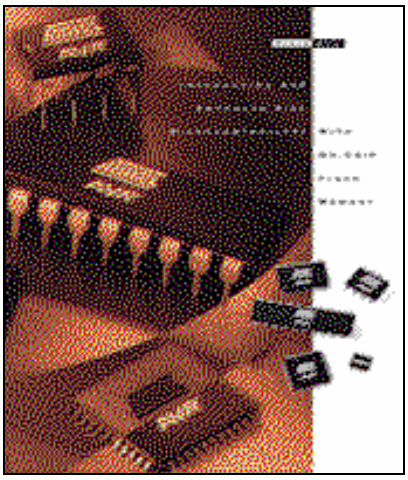
# BASCOM-AVR



Version 1.11.6.3

# Index

If you have questions, remarks or suggestions please let us know.

You can contact us by sending an email to **avr@mcselec.com**

Our website is at **http://www.mcselec.com**

**For info on updates : please read the readme.txt file that is installed into the BASCOM-AVR directory**

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Products specification and usage may change accordingly.

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## Installation of BASCOM-AVR

When you downloaded the ZIP files from our website you need to UNZIP them.

The first file will unzip the file named SETUP.EXE

The second will unzip the file named SETUP.W02

When there is a third file provided, it will contain the file SETUP.W03.

The files can also come on diskettes. In that case there are no zip files and

you can continue without unzipping.

And finally the files can be on a CD-ROM. In that case the files are unzipped already too.

The commercial edition comes with a license file in the form of a dll. This file is always on the first disk where the file SETUP.EXE is located. When explorer does not show this file, you must set the option in explorer to view system files(because a DLL is a system file).

Some resellers might distribute the DLL file in a zipped file. Or the file might have the extension of a number like 123. In this case you must rename the number into DLL.

Make sure the DLL is in the same directory as the SETUP.EXE file.

When you are using the DEMO you don't need to worry about the license file.

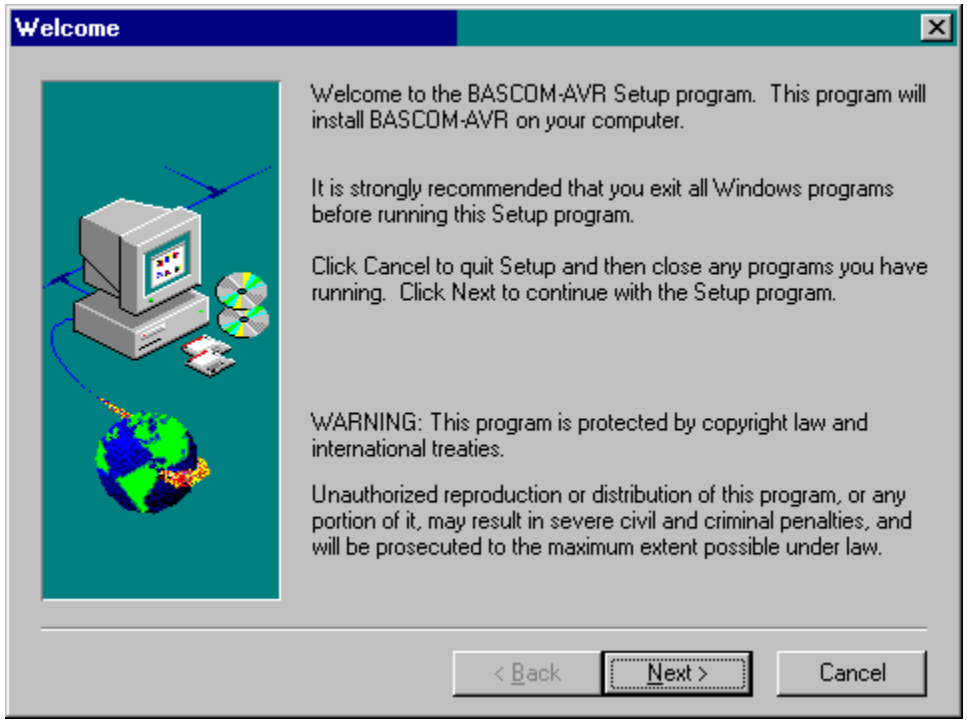
When you are installing on a NT machine like NT4 or W2000, you need to have Administrator rights.

After installing BASCOM you need to run BASCOM once as an administrator too. After that you may run BASCOM as any other user.

Now run the SETUP.EXE by double clicking on it in explorer. Or from the DOS command prompt.

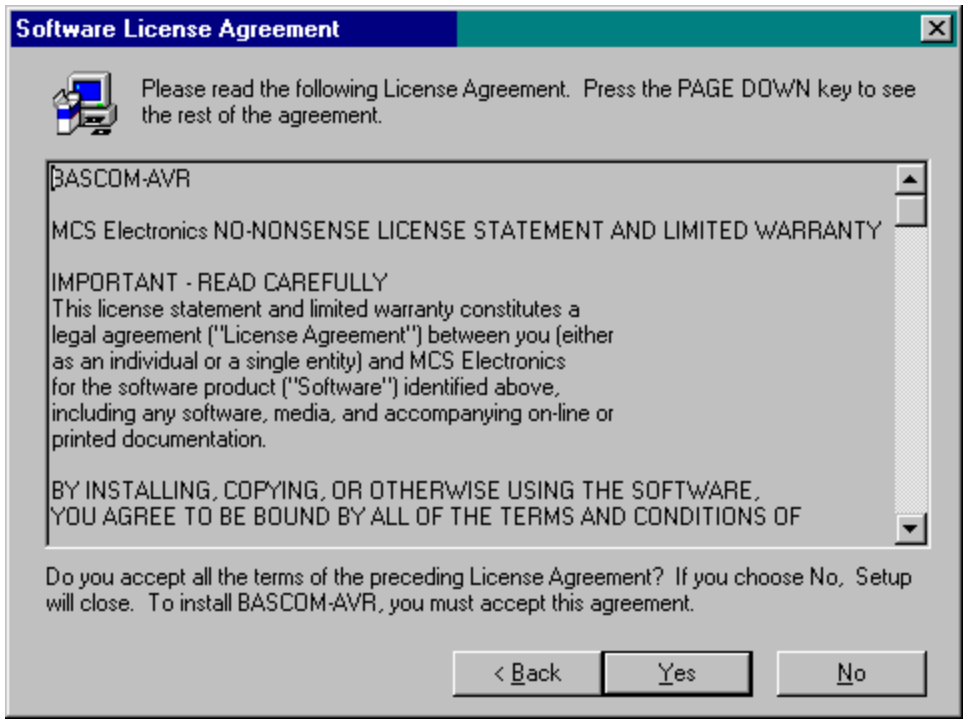
The following window will appear:

(screen shots may differ a bit)




Click on the Next button to continue installation.

The following license info window will appear:

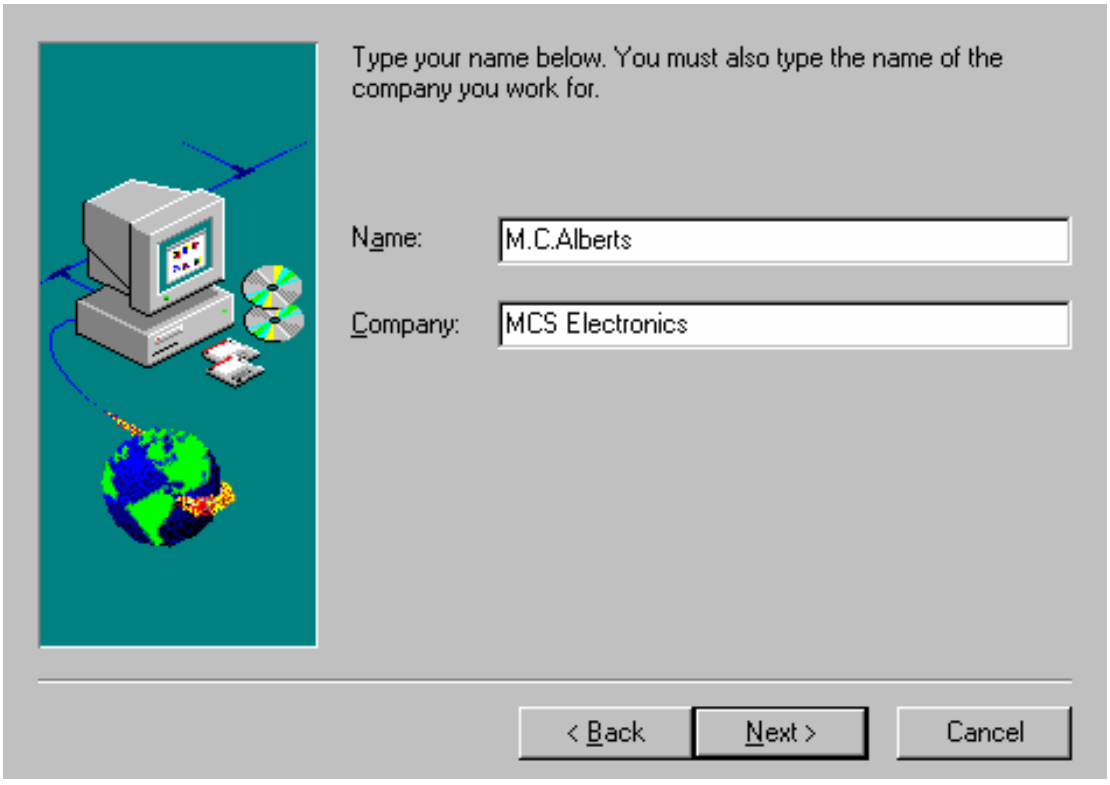


Read the license agreement and click the Yes button when you agree.

A window with additional information is then displayed. This information will be installed as a readme.txt file and contains information on how to get free updates. It also contains the password needed to unzip updates.

After reading the information, click the Next button.

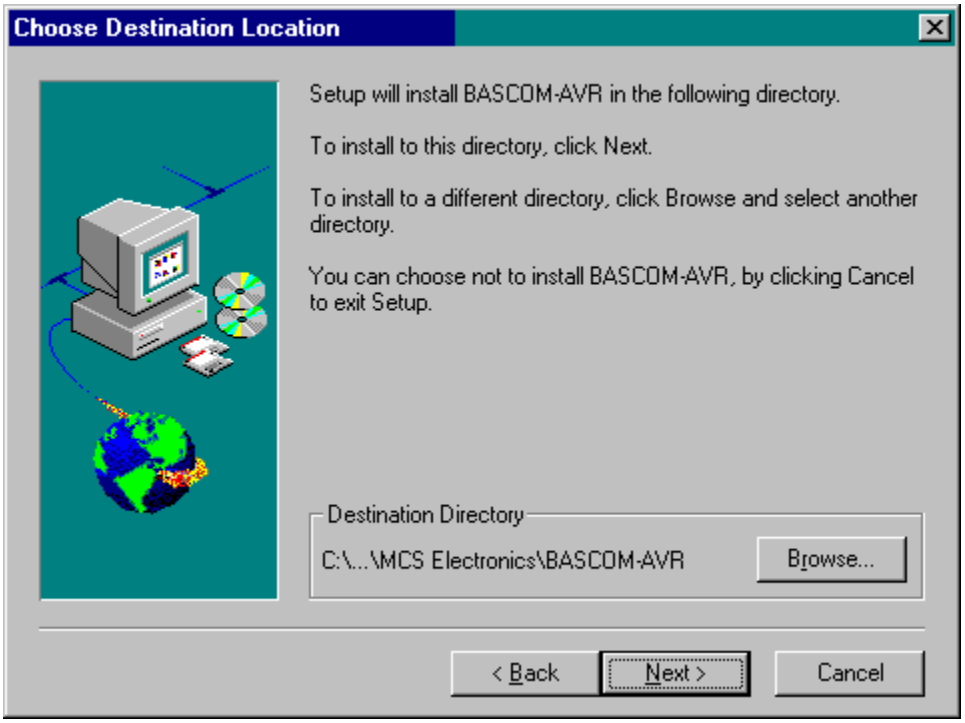
Now the following window appears:




Fill in your name and company name.

Click the Next button to continue.

Now you have the change to select the directory in which BASCOM will be installed.




Select the Browse button to change the directory path if required.

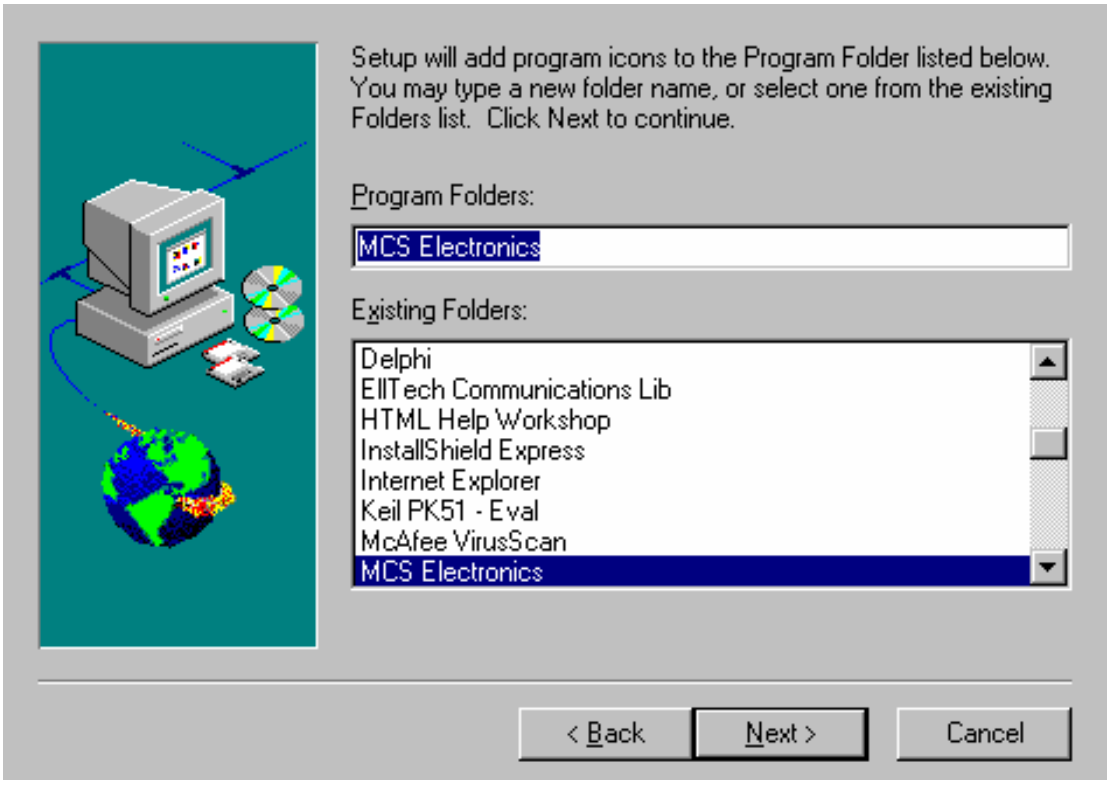
By default BASCOM-AVR will be installed into:

**C:\Program Files\MCS Electronics\BASCOM-AVR**

After selecting the installation directory, click the Next button.

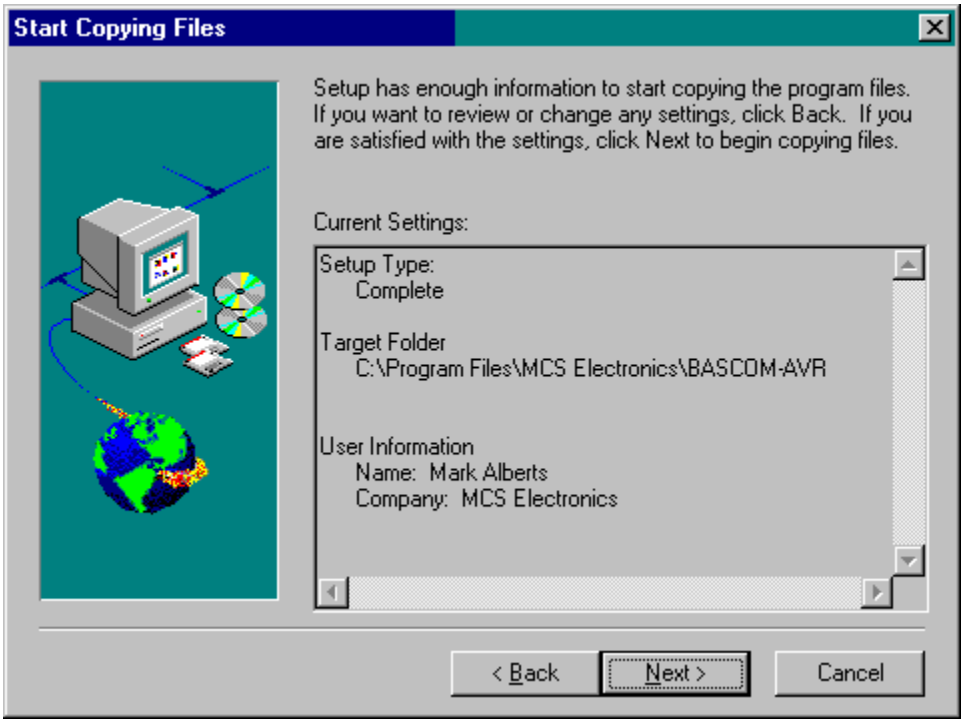
This time you will be asked in which program group the BASCOM-AVR icon must be placed.

By default, a new program group named MCS Electronics will be made.




After selecting the group, click the Next button to continue.

A summary will be shown. You may go back and change your settings. Otherwise, click the Next button to complete the installation of BASCOM-AVR.




When the installation is completed you must click the Finish-button, and restart Windows.

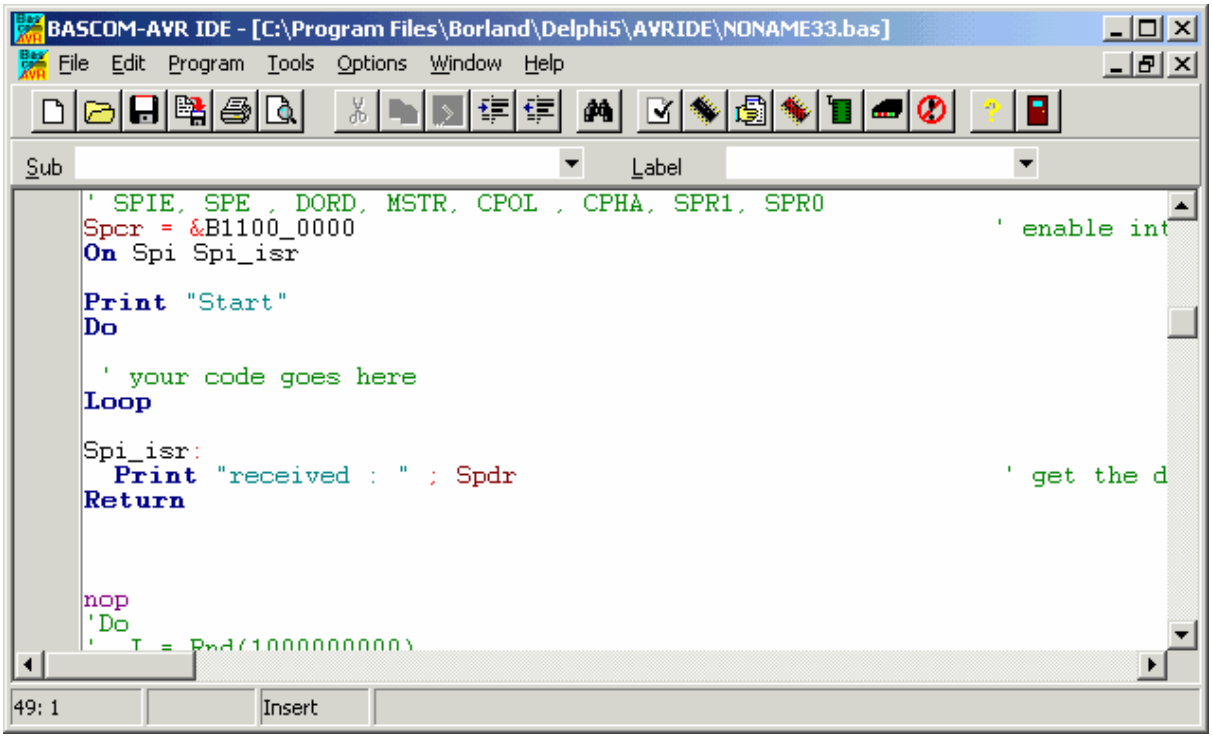
A sub directory named SAMPLES contains all the BASCOM-AVR sample files.

A sub directory named LIB contains the Library files.

## Running BASCOM-AVR

Double-click the BASCOM-AVR icon to run BASCOM.

The following window will appear. (If this is your first run, the edit window will be empty.)




The most-recently opened file will be loaded.

## File New

This option creates a new window in which you will write your program.

The focus is set to the new window.

File new shortcut: , CTRL + N

## File Open

With this option you can load an existing program from disk.

BASCOM saves files in standard ASCII format. Therefore, if you want to load a file that was made with another editor be sure that it is saved as an ASCII file.

Note that you can specify that BASCOM must reformat the file when it opens

it with the **O**ptions **E**nvironment option. This should only be necessary when loading files made with another editor.

File open shortcut :  , CTRL+O

## File Close

Close the current program.

When you have made changes to the program, you will be asked to save the program first.

File close shortcut : 

## File Save

With this option, you save your current program to disk under the same file name.

If the program was created with the **F**ile **N**ew option, you will be asked to name the file first. Use the **F**ile **S**ave **A**s option to give the file another name.

Note that the file is saved as an ASCII file.

File save shortcut :  , CTRL+S

## File Save As

With this option, you can save your current program to disk under a different file name.

Note that the file is saved as an ASCII file.

File save as shortcut : 

## File Print Preview

With this option, you can preview the current program before it is printed.

Note that the current program is the program that has the focus.

File print preview shortcut : 

## File Print

With this option, you can print the current program.

Note that the current program is the program that has the focus.

File print shortcut :  , CTRL+P

## File Exit

With this option, you can leave BASCOM.

If you have made changes to your program, you can save them upon leaving BASCOM.

File exit shortcut : 

## Edit Undo

With this option, you can undo the last text manipulation.

Edit Undo shortcut :  , CTRL+Z

## Edit Redo

With this option, you can redo the last undo.

Edit Redo shortcut :  , CTRL+SHIFT+Z

## Edit Cut

With this option, you can cut selected text into the clipboard.

Edit cut shortcut :  , CTRL+X

## Edit Copy

With this option, you can copy selected text into the clipboard.

Edit copy shortcut :  , CTRL+C

## Edit Paste

With this option, you can paste text from the clipboard into the current cursor position.

Edit paste shortcut :  , CTRL+V

## Edit Find

With this option, you can search for text in your program.

Text at the cursor position will be placed in the find dialog box.

Edit Find shortcut :  , CTRL+F

## Edit Find Next

With this option, you can search for the last specified search item.

Edit Find Next shortcut :  , F3

## Edit Replace

With this option, you can replace text in your program.

Edit Replace shortcut :  , CTRL+R

## Edit Goto

With this option, you can immediately go to a line .

Edit go to line shortcut :  ,CTRL+G

## Edit Toggle Bookmark

With this option, you can set/reset a bookmark, so you can jump in your code with the Edit Go to Bookmark option. Shortcut : CTRL+K + x where x can be 1-8

## Edit Goto Bookmark

With this option, you can jump to a bookmark.

There can be up to 8 bookmarks. Shortcut : CTRL+Q+ x where x can be 1-8

## Edit Indent Block

With this option, you can indent a selected block of text.

Edit Indent Block shortcut :  , CTRL+SHIFT+I

## Edit Unindent Block

With this option, you can un-indent a block.

Edit Unindent Block shortcut :  , CTRL+SHIFT+U

## Program Compile

With this option, you can compile your current program.

Your program will be saved automatically before being compiled.

The following files will be created depending on the Option Compiler Settings.

| File | Description |
|---|---|
| xxx.BIN | Binary file which can be programmed into the microprocessor |
| xxx.DBG | Debug file that is needed by the simulator. |
| xxx.OBJ | Object file for simulating using AVR Studio. Also needed by the internal simulator. |
| xxx.HEX | Intel hexadecimal file, which is needed by some programmers. |
| xxx.ERR | Error file. Only created when errors are found. |
| xxx.RPT | Report file. |
| xxx.EEP | EEPROM image file |

If a serious error occurs, you will receive an error message in a dialog box and the compilation will end.

All other errors will be displayed at the bottom above the status bar.

When you click on the line with the error info, you will jump to the line that contains the error. The margin will also display the  sign.

At the next compilation, the error window will disappear.

Program compile shortcut:  , F7

## Program Syntax Check

With this option, your program is checked for syntax errors. No file will be created except for an error file, if an error is found.

Program syntax check shortcut  , CTRL + F7

## Program Show Result

Use this option to view the result of the compilation.

See the Options Compiler Output for specifying which files must be created.

The files that can be viewed are report and error.

File show result shortcut :  ,CTRL+W

Information provided in the report:

| Info | Description |
|---|---|
| Report | Name of the program |
| Date and time | The compilation date and time. |
| Compiler | The version of the compiler. |
| Processor | The selected target processor. |
| SRAM | Size of microprocessor SRAM (internal RAM). |
| EEPROM | Size of microprocessor EEPROM (internal EEPROM). |
| ROMSIZE | Size of the microprocessor FLASH ROM. |
| ROMIMAGE | Size of the compiled program. |
| BAUD | Selected baud rate. |
| XTAL | Selected XTAL or frequency. |
| BAUD error | The error percentage of the baud rate. |
| XRAM | Size of external RAM if available. |

| | |
|---|---|
| Stack start | The location in memory, where the hardware stack points to. The HW-stack pointer grows down. |
| S-Stacksize | The size of the software stack. |
| S-Stackstart | The location in memory where the software stack pointer points to. The software stack pointer grows down. |
| Framesize | The size of the frame. The frame is used for storing local variables. |
| Framestart | The location in memory where the frame starts. |
| LCD address | The address that must be placed on the bus to enable the LCD display E-line. |
| LCD RS | The address that must be placed on the bus to enable the LCD RS-line |
| LCD mode | The mode the LCD display is used with. 4 bit mode or 8 bit mode. |
| LCD DB7-DB4 | The port pins used for controlling the LCD in pin mode. |
| LCD E | The port pin used to control the LCD enable line. |
| LCD RS | The port pin used to control the LCD RS line. |
| Variable | The variable name and address in memory |
| Constant | Constants name and value<br>Some internal constants are :<br>_CHIP : number that identifies the selected chip<br>_RAMSIZE : size of SRAM<br>_ERAMSIZE : size of EEPROM<br>_XTAL : value of crystal<br>_BUILD : number that identifies the version of the compiler |

## Program Simulate

With this option, you can simulate your program.

You can simulate your programs with AVR Studio or any other Simulator available or you can use the build in Simulator.

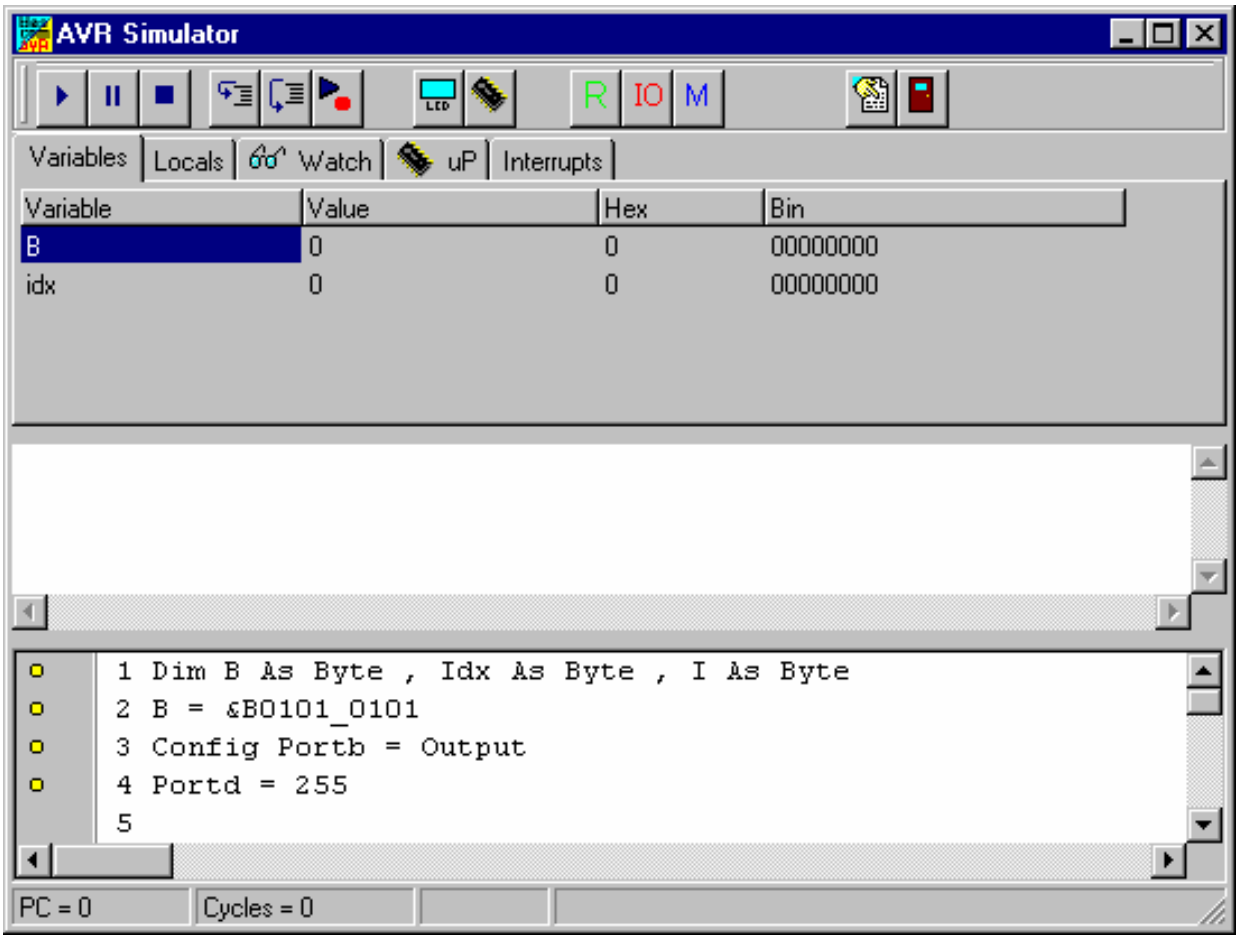
Which one will be used when you press F2 depends on the selection you made in the Options Simulator TAB.

Program Simulate shortcut :  , F2

To use the build in Simulator the files DBG and OBJ must be selected from the Options Compiler Output TAB.

The OBJ file is the same file that is used with the AVR Studio simulator.

The DBG file contains info on variables used and many more info needed to simulate a program.




The Sim window is divided into a few sections:

**The Toolbar**

The toolbar contains the buttons you can press to start an action.

 This starts a simulation. It is the RUN button. The simulation will pause when you press the pause button. You can also press F5.

 This is the pause button. Pressing this button will pause simulation.

 This is the STOP button. Pressing this button will stop simulation and you can't continue. This because all variables are reset. You need to press this button when you want to simulate your program again.

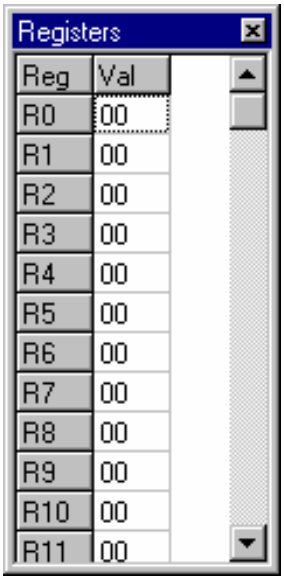
 This is sthe STEP button. Pressing this button(or F8) will execute one

code line of your BASIC program. After the line is executed the simulator will be in the pause state.

