The READ command is functionally the same. Read address 0 to 4095 on the AtomPro 28/40. Read addresses 0 to 32,767 on ARC32

RETURN
The RETURN command is functionally the same. We support returning a value.

REVERSE
The REVERSE command is functionally the same.

RUN
The RUN command has no MBasic equivalent. Can replace with a GOTO command in order to jump to another section of code. There is no 2K program limits in MBasic.

SELECT..CASE
The SELECT..CASE commands can be replaced with MBasic IF..THEN..ELSEIF..ELSE..ENDIF.

SERIN..SEROUT
The serial commands are functionally the same. The maximum standard baudrate is 57,600bps on all AtomPro modules.
no limit to qualifiers. Time out is in .5us units

SHIFTIN..SHIFTOUT
The shift commands are functionally the same except for speed and extended modes

SLEEP
The SLEEP commands is functionally the same but it is in ~2ms units.

SOUND
The SOUND command is functionally the same but Mbasic allows multiple sounds in a sequence. Units are in ms and Hz.

STOP
The STOP command is functionally the same.

STORE
The STORE command has no MBasic equivalent. This command is not necessary with MBasic. Since all memory is flat.

TOGGLE
The TOGGLE command has no MBasic equivalent.

WRITE
The WRITE command is functionally the same. Same memory size as listed for READ

XOUT
The X10 commands have no MBasic equivalent. Most X10 units now use a serial protocol making the XOUT / XIN commands obsolete.

Compiler Directives

Compiler Directives

MBasic supports compile time directives. Compile time directives can be used to selectively include or exclude parts of a program which can be very useful. An example would be a product that has several configurations but only requires one program with some minor changes. During compile time you can define what the master program is compiled for allowing MBasic to conditionally compile certain parts of the program.

This lets you keep a collection of frequently used program modules (“snippets” of code) and include them whenever you need them. It also provides conditional tests (IF ... THEN) to modify the code to compile different versions of a program.

Including Files

Perhaps you’ve written a subroutine to control an LCD display, and you’d like to use this subroutine in various different programs. You can save the subroutine on disk, and “include” it whenever you need it. The #include directive is used to “paste” program modules at compile time. Modules are pasted at the location of the #include directive.

#Include

#include “filename”
#include “partial or complete path to file”

Example

Assume that your LCD subroutine is called “lcd.bas” and is in the same directory as your main program. The subroutine contains the label “displaywrite”. You can include this in your program as shown:

```
main
(some code)
     gosub displaywrite
(some more code)
#include "lcd.bas"
end
```

The #include directive simply pastes in the code from lcd.bas as if it was part of your program.
If lcd.bas is in a subdirectory of your program directory, just put the partial path, for example:

#include “modules\lcd.bas”

If it’s in another directory, you can include the relative or absolute path, using normal Windows notation.

Conditional Compiling

Sometimes the same program may be used for slightly different applications. For example, if you’ve written a program to display temperature from a sensor, you may want versions for Celsius and Fahrenheit degrees, or perhaps you want one version to use an LCD display and a different one to output serial data to your computer. Most of the code is identical, but some constants, variables and subroutines may differ.

Conditional compiling lets you set a “switch” in your program (usually a constant, but not necessarily) that controls compiling. You can have different constants, variables, or even different sections of code compiled depending on the switch or switches that you set.

#IF .. #ENDIF

#IF expression
optional code
#ENDIF

Example

Similar to Mbasic IF..THEN conditional branch but specifies code to be compiled if the expression is true. In the example below the constant temp is set to 1. During compile time the #IF will test temp to see if it is true. Which in the example below will return true so the following block of code is included during compile time.

```
temp con 1
#IF temp=1
     ..optional code..
#ENDIF
..rest of program..
```

#IFDEF .. #ENDIF

#IFDEF name
..optional code..
#ENDIF
..rest of program..

Example

Compiles the code (up to #ENDIF) if the constant or variable (name) is defined, or if the label appears previously in the code.

```
temperature var byte
#IFDEF temperature
     ..optional code..
#ENDIF
..rest of program..
```

This will compile “optional code” because “temperature” has been defined.

#IFNDEF .. #ENDIF

#IFNDEF name
..optional code..
#ENDIF
..rest of program..

Example

Compiles the code between #IFNDEF and #ENDIF only if the constant or variable has not been defined, or the label has not been previously used in the program. In effect, it's the opposite of #IFDEF.

```
temperature var byte
#IFDEF temperature
     ..optional code..
#ENDIF
..rest of program..
```

This will NOT compile "optional code" because "temperature" has been defined.

#ELSE .. #ELSIF

#IF expression
..optional code..
#ELSE
..more optional code..
#ENDIF
..rest of program..

Example

Allows you to have two code snippets, and compile one or the other depending on the result of the #IF, #IFDEF or #IFNDEF directive.

```
temp con 1
#IF temp=1
     ..optional code..
#ELSE
     ..more optional code..
#ENDIF
     ..rest of program..
```

Compiles “optional code” if “temp = 1” and “more optional code” if “temp” is equal to any other value.

#ELSIF

#IF expression
..optional code..
#ELSE
..more optional code..
#ELSEIF
..even more optional code..
#ENDIF
..rest of program..

Example

Allows multiple snippets of code to be compiled based on multiple tests. ELSEIF is an extension of #ELSE and allows multiple test to be ran during compile time.

```
screentype con 1

#IF screentype=1
     ..optional code..
#ELSEIF screentype=2
     .. more optional code..
#ELSEIF screentype=3
     ..even more optional code..
#ENDIF
... rest of program ...
```

Compiles “optional code”, “more other code”, or “even more optional code” depending on what the constant “screentype” is set to (1, 2 or 3). If “screentype” has some other value than 1,2 or 3 compilation simply continues with “rest of program” and none of the optional code is compiled.

#ELSEIFDEF, #ELSEIFNDEF

Equivalents of #ELSEIF for the #IFDEF and #IFNDEF directives.
Syntax
#ELSEIFDEF name
#ELSEIFNDEF name
Example
Similar to the example given for #ELSEIF.
Note: All compiler preprocessor directives must start with the # sign. If you forget this, results will not be what you expect.

Reserved Words

Reserved Words

The following section list all the names and words used internally by MBasic. These words can not be used in your program for constants and variable names. Otherwise MBasic will mistake them for commands or other internal names.

Reserved Words

Name	Name	Name	Name
DIRS	DIR24	IN14	OUT4
DIRL	DIR25	IN15	OUT5
DIRH	DIR26	IN16	OUT6
DIRA	DIR27	IN17	OUT7
DIRB	DIR28	IN18	OUT8
DIRC	DIR29	IN19	OUT9
DIRD	DIR30	IN20	OUT10
DIREA	DIR31	IN21	OUT11
DIREB	DIR32	IN22	OUT12
DIREC	DIR33	IN23	OUT13
DIRED	INS	IN24	OUT14
DIR0	INL	IN25	OUT15
DIR1	INH	IN26	OUT16
DIR2	INA	IN27	OUT17
DIR3	INB	IN28	OUT18
DIR4	INC	IN29	OUT19
DIR5	IND	IN30	OUT20
DIR6	INEA	IN31	OUT21
DIR7	INEB	IN32	OUT22
DIR8	INEC	IN33	OUT23
DIR9	INED	OUTS	OUT24
DIR10	IN0	OUTL	OUT25
DIR11	IN1	OUTH	OUT26
DIR12	IN2	OUTA	OUT27
DIR13	IN3	OUTB	OUT28
DIR14	IN4	OUTC	OUT29
DIR15	IN5	OUTD	OUT30
DIR16	IN6	OUTEA	OUT31
DIR17	IN7	OUTEB	OUT32
DIR18	IN8	OUTEC	OUT33
DIR19	IN9	OUTED	INDF
DIR20	IN10	OUT0	TMR0
DIR21	IN11	OUT1	PCL
DIR22	IN12	OUT2	STATUS
DIR23	IN13	OUT3	FSR