 This is the STEP OVER button. It has the same effect as the STEP button but sub programs are executed and there is no step into the SUB program. You can also press SHIFT+F8

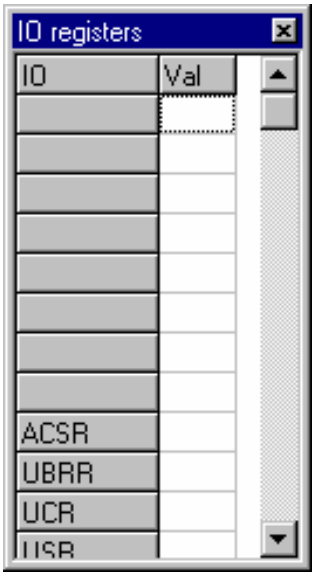
 This is the RUN TO button. The simulator will RUN to the current line. The line must contain executable code.

 This button will show the register window.



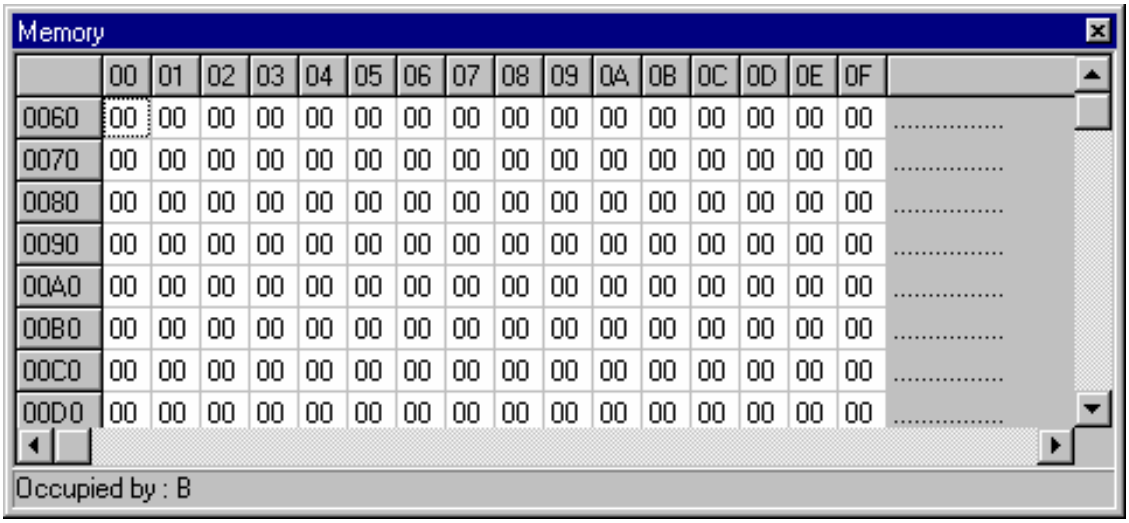

The values are show in hexadecimal format. To change a value click the cell of the Val column and type the new value.

 This is the IO button and will show the IO registers.




The IO window works the same like the Register window. Blank rows indicate that there is no IO-register assigned to that address.( The blank rows might be deleted later.)

Pressing this button shows the Memory window.

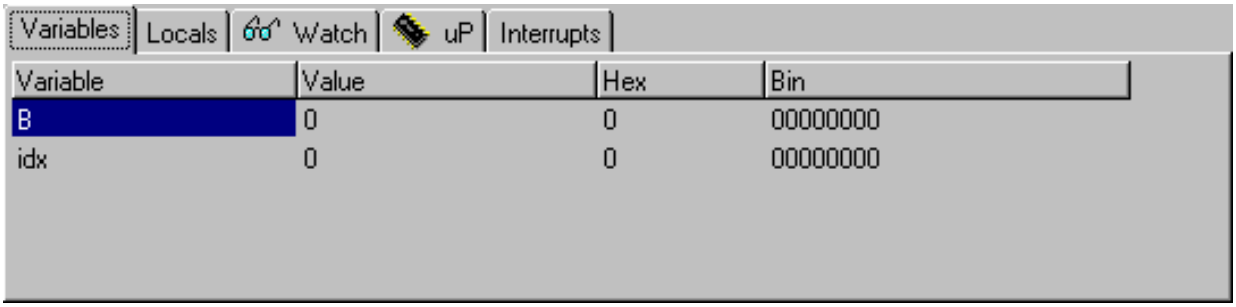



The values can be changed the same way like in the Register window.

When you move from cell to cell you can view in the status bar which variable is stored in the address.

Under the toolbar section there is a TAB with the pages:

**VARIABLES**



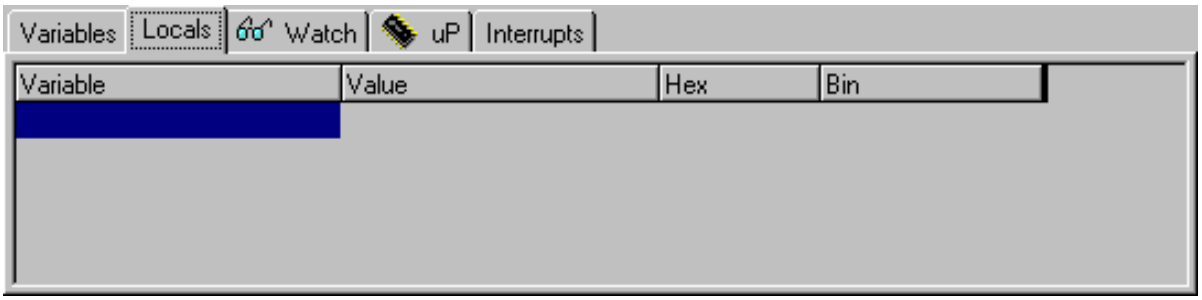

You can add variables by double clicking in the Variable-column. A list will pop up from which you can select the variable.

To watch an array variable you can type the name of the variable with the index.

During simulation you can change the values of the variables in the Value-column, Hex-column or Bin-column. You must press ENTER to store the change.

To delete a row you can press CTRL+DEL.

**LOCALS**




The LOCAL window show the variables in a SUB or FUNCTION. LOCAL variables are also shown. You can not add variables.

Changing the value of the variables works the same as for the Variable TAB.

**WATCH**

The Watch-TAB can be used to enter an expression that will be evaluated during simulation. When the expression is true the simulation is paused.

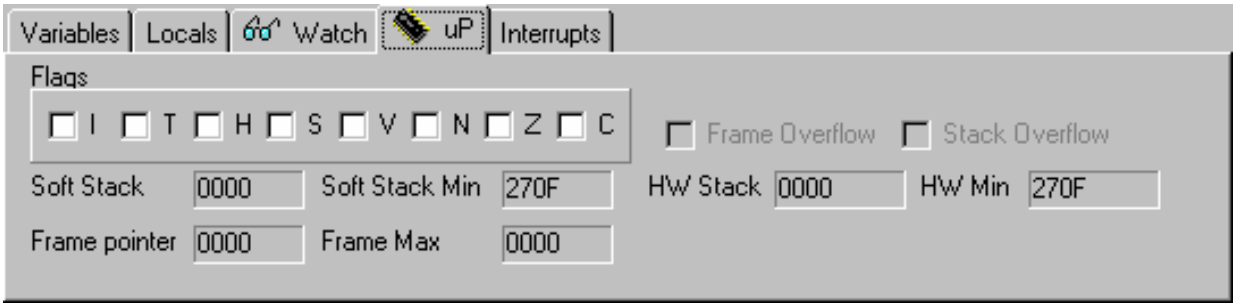
Type the expression in the text-field and press the Add-button.

When you press the Modify-button the current selected expression from the list is modified with the typed value.

To delete an expression you must select the expression from the list and press the Remove-button.

When the expression becomes true the expression that matches will be selected and the Watch-TAB will be shown.

**UP**




This TAB shows the status of the microprocessor SREG register.

The flags can be changed by clicking their checkboxes.

The software stack , hardware stack and frame pointer values are also shown. The minimum or maximum value during simulation is shown. When one of the data is entering another one there is a case of stack/frame overflow.

This will be signaled with a pause and a checkbox.

**INTERRUPTS**


This TAB shows the interrupt sources. When no ISR's are programmed all buttons will be disabled.

By clicking a button the corresponding ISR is executed.

### TERMINAL Section

Under the TAB window you will find the terminal emulator window.

When you use PRINT, the output will be shown in this window.

When you use INPUT in your program, you must set the focus to the terminal window and press the needed value.

### SOURCE Section

Under the Terminal section you find the Source Window.

It contains the program you simulate. All lines that contain executable code have a yellow point in the left margin.

You can set a breakpoint on these lines by pressing F9.

By moving the mouse cursor over a variable name the value is shown in the status bar.

When you select a variable and press ENTER it will be added to the Variable window.

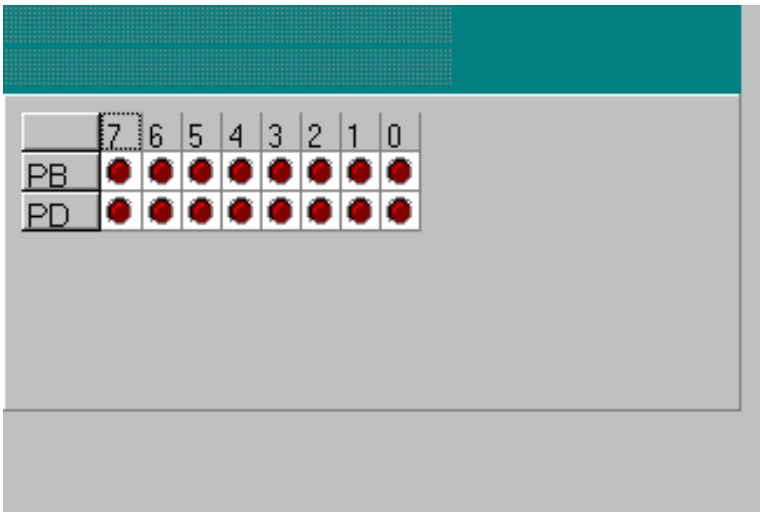
When you want to use the keys (F8 for stepping for example) the focus must be set to the Source Window.

A blue arrow will show the line that will be executed next.

### The hardware simulator.

By pressing the hardware simulation button 

the windows shown below will be displayed.




The top section is a virtual LCD display. It works for display code in PIN mode and bus mode. For bus mode only 8-bit bus mode works.

The LED bars below are a visual indication of the ports.

By clicking a LED it will toggle.

**Enable Real Hardware Simulation**

By clicking the  button you can simulate the ports in circuit!

In order to get it work you must compile the basmon.bas file.

When compiled program a chip.

Lets say you have the DT006 simmstick. And you are using a 2313 AVR chip.

Open the basmon.bas file and change the line with $REGFILE = "xxx" into $REGFILE = "2313def.dat"

Now compile the program. Program the chip. It is best to set the lock bits so the monitor does not get overwritten when you accidentally press F4.

The real hardware simulation only works when the target micro system has a serial port. Most have and so does the DT006.

Connect a cable between the COM port of your PC and the DT006. You probably already have one connected. Normally it is used to send data to the terminal emulator with PRINT.

The monitor program is compile with 19200 baud. The Options Communication settings must be set to the same baud rate!

The same settings for the monitor program are used as for the Terminal emulator. So select the COM port and the baud rate of 19200.

Power up the DT006. It probably was since you created the basmon program and stored it in the 2313.

When you press the real hardware simulation button now the simulator will send and receive data when a port, pin or ddr register is changed.

This allows you to simulate an attached LCD display for example. Or something simpler, the LED. In the SAMPLE dir you will find a program DT006. You can compile thie program and press F2.

When you step through the program the LED's will change!

All statements can be simulated this way but the have to be static. Which means that 1wire will not work because it depends on timing. I2C has a static bus and that will work.

It is important that when you finish your simulation sessions that you click the button again to disable the Real hardware simulation.

When the program hangs it probably means that something wend wrong in the communication. The only way to escape is to press the Real hardware simulation again.

I think the simulation is a cost effective way to test attached hardware.

## Program Send to Chip

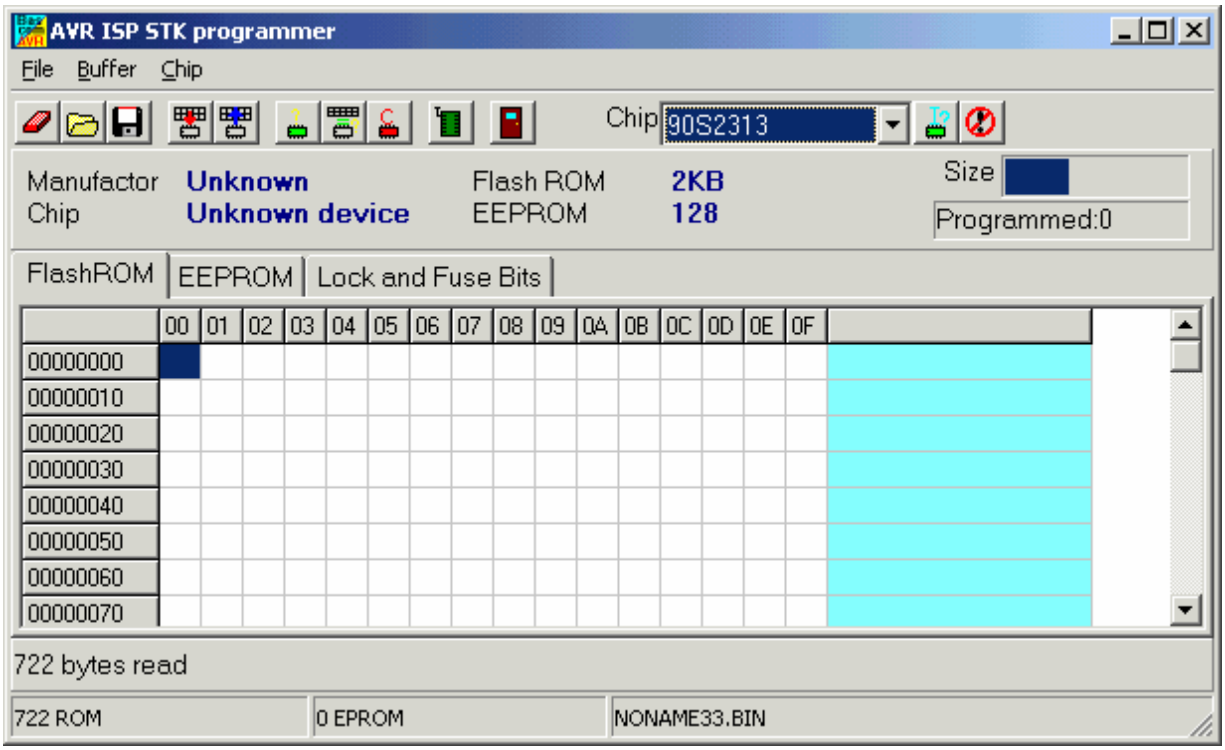
This option will bring up the selected programmer or will program the chip directly if this option is selected from the Programmer options.

Program send to chip shortcut  , F4

| Menu item | Description |
|---|---|
| File Exit | Return to editor |
| File, Test | With this option you can set the logic level to the LPT pins. This is only intended for the Sample Electronics programmer. |
| Buffer Clear | Clears buffer |
| Buffer Load from file | Loads a file into the buffer |
| Buffer Save to file | Saves the buffer content to a file |
| Chip Identify | Identifies the chip |
| Write buffer into chip | Programs the buffer into the chip ROM or EEPROM |
| Read chipcode into buffer | Reads the code or data from the chips code memory or data memory |

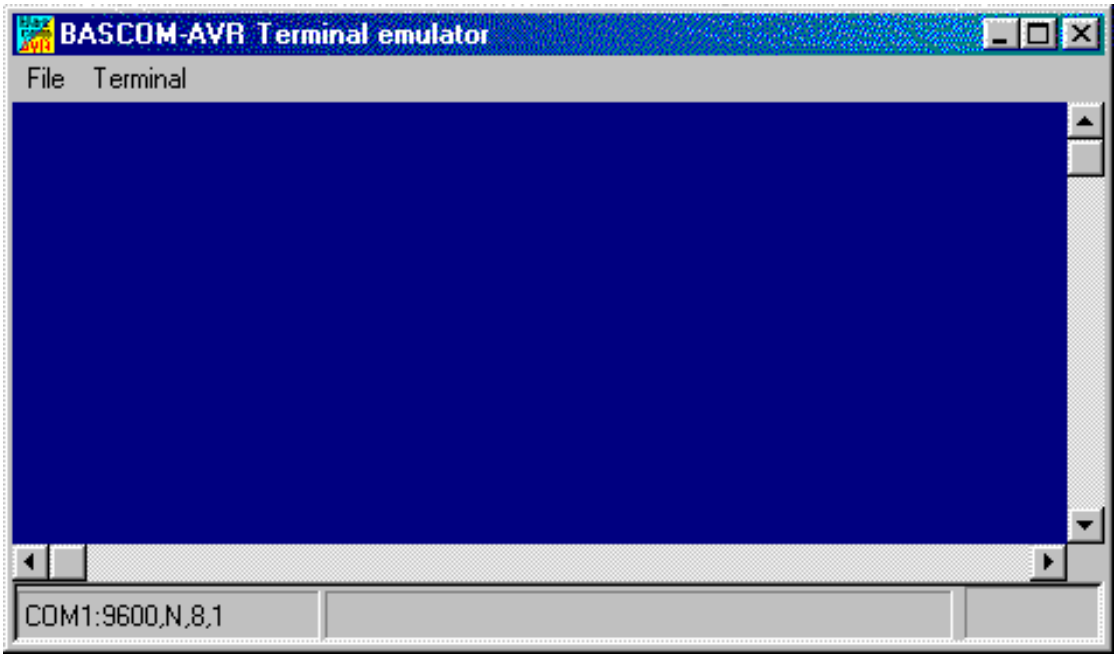
| | |
|---|---|
| Chip blank check | Checks if the chip is blank |
| Chip erase | Erase the content of both the program memory and the data memory |
| Chip verify | Verifies if the buffer is the same as the chip program or data memory |
| Chip Set lockbits | Writes the selected lock bits LB1 and/or LB2. Only an erase will reset the lock bits |
| Chip autoprogram | Erases the chip and programs the chip. After the programming is completed, verification is performed. |
| RCEN | Writes a bit to enable the internal oscillator. This RCEN bit is only available on some AVR chips. |

The following window will be shown:




## Tools Terminal Emulator

With this option you can communicate via the RS-232 interface to the microcomputer. The following window will appear:




Information you type and information that the computer board sends are displayed in the same window.

Note that you must use the same baud rate on both sides of the transmission. If you compiled your program with the Compiler Settings at 4800 baud, you must also set the Communication Settings to 4800 baud.

The setting for the baud rate is also reported in the report file.

**File Upload**

Uploads the current program in HEX format. This option is meant for loading the program into a monitor program.

**File Escape**

Aborts the upload to the monitor program.

**File Exit**

Closes terminal emulator.

**Terminal Clear**

Clears the terminal window.

### Terminal Open Log

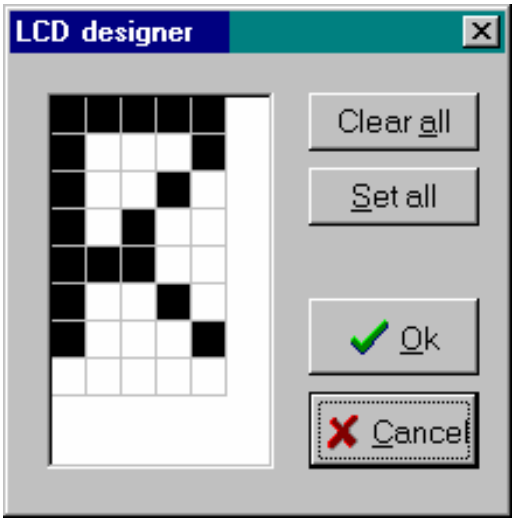
Open or closes a LOG file. When there is no LOG file selected you will be asked to enter or select a filename. All info that is printed to the terminal window is captured into the log file. The menu caption will change into 'Close Log' and when you choose this option the file will be closed.

The terminal emulator has a strange bug that you can't select the menu options by using the keyboard. This is an error in the terminal component and I hope the third party will fix this bug.

## Tools LCD Designer

With this option you can design special characters for LCD-displays.

The following window will appear:




The LCD-matrix has 7x5 points. The bottom row is reserved for the cursor but can be used.

You can select a point by clicking the left mouse button. If a cell was selected it will be deselected.

Clicking the Set All button will set all points.

Clicking the Clear All button will clear all points.

When you are finished you can press the Ok button : a statement will be inserted in your active program-editor window at the current cursor position. The statement looks like this :

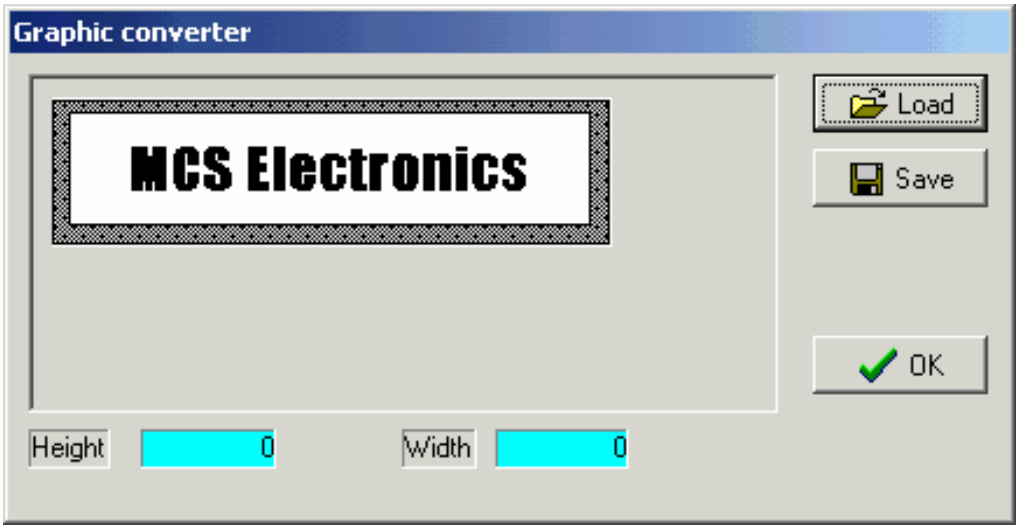
Deflcdchar ?,1,2,3,4,5,6,7,8

You must replace the ?-sign with a character number ranging from 0-7.

## Tools Graphic Converter

The Graphic converter is intended to convert BMP files into BASCOM Graphic Files (BGF) that can be used with Graphic LCD displays.

The following dialog box will be shown :




To load a picture click the Load button.

The picture can be 64 pixels high and 240 pixels width.

When the picture is larger it will be adjusted.

You can use your favorite graphic tool to create the bitmaps and use the Graphic converter to convert them into black and white images.

When you click the Save-button the picture will be converted into black and white.

Any non-white color will be converted into black.

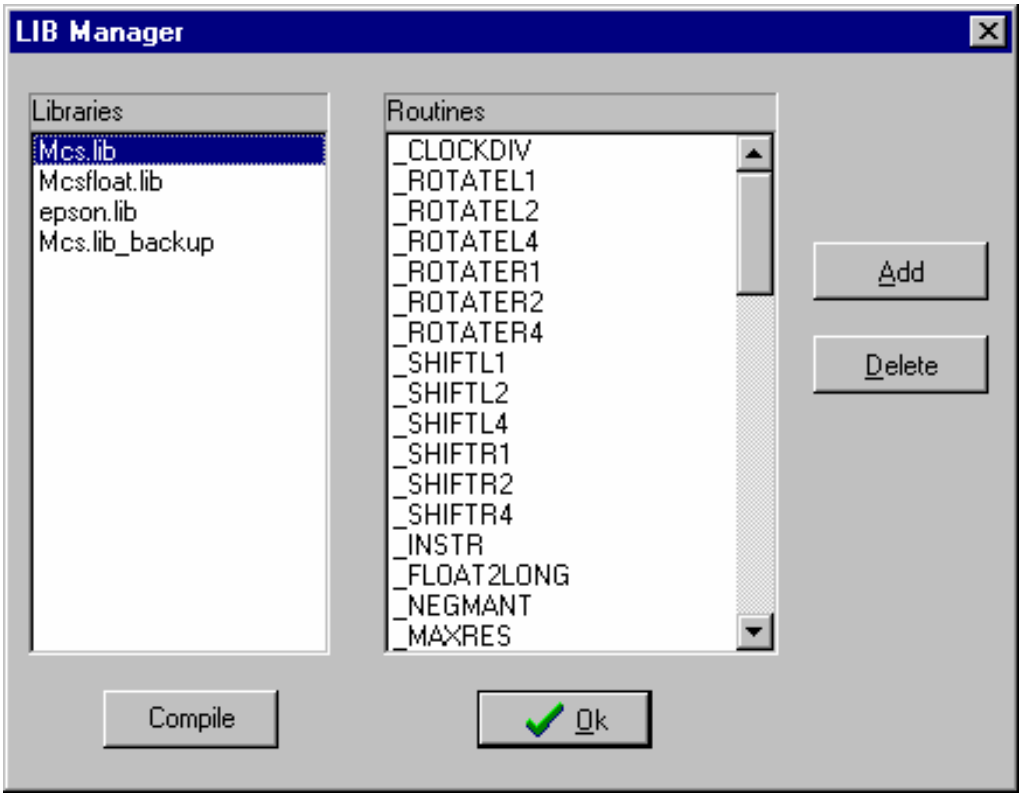
The resulting file will have the BGF extension.

Press the Ok-button to return to the editor.

The picture can be shown with the ShowPic statement.

## Tools LIB Manager

With this option the following window will appear:




The Libraries are shown in the left pane. When you select one the routines that are in the library will be shown in the right pane.

By selecting a routine you can DELETE it.

By clicking the ADD button you can add an ASM routine to the library.

The COMPILE button works only in the commercial edition. When you click it the selected library will be compiled into a LBX file.

A compiled LBX file does not contain comment and a huge amount of mnemonics is compiled into object code. This object code is inserted at compile time of the main BASIC program. And this results in faster compilation.

The DEMO version comes with the compiled MCS.LIB file and is named MCS.LBX. The ASM source is included with the commercial edition.

With the ability to create LBX files you can create add on packages for BASCOM and sell them. The LBX files could be distributed for free and the ASM source could be sold.

Two examples you will find soon :

- A library to read IDE harddisks.
- MODBUS slave routines

Libraries included with BASCOM-AVR:

## LCD4.LIB

The built in LCD driver for the PIN mode is written to support a worst case scenario where you use random pins of the microprocessor to drive the LCD pins.

This makes it easy to design your PCB but it needs more code.

When you want to have less code you need fixed pins for the LCD display.

With the statement $LIB "LCD4.LBX" you specify that the LCD4.LIB will be used.

The following connections are used in the asm code:

Rs = PortB.0

RW = PortB.1 we dont use the R/W option of the LCD in this version so connect to ground

E = PortB.2

E2 = PortB.3 optional for lcd with 2 chips

Db4 = PortB.4 the data bits must be in a nibble to save code

Db5 = PortB.5
Db6 = PortB.6
Db7 = PortB.7

You can change the lines from the lcd4.lib file to use another port.
Just change the address used :
.EQU LCDDDR=$17 ; change to another address for DDRD ($11)
.EQU LCDPORT=$18 ; change to another address for PORTD ($12)

See the demo **lcdcustom4bit.bas** in the SAMPLES dir.

Note that you still must select the display that you use with the CONFIG LCD statement.

See also the lcd42.lib for driving displays with 2 E lines.

Note that LBX is a compiled LIB file. In order to change the routines you need the commercial edition with the source code(lib files). After a change you should compile the library with the library manager.

## LCD4E2

The built in LCD driver for the PIN mode is written to support a worst case scenario where you use random pins of the microprocessor to drive the LCD pins.
This makes it easy to design your PCB but it needs more code.

When you want to have less code you need fixed pins for the LCD display.
With the statement $LIB "LCD4E2.LBX" you specify that the LCD4.LIB will be used.
The following connections are used in the asm code:
Rs = PortB.0
RW = PortB.1 we don't use the R/W option of the LCD in this version so connect to ground
E = PortB.2

E2 = PortB.3 the second E pin of the LCD
Db4 = PortB.4 the data bits must be in a nibble to save code
Db5 = PortB.5
Db6 = PortB.6
Db7 = PortB.7

You can change the lines from the lcd4e2.lib file to use another port.
Just change the address used :

```
.EQU LCDDDR=$17      ; change to another address for DDRD ($11)
.EQU LCDPORT=$18     ; change to another address for PORTD ($12)
```

See the demo **lcdcustom4bit2e.bas** in the SAMPLES dir.

Note that you still must select the display that you use with the CONFIG LCD statement.

See also the lcd4.lib for driving a display with 1 E line.

A display with 2 E lines actually is a display with 2 control chips. They must both be controlled. This library allows you to select the active E line from your code.
In your basic code you must first select the E line before you use a LCD statement.
The initialization of the display will handle both chips.

Note that LBX is a compiled LIB file. In order to change the routines you need the commercial edition with the source code(lib files). After a change you should compile the library with the library manager.

## MCSBYTE

The numeric<>string conversion routines are optimized when used for byte, integer,word and longs.

When do you use a conversion routine ?

-When you use STR() , VAL() or HEX().

-When you print a numeric variable

-When you use INPUT on numeric variables.

To support all data types the built in routines are efficient in terms of code size.

But when you use only conversion routines on bytes there is a overhead.

The mcsbyte.lib library is an optimized version that only support bytes.

Use it by including : $LIB "mcsbyte.lbx" in your code.

Note that LBX is a compiled LIB file. In order to change the routines you need the commercial edition with the source code(lib files). After a change you should compile the library with the library manager.

See also the library mcsbyteint.lib

## MCSBYTEINT

The numeric<>string conversion routines are optimized when used for byte, integer,word and longs.

When do you use a conversion routine ?

-When you use STR() , VAL() or HEX().

-When you print a numeric variable

-When you use INPUT on numeric variables.

To support all data types the built in routines are efficient in terms of code size.

But when you use only conversion routines on bytes there is a overhead.

The mcsbyteint.lib library is an optimized version that only support bytes, integers and words.

Use it by including : $LIB "mcsbyteint.lbx" in your code.

Note that LBX is a compiled LIB file. In order to change the routines you need the commercial edition with the source code(lib files). After a change you should compile the library with the library manager.

See also the library mcsbyte.lib

## Options Compiler

With this option, you can modify the compiler options.

The following TAB pages are available:

Options Compiler Chip

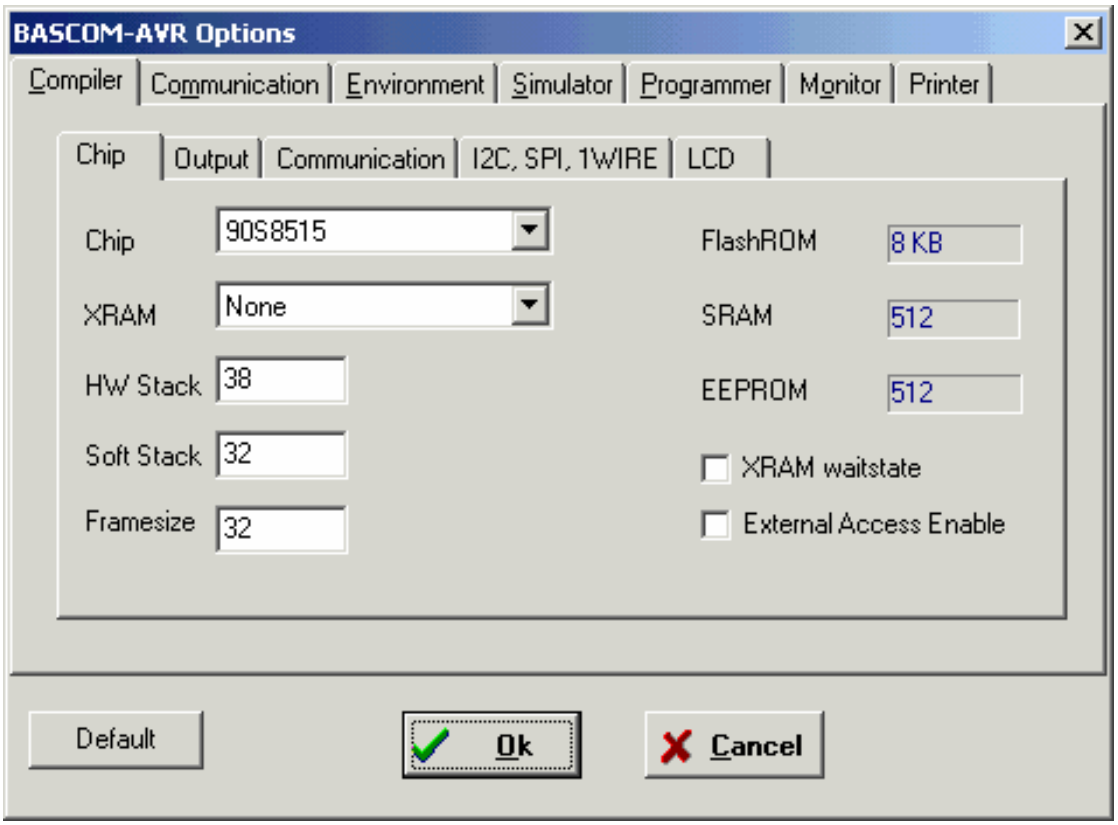
Options Compiler Output

Options Compiler Communication

Options Compiler I2C , SPI, 1WIRE

Options Compiler LCD

# Options Compiler Chip



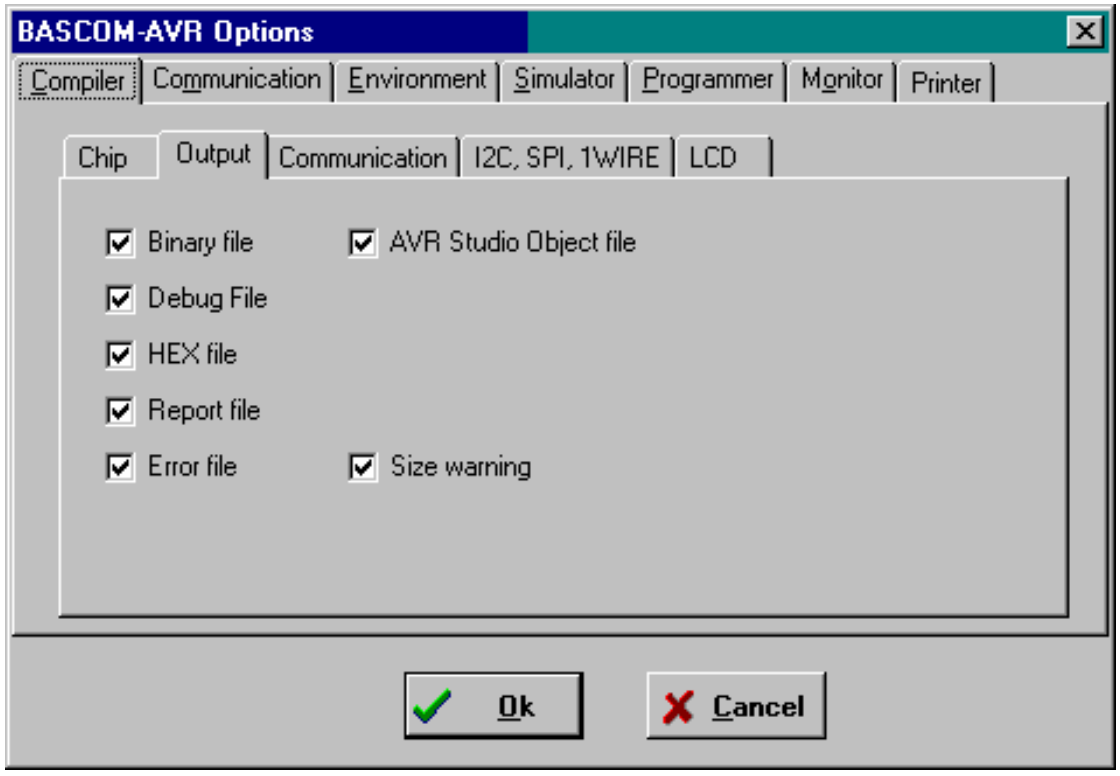

The following options are available:

Options Compiler Chip

| Item | Description |
|---|---|
| Chip | Selects the target chip. Each chip has a corresponding x.DAT file with specifications of the chip. Note that some DAT files are not available yet. |
| XRAM | Selects the size of the external RAM. KB means Kilo Bytes.<br>For 32 KB you need a 62256 STATIC RAM chip. |
| HW Stack | The amount of bytes available for the hard ware stack. When you use GOSUB or CALL, you are using 2 bytes of HW stack space.<br>When you nest 2 GOSUB's you are using 4 bytes (2*2). Most statements need HW stack too. An interrupt needs 32 bytes. |
| Soft Stack | Specifies the size of the software stack.<br>Each local variable uses 2 bytes. Each variable that is passed to a sub program uses 2 bytes too. So when you have used 10 locals in a SUB |

| | |
|---|---|
| | and the SUB passes 3 parameters, you need 13 * 2 = 26 bytes. |
| Frame size | Specifies the size of the frame.<br>Each local is stored in a space that is named the frame space.<br>When you have 2 local integers and a string with a length of 10, you need a frame size of (2*2) + 11 = 15 bytes.<br>The internal conversion routines used when you use INPUT num,STR(),VAL() etc, also use the frame. They need a maximum of 16 bytes. So for this example 15+16 = 31 would be a good value. |
| XRAM waitstate | Select to insert a wait state for the external RAM. |
| External Access enable | Select this option to allow external access of the micro. The 8515 for example can use port A and C to control a RAM chip. |
| Default | Press or click this button to use the current Compiler Chip settings as default for all new projects. |

## Options Compiler Output

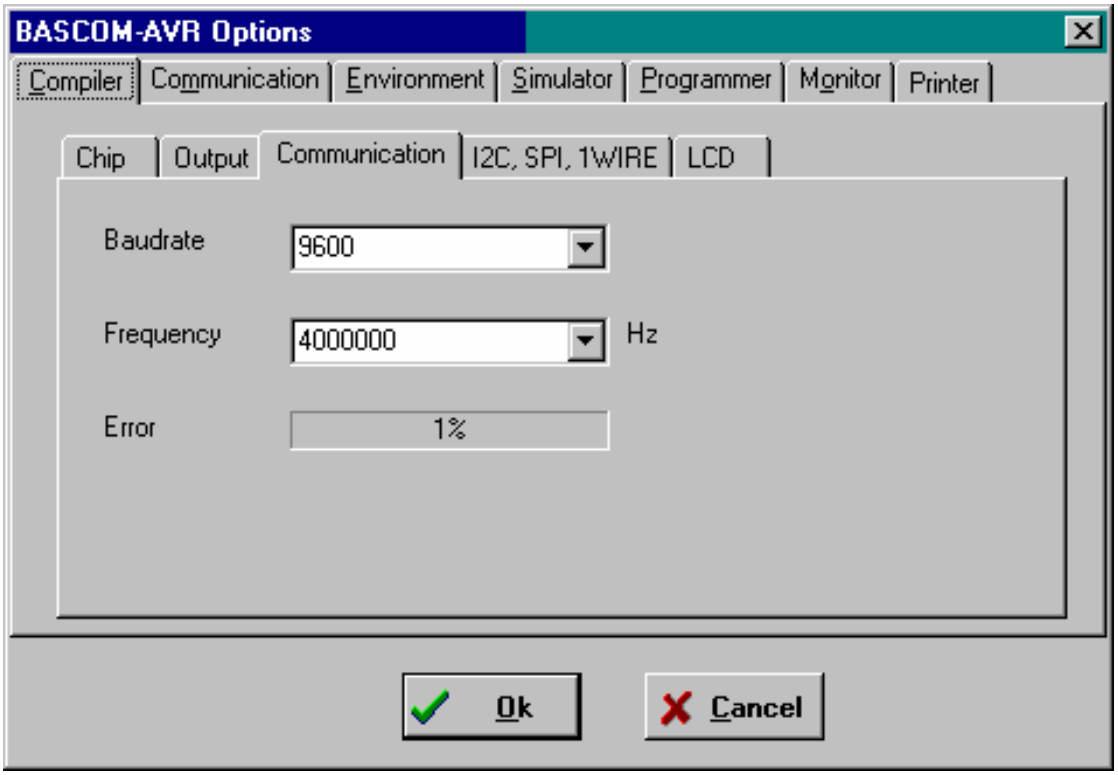



Options Compiler Output

| Item | Description |
|---|---|
| Binary file | Select to generate a binary file. (xxx.bin) |
| Debug file | Select to generate a debug file (xxx.dbg) |

| | |
|---|---|
| Hex file | Select to generate an Intel HEX file (xxx.hex) |
| Report file | Select to generate a report file (xxx.rpt) |
| Error file | Select to generate an error file (xxx.err) |
| AVR Studio object file | Select to generate an AVR Studio object file (xxx.obj) |
| Size warning | Select to generate a warning when the code size exceeds the Flash ROM size. |
| Swap words | This option will swap the bytes of the object code words. Useful for some programmers. Should be disabled for most programmers.<br>Don't use it with the internal supported programmers. |
| Optimize code | This options does additional optimization of the generated code. Since it takes more time it is an option. |
| Show internal variables | Internal variables are used. Most of them refer to a register. Like _TEMP1 = R24. This option shows these variables in the report. |

## Options Compiler Communication




Options Compiler Communication

**Item** **Description**

Baud rate Selects the baud rate for the serial statements. You can also type in a new baud rate.

Frequency Select the frequency of the used crystal. You can also type in a new frequency.

The settings for the internal hardware UART are:

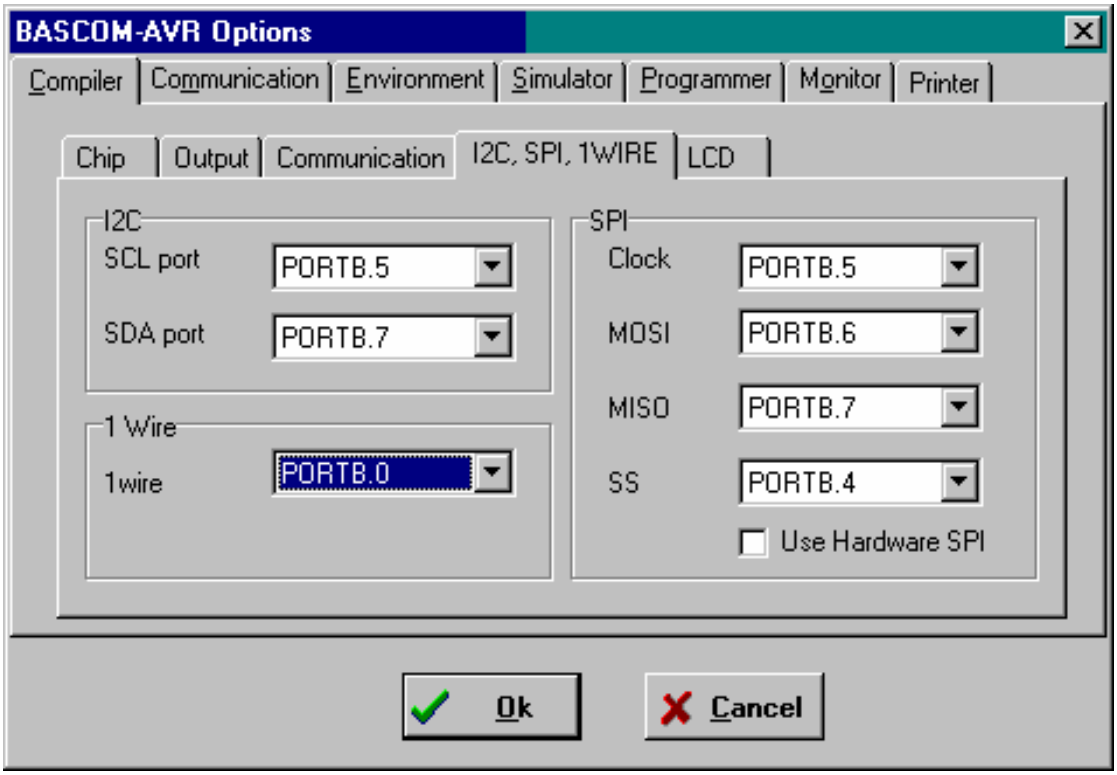
No parity

8 data bits

1 stop bit

Note that these settings must match the settings of the terminal emulator. In the simulator the output is always shown correct since the baud rate is not taken in consideration during simulation. With real hardware when you print data at 9600 baud, the terminal emulator will show weird characters when not set to the same baud rate, in this example, to 9600 baud.

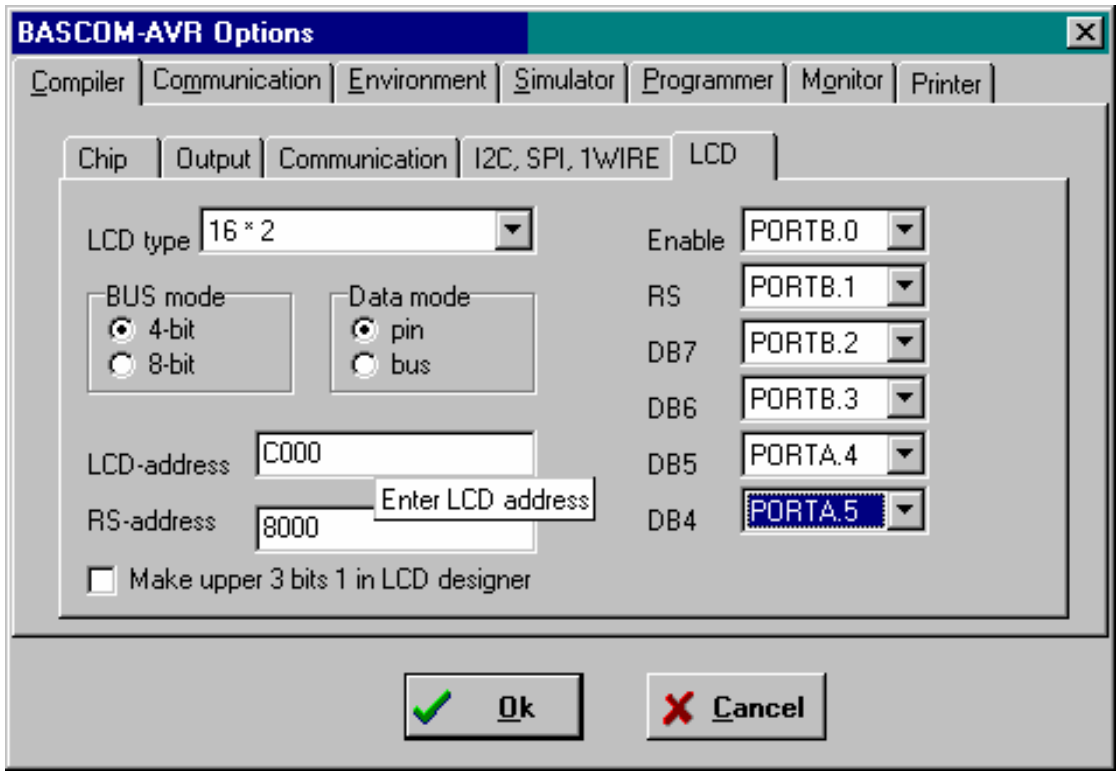
**Options Compiler I2C, SPI, 1WIRE**




Options Compiler I2C, SPI, 1WIRE

| Item | Description |
|---|---|
| SCL port | Select the port that serves as the SCL-line for the I2C related statements. |
| SDA port | Select the port that serves as the SDA-line for the I2C related statements. |
| 1WIRE | Select the port that serves as the 1WIRE-line for the 1Wire related statements. |
| Clock | Select the port that serves as the clock-line for the SPI related statements. |
| MOSI | Select the port that serves as the MOSI-line for the SPI related statements. |
| MISO | Select the port that serves as the MISO-line for the SPI related statements. |
| SS | Select the port that serves as the SS-line for the SPI related statements. |
| Use hardware SPI | Select to use built-in hardware for SPI, otherwise software emulation of SPI will be used. The 2313 does not have internal HW SPI so can only be used with software spi mode. |

# Options Compiler LCD



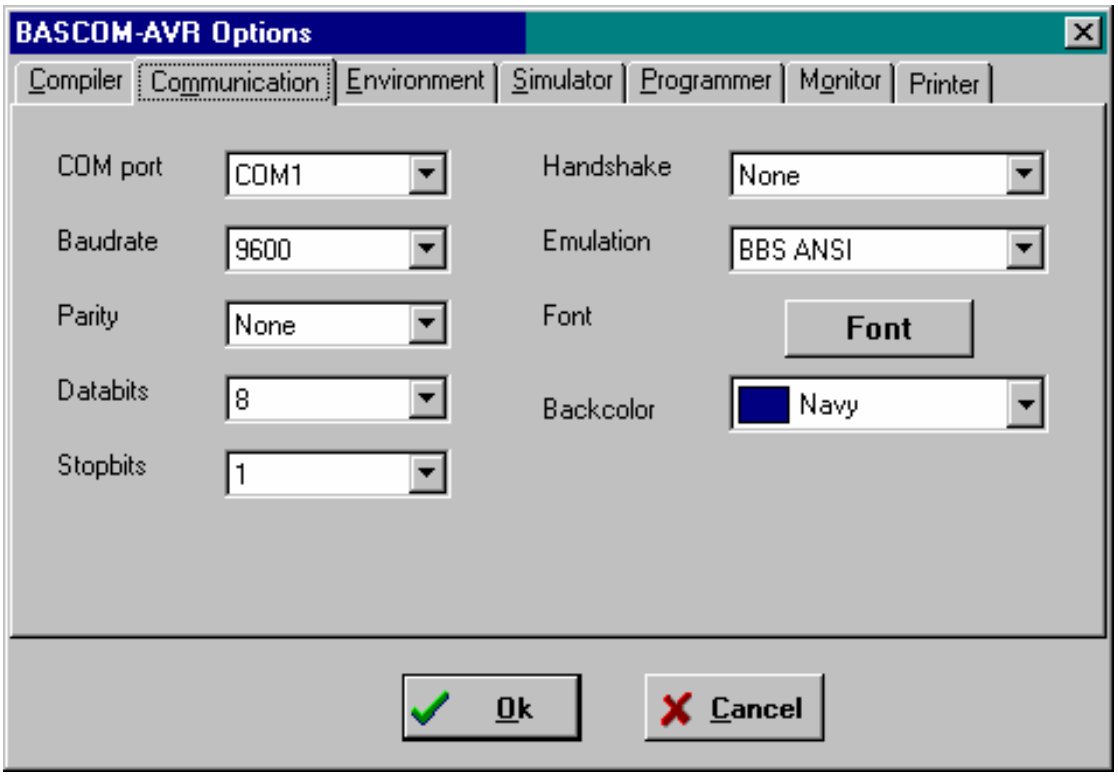

Options Compiler LCD

| Item | Description |
|---|---|
| LCD type | The LCD display used. |
| Bus mode | The LCD can be operated in BUS mode or in PIN mode. In PIN mode, the data lines of the LCD are connected to the processor pins. In BUS mode the data lines of the LCD are connected to the data lines of the BUS.<br>Select 4 when you have only connect DB4-DB7. When the data mode is 'pin' , you should select 4. |
| Data mode | Select the mode in which the LCD is operating. In PIN mode, individual processor pins can be used to drive the LCD. In BUS mode, the external data bus is used to drive the LCD. |
| LCD address | In BUS mode you must specify which address will select the enable line of the LCD display. For the STK200, this is C000 = A14 + A15. |
| RS address | In BUS mode you must specify which address will select the RS line of the LCD display. For the STK200, this is 8000 = A15 |
| Enable | For PIN mode, you must select the processor pin that is connected to the enable line of the LCD display. |
| RS | For PIN mode, you must select the processor pin that is connected to |

| | |
|---|---|
| | the RS line of the LCD display. |
| DB7-DB4 | For PIN mode, you must select the processor pins that are connected to the upper four data lines of the LCD display. |
| Make upper 3 bits high in LCd designer | Some displays require that for setting custom characters, the upper 3 bits must be 1. Should not be used by default. |

## Options Communication

With this option, you can modify the communication settings for the terminal emulator.

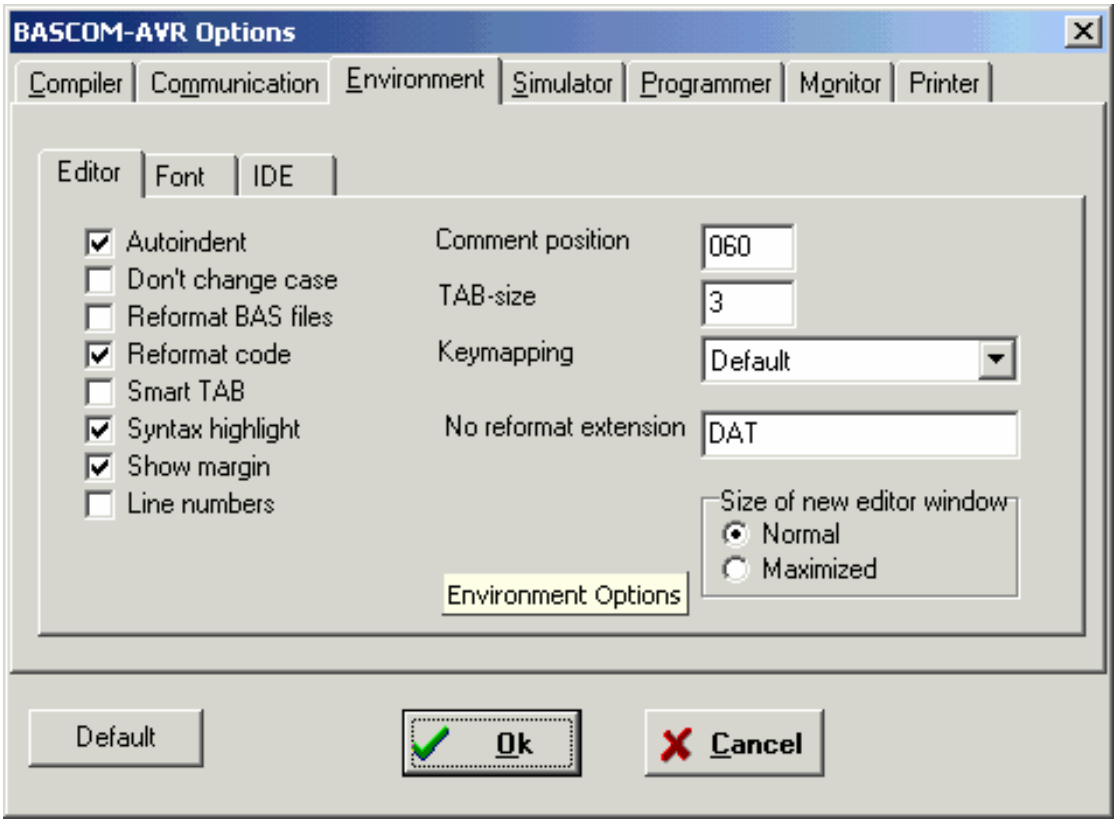



| Item | Description |
|---|---|
| Comport | The communication port of your PC that you use for ther terminal emulator. |
| Baud rate | The baud rate to use. |
| Parity | Parity, default None. |

| | |
|---|---|
| Data bits | Number of data bits, default 8. |
| Stop bits | Number of stop bits, default 1. |
| Handshake | The handshake used, default is none. |
| Emulation | Emulation used, default BBS ANSI. |
| Font | Font type and color used by the emulator. |
| Back color | Background color of the terminal emulator. |

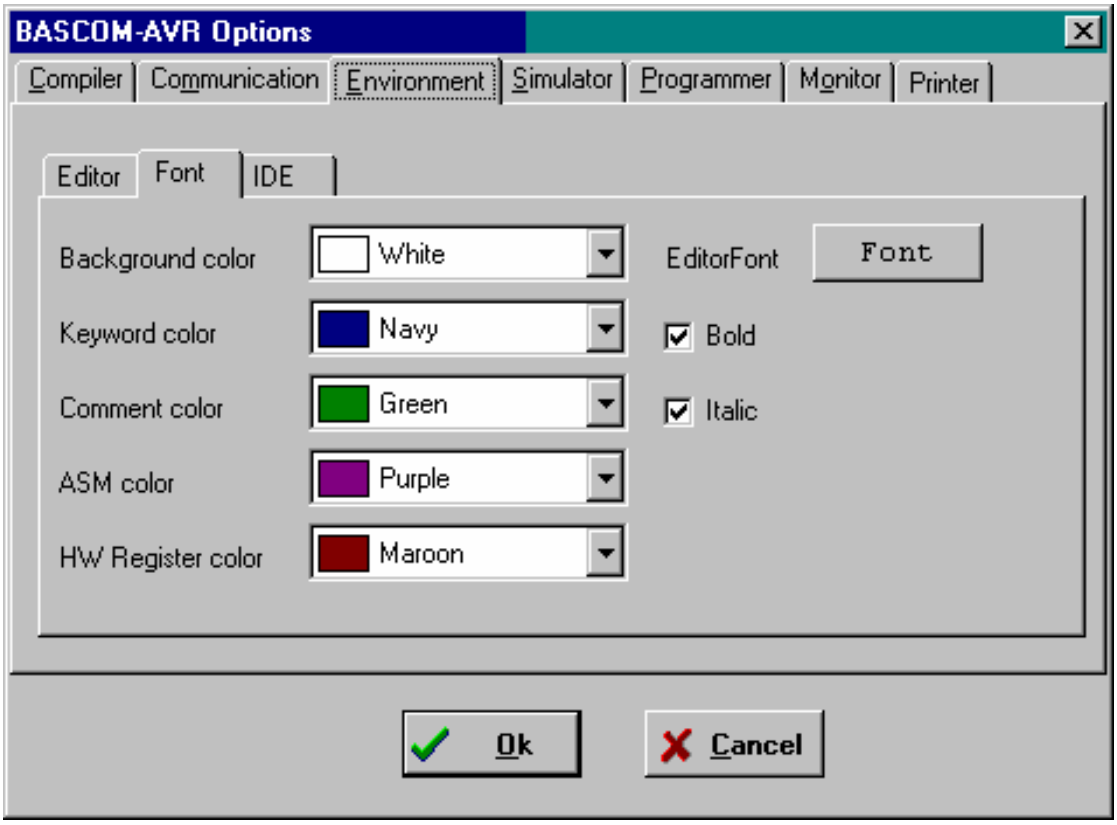
Note that the baud rate of the terminal emulator and the baud rate setting of the compiler options, must be the same in order to work correctly.

## Options Environment

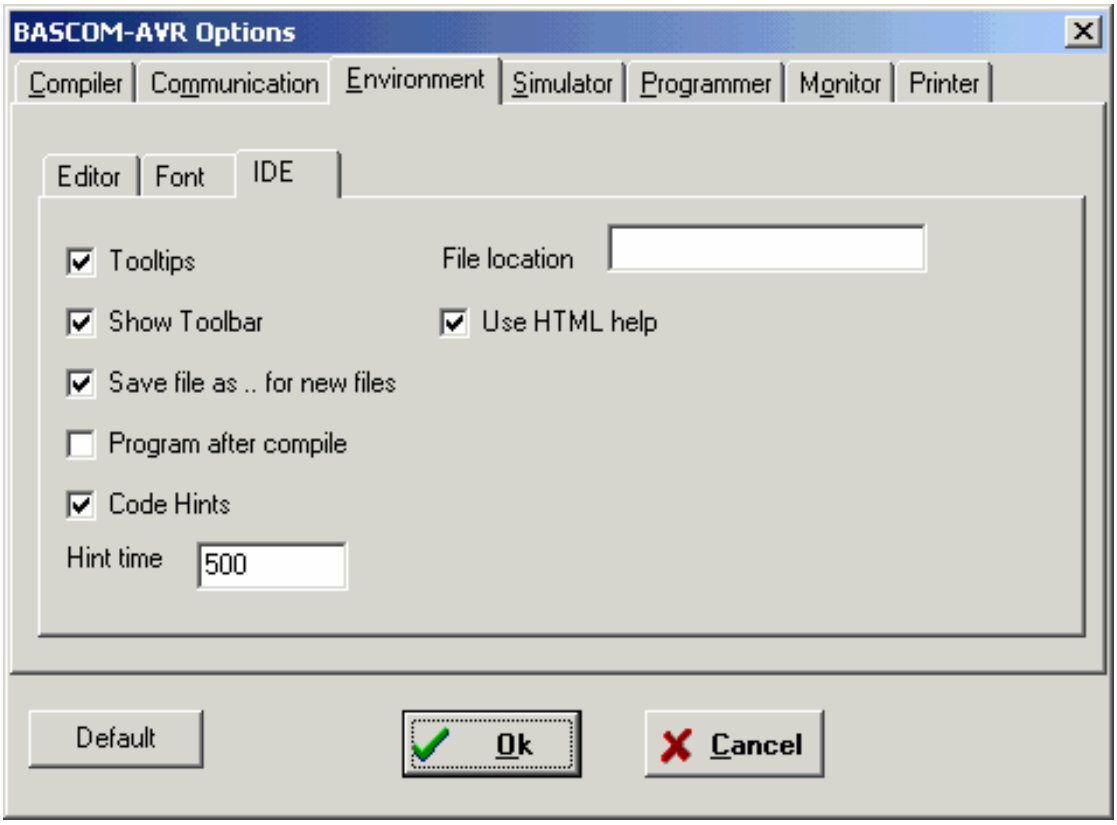



| OPTION | DESCRIPTION |
|---|---|
| Auto Indent | When you press return, the cursor is set to the next line at the current column position |

| | |
|---|---|
| Don't change case | When set, the reformat won't change the case of the text. Default is that the text is reformatted so every word begins with upper case. |
| Reformat BAS files | Reformat files when loading them into the editor. This is only necessary when you are loading files that where created with another editor. Normally you won't need to set this option. |
| Reformat code | Reformat code when entered in the editor. |
| Smart TAB | When set, a TAB will go to the column where text starts on the previous line. |
| Syntax highlighting | This options highlights BASCOM statements in the editor. |
| Show margin | Shows a margin on the right side of the editor. |
| Comment | The position of the comment. Comment is positioned at the right of your source code. |
| TAB-size | Number of spaces that are generated for a TAB. |
| Keymapping | Choose default, Classic, Brief or Epsilon. |
| No reformat extension | File extensions separated by a space that will not be reformatted when loaded. |
| Size of new editor window | When a new editor window is created you can select how it will be made. Normal or Maximized (full window) |




| OPTION | DESCRIPTION |
|---|---|
| Background color | The background color of the editor window. |
| Keyword color | The color of the reserved words. Default Navy.<br>The keywords can be displayed in bold too. |
| Comment color | The color of comment. Default green.<br>Comment can be shown in Italic too. |
| ASM color | Color to use for ASM statements. Default purple. |
| HW registers color | The color to use for the hardware registers/ports. Default maroon. |
| Editor font | Click on this label to select another font for the editor window. |




| OPTION | DESCRIPTION |
|---|---|
| Tooltips | Show tool tips. |
| Show toolbar | Shows the toolbar with the shortcut icons. |
| Save File As … for new files. | Will display a dialogbox so you can give new files a name when they must be saved. When you dont select this option the default name will be give to the file (nonamex.bas). Where x is a number. |
| Program after Compile | This option will run the programmer after the program is compiled with success. |
| File location | Double click to select a directory where your program files are stored. By default Windows will use the My Documents path. |
| Use HTML Help | HTML help is available for download and when your OS supports HTML help, you can turn this option on.<br>W98,W98SE,W98ME and W2000 support HTML Help. |