Reserved Words

Name	Name	Name	Name
PORTA	SSPADD	RBIE	SSPM1
PORTB	SSPSTAT	T0IF	SSPM0
PORTC	WPUB	TMR0IF	P1M1
PORTD	IOCB	INTF	P1M0
PORTE	VRCON	RBIF	DC1B1
PCLATH	TXSTA	ADIF	CCP1X
INTCON	SPBRG	RCIF	DC1B0
PIR1	SPBRGH	TXIF	CCP1Y
PIR2	PWM1CON	SSPIF	CCP1M3
TMR1L	ECCPAS	CCP1IF	CCP1M2
TMR1H	PSTRCON	TMR2IF	CCP1M1
T1CON	ADRESL	TMR1IF	CCP1M0
TMR2	ADCON1	OSPIF	SPEN
T2CON	WDTCON	C2IF	RX9
SSPBUF	CM1CON0	C1IF	RC9
SSPCON	CM2CON0	EEIF	NOT_RC8
CCPR1L	CM2CON1	BCLIF	RC8_9
CCPR1H	EEDATA	ULPWUIF	SREN
CCP1CON	EEADR	CCP2IF	CREN
RCSTA	EEDATH	T1CKPS1	ADDEN
TXREG	EEADRH	T1CKPS0	FERR
RCREG	SRCON	T1OSCEN	OERR
CCPR2L	BAUDCTL	NOT_T1SYNC	RX9D
CCPR2H	ANSEL	T1INSYNC	RCD8
CCP2CON	ANSELH	T1SYNC	CCP2X
ADRESH	EECON1	TMR1CS	DC2B1
ADCON0	EECON2	TMR1ON	CCP2Y
OPTION_REG	IRP	TOUTPS3	DC2B0
TRISA	RP1	TOUTPS2	CCP2M3
TRISB	RP0	TOUTPS1	CCP2M2
TRISC	NOT_TO	TOUTPS0	CCP2M1
TRISD	NOT_PD	TMR2ON	CCP2M0
TRISE	Z	T2CKPS1	ADCS1
PIE1	DC	T2CKPS0	ADCS0
PIE2	C	WCOL	CHS3
PCON	GIE	SSPOV	CHS2
OSCCON	PEIE	SSPEN	CHS1
OSCTUNE	T0IE	CKP	CHS0
SSPCON2	TMR0IE	SSPM3	GO
PR2	INTE	SSPM2	NOT_DONE

Reserved Words

Name	Name	Name	Name
GO_DONE	TUN0	IOCB4	PDC6
ADON	GCEN	IOCB3	PDC5
NOT_RBPU	ACKSTAT	IOCB2	PDC4
INTEDG	ACKDT	IOCB1	PDC3
T0CS	ACKEN	IOCB0	PDC2
T0SE	RCEN	VREN	PDC1
PSA	PEN	VROE	PDC0
PS2	RSEN	VRR	ECCPASE
PS1	SEN	VRSS	ECCPAS2
PS0	SMP	VR3	ECCPAS1
ADIE	CKE	VR2	ECCPAS0
RCIE	D	VR1	PSSAC1
TXIE	I2C_DATA	VR0	PSSAC0
SSPIE	NOT_A	CSRC	PSSBD1
CCP1IE	NOT_ADDRESS	TX9	PSSBD0
TMR2IE	D_A	NOT_TX8	STRSYNC
TMR1IE	DATA_ADDRESS	TX8_9	STRD
OSFIE	P	TXEN	STRC
C2IE	I2C_STOP	SYNC	STRB
C1IE	S	BRGH	STRA
EEIE	I2C_START	TRMT	ADFM
BCLIE	R	TX9D	VCFG0
ULPWUIE	I2C_READ	TXD8	VCFG1
CCP2IE	NOT_W	BRG7	WDTPS3
ULPWUE	NOT_WRITE	BRG6	WDTPS2
SBOREN	R_W	BRG5	WDTPS1
NOT_POR	READ_WRITE	BRG4	WDTPS0
NOT_BO	UA	BRG3	SWDTEN
NOT_BOR	BF	BRG2	C1ON
IRCF2	WPUB7	BRG1	C1OUT
IRCF1	WPUB6	BRG0	C1OE
IRCF0	WPUB5	BRG15	C1POL
OSTS	WPUB4	BRG14	C1R
HTS	WPUB3	BRG13	C1CH1
LTS	WPUB2	BRG12	C1CH0
SCS	WPUB1	BRG11	C2ON
TUN4	WPUB0	BRG10	C2OUT
TUN3	IOCB7	BRG9	C2OE
TUN2	IOCB6	BRG8	C2POL
TUN1	IOCB5	PRSEN	C2R