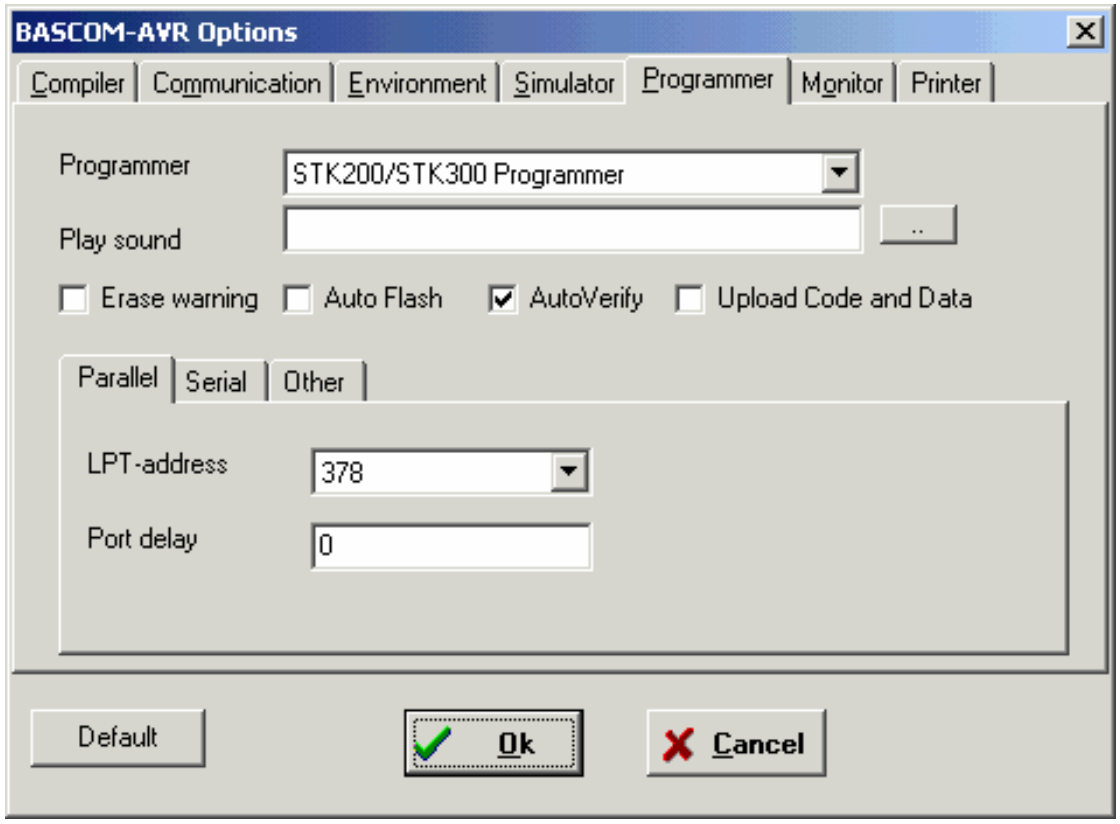
## Options Simulator

With this option you can modify the simulator settings.

| OPTION | DESCRIPTION |
|---|---|
| Use integrated simulator | Set this option to use BASCOM's simulator. You can also use AVR Studio by clearing this option. |
| Run simulator after compilation | Run the selected simulator after a successful compilation. |
| Program | The path with the program name of the simulator. |
| Parameter | The parameter to pass to the program. {FILE}.OBJ will supply the name of the current program with the extension .OBJ to the simulator. |

## Options Programmer

With this option you can modify the programmer settings.



| OPTION | DESCRIPTION |
|---|---|
| Programmer | Select one from the list. |
| Play sound | Name of a WAV file to be played when programming is finished. Press the ..-button to select the file. |
| Erase Warning | Set this option when you want a confirmation when the chip is erased. |
| Auto flash | Some programmers support auto flash. Pressing F4 will program the chip without showing the programmer window. |
| Auto verify | Some programmers support verifying. The chip content will be verified after programming. |
| Upload code and data | Set this option to program both the FLASH memory and the EEPROM memory |
| | Parallel printer port programmers |
| LPT address | Port address of the LPT that is connected to the programmer. |
| | Serial port programmer |
| COM port | The com port the programmer is connected to. |
| STK500 EXE | The path of stk500.exe. This is the full file location to the files stk500.exe that comes with the STK500. |
| | Other |
| Use HEX | Select when a HEX file must be sent instead of the bin file. |
| Program | The program to execute. This is your programmer software. |
| Parameter | The optional parameter that the program might need. |

## Options Monitor

With this option you can modify the monitor settings.

| OPTION | DESCRIPTION |
|---|---|
| Upload speed | Selects the baud rate used for uploading |
| Monitor prefix | String that will be send to the monitor before the upload starts |
| Monitor suffix | String that us sent to the monitor after the download is completed. |

| | |
|---|---|
| Monitor delay | Time in millions of seconds to wait after a line has been sent to the monitor. |
| Prefix delay | Time in millions of seconds to wait after a prefix has been sent to the monitor. |

## Options Printer

With this option you can modify the printer settings.

There are only settings to change the margins of the paper.

| OPTION | DESCRIPTION |
|---|---|
| Left | The left margin. |
| Right | The right margin. |
| Top | The top margin. |
| Bottom | The bottom margin. |

## Window Cascade

Cascade all open editor windows.

## Window Tile

Tile all open editor windows.

## Window Arrange Icons

Arrange the icons of the minimized editor windows.

## Window Minimize All

Minimize all open editor windows.

## Help About

This option shows an about box as showed below.


Your serial number is shown in the about box.

You will need this when you have questions about the product.

The library version is also shown. In this case, it is **1.00**.

You can compare it with the one on our web site in case you need an update.

Click on **Ok** to return to the editor.

## Help Index

Shows the BASCOM help file.

When you are in the editor window, the current word will be used as a keyword.

## Help on Help

Shows help on how to use the Windows help system.

## Help Credits

Shows a form with credits to people I would like to thank for their contributions to BASCOM.

## BASCOM Editor Keys

| Key | Action |
|---|---|
| LEFT ARROW | One character to the left |
| RIGHT ARROW | One character to the right |
| UP ARROW | One line up |
| DOWN ARROW | One line down |
| HOME | To the beginning of a line |
| END | To the end of a line |
| PAGE UP | Up one window |
| PAGE DOWN | Down one window |
| CTRL+LEFT | One word to the left |
| CTRL+RIGHT | One word to the right |
| CTRL+HOME | To the start of the text |
| CTRL+END | To the end of the text |
| CTRL+ Y | Delete current line |
| INS | Toggles insert/overstrike mode |
| F1 | Help (context sensitive) |
| F2 | Run simulator |

| | |
|---|---|
| F3 | Find next text |
| F4 | Send to chip (run flash programmer) |
| F5 | Run |
| F7 | Compile File |
| F8 | Step |
| F9 | Set breakpoint |
| F10 | Run to |
| CTRL+F7 | Syntax Check |
| CTRL+F | Find text |
| CTRL+G | Go to line |
| CTRL+K+x | Toggle bookmark. X can be 1-8 |
| CTRL+L | LCD Designer |
| CTRL+M | File Simulation |
| CTRL+N | New File |
| CTRL+O | Load File |
| CTRL+P | Print File |
| CTRL+Q+x | Go to Bookmark. X can be 1-8 |
| CTRL+R | Replace text |
| CTRL+S | Save File |
| CTRL+T | Terminal emulator |
| CTRL+P | Compiler Options |
| CTRL+W | Show result of compilation |
| CTRL+X | Cut selected text to clipboard |
| CTRL+Z | Undo last modification |
| SHIFT+CTRL+Z | Redo last undo |
| CTRL+INS | Copy selected text to clipboard |
| SHIFT+INS | Copy text from clipboard to editor |
| CTRL+SHIFT+J | Indent Block |
| CTRL+SHIFT+U | Unindent Block |
| Select text | Hold the SHIFT key down and use the cursor keys to select text. or keep the left mouse key pressed and tag the cursor over the text to select. |

## Developing Order

- Start BASCOM;
- Open a file or create a new one;
- Check the chip settings, baud rate and frequency settings for the target system;
- Save the file;
- Compile the file;
- If an error occurs fix it and recompile (F7);
- Run the simulator;
- Program the chip(F4);

## Memory usage

Every variable uses memory. This memory is also called SRAM.

The available memory depends on the chip.

A special kind of memory are the registers in the AVR. Registers 0-31 have addresses 0-31.

Almost all registers are used by the compiler or might be used in the future.

Which registers are used depends on the statements you used.

This brings us back to the SRAM.

No SRAM is used by the compiler other than the space needed for the software stack and frame.

Some statements might use some SRAM. When this is the case it is mentioned in the help topic of that statement.

Each 8 used bits occupy one byte.

Each byte occupies one byte.

Each integer/word occupies two bytes.

Each Long or Single occupies four bytes.

Each String occupies at least 2 byes.

A string with a length of 10. occupies 11 byes. The extra byte is needed to indicate the end of the string.

Use bits or bytes where you can to save memory. (not allowed for negative values)

The software stack is used to store the addresses of LOCAL variables and for variables that are passed to SUB routines.

Each LOCAL variable and passed variable to a SUB, uses two bytes to store the address. So when you have a SUB routine in your program that passes 10 variables, you need 10 * 2 = 20 bytes. When you use 2 LOCAL variables in the SUB program that receives the 10 variables, you need additional 2 * 2 = 4 bytes.

The software stack size can be calculated by taking the maximum number of parameters in a SUB routine, adding the number of LOCAL variables and multiplying the result by 2. To be safe, add 4 more bytes for internally used LOCAL variables.

LOCAL variables are stored in a place that is named the frame.

When you have a LOCAL STRING with a size of 40 bytes, and a LOCAL LONG, you need 41 + 4 bytes = 45 bytes of frame space.

When you use conversion routines such as STR(), VAL() etc. that convert from numeric to string and vice versa, you also need a frame. It should be 16 bytes in that case.
Add additional space for the local data.

Note that the use of the INPUT statement with a numeric variable, or the use of the PRINT/LCD statement with a numeric variable, will also force you to reserve 16 bytes of frame space. This because these routines use the internal numeric<>string conversion routines.

## XRAM

You can easy add external memory to an 8515. Then XRAM will become available.(extended memory).

When you add a 32KB RAM, the first address wil be 0.

But because the XRAM can only start after the SRAM, which is **&H**0260, the lower memory locations of the XRAM will not be used.

**ERAM**

Most AVR chips have internal EEPROM on board.

This EEPROM can be used to store and retrieve data.

In BASCOM, this data space is called ERAM.

An important difference is that an ERAM variable can be written for a maximum of 100.000 times. So only assign an ERAM variable when it is needed and not in a loop.

**Constant code usage**

Constants are stored in a constant table.

Each used constant in your program will end up in the constant table.

For example:

```
Print "ABCD"
Print "ABCD"
```

This example will only store one constant (ABCD).

```
Print  "ABCD"
Print "ABC"
```

In this example, two constants will be stored because the strings differ.

## Error Codes

The following table lists errors that can occur.

| Error | Description |
|---|---|
| 1 | Unknown statement |
| 2 | Unknown structure EXIT statement |
| 3 | WHILE expected |
| 4 | No more space for IRAM BIT |
| 5 | No more space for BIT |
| 6 | . expected in filename |
| 7 | IF THEN expected |
| 8 | BASIC source file not found |
| 9 | Maximum 128 aliases allowed |
| 10 | Unknown LCD type |
| 11 | INPUT, OUTPUT, 0 or 1 expected |
| 12 | Unknown CONFIG parameter |
| 13 | CONST already specified |
| 14 | Only IRAM bytes supported |
| 15 | Wrong data type |
| 16 | Unknown Definition |
| 17 | 9 parameters expected |
| 18 | BIT only allowed with IRAM or SRAM |
| 19 | STRING length expected (DIM S AS STRING * 12 ,for example) |
| 20 | Unknown DATA TYPE |
| 21 | Out of IRAM space |
| 22 | Out of SRAM space |
| 23 | Out of XRAM space |
| 24 | Out of EPROM space |
| 25 | Variable already dimensioned |
| 26 | AS expected |
| 27 | parameter expected |
| 28 | IF THEN expected |
| 29 | SELECT CASE expected |
| 30 | BIT's are GLOBAL and can not be erased |
| 31 | Invalid data type |

32 Variable not dimensioned
33 GLOBAL variable can not be ERASED
34 Invalid number of parameters
35 3 parameters expected
36 THEN expected
37 Invalid comparison operator
38 Operation not possible on BITS
39 FOR expected
40 Variable can not be used with RESET
41 Variable can not be used with SET
42 Numeric parameter expected
43 File not found
44 2 variables expected
45 DO expected
46 Assignment error
47 UNTIL expected
50 Value doesn't fit into INTEGER
51 Value doesn't fit into WORD
52 Value doesn't fit into LONG
60 Duplicate label
61 Label not found
62 SUB or FUNCTION expected first
63 Integer or Long expected for ABS()
64 , expected
65 device was not OPEN
66 device already OPENED
68 channel expected
70 BAUD rate not possible
71 Different parameter type passed then declared
72 Getclass error. This is an internal error.
73 Printing this FUNCTION not yet supported
74 3 parameters expected

80 Code does not fit into target chip
81 Use HEX(var) instead of PRINTHEX
82 Use HEX(var) instead of LCDHEX
85 Unknown interrupt source
86 Invalid parameter for TIMER configuration
87 ALIAS already used
88 0 or 1 expected
89 Out of range : must be 1-4
90 Address out of bounds
91 INPUT, OUTPUT, BINARY, or RANDOM expected
92 LEFT or RIGHT expected
93 Variable not dimensioned
94 Too many bits specified
95 Falling or rising expected for edge
96 Prescale value must be 1,8,64,256 or 1024
97 SUB or FUNCTION must be DECLARED first
98 SET or RESET expected
99 TYPE expected
100 No array support for IRAM variables
101 Can't find HW-register
102 Error in internal routine
103 = expected
104 LoadReg error
105 StoreBit error
106 Unknown register
107 LoadnumValue error
108 Unknown directive in device file
109 = expected in include file for .EQU
110 Include file not found
111 SUB or FUNCTION not DECLARED
112 SUB/FUNCTION name expected
113 SUB/FUNCTION already DECLARED

114 LOCAL only allowed in SUB or FUNCTION
115 #channel expected
116 Invalid register file
117 Unknown interrupt
200 .DEF not found
201 Low Pointer register expected
202 .EQU not found, probably using functions that are not supported by the selected chip
203 Error in LD or LDD statement
204 Error in ST or STD statement
205 } expected
206 Library file not found
207 Library file already registered
210 Bit definition not found
211 External routine not found
212 LOW LEVEL, RISING or FALLING expected
213 String expected for assignment
214 Size of XRAM string 0
215 Unknown ASM mnemonic
216 CONST not defined
217 No arrays allowed with BIT/BOOLEAN data type
218 Register must be in range from R16-R31
219 INT0-INT3 are always low level triggered in the MEGA
220 Forward jump out of range
221 Backward jump out of range
222 Illegal character
223 * expected
224 Index out of range
225 () may not be used with constants
226 Numeric of string constant expected
227 SRAM start greater than SRAM end
228 DATA line must be placed after the END statement
229 End Sub or End Function expected

230 You can not write to a PIN register
231 TO expected
232 Not supported for the selected micro
233 READ only works for normal DATA lines, not for EPROM data
234 ') block comment expected first
235 '( block comment expected first
236 Value does not fit into byte
238 Variable is not dimensioned as an array
239 Invalid code sequence because of AVR hardware bug
240 END FUNCTION expected
241 END SUB expected
242 Source variable does not match the target variable
243 Bit index out of range for supplied data type
244 Do not use the Y pointer
245 No arrays supported with IRAM variable
246 No more room for .DEF definitions
247 . expected
248 BYVAL should be used in declaration
249 ISR already defined
250 GOSUB expected
251 Label must be named SECTIC
252 Integer or Word expected
253 ERAM variable can not be used
254 Variable expected
255 Z or Z+ expected
256 Single expected
257 "" expected
258 SRAM string expected
259 - not allowed for a byte
260 Value larger than string length
261 Array expected
262 ON or OFF expected

263 Array index out of range

264 Use ECHO OFF and ECHO ON instead

999 DEMO/BETA only supports 2048 bytes of code

Other error codes are internal ones. Please report them when you get them.

## Additional Hardware

Of course just running a program on the chip is not enough. You will probably attach all kind of electronics to the processor ports.

BASCOM supports a lot of hardware and so has lots of hardware related statements.

Before explaining about programming the additional hardware, it might be better to talk about the chip.

The AVR internal hardware

Attaching an LCD display

Using the I2C protocol

Using the 1WIRE protocol

Using the SPI protocol

You can attach additional hardware to the ports of the microprocessor.

The following statements will become available:

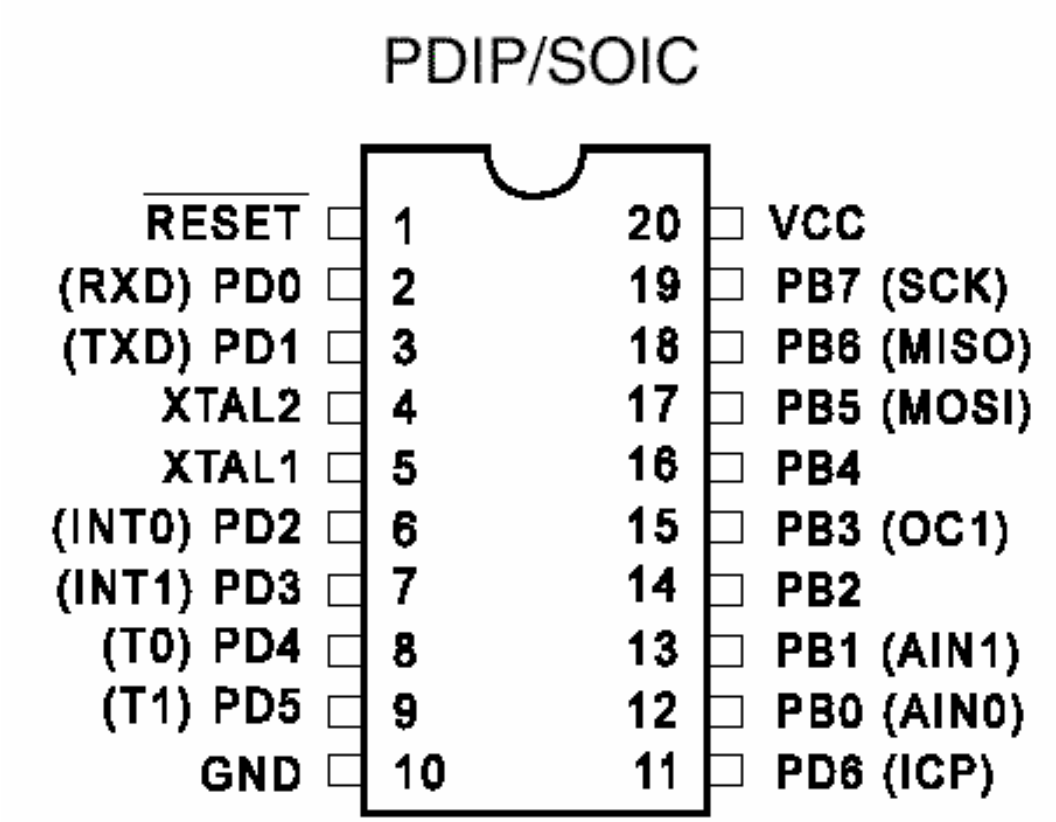
I2CSEND and I2CRECEIVE and other I2C related statements.

CLS, LCD, DISPLAY and other related LCD-statements.

1WRESET , 1WWRITE and 1WREAD

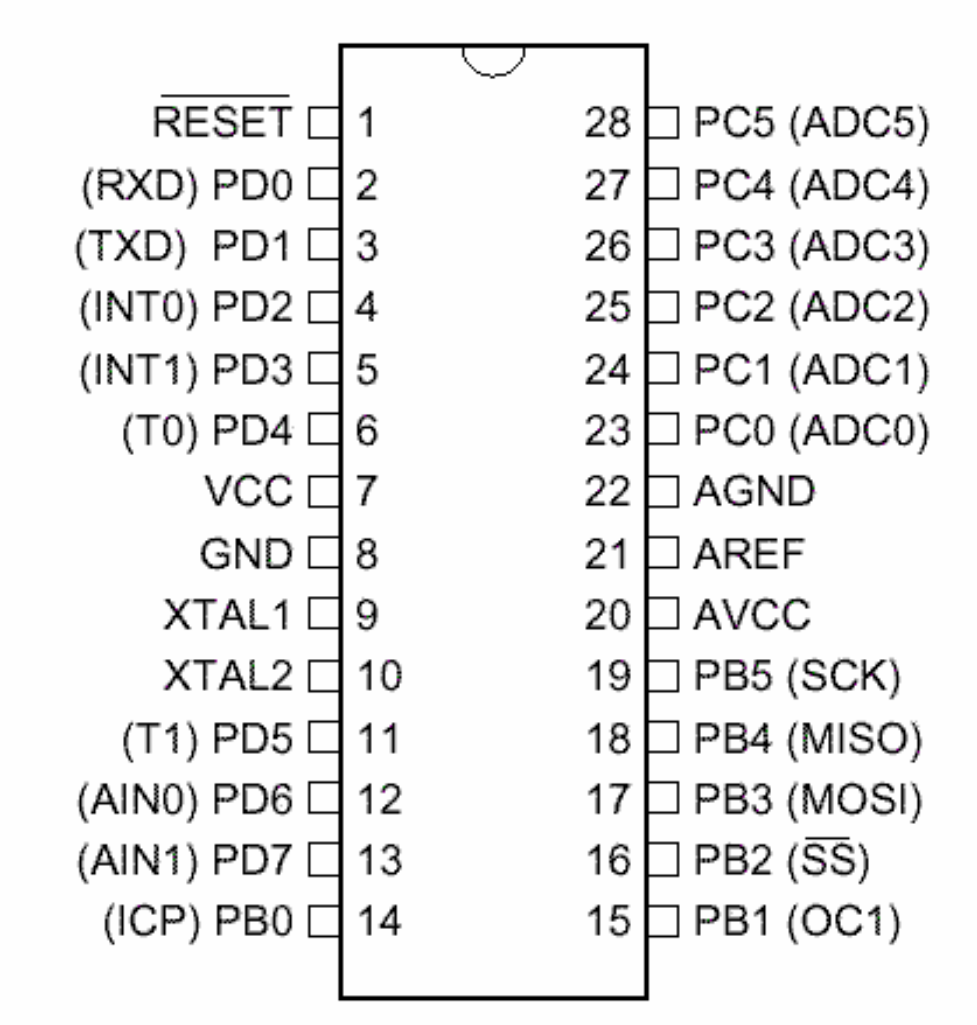
## AT90S2313

This page is intended to show user comments about the chip.
Your comment is welcome.



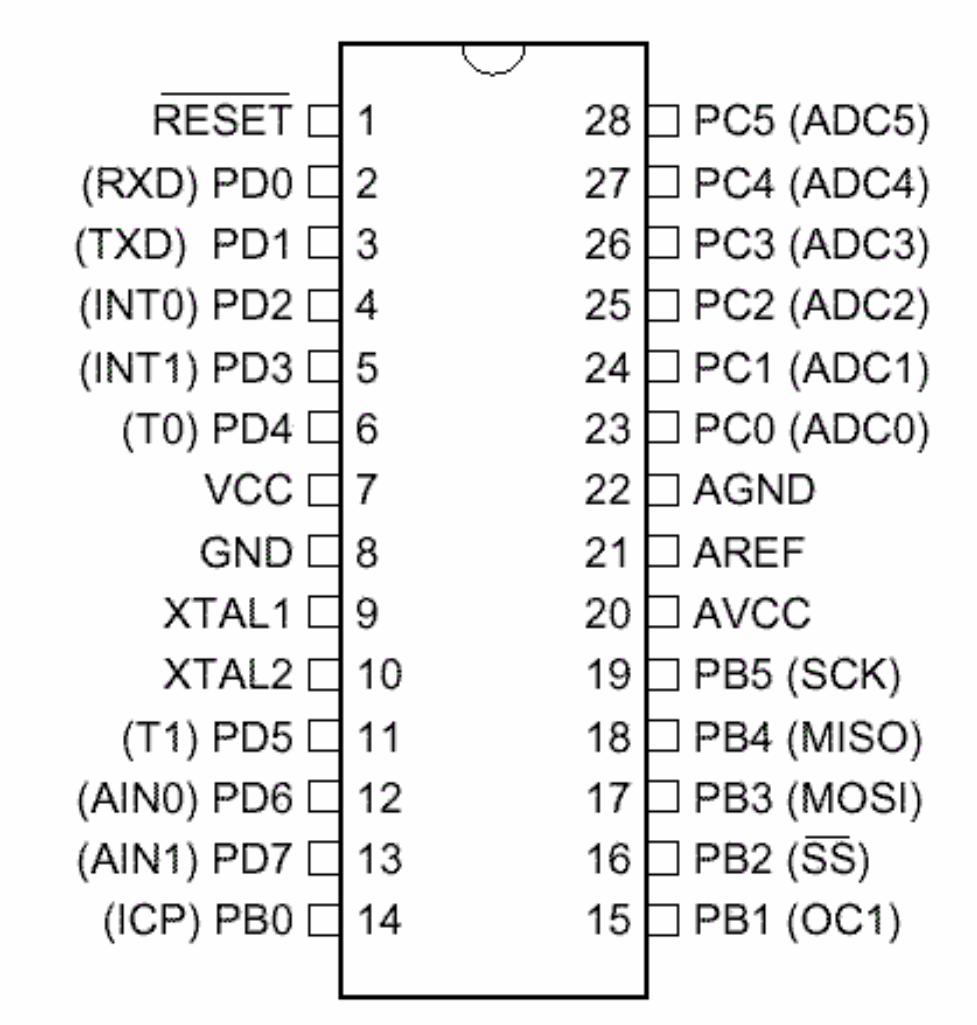

## AT90S2333

This page is intended to show user comments about the chip.
Your comment is welcome.




## AT90S4433

This page is intended to show user comments about the chip.
Your comment is welcome.




## AVR Internal Hardware

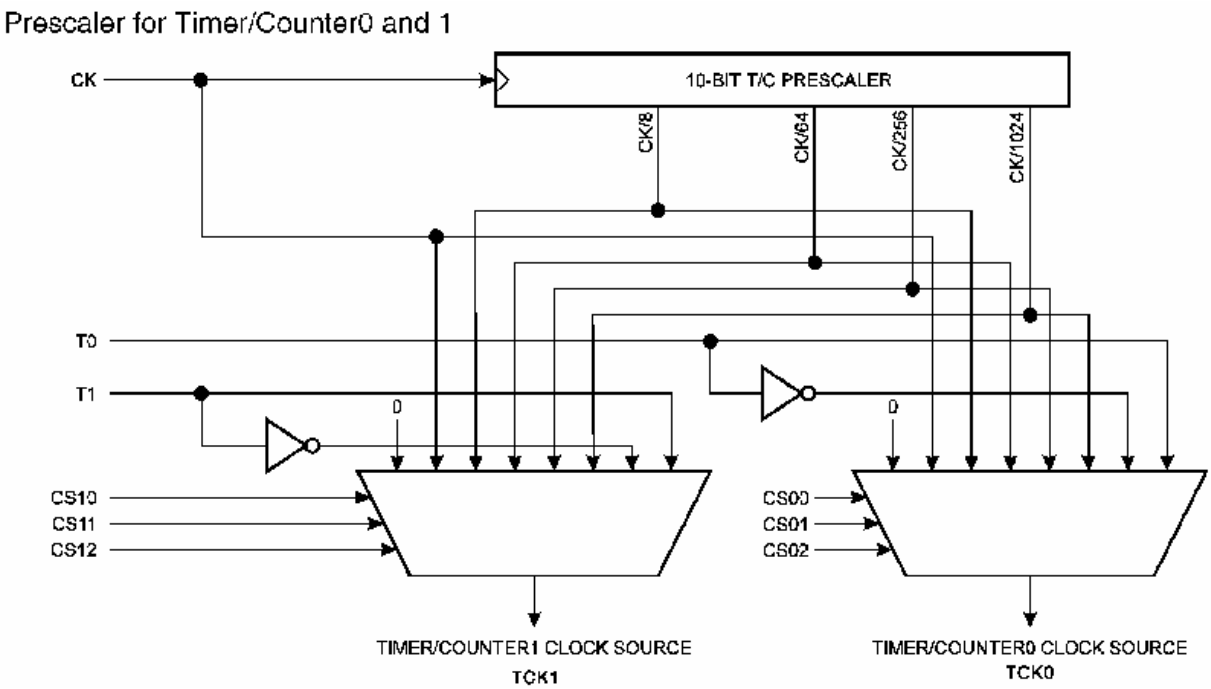
The AVR chips all have internal hardware that can be used.

For the description we have used the 8515 so some described hardware will not be available when you select a 2313 for example.

### Timer / Counters

The AT90S8515 provides two general purpose Timer/Counters - one 8-bit T/C and one 16-bit T/C. The Timer/Counters have individual pre-scaling selection from the same 10-bit pre-scaling timer. Both Timer/Counters can either be

used as a timer with an internal clock time base or as a counter with an external pin connection which triggers the counting.




More about TIMERO

More about TIMER1

## The WATCHDOG Timer.

Almost all AVR chips have the ports B and D. The 40 pin devices also have ports A and C that also can be used for addressing an external RAM chip. Since all ports are identical but the PORT B and PORT D have alternative functions, only these ports are described.