Reserved Words

Name	Name	Name	Name
C2CH1	P0	P40	D2
C2CH0	P1	P41	D3
MC1OUT	P2	AX0	D4
MC2OUT	P3	AX1	D5
C1RSEL	P4	AX2	D6
C2RSEL	P5	AX3	D7
T1GSS	P6	S_IN	E0
C2SYNC	P7	S_OUT	E1
SR1	P8	GP0	E2
SR0	P9	GP1	E3
C1SEN	P10	GP2	E4
C2REN	P11	GP3	E5
PULSS	P12	GP4	E6
PULSR	P13	GP5	E7
FVREN	P14	A0	F0
ABDOVF	P15	A1	F1
RCIDL	P16	A2	F2
SCKP	P17	A3	F3
BRG16	P18	A4	F4
WUE	P19	A5	F5
ABDEN	P20	A6	F6
ANS7	P21	A7	F7
ANS6	P22	B0	G0
ANS5	P23	B1	G1
ANS4	P24	B2	G2
ANS3	P25	B3	G3
ANS2	P26	B4	G4
ANS1	P27	B5	G5
ANS0	P28	B6	G6
ANS13	P29	B7	G7
ANS12	P30	C0	H300
ANS11	P31	C1	H600
ANS10	P32	C2	H1200
ANS9	P33	C3	H2400
ANS8	P34	C4	H4800
EEPGD	P35	C5	H7200
WRERR	P36	C6	H9600
WREN	P37	C7	H12000
WR	P38	D0	H14400
RD	P39	D1	H16800

Reserved Words

Name	Name	Name	Name
H19200	TMR0INT128	TMR2PRE1POST7	TMR2PRE16POST15
H21600	TMR0INT256	TMR2PRE1POST8	TMR2PRE16POST16
H24000	TMR0EXTL1	TMR2PRE1POST9	CAPTUREOFF
H26400	TMR0EXTL2	TMR2PRE1POST10	CAPTURE1H2L
H28800	TMR0EXTL4	TMR2PRE1POST11	CAPTURE1L2H
H31200	TMR0EXTL8	TMR2PRE1POST12	CAPTURE4L2H
H33600	TMR0EXTL16	TMR2PRE1POST13	CAPTURE16L2H
H36000	TMR0EXTL32	TMR2PRE1POST14	COMPAREOFF
H38400	TMR0EXTL64	TMR2PRE1POST15	COMPARESETHIGH
H57600	TMR0EXTL128	TMR2PRE1POST16	COMPARESETLOW
H115200	TMR0EXTL256	TMR2PRE4POST1	COMPAREINT
H250000	TMR0EXTH1	TMR2PRE4POST2	COMPARESPECIAL
H312500	TMR0EXTH2	TMR2PRE4POST3	X_A
H625000	TMR0EXTH4	TMR2PRE4POST4	X_B
H1250000	TMR0EXTH8	TMR2PRE4POST5	X_C
MSBPRE	TMR0EXTH16	TMR2PRE4POST6	X_D
LSBPRE	TMR0EXTH32	TMR2PRE4POST7	X_E
MSBPOST	TMR0EXTH64	TMR2PRE4POST8	X_F
LSBPOST	TMR0EXTH128	TMR2PRE4POST9	X_G
FASTMSBPRE	TMR0EXTH256	TMR2PRE4POST10	X_H
FASTLSBPRE	TMR1OFF	TMR2PRE4POST11	X_I
FASTMSBPOST	TMR1INT1	TMR2PRE4POST12	X_J
FASTLSBPOST	TMR1INT2	TMR2PRE4POST13	X_K
SLOWMSBPRE	TMR1INT4	TMR2PRE4POST14	X_L
SLOWLSBPRE	TMR1INT8	TMR2PRE4POST15	X_M
SLOWMSBPOST	TMR1EXT1	TMR2PRE4POST16	X_N
SLOWLSBPOST	TMR1EXT2	TMR2PRE16POST1	X_O
MSBFIRST	TMR1EXT4	TMR2PRE16POST2	X_P
LSBFIRST	TMR1EXT8	TMR2PRE16POST3	X_1
PU_OFF	TMR1ASYNC1	TMR2PRE16POST4	X_2
PU_ON	TMR1ASYNC2	TMR2PRE16POST5	X_3
EXT_H2L	TMR1ASYNC4	TMR2PRE16POST6	X_4
EXT_L2H	TMR1ASYNC8	TMR2PRE16POST7	X_5
TMR0INT1	TMR2OFF	TMR2PRE16POST8	X_6
TMR0INT2	TMR2PRE1POST1	TMR2PRE16POST9	X_7
TMR0INT4	TMR2PRE1POST2	TMR2PRE16POST10	X_8
TMR0INT8	TMR2PRE1POST3	TMR2PRE16POST11	X_9
TMR0INT16	TMR2PRE1POST4	TMR2PRE16POST12	X_10
TMR0INT32	TMR2PRE1POST5	TMR2PRE16POST13	X_11
TMR0INT64	TMR2PRE1POST6	TMR2PRE16POST14	X_12