## PORT B

## PORT D

# AVR Internal Registers

You can manipulate the register values directly from BASIC. They are also reserved words. The internal registers for the AVR90S8515 are :

| Addr. | Register | |
|---|---|---|
| $3F | SREG | I T H S V N Z C |
| $3E | SPH | SP15 SP14 SP13 SP12 SP11 SP10 SP9 SP8 |
| $3D | SPL | SP7 SP6 SP5 SP4 SP3 SP2 SP1 SP0 |
| $3C | Reserved | |
| $3B | GIMSK | INT1 INT0 - - - - - - |
| $3A | GIFR | INTF1 INTF0 |
| $39 | TIMSK | TOIE1 OCIE1A OCIE1B - TICIE1 - TOIE0 - |
| $38 | TIFR | TOV1 OCF1A OCF1B -ICF1 -TOV0 - |
| $37 | Reserved | |
| $36 | Reserved | |
| $35 | MCUCR | SRE SRW SE SM ISC11 ISC10 ISC01 ISC00 |
| $34 | Reserved | |
| $33 | TCCR0 | - - - - - CS02 CS01 CS00 |
| $32 | TCNT0 | Timer/Counter0 (8 Bit) |
| $31 | Reserved | |
| $30 | Reserved | |
| $2F | TCCR1A | COM1A1 COM1A0 COM1B1 COM1B0 - -PWM11 PWM10 |
| $2E | TCCR1B | ICNC1 ICES1 - - CTC1 CS12 CS11 CS10 |
| $2D | TCNT1H | Timer/Counter1 - Counter Register High Byte |
| $2C | TCNT1L | Timer/Counter1 - Counter Register Low Byte |
| $2B | OCR1AH | Timer/Counter1 - Output Compare Register A High Byte |
| $2A | OCR1AL | Timer/Counter1 - Output Compare Register A Low Byte |
| $29 | OCR1BH | Timer/Counter1 - Output Compare Register B High Byte |
| $28 | OCR1BL | Timer/Counter1 - Output Compare Register B Low Byte |
| $27 | Reserved | |
| $26 | Reserved | |
| $25 | ICR1H | Timer/Counter1 - Input Capture Register High Byte |
| $24 | ICR1L | Timer/Counter1 - Input Capture Register Low Byte |
| $23 | Reserved | |
| $22 | Reserved | |
| $21 | WDTCR | - - - WDTOE WDE WDP2 WDP1 WDP0 |

| | | |
|---|---|---|
| $20 | Reserved | |
| $1F | Reserved | - - - - - - - EEAR8 |
| $1E | EEARL | EEPROM Address Register Low Byte |
| $1D | EEDR | EEPROM Data Register |
| $1C | EECR | - - - - - EEMWE EEWE EERE |
| $1B | PORTA | PORTA7 PORTA6 PORTA5 PORTA4 PORTA3 PORTA2 PORTA1 PORTA0 |
| $1A | DDRA | DDA7 DDA6 DDA5 DDA4 DDA3 DDA2 DDA1 DDA0 |
| $19 | PINA | PINA7 PINA6 PINA5 PINA4 PINA3 PINA2 PINA1 PINA0 |
| $18 | PORTB | PORTB7 PORTB6 PORTB5 PORTB4 PORTB3 PORTB2 PORTB1 PORTB0 |
| $17 | DDRB | DDB7 DDB6 DDB5 DDB4 DDB3 DDB2 DDB1 DDB0 |
| $16 | PINB | PINB7 PINB6 PINB5 PINB4 PINB3 PINB2 PINB1 PINB0 |
| $15 | PORTC | PORTC7 PORTC6 PORTC5 PORTC4 PORTC3 PORTC2 PORTC1 PORTC0 |
| $14 | DDRC | DDC7 DDC6 DDC5 DDC4 DDC3 DDC2 DDC1 DDC0 |
| $13 | PINC | PINC7 PINC6 PINC5 PINC4 PINC3 PINC2 PINC1 PINC0 |
| $12 | PORTD | PORTD7 PORTD6 PORTD5 PORTD4 PORTD3 PORTD2 PORTD1 PORTD0 |
| $11 | DDRD | DDD7 DDD6 DDD5 DDD4 DDD3 DDD2 DDD1 DDD0 |
| $10 | PIND | PIND7 PIND6 PIND5 PIND4 PIND3 PIND2 PIND1 PIND0 |
| $0F | SPDR | SPI Data Register |
| $0E | SPSR | SPIF WCOL - - - - - - |
| $0D | SPCR | SPIE SPE DORD MSTR CPOL CPHA SPR1 SPR0 |
| $0C | UDR | UART I/O Data Register |
| $0B | USR | RXC TXC UDRE FE OR - - - |
| $0A | UCR | RXCIE TXCIE UDRIE RXEN TXEN CHR9 RXB8 TXB8 |
| $09 | UBRR | UART Baud Rate Register |
| $08 | ACSR | ACD - ACO ACI ACIE ACIC ACIS1 ACIS0 |
| $00 | Reserved | |

The registers and their addresses are defined in the xxx.DAT files which are placed in the BASCOM-AVR application directory.

The registers can be used as normal byte variables.

PORTB = 40 will place a value of 40 into port B.

Note that internal registers are reserved words. This means that they can't be dimensioned as BASCOM variables!

So you can't use the statement **DIM SREG As Byte** because **SREG** is an internal register.

You can however manipulate the register with the SREG = value statement.

## AVR Internal Hardware TIMER0

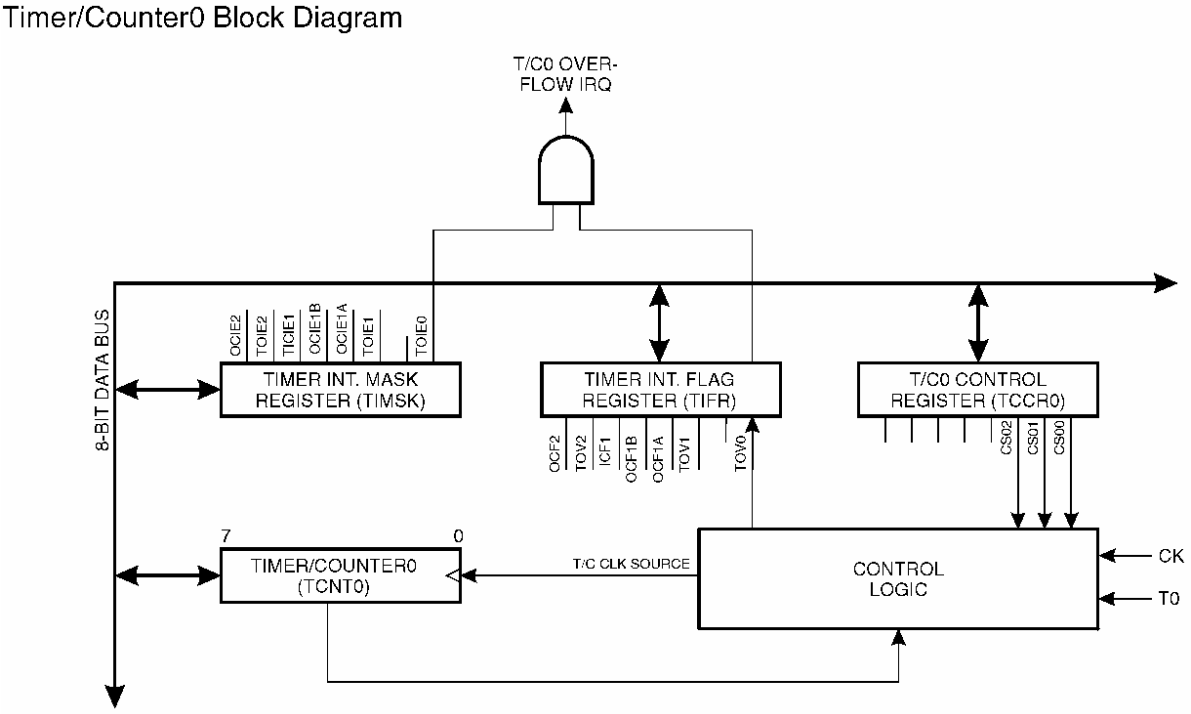
**The 8-Bit Timer/Counter0**

The 8-bit Timer/Counter0 can select its clock source from CK, pre-scaled CK, or an external pin. In addition it can be stopped.

The overflow status flag is found in the Timer/Counter Interrupt Flag Register - TIFR. Control signals are found in the Timer/Counter0 Control Register - TCCR0. The interrupt enable/disable settings for Timer/Counter0 are found in the Timer/Counter Interrupt Mask Register - TIMSK.

When Timer/Counter0 is externally clocked, the external signal is synchronized with the oscillator frequency of the CPU. To assure proper sampling of the external clock, the minimum time between two external clock transitions must be at least one internal CPU clock period. The external clock signal is sampled on the rising edge of the internal CPU clock.

Timer/Counter0 Block Diagram




The 8-bit Timer/Counter0 features both a high resolution and a high accuracy usage with the lower pre-scaling opportunities. Similarly, the high pre-scaling opportunities make the Timer/Counter0 useful for lower speed functions or exact timing functions with infrequent actions.

## AVR Internal Hardware TIMER1

**The 16-Bit Timer/Counter1 (8515 other timers may be different)**

The 16-bit Timer/Counter1 can select clock source from CK, pre-scaled CK, or an external pin. In addition it can be stopped.

The different status flags (overflow, compare match and capture event) and control signals are found in the Timer/Counter1 Control Registers - TCCR1A and TCCR1B.

The interrupt enable/disable settings for Timer/Counter1 are found in the Timer/Counter Interrupt Mask Register - TIMSK.

When Timer/Counter1 is externally clocked, the external signal is

synchronized with the oscillator frequency of the CPU. To assure proper sampling of the external clock, the minimum time between two external clock transitions must be at least one internal CPU clock period.

The external clock signal is sampled on the rising edge of the internal CPU clock.

The 16-bit Timer/Counter1 features both a high resolution and a high accuracy usage with the lower prescaling opportunities.

Similarly, the high prescaling opportunities make the Timer/Counter1 useful for lower speed functions or exact timing functions with infrequent actions.

The Timer/Counter1 supports two Output Compare functions using the Output Compare Register 1 A and B -OCR1A and OCR1B as the data sources to be compared to the Timer/Counter1 contents.

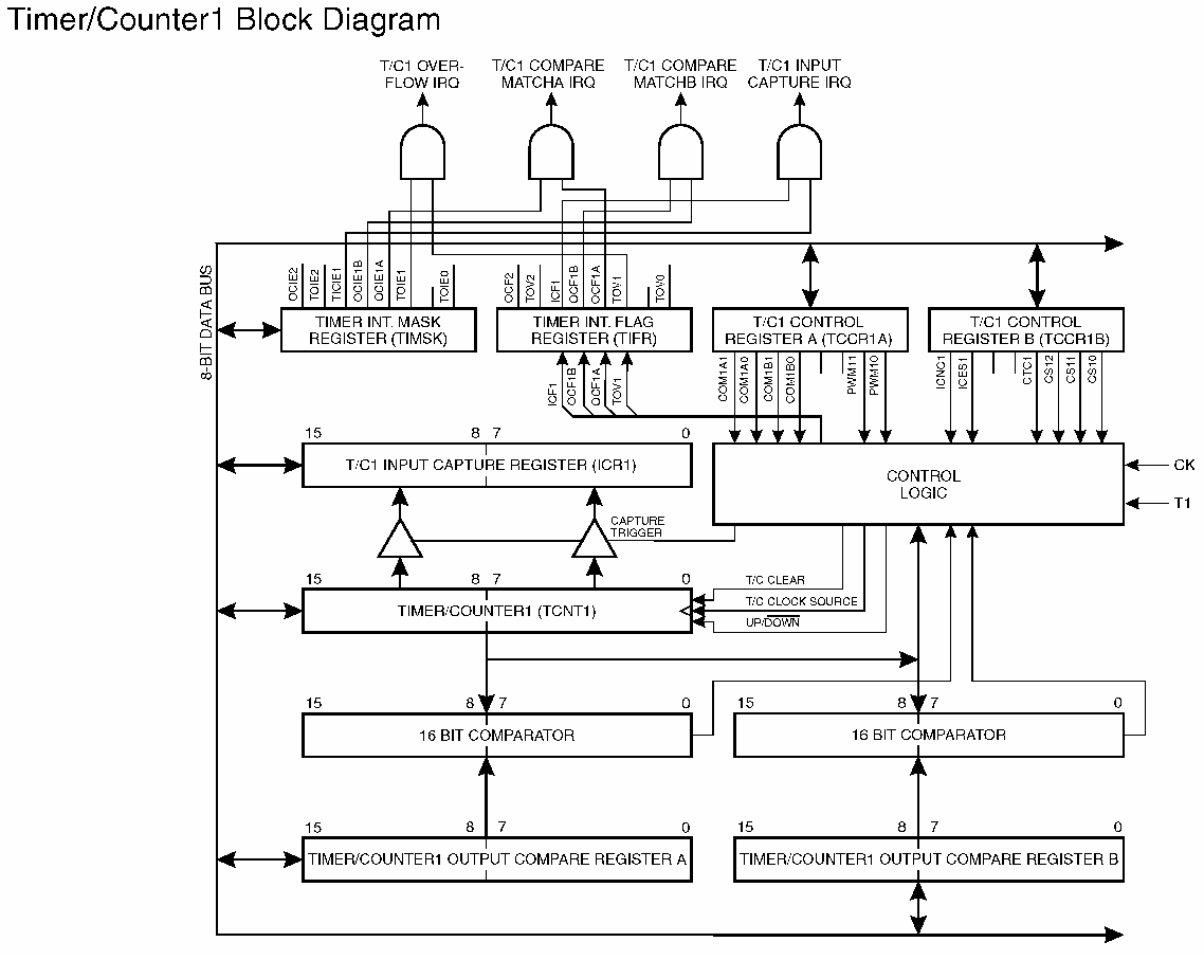
The Output Compare functions include optional clearing of the counter on compareA match, and actions on the Output Compare pins on both compare matches.

Timer/Counter1 can also be used as a 8, 9 or 10-bit Pulse With Modulator. In this mode the counter and the OCR1A/OCR1B registers serve as a dual glitch-free stand-alone PWM with centered pulses.

The Input Capture function of Timer/Counter1 provides a capture of the Timer/Counter1 contents to the Input Capture Register - ICR1, triggered by an external event on the Input Capture Pin - ICP. The actual capture event settings are defined by the Timer/Counter1 Control Register -TCCR1B.

In addition, the Analog Comparator can be set to trigger the Input Capture.

Timer/Counter1 Block Diagram




## AVR Internal Hardware Watchdog timer

**The Watchdog Timer**

The Watchdog Timer is clocked from a separate on-chip oscillator which runs at 1MHz. This is the typical value at VCC = 5V.

By controlling the Watchdog Timer pre-scaler, the Watchdog reset interval can be adjusted from 16K to 2,048K cycles (nominally 16 - 2048 ms). The RESET WATCHDOG - instruction resets the Watchdog Timer.

Eight different clock cycle periods can be selected to determine the reset period.

If the reset period expires without another Watchdog reset, the AT90Sxxxx resets and executes from the reset vector.

# AVR Internal Hardware Port B

## Port B

Port B is an 8-bit bi-directional I/O port. Three data memory address locations are allocated for the Port B, one each for the Data Register - PORTB, $18($38), Data Direction Register - DDRB, $17($37) and the Port B Input Pins - PINB, $16($36). The Port B Input Pins address is read only, while the Data Register and the Data Direction Register are read/write.

All port pins have individually selectable pull-up resistors. The Port B output buffers can sink 20mA and thus drive LED displays directly. When pins PB0 to PB7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated.

The Port B pins with alternate functions are shown in the following table:

When the pins are used for the alternate function the DDRB and PORTB register has to be set according to the alternate function description.

*Port B Pins Alternate Functions*

| Port | Pin | Alternate Functions |
|---|---|---|
| PORTB.0 | T0 | (Timer/Counter 0 external counter input) |
| PORTB.1 | T1 | (Timer/Counter 1 external counter input) |
| PORTB.2 | AIN0 | (Analog comparator positive input) |
| PORTB.3 | AIN1 | (Analog comparator negative input) |
| PORTB.4 | SS | (SPI Slave Select input) |
| PORTB.5 | MOSI | (SPI Bus Master Output/Slave Input) |
| PORTB.6 | MISO | (SPI Bus Master Input/Slave Output) |
| PORTB.7 | SCK | (SPI Bus Serial Clock) |

The Port B Input Pins address - PINB - is not a register, and this address enables access to the physical value on each Port B pin. When reading PORTB, the PORTB Data Latch is read, and when reading PINB, the logical values present on the pins are read.

### PortB As General Digital I/O

All 8 bits in port B are equal when used as digital I/O pins. PORTB.X, General I/O pin: The DDBn bit in the DDRB register selects the direction of this pin, if DDBn is set (one), PBn is configured as an output pin. If DDBn is cleared (zero), PBn is configured as an input pin. If PORTBn is set (one) when the pin configured as an input pin, the MOS pull up resistor is activated.

To switch the pull up resistor off, the PORTBn has to be cleared (zero) or the pin has to be configured as an output pin.

*DDBn Effects on Port B Pins*

| DDBn | PORTBn | I/O | Pull up | Comment |
|---|---|---|---|---|
| 0 | 0 | Input | No | Tri-state (Hi-Z) |
| 0 | 1 | Input | Yes | PBn will source current if ext. pulled low. |
| 1 | 0 | Output | No | Push-Pull Zero Output |
| 1 | 1 | Output | No | Push-Pull One Output |

## AVR Internal Hardware Port D

### Port D

*Port D Pins Alternate Functions*

| Port | Pin | Alternate Function |
|---|---|---|
| PORTD.0 | RDX | (UART Input line ) |
| PORTD.1 | TDX | (UART Output line) |
| PORTD.2 | INT0 | (External interrupt 0 input) |
| PORTD.3 | INT1 | (External interrupt 1 input) |
| PORTD.5 | OC1A | (Timer/Counter1 Output compareA match output) |
| PORTD.6 | WR | (Write strobe to external memory) |
| PORTD.7 | RD | (Read strobe to external memory) |

### RD - PORTD, Bit 7

RD is the external data memory read control strobe.

**WR - PORTD, Bit 6**

WR is the external data memory write control strobe.

**OC1- PORTD, Bit 5**

Output compare match output: The PD5 pin can serve as an external output when the Timer/Counter1 com-pare matches.

The PD5 pin has to be configured as an out-put (DDD5 set (one)) to serve this f unction. See the Timer/Counter1 description for further details, and how to enable the output. The OC1 pin is also the output pin for the PWM mode timer function.

**INT1 - PORTD, Bit 3**

External Interrupt source 1: The PD3 pin can serve as an external interrupt source to the MCU. See the interrupt description for further details, and how to enable the source

**INT0 - PORTD, Bit 2**

INT0, External Interrupt source 0: The PD2 pin can serve as an external interrupt source to the MCU. See the interrupt description for further details, and how to enable the source.

**TXD - PORTD, Bit 1**

Transmit Data (Data output pin for the UART). When the UART transmitter is enabled, this pin is configured as an output regardless of the value of DDRD1.

**RXD - PORTD, Bit 0**

Receive Data (Data input pin for the UART). When the UART receiver is enabled this pin is configured as an output regardless of the value of DDRD0. When the UART forces this pin to be an input, a logical one in PORTD0 will turn on the internal pull-up.

When pins TXD and RXD are not used for RS-232 they can be used as an input or output pin.

No PRINT, INPUT or other RS-232 statement may be used in that case.

The UCR register will by default not set bits 3 and 4 that enable the TXD and RXD pins for RS-232 communication. It is however reported that this not works for all chips. In this case you must clear the bits in the UCR register

with the following statements:

RESET UCR.3

RESET UCR.4

## Adding XRAM

Some AVR chips like the 8515 for example can be extended with external RAM memory.

On these chips Port A serves as a Multiplexed Address/Data input/output. Port C also serves as Address output when using external SRAM.

The maximum size of a XRAM chip can be 64Kbytes.

The STK200 has a 62256 ram chip (32K x 8 bit).

Here is some info from the BASCOM userlist :

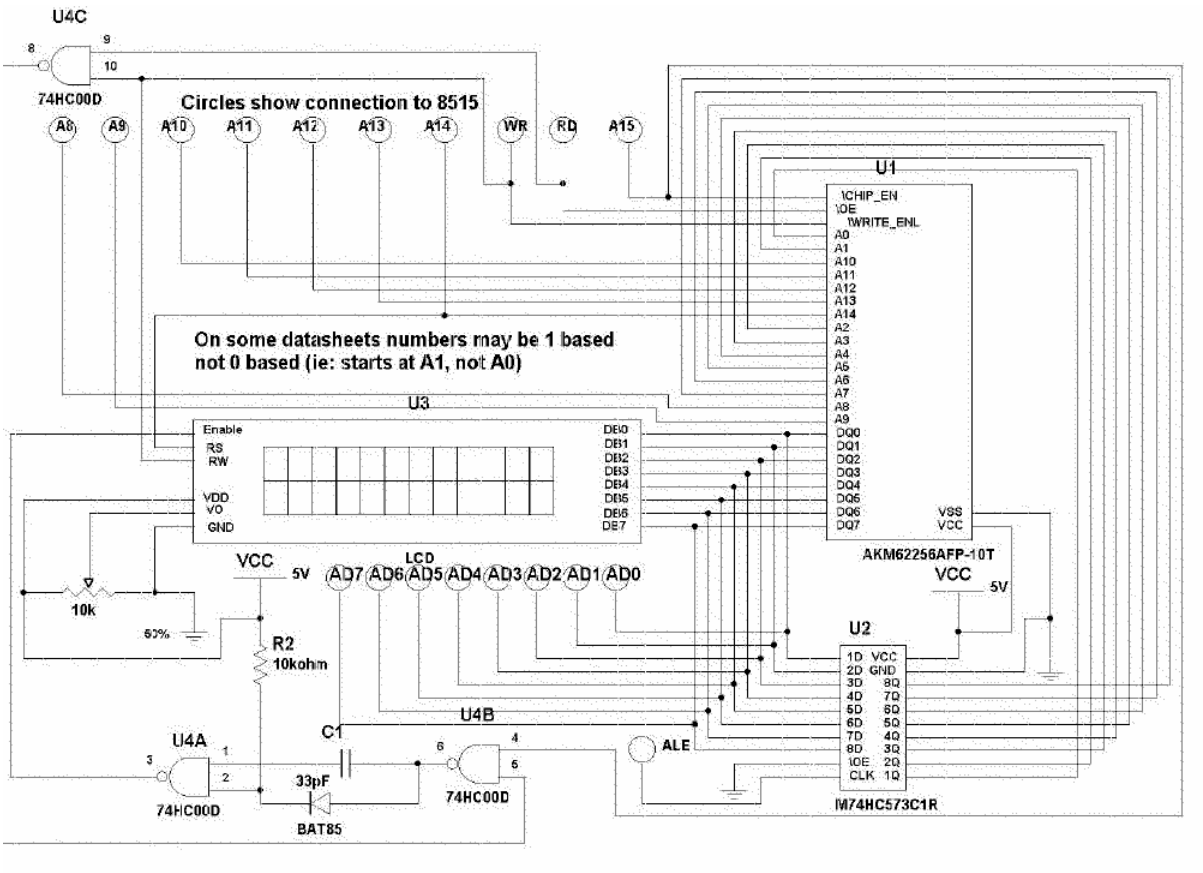
If you do go with the external ram , be careful of the clock speed.
Using a 4Mhz crystal , will require a SRAM with 70nS access time
or better. Also the data latch (74HC573) will have to be from a faster
family such as a 74FHC573 if you go beyond 4Mhz.

You can also program an extra wait state, which slow it down a bit.

Here you find a pdf file showing STK200 schematics:
http://www.avr-forum.com/Stk200_schematic.pdf

If you use 32kRAM, then connect the /CS signal to A15 which give
to the range of &H0000 to &H7FFF, if you use a 64kRAM, then
tie /CS to GND, so the RAM is selected all the time.

Thanks to Colin O'Flynn for creating this circuit :




## Attaching an LCD Display

A LCD display can be connected with two methods.

- By wiring the LCD-pins to the processor port pins.
  This is the pin mode. The advantage is that you can choose the pins and that they don't have to be on the same port. This can make your PCB design simple. The disadvantage is that more code is needed.
- By attaching the LCD-data pins to the data bus. This is convenient when you have an external RAM chip and will adds little code.

The LCD-display can be connected in PIN mode as follows:

| LCD DISPLAY | PORT | PIN |
|---|---|---|
| DB7 | PORTB.7 | 14 |
| DB6 | PORTB.6 | 13 |
| DB5 | PORTB.5 | 12 |
| DB4 | PORTB.4 | 11 |
| E | PORTB.3 | 6 |
| RS | PORTB.2 | 4 |
| RW | Ground | 5 |
| Vss | Ground | 1 |
| Vdd | +5 Volt | 2 |
| Vo | 0-5 Volt | 3 |

This leaves PORTB.1 and PORTB.0 and PORTD for other purposes.

You can change these settings from the Options LCD menu.

BASCOM supports many statements to control the LCD-display.

For those who want to have more control the example below shows how to use the internal routines.

```
$ASM
Ldi _temp1, 5              'load register R24 with value
Rcall _Lcd_control         'it is a control value to control the display
Ldi _temp1,65              'load register with new value (letter A)
Rcall _Write_lcd           'write it to the LCD-display
$END ASM
```

Note that _lcd_control and _write_lcd are assembler subroutines which can be called from BASCOM.

See the manufacturer's details from your LCD display for the correct assignment.

# Using the I2C protocol

The I2C protocol is a 2-wire protocol designed by Philips. Of course you also need power and ground so it really needs 4 wires.

The I2C protocol was invented for making designs of TV PCB's more simple. But with the availability of many I2C chips, it is ideal for the hobbyist too.

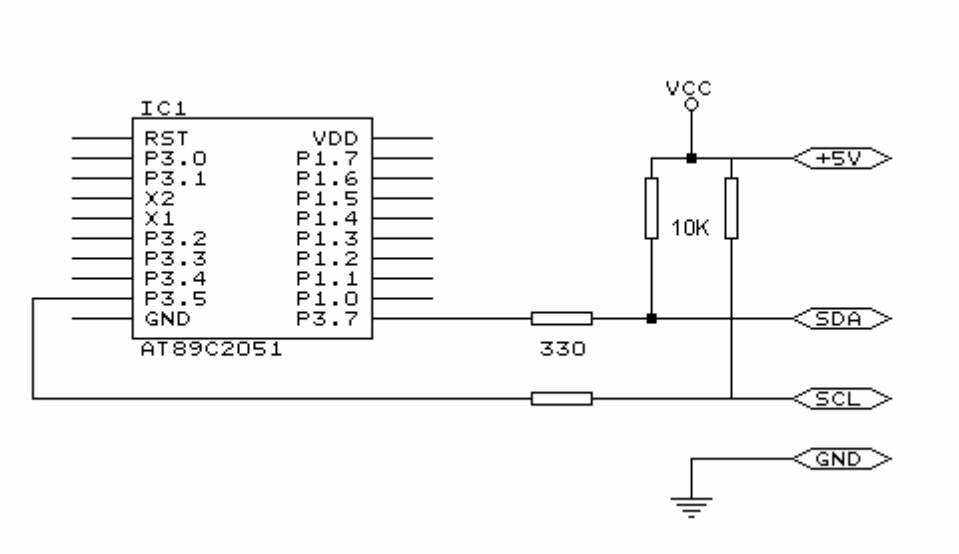
The PCF8574 is a nice chip - it is an I/O extender with 8 pins that you can use either as input or output.

The design below shows how to implement an I2C-bus. The circuit shown is for the 8051 micro the AT89C2051 which is pin compatible with the AT90S2313. It also works for the AVR.

R1 and R2 are 330 ohm resistors.

R3 and R4 are 10 kilo-ohm resistors. For 5V, 4K7 is a good value in combination with AVR chips.

You can select which port pins you want to use for the I2C interface with the compiler settings.




## Using the 1 WIRE protocol

The 1 wire protocol was invented by Dallas Semiconductors and needs only 1 wire for the communication. You also need power and ground of course.

*This topic is written by Göte Haluza. He tested the new 1wire search routines and is building a weather station. Thanks!*

Dallas Semiconductor (DS) 1wire. This is a brief description of DS 1wirebus when used in combination with BASCOM. For more detailed explanations about the 1w-bus, please go to http://www.dalsemi.com. Using BASCOM, makes the world a lot easier. This paper will approach the subject from a "BASCOM-user-point-of-view".

1wire-net is a serial communication protocol, used by DS devices. The bus could be implemented in two basic ways :

**With 2 wires**, then DQ and ground is used on the device. Power is supplied on the DQ line, which is +5V, and used to charge a capacitor in the DS device. This power is used by the device for its internal needs during communication, which makes DQ go low for periods of time. This bus is called the **1wirebus.**

**With 3 wires**, when +5V is supplied to the VDD line of the device, and DQ + ground as above. This bus is called the **2wirebus.**

So, the ground line is "not counted" by DS. But hereafter we use DS naming conventions.

**How it works. (1wire)**

The normal state of the bus is DQ=high. Through DQ the device gets its power, and performs the tasks it is designed for.

When the host (your micro controller (uC)) wants something to happen with the 1w-bus, it issues a reset-command. That is a very simple electric function that happens then; the DQ goes active low for a time (480uS on original DS 1w-bus). This put the DS-devices in reset mode; then (they) send a presence pulse, and then (they) listen to the host.

The presence pulse is simply an active low, this time issued by the device(s).

Now, the host cannot know what is on the bus, it is only aware of that at least 1 DS device is attached on the bus.

All communication on the 1w-bus is initialized by the host, and issued by time-slots of active-low on a normally high line (DQ), issued by the device, which is sending at the moment. The devices(s) internal capacitor supplies its power needs during the low-time.

**How you work with 1w-bus**

Thereafter, you can read a device, and write to it. If you know you only have 1 sensor attached, or if you want to address all sensors, you can start with a "Skip Rom" - command. This means; take no notice about the Ids of the sensors - skip that part of the communication.

When you made a 1w-reset, all devices of the bus are listening. If you chose to address only one of them, the rest of them will not listen again before you have made a new 1w-reset on the bus.

I do not describe BASCOM commands in this text - they are pretty much self-explaining. But the uC has to write the commands to the bus - and thereafter read the answer. What you have to write as a command depends on devices you are using - and what you want to do with it. Every DS chip has a datasheet, which you can find at http://www.dalsemi.com/datasheets/pdfindex.html. There you can find out all about the actual devices command structure.

**There are some things to have in mind when deciding which of the bus-types to use.**

The commands, from BASCOM, are the same in both cases. So this is not a problem.

The +5V power-supply on the VDD when using a 2wire-bus has to be from separate power supply, according to DS. But it still works with taking the power from the same source as for the processor, directly on the stabilizing transistor. I have not got it to work taking power directly from the processor pin.

Some devices consume some more power during special operations. The DS1820 consumes a lot of power during the operation "Convert Temperature". Because the sensors knows how they are powered (it is also possible to get this information from the devices) some operations, as "Convert T" takes different amount of time for the sensor to execute. The command "Convert T" as example, takes ~200mS on 2wire, but ~700mS on 1wire. This has to be considered during programming.

**And that power also has to be supplied somehow.**

If you use 2wire, you don't have to read further in this part. You can do simultaneously "Convert T" on all the devices you attach on the bus. And save time. This command is the most power-consuming command, possible to execute on several devices, I am aware of.

If you use 1wire, there are things to think about. It is about not consuming more power than you feed. And how to feed power? That depends on the devices (their consumption) and what you are doing with them (their consumption in a specific operation).

**Short, not-so-accurate description of power needs,** not reflecting on cable lengths

Only the processor pin as power supplier, will work < 5 sensors. (AVR, 1w-functions use an internal pull-up. 8051 not yet tested). Don't even think of simultaneously commands on multiple sensors.

With +5V through a 4K7 resistor, to the DQ-line, 70 sensors are tested. But, take care, cause issuing "Convert T" simultaneously, would cause that to give false readings. About ~15 sensors is the maximum amount of usable devices, which simultaneously performs some action. This approach DS refers to as "pull-up resistor".
With this in mind, bus up to 70 devices has been successfully powered this way.

The resistor mentioned, 4K7, could be of smaller value. DS says minimum 1K5, I have tested down to 500 ohm - below that the bus is not usable any

more. (AVR). Lowering the resistor feeds more power - and makes the bus more noise -resistant. But, the resistor minimum value is naturally also depending on the uC-pin electric capabilities. Stay at 4K7 - which is standard recommendation.

DS recommends yet another approach, called "strong pull-up" which (short) works via a MOS-FET transistor, feeding the DQ lines with enough power, still on 1wire, during power-consuming tasks. This is not tested, but should naturally work. Cause this functionality is really a limited one; BASCOM has no special support for that. But anyway, we tell you about it, just in case you wonder. Strong pull-up has to use one uC pin extra - to drive the MOS-FET.

**Cable lengths (this section is only for <u>some</u> limitation understanding)**

For short runs up to 30 meters, cable selection for use on the 1W bus is less critical. Even flat modular phone cable works with limited numbers of 1-Wire devices. However, the longer the 1W bus, the more pronounced cable effects become, and therefore the greater importance placed on cable selection.

For longer distances, DS recommends twisted-pair-cable (CAT5).

DS standard examples show 100 meters cable lengths, so they say, that's no problem. They also show examples with 300m cabling, and I think I have seen something with 600-meter bus (but I cant find it again).

**Noise and CRC**

The longer cable and the noisier environment, the more false readings will be made. The devices are equipped with a CRC-generator - the LSByte of the sending is always a checksum. Look in program examples to learn how to re-calculate this checksum in your uC. AND, if you notice that there are false readings - do something about your cables. (Shield, lower resistor)

**Transfer speed**

On the original 1w-bus, DS says the transfer speed is about 14Kbits /second. And, if that was not enough, some devices has an overdrive option. That multiplies the speed by 10. This is issued by making the communication-time-slots smaller (from 60 uS to 6uS ) which naturally will make the devices more sensitive, and CRC-error will probably occur more often. But, if that is not an issue, ~140Kbit is a reachable speed to the devices. So, whatever you thought before, it is FAST.

The BASCOM scanning of the bus is finds about 50 devices / second , and reading a specific sensors value to a uC should be about 13 devices / second.

### Topology

Of the 1w-net - that is an issue we will not cover so much. Star-net, bus-net? It seems like you can mix that. It is a bus-net, but not so sensitive about that.

### The benefit of the 1w-bus

Each device is individual - and you can communicate with it over the media of 2 wires. Still, you can address one individual device, if you like. Get its value. There are 64 ^ 2 unique identifications-numbers.
Naturally, if lot of cables are unwanted, this is a big benefit. And you only occupy 1 processor pin.

DS supplies with different types of devices, which all are made for interfacing an uC - directly. No extra hardware. There are sensors, so you can get knowledge about the real world, and there are also potentiometers and relays, so you can do something about it. On the very same bus.

And the Ibutton approach from DS (ever heard of it?) is based on 1wire technology. Maybe something to pick up.

BASCOM let you use an uC with 1wire-devices so easy, that (since now) that also has to count as a benefit - maybe one of the largest. ;-)

### The disadvantages of the 1w-bus

So far as I know, DS is the only manufacturer of sensors for the bus. Some people think their devices are expensive. And, until now, it was really difficult to communicate with the devices. Particularly when using the benefit of several devices on one bus. Still some people say that the 1w-bus is slow - but I don't think so.

Göte Haluza
System engineer

## Using the SPI protocol

The Serial Peripheral Interface (SPI) allows high-speed synchronous data transfer between the micro processor and peripheral devices or between several micro processors devices.

The interconnection between master and slave CPUs with SPI is shown in

Figure 2. The PB5(SCK) pin is the clock output in the master mode and is the clock input in the slave mode. Writing to the SPI data register of the master CPU starts the SPI clock generator, and the data written shifts out of the PB3(MOSI) pin and into the PB3(MOSI) pin of the slave CPU. After shifting one byte, the SPI clock generator

stops, setting the end of transmission flag (SPIF). If the SPI interrupt enable bit (SPIE) in the SPCR register is set, an interrupt is requested. The Slave Select input,

PB2(SS), is set low to select an individual SPI device as a slave. The two shift registers in the Master and the Slave can be considered as one distributed 16-bit circular shift register. This is shown in Figure 2. When data is shifted from the master to the slave, data is also shifted in the opposite direction, simultaneously. This means that during one shift cycle, data in the master and the slave are inter-changed.

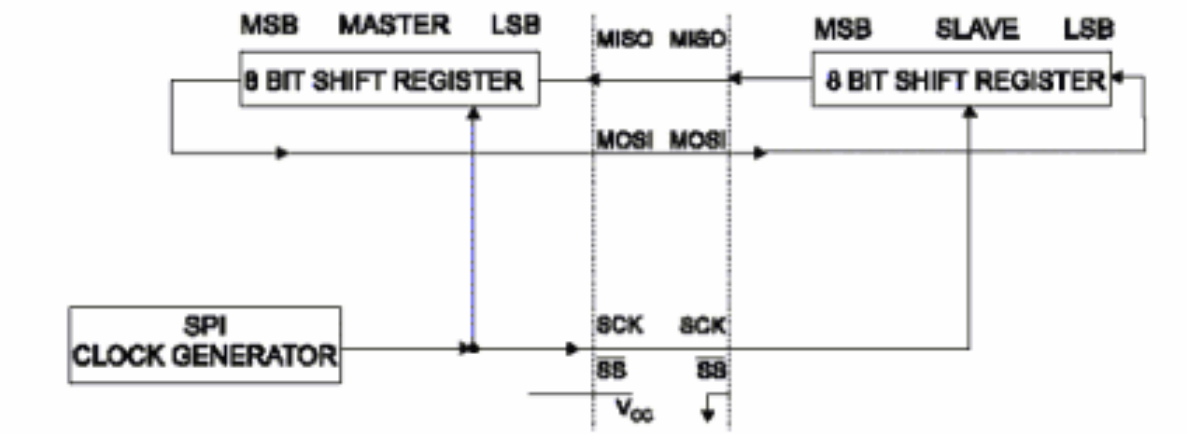



Figure 2

The system is single buffered in the transmit direction and double buffered in the receive direction. This means that characters to be transmitted cannot be written to the SPI Data Register before the entire shift cycle is completed.

When receiving data, however, a received character must be read from the SPI Data Register before the next character has been completely shifted in. Otherwise, the first character is lost.

When the SPI is enabled, the data direction of the MOSI, MISO, SCK and SS pins is overridden according to the fol-lowing table:

| Pin Direction Overrides | Master SPI Mode Direction Overrides | Slave SPI Modes |
|---|---|---|
| MOSI | User Defined | Input |

| | | |
|---|---|---|
| MISO | Input | User Defined |
| SCK | User Defined | Input |
| SS | User Defined | Input |

**SS Pin Functionality**

When the SPI is configured as a master (MSTR in SPCR is set), the user can determine the direction of the SS pin. If SS is configured as an output, the pin is a general output pin which does not affect the SPI system. If SS is configured

as an input, it must be hold high to ensure Master SPI operation. If, in master mode, the SS pin is input, and is driven low by peripheral circuitry, the SPI system interprets

this as another master selecting the SPI as a slave and starting to send data to it. To avoid bus contention, the SPI system takes the following actions:

1. The MSTR bit in SPCR is cleared and the SPI system becomes a slave. As a result of the SPI becoming a slave, the MOSI and SCK pins become inputs.

2. The SPIF flag in SPSR is set, and if the SPI interrupt is enabled, the interrupt routine will be executed.

Thus, when interrupt-driven SPI transmittal is used in master mode, and there exists a possibility that SS is driven low, the interrupt should always check that the MSTR bit is

still set. Once the MSTR bit has been cleared by a slave select, the user must set it.

When the SPI is configured as a slave, the SS pin is always input. When SS is held low, the SPI is activated and MISO becomes an output if configured so by the user. All other pins are inputs. When SS is driven high, externally all pins are inputs, and the SPI is passive, which means that it will not receive incoming data.

**Data Modes**

There are four combinations of SCK phase and polarity with respect to serial data, which are determined by control bits CPHA and CPOL. The SPI data transfer formats are shown in Figure 3 and Figure 4.

Figure 3

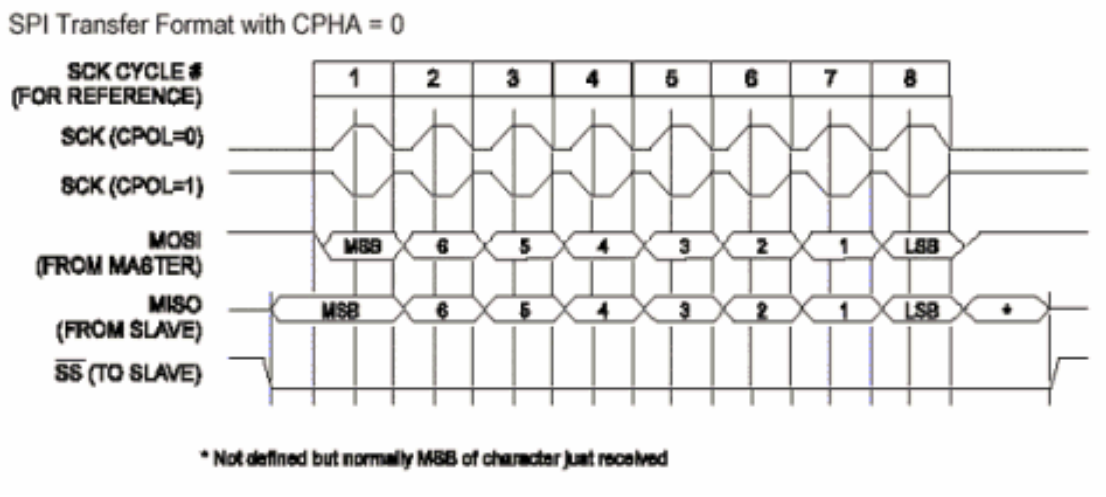
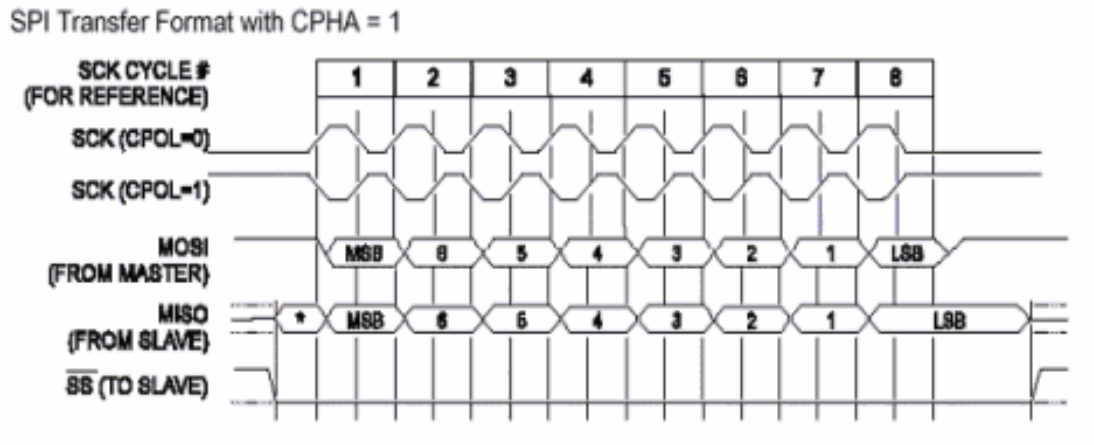



Figure 4




When you set the SPI option from the Options, Compiler, SPI menu SPCR will be set to 01010100 which means ; enable SPI, master mode, CPOL = 1

When you want to control the various options with the hardware SPI you can use the CONFIG SPI statement.

## Power Up

At power up all ports are in Tri-state and can serve as input pins.

When you want to use the ports (pins) as output, you must set the data direction first with the statement : CONFIG PORTB = OUTPUT

Individual bits can also be set to be uses as input or output.

For example : DDRB = **&B**00001111 , will set a value of 15 to the data direction register of PORTB.

PORTB.0 to PORTB.3 (the lower 5 bits) can be used as outputs because they are set low. The upper four bits (PORTB.4 to PORTB.7), can be used for input because they are set low.

You can also set the direction of a port pin with the statement :

CONFIG PINB.0 = OUTPUT | INPUT

The internal RAM is cleared at power up or when a reset occurs. Use $NORAMCLEAR to disable this future.

## Language Fundamentals

Characters from the BASCOM character set are put together to form labels, keywords, variables and operators.

These in turn are combined to form the statements that make up a program.

This chapter describes the character set and the format of BASCOM program lines. In particular, it discusses:

- The specific characters in the character set and the special meanings of some characters.
- The format of a line in a BASCOM program.
- Line labels.
- Program line length.

### Character Set

The BASCOM BASIC character set consists of alphabetic characters, numeric characters, and special characters.

The alphabetic characters in BASCOM are the uppercase letters (A-Z) and lowercase letters (az) of the alphabet.

The BASCOM numeric characters are the digits 0-9.

The letters A-H can be used as parts of hexadecimal numbers.

The following characters have special meanings in BASCOM statements and expressions:

| Character | Name |
|---|---|
| ENTER | Terminates input of a line |
| | Blank ( or space) |
| ' | Single quotation mark (apostrophe) |
| * | Asterisks (multiplication symbol) |
| + | Plus sign |
| , | Comma |
| - | Minus sign |
| . | Period (decimal point) |
| / | Slash (division symbol) will be handled as \ |
| : | Colon |
| " | Double quotation mark |
| ; | Semicolon |
| < | Less than |
| = | Equal sign (assignment symbol or relational operator) |
| > | Greater than |
| \ | Backslash (integer/word division symbol) |
| ^ | Exponent |

## The BASCOM program line

BASCOM program lines have the following syntax:

[[*line-identifier*]] [[*statement*]] [[:*statement*]] ... [[*comment*]]

## Using Line Identifiers

BASCOM support one type of line-identifier; alphanumeric line labels:

An alphabetic line label may be any combination of from 1 to 32 letters and digits, starting with a letter and ending with a colon.

BASCOM keywords are not permitted.

The following are valid alphanumeric line labels:

Alpha:

ScreenSUB:

Test3A:

Case is not significant. The following line labels are equivalent:

alpha:

Alpha:

ALPHA:

Line labels may begin in any column, as long as they are the first characters other than blanks on the line.

Blanks are not allowed between an alphabetic label and the colon following it.

A line can have only one label.

## BASCOM Statements

A BASCOM statement is either "executable" or " non-executable".

An executable statement advances the flow of a programs logic by telling the program what to do next.

Non executable statement perform tasks such as allocating storage for variables, declaring and defining variable types.

The following BASCOM statements are examples of non-executable statements:

- REM or  (starts a comment)
- DIM

A "comment"  is a non-executable statement used to clarify a programs operation and purpose.

A comment is introduced by the REM statement or a single quote character(').

The following lines are equivalent:

```
PRINT " Quantity remaining"  : REM Print report label.
PRINT " Quantity remaining"   ' Print report label.
```

More than one BASCOM statement can be placed on a line, but colons(:) must separate statements, as illustrated below.

```
FOR I = 1 TO 5 : PRINT " Gday, mate."  : NEXT I
```

## BASCOM LineLength

If you enter your programs using the built-in editor, you are not limited to any line length, although it is advised to shorten your lines to 80 characters for clarity.

## Data Types

Every variable in BASCOM has a data type that determines what can be stored in the variable. The next section summarizes the elementary data types.

## Elementary Data Types

- Bit  (1/8 byte). A bit can hold only the value 0 or 1.

  A group of 8 bits is called a byte.
- Byte (1 byte).
  Bytes are stores as unsigned 8-bit binary numbers ranging in value from 0 to 255.

- Integer (two bytes).
  Integers are stored as signed sixteen-bit binary numbers ranging in value from -32,768 to +32,767.
- Word (two bytes).
  Words are stored as unsigned sixteen-bit binary numbers ranging in value from 0 to 65535.
- Long (four bytes).
  Longs are stored as signed 32-bit binary numbers ranging in value from -2147483648 to 2147483647.
- Single.
  Singles are stored as signed 32 bit binary numbers.
- String (up to 254 bytes).
  Strings are stored as bytes and are terminated with a 0-byte.
  A string dimensioned with a length of 10 bytes will occupy 11 bytes.

Variables can be stored internal (default) , external or in EEPROM.

## Variables

A variable is a name that refers to an object--a particular number.

A numeric variable, can be assigned only a numeric value (either integer, byte, long, single or bit).

The following list shows some examples of variable assignments:

- A constant value:
  A = 5
  C = 1.1

- The value of another numeric variable:
  abc = def
  k = g

- The value obtained by combining other variables, constants, and operators: Temp = a + 5
  Temp = C + 5

- The value obtained by calling a function:

```
Temp = Asc(S)
```

## Variable Names

A BASCOM variable name may contain up to 32 characters.

The characters allowed in a variable name are letters and numbers.

The first character in a variable name must be a letter.

A variable name cannot be a reserved word, but embedded reserved words are allowed.

For example, the following statement is illegal because AND is a reserved word.

```
AND = 8
```

However, the following statement is legal:

```
ToAND = 8
```

Reserved words include all BASCOM commands, statements, function names, internal registers and operator names.

(see BASCOM Reserved Words , for a complete list of reserved words).

You can specify a hexadecimal or binary number with the prefix &H or &B.

a = **&H**A , a = **&B**1010 and a = 10 are all the same.

Before assigning a variable, you must tell the compiler about it with the DIM statement.

```
Dim b1 As Bit, I as Integer, k as Byte , s As String * 10
```

The STRING type needs an additional parameter to specify the length.

You can also use DEFINT, DEFBIT, DEFBYTE ,DEFWORD ,DEFLNG or DEFSNG.

*For example* DEFINT c tells the compiler that all variables that are not dimensioned and that are beginning with the character c are of the Integer type.

## Expressions and Operators

This chapter discusses how to combine, modify, compare, or get information about expressions by using the operators available in BASCOM.

Anytime you do a calculation you are using expressions and operators.

This chapter describes how expressions are formed and concludes by describing the following kind of operators:

- Arithmetic operators, used to perform calculations.
- Relational operators, used to compare numeric or string values.
- Logical operators, used to test conditions or manipulate individual bits.
- Functional operators, used to supplement simple operators.

## Expressions and Operators

An expression can be a numeric constant, a variable, or a single value

obtained by combining constants, variables, and other expressions with operators.

Operators perform mathematical or logical operations on values.

The operators provided by BASCOM can be divided into four categories, as follows:

1. Arithmetic
2. Relational
3. Logical

4. Functional

## Arithmetic

Arithmetic operators are +, - , * , \, / and ^.

- Integer

Integer division is denoted by the backslash (\).
Example: Z = X \ Y

- Modulo Arithmetic

Modulo arithmetic is denoted by the modulus operator **MOD**.

Modulo arithmetic provides the remainder, rather than the quotient, of an integer division.

Example: X = 10 \ 4 : remainder = 10 MOD 4

- Overflow and division by zero

  Division by zero, produces an error.

  At the moment no message is produced, so you have to make sure yourself that this won't happen.

## Relational Operators

Relational operators are used to compare two values as shown in the table below.

The result can be used to make a decision regarding program flow.

| Operator | Relation Tested | Expression |
|---|---|---|
| = | Equality | X = Y |
| <> | Inequality | X <> Y |
| < | Less than | X < Y |
| > | Greater than | X > Y |
| <= | Less than or equal to | X <= Y |
| >= | Greater than or equal to | X >= Y |

## Logical Operators

Logical operators perform tests on relations, bit manipulations, or Boolean operators.

There four operators in BASCOM are :

| Operator | Meaning |
|---|---|
| NOT | Logical complement |
| AND | Conjunction |
| OR | Disjunction |
| XOR | Exclusive or |

It is possible to use logical operators to test bytes for a particular bit pattern.

For example the AND operator can be used to mask all but one of the bits

of a status byte, while OR can be used to merge two bytes to create a particular binary value.

*Example*

```
A = 63 And 19
PRINT A
A = 10 Or 9
PRINT A
```

*Output*

*19*

*11*

## Floating point (ASM code used is supplied by Jack Tidwell)

Single numbers conforming to the IEEE binary floating point standard.

An eight bit exponent and 24 bit mantissa are supported.

Using four bytes the format is shown below:

31 30_____23 22_____0
s exponent mantissa

The exponent is biased by 128. Above 128 are positive exponents and below are negative. The sign bit is 0 for positive numbers and 1 for negative. The mantissa is stored in hidden bit normalized format so that 24 bits of precision can be obtained.

All mathematical operations are supported by the single.
You can also convert a single to an integer or word or vise versa:

```
Dim I as Integer, S as Single
S = 100.1      'assign the single
I = S          'will convert the single to an integer
```

Here is a fragment from the Microsoft knowledge base about FP:

Floating-point mathematics is a complex topic that confuses many programmers. The tutorial below should help you recognize programming situations where floating-point errors are likely to occur and how to avoid them. It should also allow you to recognize cases that are caused by inherent floating-point math limitations as opposed to
actual compiler bugs.

**Decimal and Binary Number Systems**

Normally, we count things in base 10. The base is completely arbitrary. The only reason that people have traditionally used base 10 is that they have 10 fingers, which have made handy counting tools.

The number 532.25 in decimal (base 10) means the following:

(5 * 10^2) + (3 * 10^1) + (2 * 10^0) + (2 * 10^-1) + (5 * 10^-2)

```
   500   +    30    +     2    +    2/10   +   5/100

 _________
=  532.25
```

In the binary number system (base 2), each column represents a power of 2 instead of 10. For example, the number 101.01 means the following:

```
(1 * 2^2) + (0 * 2^1) + (1 * 2^0) + (0 * 2^-1) + (1 * 2^-2)
   4    +     0   +    1    +     0    +   1/4

 _________
=  5.25  Decimal
```

How Integers Are Represented in PCs

---

Because there is no fractional part to an integer, its machine representation is much simpler than it is for floating-point values. Normal integers on personal computers (PCs) are 2 bytes (16 bits) long with the most significant bit indicating the sign. Long integers are 4 bytes long. Positive values are straightforward binary numbers. For example:

```
 1 Decimal = 1 Binary

 2 Decimal = 10 Binary
22 Decimal = 10110 Binary, etc.
```

However, negative integers are represented using the two's complement scheme. To get the two's complement representation for a negative number, take the binary representation for the number's absolute value and then flip all the bits and add 1. For example:

```
4 Decimal = 0000 0000 0000 0100
            1111 1111 1111 1011     Flip the Bits
```

-4 = 1111 1111 1111 1100 Add 1

Note that adding any combination of two's complement numbers together using ordinary binary arithmetic produces the correct result.

**Floating-Point Complications**

Every decimal integer can be exactly represented by a binary integer; however, this is not true for fractional numbers. In fact, every number that is irrational in base 10 will also be irrational in any system with a base smaller than 10.

For binary, in particular, only fractional numbers that can be represented in the form p/q, where q is an integer power of 2, can be expressed exactly, with a finite number of bits.

Even common decimal fractions, such as decimal 0.0001, cannot be represented exactly in binary. (0.0001 is a repeating binary fraction with a period of 104 bits!)

This explains why a simple example, such as the following

```
SUM = 0
FOR I% = 1 TO 10000
  SUM = SUM + 0.0001
NEXT I%
PRINT SUM                ' Theoretically = 1.0.
```

will PRINT 1.000054 as output. The small error in representing 0.0001 in binary propagates to the sum.

For the same reason, you should always be very cautious when making comparisons on real numbers. The following example illustrates a common programming error:

```
item1# = 69.82#
item2# = 69.20# + 0.62#
IF item1# = item2# then print "Equality!"
```

This will NOT PRINT "Equality!" because 69.82 cannot be represented exactly in binary, which causes the value that results from the assignment to be SLIGHTLY different (in binary) than the value that is generated from the expression. In practice, you should always code such comparisons in such a way as to allow for some tolerance.

General Floating-Point Concepts

It is very important to realize that any binary floating-point system can represent only a finite number of floating-point values in exact form. All other values must be approximated by the closest representable value. The IEEE standard specifies the method for rounding values to the "closest" representable value. BASCOM supports the standard and rounds according to the IEEE rules.

Also, keep in mind that the numbers that can be represented in IEEE are spread out over a very wide range. You can imagine them on a number line. There is a high density of representable numbers near 1.0 and -1.0 but fewer and fewer as you go towards 0 or infinity.

The goal of the IEEE standard, which is designed for engineering calculations, is to maximize accuracy (to get as close as possible to the actual number). Precision refers to the number of digits that you can represent. The IEEE standard attempts to balance the number of bits dedicated to the exponent with the number of bits used for the fractional part of the number, to keep both accuracy and precision within acceptable limits.

IEEE Details

Floating-point numbers are represented in the following form, where

[exponent] is the binary exponent:

X = Fraction * 2^(exponent - bias)

[Fraction] is the normalized fractional part of the number, normalized because the exponent is adjusted so that the leading bit is always a 1. This way, it does not have to be stored, and you get one more bit of precision. This is why there is an implied bit. You can think of this like scientific notation, where you manipulate the exponent to have one digit to the left of the decimal point, except in binary, you can always manipulate the exponent so that the first bit is a 1, since there are only 1s and 0s.

[bias] is the bias value used to avoid having to store negative exponents.

The bias for single-precision numbers is 127 and 1023 (decimal) for double-precision numbers.

The values equal to all 0's and all 1's (binary) are reserved for representing special cases. There are other special cases as well, that indicate various error conditions.

Single-Precision Examples

2 = 1 * 2^1 = 0100 0000 0000 0000 ... 0000 0000 = 4000 0000 hex
Note the sign bit is zero, and the stored exponent is 128, or

100 0000 0 in binary, which is 127 plus 1. The stored mantissa is (1.) 000 0000 ... 0000 0000, which has an implied leading 1 and binary point, so the actual mantissa is 1.

-2 = -1 * 2^1 = 1100 0000 0000 0000 ... 0000 0000 = C000 0000 hex
Same as +2 except that the sign bit is set. This is true for all IEEE format floating-point numbers.

4 = 1 * 2^2 = 0100 0000 1000 0000 ... 0000 0000 = 4080 0000 hex
Same mantissa, exponent increases by one (biased value is 129, or 100 0000 1 in binary.

6 = 1.5 * 2^2 = 0100 0000 1100 0000 ... 0000 0000 = 40C0 0000 hex

Same exponent, mantissa is larger by half -- it's
(1.) 100 0000 ... 0000 0000, which, since this is a binary
fraction, is 1-1/2 (the values of the fractional digits are 1/2,
1/4, 1/8, etc.).

1 = 1 * 2^0 = 0011 1111 1000 0000 ... 0000 0000 = 3F80 0000 hex
Same exponent as other powers of 2, mantissa is one less than
2 at 127, or 011 1111 1 in binary.

.75 = 1.5 * 2^-1 = 0011 1111 0100 0000 ... 0000 0000 = 3F40 0000 hex
The biased exponent is 126, 011 1111 0 in binary, and the mantissa

is (1.) 100 0000 ... 0000 0000, which is 1-1/2.

2.5 = 1.25 * 2^1 = 0100 0000 0010 0000 ... 0000 0000 = 4020 0000 hex
Exactly the same as 2 except that the bit which represents 1/4 is
set in the mantissa.

0.1 = 1.6 * 2^-4 = 0011 1101 1100 1100 ... 1100 1101 = 3DCC CCCD hex

1/10 is a repeating fraction in binary. The mantissa is just shy of 1.6, and the biased exponent says that 1.6 is to be divided by 16 (it is 011 1101 1 in binary, which is 123 n decimal). The true exponent is 123 - 127 = -4, which means that the factor by which to multiply is 2**-4 = 1/16. Note that the stored mantissa is rounded up in the last bit. This is an attempt to represent the unrepresentable number as accurately as possible. (The reason that 1/10 and 1/100 are not exactly representable in binary is similar to the way that 1/3 is not exactly representable in decimal.)

0 = 1.0 * 2^-128 = all zeros -- a special case.

Other Common Floating-Point Errors

The following are common floating-point errors:

1. Round-off error

This error results when all of the bits in a binary number cannot be used in a calculation.

Example: Adding 0.0001 to 0.9900 (Single Precision)

Decimal 0.0001 will be represented as:

(1.)10100011011011100010111 * 2^(-14+Bias) (13 Leading 0s in Binary!)

0.9900 will be represented as:

(1.)11111010111000010100011 * 2^(-1+Bias)

Now to actually add these numbers, the decimal (binary) points must be aligned. For this they must be Unnormalized. Here is the resulting addition:

```
 .00000000000011010001101 * 2^0  <- Only 11 of 23 Bits retained
+.11111010111000010100011 * 2^0
_____________________________________
 .11111010111011100110000 * 2^0
```

This is called a round-off error because some computers round when shifting for addition. Others simply truncate. Round-off errors are important to consider whenever you are adding or multiplying two very different values.

2. Subtracting two almost equal values

```
 .1235
-.1234
_____
```

.0001

This will be normalized. Note that although the original numbers each had four significant digits, the result has only one significant digit.

3. Overflow and underflow

This occurs when the result is too large or too small to be represented by the data type.

4. Quantizing error

This occurs with those numbers that cannot be represented in exact form by the floating-point standard.

## Arrays

An array is a set of sequentially indexed elements having the same type. Each element of an array has a unique index number that identifies it. Changes made to an element of an array do not affect the other elements.

The index must be a numeric constant, a byte, an integer , word or long.

The maximum number of elements is 65535.

The first element of an array is always one. This means that elements are 1-based.

Arrays can be used on each place where a 'normal' variable is expected.

Example:

```
'create an array named a, with 10 elements (1 to 10)
Dim A(10) As Byte
'create an integer
Dim C As Integer
'now fill the array
For C = 1 To 10
 'assign array element
  A(c) = C
 ' print it
  Print A(c)
```

```
Next
'you can add an offset to the index too
C = 0
A(c + 1) = 100
Print A(c + 1)
End
```

## Strings

A string is used to store text. A string must be dimensioned with the length specified.

DIM S as STRING * 5

Will create a string that can store a text with a maximum length of 5 bytes.

The space used is 6 bytes because a string is terminated with a null byte.

To assign the string:

s = "abcd"

To insert special characters into the string :

s= "AB{027}cd"

The {ascii} will insert the ASCII value into the string.

The  number of digits must be 3. s = "{27} will assign "{27}" to the string instead of escape character 27!

## Casting

In BASCOM-AVR when you perform operations on variables they all must be of the same data type.

long = long1 * long2 ' for example

The assigned variables data type determines what kind of math is performed.

For example when you assign a long, long math will be used.

If you try to store the result of a LONG into a byte, only the LSB of the LONG will be stored into the BYTE.

Byte = LONG

When LONG = 256 , it will not fit into a BYTE. The result will be 256 AND 255 = 0.

Of course you are free to use different data types. The correct result is only guaranteed when you are using data types of the same kind or that that result always can fit into the target data type.

When you use strings, the same rules apply. But there is one exception:

```
Dim b as Byte
b = 123 ' ok this is normal
b = "A" ' b = 65
```

When the target is a byte and the source variable is a string constant denoted by "", the ASCII value will be stored in the byte. This works also for tests :

```
IF b = "A" then  ' when b = 65
END IF
```

This is different compared to QB/VB where you can not assign a string to a byte variable.

**SINGLE CONVERSION**

When you want to convert a SINGLE into a byte, word, integer or long the compiler will automatic convert the values when the source string is of the SINGLE data type.

```
integer = single
```

You can also convert a byte, word, integer or long into a SINGLE by assigning this variable to a SINGLE.

```
single = long
```

## Reserved Words

The following table shows the reserved BASCOM statements or characters.

^

!

;

$BAUD

$CRYSTAL

$DATA

$DEFAULT

$END

$EEPROM

$EXTERNAL

$INCLUDE
$LCD
$LCDRS
$LCDPUTCTRL
$LCDPUTDATA
$LIB
$REGFILE
$SERIALINPUT
$SERIALINPUT2LCD
$SERIALOUTPUT
$WAITSTATE
$XRAMSIZE
$XRAMSTART

1WRESET
1WREAD
1WWRITE

ACK
ABS()
ALIAS
AND
AS
ASC()
AT

BAUD
BCD()
BIT
BITWAIT
BLINK
BOOLEAN
BYTE
BYVAL

CALL
CAPTURE1

CASE
CHR()
CLS
CLOSE
COMPARE1A
COMPARE1B
CONFIG
CONST
COUNTER
COUNTER0
COUNTER1
COUNTER2
CPEEK()
CPEEKH()
CRYSTAL
CURSOR

DATA
DATE$
DEBOUNCE
DECR
DECLARE
DEFBIT
DEFBYTE
DEFLNG
DEFWORD
DEGSNG
DEFLCDCHAR
DEFINT
DEFWORD
DELAY
DIM
DISABLE
DISPLAY
DO
DOWNTO

ELSE
ELSEIF
ENABLE
END
ERAM
ERASE
ERR
EXIT
EXTERNAL

FOR
FOURTH
FOURTHLINE
FUNCTION

GATE
GETAD()
GETRC5()
GOSUB
GOTO

HEXVAL()
HIGH()
HOME

I2CRECEIVE
I2CSEND
I2CSTART
I2CSTOP
I2CRBYTE
I2CWBYTE
IDLE
IF
INCR
INKEY
INP()
INPUT

INPUTBIN
INPUTHEX
INT0
INT1
INTEGER
INTERNAL
INSTR
IS

LCASE()
LCD
LEFT
LEFT()
LEN()
LOAD
LOCAL
LOCATE
LONG
LOOKUP()
LOOKUPSTR()
LOOP
LTRIM()
LOW()
LOWER
LOWERLINE

MAKEBCD()
MAKEDEC()
MAKEINT()
MID()
MOD
MODE

NACK
NEXT
NOBLINK
NOSAVE

NOT

OFF
ON
OR
OUT
OUTPUT

PEEK()
POKE
PORTA
PORTB
PORTC
PORTD
PORTE
PORTF
POWERDOWN
PRINT
PRINTBIN
PULSEOUT
PWM1A
PWM1B

READ
READEEPROM
REM
RESET
RESTORE
RETURN
RIGHT
RIGHT()
ROTATE
RTRIM()

SELECT
SERIAL
SET

SHIFT
SHIFTLCD
SHIFTCURSOR
SHIFTIN
SHIFTOUT
SOUND
SPACE()
SPIINIT
SPIIN
SPIMOVE
SPIOUT
START
STEP
STR()
STRING()
STOP
STOP TIMER
SUB
SWAP

THEN
TIME$
THIRD
THIRDLINE
TIMER0
TIMER1
TIMER2
TO
TRIM()

UCASE()
UNTIL
UPPER
UPPERLINE

VAL()
VARPTR()

WAIT
WAITKEY()
WAITMS
WAITUS
WATCHDOG
WRITEEEPROM
WEND
WHILE
WORD

XOR
XRAM

## #IF ELSE ENDIF

### Action

Conditional compilation directives intended for conditional compilation.