Reserved Words

Name	Name	Name	Name
X_13	HOMELCD	ONELINE5X11	
X_14	LCDCLEAR	CGRAM	
X_15	LCDHOME	SCRRAM	
X_16	INCCUR	HSERSTAT_INCLEAR	
X_UNITS_ON	INCSCR	HSERSTAT_OUTCLEAR	
X_LIGHTS_ON	DECCUR	HSERSTAT_CLEAR	
X_ON	DECSCR	HSERSTAT_INDATA	
X_OFF	LCDOFF	HSERSTAT_INNODATA	
X_DIM	SCR	HSERSTAT_OUTDATA	
X_BRIGHT	SCRBLK	HSERSTAT_OUTNODATA	
X_LIGHTS_OFF	SCRCUR		
X_HAIL	SCRCURBLK		
X_STATUS_ON	CURLEFT		
X_STATUS_OFF	CURRIGHT		
X_STATUS_REQUEST	SCRLEFT		
INITLCD1	SCRRIGHT		
INITLCD2	ONELINE		
CLEARLCD	TWOLINE		

Dec	Hex	Char	Function
0	0x00	NUL	Null
1	0x01	SOH	Start of Heading
2	0x02	STX	Start of Text
3	0x03	ETX	End of Text
4	0x04	EOT	End of Transmit
5	0x05	ENQ	Enquiry
6	0x06	ACK	Acknowledge
7	0x07	BEL	Bell
8	0x08	BS	Basckspace
9	0x09	HT	Horizontal Tab
10	0x0A	LF	Line Feed
11	0x0B	VT	Vertical Tab
12	0x0C	FF	Form Feed
13	0x0D	CR	Carriage Return
14	0x0E	SO	Shift Out
15	0x0F	SI	Shift In
16	0x10	DLE	Data Line Escape
17	0x11	DC1	Device Cntrl 1
18	0x12	DC2	Device Cntrl 2
19	0x13	DC3	Device Cntrl 3
20	0x14	DC4	Device Cntrl 4
21	0x15	NAK	Non Acknowledge
22	0x16	SYN	Synchronous Idle
23	0x17	ETB	End Transmit Block
24	0x18	CAN	Cancel
25	0x19	EM	End of Medium
26	0x1A	SUB	Substitute
27	0x1B	ESC	Escape
28	0x1C	FS	File Separator
29	0x1D	GS	Group Separator
30	0x1E	RS	Record Separator
31	0x1F	US	Unit Separator
32	0x20	SPACE	
33	0x21	!	
34	0x22	“	
35	0x23	#	
36	0x24	$	
37	0x25	%	
38	0x26	&	
39	0x27	‘	
40	0x28	(	
41	0x29	)	
42	0x2A	*	

Dec	Hex	Char
43	0x2B	+
44	0x2C	,
45	0x2D	-
46	0x2E	.
47	0x2F	/
48	0x30	0
49	0x31	1
50	0x32	2
51	0x33	3
52	0x34	4
53	0x35	5
54	0x36	6
55	0x37	7
56	0x38	8
57	0x39	9
58	0x3A	:
59	0x3B	;
60	0x3C	<
61	0x3D	=
62	0x3E	>
63	0x3F	?
64	0x40	@
65	0x41	A
66	0x42	B
67	0x43	C
68	0x44	D
69	0x45	E
70	0x46	F
71	0x47	G
72	0x38	H
73	0x49	I
74	0x4A	J
75	0x4B	K
76	0x4C	L
77	0x4D	M
78	0x4E	N
79	0x4F	O
80	0x50	P
81	0x51	Q
82	0x52	R
83	0x53	S
84	0x54	T
85	0x55	U

Dec	Hex	Char
86	0x56	V
87	0x57	W
88	0x58	X
89	0x59	Y
90	0x5A	Z
91	0x5B	[
92	0x5C	\
93	0x5D	]
94	0x5E	^
95	0x5F	_
96	0x60	`
97	0x61	a
98	0x62	b
99	0x63	c
100	0x64	d
101	0x65	e
102	0x66	f
103	0x67	g
104	0x68	h
105	0x69	i
106	0x6A	j
107	0x6B	k
108	0x6C	l
109	0x6D	m
110	0x6E	n
111	0x6F	o
112	0x70	p
113	0x71	q
114	0x72	r
115	0x73	s
116	0x74	t
117	0x75	u
118	0x76	v
119	0x77	w
120	0x78	x
121	0x79	y
122	0x7A	z
123	0x7B	{
124	0x7C	|
125	0x7D	}
126	0x7E	~
127	0x7F	Delete