### Syntax

**#IF** condition
**#ELSE**
**#ENDIF**

### Remarks

Conditional compilation is supported by the compiler.
What is conditional compilation?
Conditional compilation will only compile parts of your code that meet the criteria of the condition.

By default all your code is compiled.
Conditional compilation needs a constant to test.
So before a condition can be set up you need to define a constant.

CONST test = 1

```
#IF TEST
Print "This will be compiled"
#ELSE
Print "And this not"
#ENDIF
```

Note that there is no THEN and that #ENDIF is not #END IF (no space)

You can nest the conditions and the use of #ELSE is optional.

There are a few internal constants that you can use. These are generated by the compiler:

```
_CHIP =  0
_RAMSIZE =  128
_ERAMSIZE =  128
_SIM = 0
_XTAL =  4000000
_BUILD = 11162
```

_CHIP is an integer that specifies the chip, in this case the 2313
_RAMSIZE is the size of the SRAM
_ERAMSIZE is the size of the EEPROM
_SIM is set to 1 when the $SIM directive is used
_XTAL contains the value of the specified crystal
_BUILD is the build number of the compiler.

The build number can be used to write support for statements that are not available in a certain version :

```
#IF _BUILD >= 11162
   s =  Log(1.1)
#ELSE
  Print "Sorry, implemented in 1.11.6.2"
#ENDIF
```

# $ASM

## Action

Start of inline assembly code block.

## Syntax

$ASM

## Remarks

Use $ASM together with $END ASM to insert a block of assembler code in your BASIC code. You can also precede each line with the **!** sign.

Most ASM mnemonics can be used without the preceding **!** too.

See also the chapter Mixing BASIC and Assembly and assembler mnemonics

## Example

```
Dim C As Byte

Loadadr C , X  'load address of variable C into register X


$asm
  Ldi R24,1 'load register R24 with the constant 1
  St X,R24   ;store 1 into variable c
$end Asm
Print C
End
```

# $BAUD

## Action

Instruct the compiler to override the baud rate setting from the options menu.

## Syntax

**$BAUD =** var

## Remarks

Var The baud rate that you want to use.

**var : Constant.**

The baud rate is selectable from the Compiler Settings. It is stored in a configuration file. The $BAUD statement is provided for compatibility with BASCOM-8051.

In the generated report, you can view which baud rate is actually generated.

When you simulate a program you will not notice any problems when the baud rate is not set to the value you expected. In real hardware a wrong baud rate can give weird results on the terminal emulator screen. For best results use a XTAL that is a multiple of the baud rate.

## See also

$CRYSTAL , BAUD

## Example

```
$baud = 2400
$crystal = 14000000                                    ' 14 MHz crystal
Print "Hello"
'Now change the baud rate in a program
Baud = 9600                                            '
Print "Did you change the terminal emulator baud rate too?"
End
```

# $BGF

## Action

Includes a BASCOM Graphic File.

## Syntax

**$BGF "file"**

## Remarks

| | |
|---|---|
| file | The file name of the BGF file to include. |

Use SHOWPIC to display the BGF file.

## See also

SHOWPIC , PSET , CONFIG GRAPHLCD

## Example

```
Dim X as Byte, Y as Byte
For X = 0 To 10
  For Y = 0 To 10
    Pset X , Y , 1                  'make a nice block
  Next
Next

  End
```

# $CRYSTAL

## Action

Instruct the compiler to override the crystal frequency options setting.

## Syntax

**$CRYSTAL =** var

## Remarks

var Frequency of the crystal.

**var : Constant.**

The frequency is selectable from the Compiler Settings. It is stored in a configuration file. The $CRYSTAL statement is provided for compatibility with BASCOM-8051.

## See also

$BAUD , BAUD

## Example

```
$baud = 2400
$crystal = 4000000
Print "Hello"
End
```

# $DATA

## Action

Instruct the compiler to store the data in the DATA lines following the $DATA directive, in code memory.

## Syntax

**$DATA**

## Remarks

The AVR has built-in EEPROM. With the WRITEEEPROM and READEEPROM statements, you can write and read to the EEPROM.

To store information in the EEPROM, you can add DATA lines to your program that hold the data that must be stored in the EEPROM.

A separate file is generated with the EEP extension. This file can be used to program the EEPROM.

The compiler must know which DATA must go into the code memory or the EEP file and therefore two compiler directives were added.

$EEPROM and $DATA.

$EEPROM tells the compiler that the DATA lines following the compiler directive, must be stored in the EEP file.

To switch back to the default behavior of the DATA lines, you must use the $DATA directive.

The READ statement that is used to read the DATA info may only be used with normal DATA lines. It does not work with DATA stored in EEPROM.

## See also

$EEPROM , READEEPROM , WRITEEEPROM

## ASM

NONE

## Example

```
'-----------------------------------------------------------
'                      READDATA.BAS
'             Copyright 1999-2000 MCS Electronics
'-----------------------------------------------------------

Dim A As Integer , B1 As Byte , Count As Byte
Dim S As String * 15
Dim L As Long
Restore Dta1                                          'point to stored data
For Count = 1 To 3                                    'for number of data items
   Read B1 : Print Count ; "  " ; B1
Next

Restore Dta2                                          'point to stored data
For Count = 1 To 2                                    'for number of data items
```

```
   Read A : Print Count ; "  " ; A
Next

Restore Dta3
Read S : Print S
Read S : Print S


Restore Dta4
Read L : Print L                                                    'long type

End


Dta1:
Data &B10 , &HFF , 10
Dta2:
Data 1000% , -1%

Dta3:
Data "Hello" , "World"
'Note that integer values (>255 or <0) must end with the %-sign
'also note that the data type must match the variable type that is
'used for the READ statement

Dta4:
Data 123456789&
'Note that LONG values must end with the &-sign
'Also note that the data type must match the variable type that is used
'for the READ statement
```

# $DEFAULT

## Action

Set the default for data types dimensioning to the specified type.

## Syntax

**$DEFAULT =** var

## Remarks

| | |
|---|---|
| Var | SRAM, XRAM, ERAM |

Each variable that is dimensioned will be stored into SRAM, the internal memory of the chip. You can override it by specifying the data type.

Dim B As XRAM Byte , will store the data into external memory.

When you want all your variables to be stored in XRAM for example, you can use the statement : $DEFAULT XRAM

Each Dim statement will place the variable in XRAM in that case.

To switch back to the default behavior, use $END $DEFAULT

## See also

NONE

## ASM

NONE

## Example

```
$default Xram
Dim A As Byte , B As Byte , C As Byte
'a,b and c will be stored into XRAM

$default Sram
Dim D As Byte
'D will be stored in internal memory, SRAM
```

# $EEPROM

## Action

Instruct the compiler to store the data in the DATA lines following the $DATA directive in an EEP file.

## Syntax

**$EEPROM**

## Remarks

The AVR has build in EEPROM. With the WRITEEEPROM and READEEPROM statements, you can write and read to the EEPROM.

To store information in the EEPROM, you can add DATA lines to your program that hold the data that must be stored in the EEPROM.

A separate file is generated with the EEP extension. This file can be used to program the EEPROM. The build in STK200/300 programmer supports the EEP file.

The compiler must know which DATA must go into the code memory or the EEP file and therefore two compiler directives were added.

$EEPROM and $DATA.

$EEPROM tells the compiler that the DATA lines following the compiler directive, must be stored in the EEP file.

To switch back to the default behavior of the DATA lines, you must use the $DATA directive.

It is important to know that the RESTORE and READ statements do NOT work with DATA lines that are stored in the EPROM.

RESTORE and READ only work with normal DATA lines.

The $EEPROM directive is only added to allow you to create a memory image of the EPROM.

To store and retrieve data from EPROM you should use an ERAM variable :

```
Dim Store As Eram Byte , B As Byte
B = 10                                                  'assign value to b
Store = B                                               'value is stored in EPROM
!
B = Store                                               'get the value back
```

## See also

$DATA , WRITEEEPROM , READEEPROM

## ASM

NONE

## Example

```
Dim B As Byte
Restore Lbl                                             'point to code data
Read B
Print B
Restore Lbl2
Read B
Print B
End
```

```
Lbl:
DATA 100

$eeprom                                                    'the following DATA lines
data will go to the EEP     'file
Data 200

$data                                                      'switch back to normal
Lbl2:
Data 300
```

# $EXTERNAL

## Action

Instruct the compiler to include ASM routines from a library.

## Syntax

**$EXTERNAL** Myroutine [, myroutine2]

## Remarks

You can place ASM routines in a library file. With the $EXTERNAL directive you tell the compiler which routines must be included in your program.

An automatic search will be added later so the $EXTERNAL directive will not be needed any longer.

## See also

$LIB

## Example

```
'-----------------------------------------------------------------------
'                          LIBDEMO.BAS
'                    (c) 2000 MCS Electronics
'In order to let this work you must put the mylib.lib file in the LIB dir
'And compile it to a LBX
'-----------------------------------------------------------------------
'define the used library
$lib "mylib.lbx"
'you can also use the original ASM :
'$LIB "mylib.LIB"

'also define the used routines
$external Test

'this is needed so the parameters will be placed correct on the stack
Declare Sub Test(byval X As Byte , Y As Byte)
```

```
'reserve some space
Dim Z As Byte


'call our own sub routine
Call Test(1 , Z)

'z will be 2 in the used example
End
```

# $INCLUDE

## Action

Includes an ASCII file in the program at the current position.

## Syntax

**$INCLUDE** "file "

## Remarks

File — Name of the ASCII file, which must contain valid BASCOM statements. This option can be used if you make use of the same routines in Many programs. You can write modules and include them into your program.
If there are changes to make you only have to change the module file, not all your BASCOM programs.
You can only include ASCII files!

## Example

```
'-----------------------------------------------------------
'                   (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: INCLUDE.BAS
'  demo: $INCLUDE
'-----------------------------------------------------------
Print "INCLUDE.BAS"
'Note that the file 123.bas contains an error
$include "123.bas"                          'include file that prints Hello
Print "Back in INCLUDE.BAS"
End
```

To get the program working rename the file a_rename.bas into a.bas

The file a.bas is located in the samples dir.

# $LCD

## Action

Instruct the compiler to generate code for 8-bit LCD displays attached to the data bus.

## Syntax

**$LCD =** [&H]*address*

## Remarks

Address

The address where must be written to, to enable the LCD display and the RS line of the LCD display.
The db0-db7 lines of the LCD must be connected to the data lines D0-D7. (or is 4 bit mode, connect only D4-D7)
The RS line of the LCD can be configured with the LCDRS statement.

On systems with external RAM, it makes more sense to attach the LCD to the data bus. With an address decoder, you can select the LCD display.

## See also

$LCDRS

## Example

```
REM We use a STK200 board so use the following addresses
$LCD = &HC000     'writing to this address will make the E-line of
                  the LCD 'high and the RS-line of the LCD high.
$LCDRS = &H8000   'writing to this address will make the E-line of
                  the LCD 'high.


Cls
LCD "Hello world"
```

# $LCDPUTCTRL

## Action

Specifies that LCD control output must be redirected.

## Syntax

**$LCDPUTCTRL =** label

## Remarks

Label — The name of the assembler routine that must be called when a control byte is printed with the LCD statement. The character must be placed in R24.

With the redirection of the LCD statement, you can use your own routines.

## See also

$LCDPUTDATA

## Example

```
'define chip to use
$regfile = "8535def.dat"

'define used crystal
$crystal = 4000000

'dimension used variables
Dim S As String * 10
Dim W As Long

'inform the compiler which routine must be called to get serial 'characters
$lcdputdata = Myoutput
$lcdputctrl = Myoutputctrl
'make a never ending loop
Do
  LCD "test"
Loop

End

'custom character handling  routine
'instead of saving and restoring only the used registers
'and write full ASM code, we use Pushall and PopAll to save and 'restore
'all registers so we can use all BASIC statements
'$LCDPUTDATA requires that the character is passed in R24

Myoutput:
  Pushall     'save all registers
```

```
'your code here
  Popall     'restore registers
Return

MyoutputCtrl:
  Pushall     'save all registers
'your code here
  Popall     'restore registers
Return
```

# $LCDPUTDATA

## Action

Specifies that LCD data output must be redirected.

## Syntax

**$LCDPUTDATA =** label

## Remarks

Label The name of the assembler routine that must be called when a character is printed with the LCD statement. The character must be placed in R24.

With the redirection of the LCD statement, you can use your own routines.

## See also

$LCDPUTCTRL

## Example

```
'define chip to use
$regfile = "8535def.dat"

'define used crystal
$crystal = 4000000

'dimension used variables
Dim S As String * 10
Dim W As Long

'inform the compiler which routine must be called to get serial 'characters
$lcdputdata = Myoutput
$lcdputctrl = Myoutputctrl
```

```
'make a never ending loop
Do
  LCD "test"
Loop

End

'custom character handling  routine
'instead of saving and restoring only the used registers
'and write full ASM code, we use Pushall and PopAll to save and 'restore
'all registers so we can use all BASIC statements
'$LCDPUTDATA requires that the character is passed in R24

Myoutput:
  Pushall     'save all registers
'your code here
  Popall     'restore registers
Return

MyoutputCtrl:
  Pushall     'save all registers
'your code here
  Popall     'restore registers
Return
```

# $LCDRS

## Action

Instruct the compiler to generate code for 8-bit LCD displays attached to the data bus.

## Syntax

**$LCDRS =** [&H]*address*

## Remarks

Address

The address where must be written to, to enable the LCD display. The db0-db7 lines of the LCD must be connected to the data lines D0-D7. (or is 4 bit mode, connect only D4-D7)

On systems with external RAM, it makes more sense to attach the LCD to the data bus. With an address decoder, you can select the LCD display.

## See also

$LCD

## Example

```
REM We use a STK200 board so use the following addresses
$LCD = &HC000     'writing to this address will make the E-line of
                  the LCD 'high and the RS-line of the LCD high.
$LCDRS = &H8000   'writing to this address will make the E-line of
                  the LCD 'high.


Cls
LCD "Hello world"
```

# $LIB

## Action

Informs the compiler about the used libraries.

## Syntax

**$LIB "**libname1**" [, "**libname2**"]**

## Remarks

Libname1 is the name of the library that holds ASM routines that are used by your program. More filenames can be specified by separating the names by a comma.

The libraries will be searched when you specify the routines to use with the $EXTERNAL directive.

The search order is the same as the order you specify the library names.

The MCS.LBX will be searched last and is always included so you don't need to specify it with the $LIB directive.

Because the MCS.LBX is searched last you can include duplicate routines in your own library. Now these routines will be used instead of the ones from the default MCS.LBX library. This is a good way when you want to enhance the MCS.LBX routines. Just copy the MCS.LIB to a new file and make the changes in this new file. When we make changes to the library your changes will be preserved.

### Creating your own LIB file

A library file is a simple ASCII file. It can be created with the BASCOM editor, notepad or any other ASCII editor.

The file must include the following header information. It is not used yet but will be later.

**copyright** = Your name

**www** = optional location where people can find the latest source

**email** = your email address

**comment** = AVR compiler library

**libversion** = the version of the library in the format : 1.00

**date** = date of last modification

**statement** = A statement with copyright and usage information

The routine must start with the name in brackets and must end with the **[END]**.

The following ASM routine example is from the MYLIB.LIB library.

```
[test]
Test:
  ldd r26,y+2 ; load address of X
  ldd r27,y+3
  ld r24,x    ; get value into r24
  Inc r24     ; value + 1
  St x,r24    ; put back
  ldd r26,y+0 ; address pf Y
  ldd r27,y+1
  st x,r24    ; store
  ret         ; ready
[end]
```

After you have saved your library in the LIB subdirectory you must compile it with the LIB Manager. Or you can include it with the LIB extension in which

case you don't have to compile it.

## See also

$EXTERNAL

## Example

```
'-----------------------------------------------------------------------
'                          LIBDEMO.BAS
'                     (c) 2000 MCS Electronics
'In order to let this work you must put the mylib.lib file in the LIB dir
'And compile it to a LBX
'-----------------------------------------------------------------------
'define the used library
$lib "mylib.lib" 'the original asm will be used not the compiled object code

'also define the used routines
$external Test

'this is needed so the parameters will be placed correct on the stack
Declare Sub Test(byval X As Byte , Y As Byte)


'reserve some space
Dim Z As Byte


'call our own sub routine
Call Test(1 , Z)

'z will be 2 in the used example
End
```

# $MAP

## Action

Will generate label info in the report.

## Syntax

**$MAP**

## Remarks

The $MAP directive will put an entry for each line number with the address into the report file. This info can be used for debugging purposes with other tools.

## See also

NONE

## ASM

NONE

## Example

```
$MAP
```

# $NOINIT

## Action

Instruct the compiler to generate code without initialization code.

## Syntax

**$NOINIT**

## Remarks

$NOINIT could be used together with $ROMSTART to generate boot loader code.

## See also

$ROMSTART

## ASM

For a simple project the following code will be generated for a 2313:

```
RJMP _BASICSTART
RETI
```

```
RETI
RETI
RETI
RETI
RETI
RETI
RETI
RETI
RETI
_BASICSTART:
; disable the watchdog timer
ldi  _temp1,$1F
out    WDTCR,_temp1
ldi  _temp1,$17
out  WDTCR,_temp1
;Init stackpointer
Ldi R24,$DF                          ; hardware stack pointer
Out SPL,R24
ldi YL,$C8                          ; softstack pointer
ldi ZL,$98
Mov _SPL,ZL                          ; point to start of frame data
Clr YH
Mov _SPH,YH
Ldi ZL,$7E                          ;number of bytes
Ldi ZH,$00
Ldi XL,$60                          ; start of RAM
Ldi XH,$00
Clr R24
_ClearRAM:
St X+,R24                           ; clear
Sbiw ZL,1
Brne _ClearRAM
Clr R6                             ; clear internal used flags
;##### Dim X As Byte
;##### X = 1
Ldi _temp1,$01
Sts $0060,R24                        ; write value to memory
```

As you can see this program just assigns 1 to a byte named X.

First the interrupt vectors are setup then the watchdog timer is cleared , the stacks are set up, the memory is cleared and an internal register R6 is cleared.

After that the program begins and you can see that 1 is written to variable X.

Now with $NOINIT the code would look like this :

```
_BASICSTART:
; disable the watchdog timer
ldi  _temp1,$1F
out    WDTCR,_temp1
ldi  _temp1,$17
out  WDTCR,_temp1
;Init stackpointer
Ldi R24,$DF                          ; hardware stack pointer
Out SPL,R24
ldi YL,$C8                          ; softstack pointer
ldi ZL,$98
Mov _SPL,ZL                          ; point to start of frame data
Clr YH
Mov _SPH,YH
Ldi ZL,$7E                          ;number of bytes
Ldi ZH,$00
Ldi XL,$60                          ; start of RAM
Ldi XH,$00
Clr R24
_ClearRAM:
St X+,R24                           ; clear
Sbiw ZL,1
Brne _ClearRAM
Clr R6                             ; clear internal used flags
;##### Dim X As Byte
;##### X = 1
Ldi _temp1,$01
Sts $0060,R24                        ; write value to memory
```

As you can see the difference is that the interrupt vectors are not setup.

The intention for the $NOINIT directive is to create support for a boot loader. As the boot loader needs are not studied yet, the $NOINIT will most likely be changed in the near future.

## $NORAMCLEAR

### Action

Instruct the compiler to not generate initial RAM clear code.

### Syntax

**$NORAMCLEAR**

### Remarks

Normally the SRAM is cleared in the initialization code. When you don't want the SRAM to be cleared(set to 0) you can use this directive.

Because all variables are automatically set to 0 or ""(strings) without the $NORAMCLEAR, using $NORAMCLEAR will set the variables to an unknown value. That is, the variables will probably set to FF but you cannot count on it.

### See also

$NOINIT

## $REGFILE

### Action

Instruct the compiler to use the specified register file instead of the selected dat file.

## Syntax

**$REGFILE = "name"**

## Remarks

Name — The name of the register file. The register files are stored in the BASCOM-AVR application directory and they all end with the DAT extension.
The register file holds information about the chip such as the internal registers and interrupt addresses.

The $REGFILE statement overrides the setting from the Options menu.

The settings are stored in a <project>.CFG file and the directive is added for compatibility with BASCOM-8051

The $REGFILE directive must be the first statement in your program. It may not be put into an included file since only the main source file is checked for the $REGFILE directive.

## See also

NONE

## ASM

NONE

## Example

```
$REGFILE = "8515DEF.DAT"
```

# $ROMSTART

## Action

Instruct the compiler to generate a hex file that starts at the specified address.

## Syntax

**$ROMSTART =** address

## Remarks

Address — The address where the code must start. By default the first address is 0.

The bin file will still begin at address 0..

The $ROMFILE could be used to locate code at a different address for example for a boot loader.

## See also

NONE

## ASM

NONE

## Example

```
$ROMSTART = &H4000
```

# $SERIALINPUT

## Action

Specifies that serial input must be redirected.

## Syntax

**$SERIALINPUT =** label

## Remarks

Label The name of the assembler routine that must be called when a character is needed from the INPUT routine. The character must be returned in R24.

With the redirection of the INPUT command, you can use your own input routines.

This way you can use other devices as input devices.
Note that the INPUT statement is terminated when a RETURN code (13) is received.

By default when you use INPUT or INKEY(), the compiler will expect data from the COM port. When you want to use a keyboard or remote control as the input device you can write a custom routine that puts the data into register R24 once it asks for this data.

## See also

$SERIALOUTPUT

## Example

```
'-----------------------------------------------------
'                   $serialinput.bas
'                (c) 1999 MCS Electronics
'  demonstrates $SERIALINPUT redirection of serial input
'-----------------------------------------------------
'define chip to use
$regfile = "8535def.dat"

'define used crystal
$crystal = 4000000

'dimension used variables
Dim S As String * 10
Dim W As Long

'inform the compiler which routine must be called to get serial characters
$serialinput = Myinput

'make a never ending loop
Do
  'ask for name
  Input "name " , S
  Print S
  'error is set on time out
  Print "Error " ; Err
Loop

End

'custom character handling  routine
'instead of saving and restoring only the used registers
'and write full ASM code, we use Pushall and PopAll to save and restore
'all registers so we can use all BASIC statements
'$SERIALINPUT requires that the character is passed back in R24
Myinput:
  Pushall                                                    'save all registers
```

```
  W = 0                                                    'reset counter
Myinput1:
   Incr W                                                  'increase counter
   Sbis USR, 7                                             ' Wait for character
   Rjmp myinput2                                           'no charac waiting so
check again
   Popall                                                  'we got something
   Err = 0                                                 'reset error
   In _temp1, UDR                                          ' Read character from
UART
   Return                                                  'end of routine
Myinput2:
   If W > 1000000 Then                                     'with 4 MHz ca 10 sec
delay
      rjmp Myinput_exit                                    'waited too long
   Else
      Goto Myinput1                                        'try again
   End If
Myinput_exit:
  Popall                                                   'restore registers
  Err = 1                                                  'set error variable
  ldi R24, 13                                              'fake enter so INPUT
will end
Return
```

# $SERIALINPUT2LCD

## Action

This compiler directive will redirect all serial input to the LCD display instead of echo-ing to the serial port.

## Syntax

$SERIALINPUT2LCD

## Remarks

You can also write your own custom input or output driver with the $SERIALINPUT and $SERIALOUTPUT statements, but the $SERIALINPUT2LCD is handy when you use a LCD display.

## See also

$SERIALINPUT , $SERIALOUTPUT

## Example

```
$serialinput2lcd
Dim v as Byte
Cls
Input "Number " , V                    'this will go to the LCD display
```

# $SERIALOUTPUT

## Action

Specifies that serial output must be redirected.

## Syntax

**$SERIALOUTPUT =** label

## Remarks

Label — The name of the assembler routine that must be called when a character is send to the serial buffer (UDR).
The character is placed into R24.

With the redirection of the PRINT and other serial output related commands, you can use your own routines.

This way you can use other devices as output devices.

## See also

$SERIALINPUT , $SERIALINPUT2LCD

## Example

```
$serialoutput = Myoutput
 'your program goes here
 Do
   Print "Hello"
 Loop
End

myoutput:
 'perform the needed actions here
 'the data arrives in R24
 'just set the output to PORTB
 !out portb,r24
ret
```

# $SIM

## Action

Instruct the compiler to generate empty wait loops for the WAIT and WAITMS statements. This to allow faster simulation.

## Syntax

**$SIM**

## Remarks

Simulation of a WAIT statement can take a long time especially when memory view windows are opened.

The $SIM compiler directive instructs the compiler to not generate code for WAITMS and WAIT. This will of course allows faster simulation.

When your application is ready you must remark the $SIM directive or otherwise the WAIT and WAITMS statements will not work as expected.

When you forget to remove the $SIM option and you try to program a chip you will receive a warning that $SIM was used.

## See also

NONE

## ASM

NONE

## Example

```
$SIM
Do
  Wait 1
Loop
```

# $TINY

## Action

Instruct the compiler to generate initialize code without setting up the stacks.

## Syntax

**$TINY**

## Remarks

The tiny11 for example is a powerful chip. It only does not have SRAM. BASCOM depends on SRAM for the hardware stack and software stack.

When you like to program in ASM you can use BASCOM with the $TINY directive.

Some BASCOM statements will also already work but the biggest part will not work.

BASCOM will support a subset of the BASCOM statements and function to be used with the chips without SRAM. There will be a special tiny.lib that will use little registers and will have at most a 3 level deep call since tiny chips do have a 3 level deep hardware stack that may be used for calls.

Note that the generated code is not yet optimized for the tiny parts. The $tiny

directive is just a start of the tiny parts implementation!

No support is available for this feature until the tiny.lib is implemented.

## See also

NONE

## ASM

NONE

## Example

```
$tiny
dim X AS iram BYTE, y AS iram BYTE
X = 1 : Y = 2 : X = x + y
```

# $WAITSTATE

## Action

Compiler directive to activate external SRAM and to insert a WAIT STATE for a slower ALE signal.

## Syntax

**$WAITSTATE**

## Remarks

The $WAITSTATE can be used to override the Compiler Chip Options setting.

## See also

NA

## Example

$WAITSTATE

# $XRAMSIZE

## Action

Specifies the size of the external RAM memory.

## Syntax

**$XRAMSIZE =** [&H] size

## Remarks

Size Size of external RAM memory chip.

**size : Constant.**

The size of the chip can be selected from the Options Compiler Chip menu.
The $XRAMSIZE overrides this setting.

## See also

$XRAMSTART

## Example

```
$XRAMSTART = &H300

$RAMSIZE = &H1000
DIM x AS XRAM Byte      'specify XRAM to store variable in XRAM
```

# $XRAMSTART

## Action

Specifies the location of the external RAM memory.

## Syntax

**$XRAMSTART =** [&H]address

## Remarks

| | |
|---|---|
| Address | The (hex)-address where the data is stored.<br>Or the lowest address that enables the RAM chip.<br>You can use this option when you want to run your code in systems with external RAM memory. |

**address : Constant.**

By default the extended RAM will start after the internal memory so the lower addresses of the external RAM can't be used to store information.

When you want to protect an area of the chip, you can specify a higher address for the compiler to store the data. For example, you can specify &H400. The first dimensioned variable will be placed in address &H400 and not in &H260.

It is important that when you use $XRAMSTART and $XRAMSIZE that $XRAMSIZE comes before $XRAMSTART.

## See also

$XRAMSIZE

## Example

```
$XRAMSIZE = &H1000

$XRAMSTART = &H400
```

```
Dim B As XRAM Byte
```

# 1WIRECOUNT

## Action

This statement reads the number of 1wire devices attached to the bus.

## Syntax

var2 **= 1WIRECOUNT( )**

var2 **= 1WIRECOUNT(** port , pin **)**

## Remarks

| | |
|---|---|
| var2 | A WORD variable that is assigned with the number of devices on the bus. |
| port | The PIN port name like PINB or PIND. |
| pin | The pin number of the port. In the range from 0-7. May be a numeric constant or variable. |

The variable must be of the type word or integer.

You can use the 1wirecount() function to know how many times the 1wsearchNext() function should be called to get all the ID's on the bus.

The 1wirecount function will take 4 bytes of SRAM.

___1w_bitstorage , Byte used for bit storage :

lastdeviceflag bit 0

id_bit bit 1

cmp_id_bit bit 2

search_dir bit 3

___1wid_bit_number, Byte

___1wlast_zero, Byte

___1wlast_discrepancy , Byte

## ASM

The following asm routines are called from mcs.lib.

_1wire_Count : (calls _1WIRE, _1WIRE_SEARCH_FIRST , _1WIRE_SEARCH_NEXT)

Parameters passed : R24 : pin number, R30 : port , Y+0,Y+1 : 2 bytes of soft stack, X : pointer to the frame space

Returns Y+0 and Y+1 with the value of the count. This is assigned to the target variable.

## See also

1WWRITE , 1WRESET , 1WREAD , 1WSEARCHFIRST, 1WSEARCHNEXT

## Example

```
'-----------------------------------------------------------------------
'                         '1wireSearch.bas
'                       (c) 2000 MCS Electronics
'                         revision b, 27 dec 2000
'-----------------------------------------------------------------------
Config 1wire = Portb.0                                      'use this pin
'On the STK200 jumper B.0 must be inserted

'The following internal bytes are used by the scan routines
'___1w_bitstorage , Byte used for bit storage :
'      lastdeviceflag bit 0
'      id_bit         bit 1
'      cmp_id_bit     bit 2
'      search_dir     bit 3
'___1wid_bit_number, Byte
'___1wlast_zero,  Byte
'___1wlast_discrepancy , Byte
'___1wire_data , string * 7 (8 bytes)

'[DIM variables used]
'we need some space from at least 8 bytes to store the ID
Dim Reg_no(8) As Byte

'we need a loop counter and a word/integer for counting the ID's on the bus
Dim I As Byte , W As Word

'Now search for the first device on the bus
Reg_no(1) = 1wsearchfirst()

For I = 1 To 8                                              'print the number
    Print Hex(reg_no(i));
Next
Print

Do
  'Now search for other devices
  Reg_no(1) = 1wsearchnext()
  For I = 1 To 8
     Print Hex(reg_no(i));
  Next
```

```
  Print
Loop Until Err = 1


'When ERR = 1 is returned it means that no device is found anymore
'You could also count the number of devices
W = 1wirecount()
'It is IMPORTANT that the 1wirecount function returns a word/integer
'So the result variable must be of the type word or integer
'But you may assign it to a byte or long too of course
Print W


'as a bonus the next routine :
' first fill the array with an existing number
Reg_no(1) = 1wsearchfirst()
' unremark next line to chance a byte to test the ERR flag
'Reg_no(1) = 2
'now verify if the number exists
1wverify Reg_no(1)
Print Err
'err =1 when the ID passed n reg_no() does NOT exist
' optinal call it with pinnumber line  1wverify reg_no(1),pinb,1

'As for the other 1wire statements/functions, you can provide the port and pin number
as anoption
'W = 1wirecount(pinb , 1)                                    'for example look at pin
PINB.1
End
```

# 1WREAD

## Action

This statement reads data from the 1wire bus into a variable.

## Syntax

var2 **= 1WREAD(** [ bytes] **)**

var2 **= 1WREAD(** bytes , port , pin **)**

## Remarks

| | |
|---|---|
| var2 | Reads a byte from the bus and places it into var2. Optional the number of bytes to read can be specified. |
| Port | The PIN port name like PINB or PIND. |
| Pin | The pin number of the port. In the range from 0-7. Maybe a numeric constant or variable. |

New is support for multi 1-wire devices on different pins.

To use this you must specify the port pin that is used for the communication.

The 1wreset, 1wwrite and 1wread statements will work together when used

with the old syntax. And the pin can be configured from the compiler options or with the CONFIG 1WIRE statement.

The syntax for additional 1-wire devices is :

1WRESET port, pin

1WWRITE var/constant , bytes, port, pin

var = 1WREAD(bytes, port, pin) for reading multiple bytes

## See also

1WWRITE , 1WRESET

## Example

```
'-----------------------------------------------------------
'            1WIRE.BAS (c) 2000 MCS Electronics
' demonstrates 1wreset, 1wwrite and 1wread()
' pull-up of 4K7 required to VCC from Portb.2
' DS2401 serial button connected to Portb.2
'-----------------------------------------------------------
'when only bytes are used, use the following lib for smaller code
$lib "mcsbyte.lib"


Config 1wire = Portb.0                                      'use this pin
'On the STK200 jumper B.0 must be inserted
Dim Ar(8) As Byte , A As Byte , I As Byte


Do
  Wait 1
  1wreset                                                   'reset the device
  Print Err                                                 'print error 1 if error
  1wwrite &H33                                              'read ROM command
  For I = 1 To 8
    Ar(i) = 1wread()                                        'place into array
  Next

'You could also read 8 bytes a time by unremarking the next line
'and by deleting the for next above
'Ar(1) = 1wread(8)                                           'read 8 bytes

  For I = 1 To 8
     Print Hex(ar(i));                                      'print output
  Next
  Print                                                     'linefeed
Loop


'NOTE THAT WHEN YOU COMPILE THIS SAMPLE THE CODE WILL RUN TO THIS POINT
'THIS because of the DO LOOP that is never terminated!!!

'New is the possibility to use more than one 1 wire bus
'The following syntax must be used:
For I = 1 To 8
  Ar(i) = 0                                                 'clear array to see
that it works
Next

1wreset Pinb , 2                                            'use this port and  pin
```

```
for the second device
1wwrite &H33 , 1 , Pinb , 2                                    'note that now the
number of bytes must be specified!
'1wwrite Ar(1) , 5,pinb,2

'reading is also different
Ar(1) = 1wread(8 , Pinb , 2)                                   'read 8 bytes from
portB on pin 2

For I = 1 To 8
  Print Hex(ar(i));
Next

'you could create a loop with a variable for the bit number !
For I = 0 To 3                                                 'for pin 0-3
  1wreset Pinb , I
  1wwrite &H33 , 1 , Pinb , I
  Ar(1) = 1wread(8 , Pinb , I)
  For A = 1 To 8
    Print Hex(ar(a));
  Next
  Print
Next

End
```

# 1WRESET

## Action

This statement brings the 1wire pin to the correct state, and sends a reset to the bus.

## Syntax

**1WRESET**

**1WRESET , PORT , PIN**

## Remarks

| | |
|---|---|
| 1WRESET | Reset the 1WIRE bus. The error variable ERR will return 1 if an error occurred |
| Port | The register name of the input port. Like PINB, PIND. |
| Pin | The pin number to use. In the range from 0-7. May be a numeric constant or variable. |

The variable ERR is set when an error occurs.

New is support for multi 1-wire devices on different pins.

To use this you must specify the port and pin that is used for the communication.

The 1wreset, 1wwrite and 1wread statements will work together when used with the old syntax. And the pin can be configured from the compiler options or with the CONFIG 1WIRE statement.

The syntax for additional 1-wire devices is :

1WRESET **port** , **pin**

1WWRITE var/constant ,bytes] , port, pin

var = 1WREAD( bytes) , for the configured 1 wire pin

var = 1WREAD(bytes, port, pin) ,for reading multiple bytes

## See also

1WREAD , 1WWRITE

## Example

```
'-----------------------------------------------------------
'            1WIRE.BAS (c) 2000 MCS Electronics
' demonstrates 1wreset, 1wwrite and 1wread()
' pull-up of 4K7 required to VCC from Portb.2
' DS2401 serial button connected to Portb.2
'-----------------------------------------------------------
'when only bytes are used, use the following lib for smaller code
$lib "mcsbyte.lib"


Config 1wire = Portb.0                                      'use this pin
'On the STK200 jumper B.0 must be inserted
Dim Ar(8) As Byte , A As Byte , I As Byte


Do
  Wait 1
  1wreset                                                   'reset the device
  Print Err                                                 'print error 1 if error
  1wwrite &H33                                              'read ROM command
  For I = 1 To 8
    Ar(i) = 1wread()                                        'place into array
  Next

'You could also read 8 bytes a time by unremarking the next line
'and by deleting the for next above
'Ar(1) = 1wread(8)                                           'read 8 bytes

  For I = 1 To 8
     Print Hex(ar(i));                                      'print output
  Next
  Print                                                     'linefeed
Loop


'NOTE THAT WHEN YOU COMPILE THIS SAMPLE THE CODE WILL RUN TO THIS POINT
'THIS because of the DO LOOP that is never terminated!!!

'New is the possibility to use more than one 1 wire bus
'The following syntax must be used:
For I = 1 To 8
  Ar(i) = 0                                                 'clear array to see
that it works
Next
```

```
1wreset Pinb , 2                                            'use this port and  pin
for the second device
1wwrite &H33 , 1 , Pinb , 2                                 'note that now the
number of bytes must be specified!
'1wwrite Ar(1) , 5,pinb,2

'reading is also different
Ar(1) = 1wread(8 , Pinb , 2)                                'read 8 bytes from
portB on pin 2

For I = 1 To 8
  Print Hex(ar(i));
Next

'you could create a loop with a variable for the bit number !
For I = 0 To 3                                              'for pin 0-3
  1wreset Pinb , I
  1wwrite &H33 , 1 , Pinb , I
  Ar(1) = 1wread(8 , Pinb , I)
  For A = 1 To 8
    Print Hex(ar(a));
  Next
  Print
Next

End
```

# 1WSEARCHFIRST

## Action

This statement reads the first ID from the 1wire bus into a variable(array).

## Syntax

var2 **= 1WSEARCHFIRST( )**

var2 **= 1WSEARCHFIRST(** port , pin **)**

## Remarks

| | |
|---|---|
| var2 | A variable or array that should be at least 8 bytes long that will be assigned with the 8 byte ID from the first 1wire device on the bus. |
| port | The PIN port name like PINB or PIND. |
| pin | The pin number of the port. In the range from 0-7. Maybe a numeric constant or variable. |

The 1wireSearchFirst() function must be called once to initiate the ID retrieval process. After the 1wireSearchFirst() function is used you should use successive function calls to the 1wireSearchNext function to retrieve other ID's on the bus.

A string can not be assigned to get the values from the bus. This because a nul may be returned as a value and the nul is also used as a string terminator.

I would advice to use a byte array as shown in the example.

The 1wirecount function will take 4 bytes of SRAM.

___1w_bitstorage , Byte used for bit storage :

lastdeviceflag bit 0

id_bit bit 1

cmp_id_bit bit 2

search_dir bit 3

___1wid_bit_number, Byte

___1wlast_zero, Byte

___1wlast_discrepancy , Byte

## ASM

The following asm routines are called from mcs.lib.

_1wire_Search_First : (calls _1WIRE, _ADJUST_PIN , _ADJUST_BIT_ADDRESS)

Parameters passed : R24 : pin number, R30 : port , X : address of target array

Returns nothing.

## See also

1WWRITE , 1WRESET , 1WREAD , 1WSEARCHNEXT, 1WIRECOUNT

## Example

```
'-----------------------------------------------------------
-----------------
'                           '1wireSearch.bas
'                         (c) 2000 MCS Electronics
'                           revision b, 27 dec 2000
'-----------------------------------------------------------
-----------------
Config 1wire = Portb.0
'use this pin
```

```
'On the STK200 jumper B.0 must be inserted

'The following internal bytes are used by the scan
routines
'___1w_bitstorage , Byte used for bit storage :
'      lastdeviceflag bit 0
'      id_bit         bit 1
'      cmp_id_bit     bit 2
'      search_dir     bit 3
'___1wid_bit_number, Byte
'___1wlast_zero,  Byte
'___1wlast_discrepancy , Byte
'___1wire_data , string * 7 (8 bytes)

'[DIM variables used]
'we need some space from at least 8 bytes to store the ID
Dim Reg_no(8) As Byte

'we need a loop counter and a word/integer for counting
the ID's on the bus
Dim I As Byte , W As Word

'Now search for the first device on the bus
Reg_no(1) = 1wsearchfirst()

For I = 1 To 8
'print the number
    Print Hex(reg_no(i));
Next
Print

Do
  'Now search for other devices
  Reg_no(1) = 1wsearchnext()
  For I = 1 To 8
     Print Hex(reg_no(i));
  Next
  Print
Loop Until Err = 1



'When ERR = 1 is returned it means that no device is
found anymore
'You could also count the number of devices
W = 1wirecount()
'It is IMPORTANT that the 1wirecount function returns a
word/integer
'So the result variable must be of the type word or
integer
'But you may assign it to a byte or long too of course
Print W
```

```
'as a bonus the next routine :
' first fill the array with an existing number
Reg_no(1) = 1wsearchfirst()
' unremark next line to chance a byte to test the ERR
flag
'Reg_no(1) = 2
'now verify if the number exists
1wverify Reg_no(1)
Print Err
'err =1 when the ID passed n reg_no() does NOT exist
' optinal call it with pinnumber line  1wverify
reg_no(1),pinb,1

'As for the other 1wire statements/functions, you can
provide the port and pin number as anoption
'W = 1wirecount(pinb , 1)
'for example look at pin PINB.1
End
```

## 1WSEARCHNEXT

### Action

This statement reads the next ID from the 1wire bus into a variable(array).

### Syntax

var2 **= 1WSEARCHNEXT( )**

var2 **= 1WSEARCHNEXT(** port , pin **)**

### Remarks

| | |
|---|---|
| var2 | A variable or array that should be at least 8 bytes long that will be assigned with the 8 byte ID from the next 1wire device on the bus. |
| Port | The PIN port name like PINB or PIND. |
| Pin | The pin number of the port. In the range from 0-7. May be a numeric constant or variable. |

The 1wireSearchFirst() function must be called once to initiate the ID retrieval process. After the 1wireSearchFirst() function is used you should use successive function calls to the 1wireSearchNext function to retrieve other

ID's on the bus.

A string can not be assigned to get the values from the bus. This because a nul may be returned as a value and the nul is also used as a string terminator.

I would advice to use a byte array as shown in the example.

The 1wirecount function will take 4 bytes of SRAM.

___1w_bitstorage , Byte used for bit storage :

lastdeviceflag bit 0

id_bit bit 1

cmp_id_bit bit 2

search_dir bit 3

___1wid_bit_number, Byte

___1wlast_zero, Byte

___1wlast_discrepancy , Byte

## ASM

The following asm routines are called from mcs.lib.

_1wire_Search_Next : (calls _1WIRE, _ADJUST_PIN , _ADJUST_BIT_ADDRESS)

Parameters passed : R24 : pin number, R30 : port , X : address of target array

Returns nothing.

## See also

1WWRITE , 1WRESET , 1WREAD , 1WSEARCHFIRST, 1WIRECOUNT

## Example

```
'-----------------------------------------------------------
-----------------
'                            '1wireSearch.bas
'                          (c) 2000 MCS Electronics
'                            revision b, 27 dec 2000
'-----------------------------------------------------------
```

```
----------------
Config 1wire = Portb.0
'use this pin
'On the STK200 jumper B.0 must be inserted

'The following internal bytes are used by the scan
routines
'___1w_bitstorage , Byte used for bit storage :
'      lastdeviceflag bit 0
'      id_bit         bit 1
'      cmp_id_bit     bit 2
'      search_dir     bit 3
'___1wid_bit_number, Byte
'___1wlast_zero,  Byte
'___1wlast_discrepancy , Byte
'___1wire_data , string * 7 (8 bytes)

'[DIM variables used]
'we need some space from at least 8 bytes to store the ID
Dim Reg_no(8) As Byte

'we need a loop counter and a word/integer for counting
the ID's on the bus
Dim I As Byte , W As Word

'Now search for the first device on the bus
Reg_no(1) = 1wsearchfirst()

For I = 1 To 8
'print the number
    Print Hex(reg_no(i));
Next
Print

Do
  'Now search for other devices
  Reg_no(1) = 1wsearchnext()
  For I = 1 To 8
     Print Hex(reg_no(i));
  Next
  Print
Loop Until Err = 1



'When ERR = 1 is returned it means that no device is
found anymore
'You could also count the number of devices
W = 1wirecount()
'It is IMPORTANT that the 1wirecount function returns a
word/integer
'So the result variable must be of the type word or
integer
```

```
'But you may assign it to a byte or long too of course
Print W


'as a bonus the next routine :
' first fill the array with an existing number
Reg_no(1) = 1wsearchfirst()
' unremark next line to chance a byte to test the ERR
flag
'Reg_no(1) = 2
'now verify if the number exists
1wverify Reg_no(1)
Print Err
'err =1 when the ID passed n reg_no() does NOT exist
' optinal call it with pinnumber line  1wverify
reg_no(1),pinb,1

'As for the other 1wire statements/functions, you can
provide the port and pin number as anoption
'W = 1wirecount(pinb , 1)
'for example look at pin PINB.1
End
```

# 1WVERIFY

## Action

This verifies if an ID is available on the 1wire bus.

## Syntax

**1WVERIFY** ar(1)

## Remarks

| | |
|---|---|
| Ar(1) | A byte array that holds the ID to verify. |

Returns ERR set to 0 when the ID is found on the bus otherwise it will be 1.

## ASM

The following asm routines are called from mcs.lib.

_1wire_Search_Next : (calls _1WIRE, _ADJUST_PIN , _ADJUST_BIT_ADDRESS)

## See also

1WWRITE , 1WRESET , 1WREAD , 1WSEARCHFIRST, 1WIRECOUNT

## Example

```
'-----------------------------------------------------------
-------------------
'                           '1wireSearch.bas
'                         (c) 2000 MCS Electronics
'                           revision b, 27 dec 2000
'-----------------------------------------------------------
-------------------
Config 1wire = Portb.0
'use this pin
'On the STK200 jumper B.0 must be inserted

'The following internal bytes are used by the scan
routines
'___1w_bitstorage , Byte used for bit storage :
'      lastdeviceflag bit 0
'      id_bit         bit 1
'      cmp_id_bit     bit 2
'      search_dir     bit 3
'___1wid_bit_number, Byte
'___1wlast_zero,  Byte
'___1wlast_discrepancy , Byte
'___1wire_data , string * 7 (8 bytes)

'[DIM variables used]
'we need some space from at least 8 bytes to store the
ID
Dim Reg_no(8) As Byte

'we need a loop counter and a word/integer for counting
the ID's on the bus
Dim I As Byte , W As Word

'Now search for the first device on the bus
Reg_no(1) = 1wsearchfirst()

For I = 1 To 8
'print the number
    Print Hex(reg_no(i));
Next
```

```
Print

Do
  'Now search for other devices
  Reg_no(1) = 1wsearchnext()
  For I = 1 To 8
     Print Hex(reg_no(i));
  Next
  Print
Loop Until Err = 1



'When ERR = 1 is returned it means that no device is
found anymore
'You could also count the number of devices
W = 1wirecount()
'It is IMPORTANT that the 1wirecount function returns a
word/integer
'So the result variable must be of the type word or
integer
'But you may assign it to a byte or long too of course
Print W


'as a bonus the next routine :
' first fill the array with an existing number
Reg_no(1) = 1wsearchfirst()
' unremark next line to chance a byte to test the ERR
flag
'Reg_no(1) = 2
'now verify if the number exists
1wverify Reg_no(1)
Print Err
'err =1 when the ID passed n reg_no() does NOT exist
' optinal call it with pinnumber line  1wverify
reg_no(1),pinb,1

'As for the other 1wire statements/functions, you can
provide the port and pin number as anoption
'W = 1wirecount(pinb , 1)
'for example look at pin PINB.1
End
```

## 1WWRITE

### Action

This statement writes a variable to the 1wire bus.

## Syntax

**1WWRITE** var1

**1WWRITE** var1, bytes

**1WWRITE** var1 , bytes , port , pin

## Remarks

| | |
|---|---|
| var1 | Sends the value of var1 to the bus. The number of bytes can be specified too but this is optional. |
| bytes | The number of bytes to write. Must be specified when port and pin are used. |
| port | The name of the PORT PINx register like PINB or PIND. |
| pin | The pin number in the range from 0-7. May be a numeric constant or variable. |

New is support for multi 1-wire devices on different pins.

To use this you must specify the port and pin that are used for the communication.

The 1wreset, 1wwrite and 1wread statements will work together when used with the old syntax. And the pin can be configured from the compiler options or with the CONFIG 1WIRE statement.

The syntax for additional 1-wire devices is :

1WRESET **port , pin**

1WWRITE **var/constant, bytes, port , pi**n

var = 1WREAD(**bytes**, **port**, **pin**) ,for reading multiple bytes

## See also

1WREAD , 1WRESET

## Example

```
'-----------------------------------------------------------------
'            1WIRE.BAS (c) 2000 MCS Electronics
' demonstrates 1wreset, 1wwrite and 1wread()
' pull-up of 4K7 required to VCC from Portb.2
' DS2401 serial button connected to Portb.2
'-----------------------------------------------------------------
'when only bytes are used, use the following lib for smaller code
$lib "mcsbyte.lib"


Config 1wire = Portb.0                                      'use this pin
'On the STK200 jumper B.0 must be inserted
Dim Ar(8) As Byte , A As Byte , I As Byte


Do
  Wait 1
  1wreset                                                   'reset the device
  Print Err                                                 'print error 1 if error
  1wwrite &H33                                              'read ROM command
  For I = 1 To 8
    Ar(i) = 1wread()                                        'place into array
  Next

'You could also read 8 bytes a time by unremarking the next line
'and by deleting the for next above
'Ar(1) = 1wread(8)                                           'read 8 bytes

  For I = 1 To 8
     Print Hex(ar(i));                                      'print output
  Next
  Print                                                     'linefeed
Loop


'NOTE THAT WHEN YOU COMPILE THIS SAMPLE THE CODE WILL RUN TO THIS POINT
'THIS because of the DO LOOP that is never terminated!!!

'New is the possibility to use more than one 1 wire bus
'The following syntax must be used:
For I = 1 To 8
  Ar(i) = 0                                                 'clear array to see
that it works
Next

1wreset Pinb , 2                                            'use this port and  pin
for the second device
1wwrite &H33 , 1 , Pinb , 2                                 'note that now the
number of bytes must be specified!
'1wwrite Ar(1) , 5,pinb,2

'reading is also different
Ar(1) = 1wread(8 , Pinb , 2)                                'read 8 bytes from
portB on pin 2

For I = 1 To 8
  Print Hex(ar(i));
Next

'you could create a loop with a variable for the bit number !
For I = 0 To 3                                              'for pin 0-3
  1wreset Pinb , I
  1wwrite &H33 , 1 , Pinb , I
  Ar(1) = 1wread(8 , Pinb , I)
  For A = 1 To 8
    Print Hex(ar(a));
  Next
  Print
Next

End
```

# ALIAS

## Action

Indicates that the variable can be referenced with another name.

## Syntax

newvar **ALIAS** oldvar

## Remarks

| | |
|---|---|
| Oldvar | Name of the variable such as PORTB.1 |
| newvar | New name of the variable such as direction |

Aliasing port pins can give the pin names a more meaningful name.

## See also

CONST

## Example

```
Config Pinb.1 = Output
Direction Alias Portb.1       'now you can refer to PORTB.1 with the variable
direction
Do
  Set Direction               'has the same effect as SET PORTB.1
  Waitms 1
  Reset Directopn
Loop
End
```

# ABS()

## Action

Returns the absolute value of a numeric signed variable.

## Syntax

var **= ABS(**var2**)**

## Remarks

| | |
|---|---|
| Var | Variable that is assigned the absolute value of var2. |
| Var2 | The source variable to retrieve the absolute value from. |

**var : Integer or Long.**

**var2 : Integer, Long.**

The absolute value of a number is always positive.

## See also

NONE

## Difference with QB

You can not use numeric constants since the absolute value is obvious for numeric constants.

Does not work with Singles.

## Asm

Calls: _abs16 for an Integer and _abs32 for a Long

Input: R16-R17 for an Integer and R16-R19 for a Long

Output:R16-R17 for an Integer and R16-R19 for a Long

## Example

```
Dim a as Integer, c as Integer
a = -1000
c = Abs(a)
Print c
End
```

# ASC

## Action

Assigns a numeric variable with the ASCII value of the first character of a string.

## Syntax

**var = ASC(**string**)**

## Remarks

| | |
|---|---|
| Var | Target numeric variable that is assigned. |
| String | String variable or constant from which to retrieve the ASCII value. |

**var : Byte, Integer, Word, Long.**

**string : String, Constant.**

Note that only the first character of the string will be used.

When the string is empty, a zero will be returned.

## See also

CHR

## Asm

NONE

## Example

```
Dim a as byte, s as String * 10
s = "ABC"
a = Asc(s)
Print a  'will print 65
End
```

# BAUD

## Action

Changes the baud rate for the hardware UART.

## Syntax

**BAUD =** var

**BAUD #x ,** const

## Remarks

| | |
|---|---|
| Var | The baud rate that you want to use. |
| X | The channel number of the software uart. |
| Const | A numeric constant for the baud rate that you want to use. |

Do not confuse the BAUD statement with the $BAUD compiler directive.

And do not confuse $CRYSTAL and CRYSTAL

$BAUD overrides the compiler setting for the baud rate and BAUD will change the current baud rate.

BAUD = ... will work on the hardware UART.

BAUD #x, yyyy will work on the software UART.

## See also

$CRYSTAL , $BAUD

## Asm

NONE

## Example

```
$baud = 2400
$crystal = 14000000                                          ' 14 MHz crystal
Print "Hello"
'Now change the baudrate in a program
Baud = 9600                                                  '
Print "Did you change the terminal emulator baud rate too?"
End
```

# BCD

## Action

Converts a variable stored in BCD format into a string.

## Syntax

**PRINT BCD(** var **)**

**LCD BCD(** var **)**

## Remarks

Var Variable to convert.

**var1 : Byte, Integer, Word, Long, Constant.**

When you want to use an I2C clock device which stores its values in BCD format you can use this function to print the value correctly.

BCD() displays values with a leading zero.

The BCD() function is intended for the PRINT/LCD statements.

Use the MAKEBCD function to convert variables from decimal to BCD.

Use the MAKEDEC function to convert variables from BCD to decimal.

## See also

MAKEDEC , MAKEBCD

## Asm

Calls: _BcdStr

Input: X hold address of variable

Output: R0 with number of bytes, frame with data.

## Example

```
Dim A As Byte
A = 65
Print A                                                    ' 65
Print Bcd(a)                                               ' 41
End
```

# BIN

## Action

Convert a numeric variable into the binary string representaion.

## Syntax

Var = Bin(source)

## Remarks

| | |
|---|---|
| Var | The target string that will be assigned with the binary representation of the variable source. |
| Source | The numeric variable that will be converted. |

The BIN() function can be used to display the state of a port.

When the variable source has the value &B10100011 the string named var will be assigned with "10100011".

It can be easily printed to the serial port.

## See also

HEX , STR , VAL , HEXVAL

## ASM

NONE

## Example

```
Dim A As Byte
A = &H14
Print Bin(a)
Prints 00010100
```

# BITWAIT

## Action

Wait until a bit is set or reset.

## Syntax

**BITWAIT** x , **SET/RESET**

## Remarks

X Bit variable or internal register like PORTB.x , where x ranges from 0-7.

When using bit variables make sure that they are set/reset by software otherwise your program will stay in a loop.

When you use internal registers that can be set/reset by hardware such as PORTB.0 this doesn't apply since this state can change as a result from for example a key press.

## See also

NONE

## Asm

Calls: NONE

Input: NONE

Output: NONE

Code : shown for address 0-31

label1:

Sbic PINB.0,label2

Rjmp label1

Label2:

## Example

```
Dim A As Bit
Bitwait A , Set                 'wait until bit a is set
Bitwait Portb.7 , Reset         'wait until bit 7 of Port B is 0.
End
```

# BYVAL

## Action

Specifies that a variable will be passed by value.

## Syntax

Sub Test(BYVAL var)

## Remarks

Var Variable name

The default for passing variables to SUBS and FUNCTIONS, is by reference(BYREF). When you pass a variable by reference, the address is

passed to the SUB or FUNCTION. When you pass a variable by Value, a temp variable is created on the frame and the address of the copy is passed.

When you pass by reference, changes to the variable will be made to the calling variable.

When you pass by value, changes to the variable will be made to the copy so the original value will not be changed.

By default passing by reference is used.

Note that calling by reference will generate less code.

## See also

CALL , DECLARE , SUB , FUNCTION

## ASM

NONE

## Example

```
Declare Sub Test(Byval X As Byte, Byref Y As Byte, Z As Byte)
```

# CALL

## Action

Call and execute a subroutine.

## Syntax

**CALL Test [ (**var1, var-n**) ]**

## Remarks

Var1 Any BASCOM variable or constant.

Var-n Any BASCOM variable or constant.

Test Name of the subroutine. In this case Test.

You can call sub routines with or without passing parameters.

It is important that the SUB routine is DECLARED before you make the CALL to the subroutine. Of course the number of declared parameters must match the number of passed parameters.

It is also important that when you pass constants to a SUB routine, you must DECLARE these parameters with the BYVAL argument.

With the CALL statement, you can call a procedure or subroutine.

For example: **Call Test2**

The call statement enables you to implement your own statements.

You don't have to use the CALL statement:

**Test2** will also call subroutine test2

When you don't supply the CALL statement, you must leave out the parenthesis.

So Call Routine(x,y,z) must be written as Routine x,y,x

Unlike normal SUB programs called with the GOSUB statement, the CALL statement enables you to pass variables to a SUB routine that may be local to the SUB.

## See also

DECLARE , SUB , EXIT , FUNCTION , LOCAL

## Example

```
Dim A As Byte , B As Byte                    'dimension some variables
Declare Sub Test(b1 As Byte , Byval B2 As Byte)'declare the SUB program
```

```
A = 65                                          'assign a value to variable A
Call Test(a , 5)                                'call test with parameter A and
constant
Test A , 5                                      'alternative call
Print A                                         'now print the new value
End

Sub Test(b1 As Byte , Byval B2 As Byte)         'use the same variable names as  'the
declared one
Print B1                                        'print it
Print Bcd(b2)
B1 = 10                                         'reassign the variable
B2 = 15                                         'reassign the variable
End Sub
```

One important thing to notice is that you can change b2 but that the change will not be reflected to the calling program!

Variable A is changed however.

This is the difference between the BYVAL and BYREF argument in the DECLARE ration of the SUB program.

When you use BYVAL, this means that you will pass the argument by its value. A copy of the variable is made and passed to the SUB program. So the SUB program can use the value and modify it, but the change will not be reflected to the calling parameter. It would be impossible too when you pass a numeric constant for example.

If you do not specify BYVAL, BYREF will be used by default and you will pass the address of the variable. So when you reassign B1 in the above example, you are actually changing parameter A.

# CHECKSUM

## Action

Returns a checksum of a string.

## Syntax

**PRINT Checksum(**var**)**

**b = Checksum(**var**)**

## Remarks

| | |
|---|---|
| Var | A string variable. |
| B | A numeric variable that is assigned with the checksum. |

The checksum is computed by counting all the bytes of the string variable.

Checksums are often used with serial communication.

## See also

CRC8

## Example

```
Dim S As String * 10                                    'dim variable
S = "test"                                              'assign variable
Print Checksum(s)                                       'print value (192)
End
```

# CHR

## Action

Convert a numeric variable or a constant to a string with a length of 1 character. The character represents the ASCII value of the numeric value.

## Syntax

**PRINT CHR(**var**)**

**s = CHR(**var**)**

## Remarks

| | |
|---|---|
| Var | Numeric variable or numeric constant. |
| S | A string variable. |

When you want to print a character to the screen or the LCD display,

you must convert it with the CHR() function.

When you use PRINT numvar, the value will be printed.

When you use PRINT Chr(numvar), the ASCII character itself will be printed.

The Chr() function is handy in combination with the LCD custom characters where you ca redefine characters 0-7 of the ASCII table.

## See also

ASC()

## Example

```
Dim A As Byte                                   'dim variable
A = 65                                          'assign variable
Lcd A                                           'print value (65)
Lowerline
Lcd Hex(a)                                      'print hex value (41)
Lcd Chr(a)                                      'print ASCII character 65
(A)
End
```

# CLS

## Action

Clear the LCD display and set the cursor to home.

## Syntax

**CLS**

## Syntax for graphical LCD

**CLS**

**CLS TEXT**

**CLS GRAPH**

## Remarks

Clearing the LCD display does not clear the CG-RAM in which the custom characters are stored.

For graphical LCD displays CLS will clear both the text and the graphical display.

## See also

$LCD , LCD , SHIFTLCD , SHIFTCURSOR , SHIFTLCD

## Example

```
Cls                                          'Clear LCD display
Lcd "Hello"                                  'show this famous text
End
```

# CLOCKDIVISION

## Action

Will set the system clock division available in the MEGA chips.

## Syntax

**CLOCKDIVISON =** var

## Remarks

| | |
|---|---|
| Var | Variable or numeric constant that sets the clock division. Valid values are from 2-129.<br>A value of 0 will disable the division. |

On the MEGA 103 and 603 the system clock frequency can be divided so you can save power for instance. A value of 0 will disable the clock divider. The divider can divide from 2 to 127. So the other valid values are from 2 - 127.

Some routines that rely on the system clock will not work proper anymore when you use the divider. WAITMS for example will take twice the time when you use a value of 2.

## See also

POWERSAVE

## Example

```
$BAUD = 2400
Clockdivision = 2
END
```

# CLOSE

## Action

Opens and closes a device.

## Syntax

OPEN "device" for MODE As #channel

CLOSE #channel

## Remarks

Device The default device is COM1 and you don't need to open a channel to use INPUT/OUTPUT on this device.
With the implementation of the software UART, the compiler must know to which pin/device you will send/receive the data.
So that is why the OPEN statement must be used. It tells the compiler about the pin you use for the serial input or output and the baud rate you want to use.
COMB.0:9600,8,N,2 will use PORT B.0 at 9600 baud with 2 stop bits.

The format for COM1 is : COM1:speed, where the speed is optional and

will override the compiler settings for the speed.

The format for the sofware UART is: COMpin:speed,8,N,stop bits[,INVERTED]
Where pin is the name of the PORT-pin.
Speed must be specified and stopbits can be 1 or 2.
An optional parameter **,INVERTED** can be specified to use inverted RS-232.
Open "COMD.1:9600,8,N,1,INVERTED" For Output As #1 , will use pin PORTD.1 for output with 9600 baud, 1 stop bit and with inverted RS-232.

MODE You can use BINARY or RANDOM for COM1, but for the software UART pins, you must specify INPUT or OUTPUT.

Channel The number of the channel to open. Must be a positive constant >0.

The statements that support the device are PRINT , INPUT and INPUTHEX.

Every opened device must be closed using the CLOSE #channel statement. Of course, you must use the same channel number.

The best place for the CLOSE statement is at the end of your program.

The INPUT statement in combination with the software UART, will not echo characters back because there is no default associated pin for this.

## See also

OPEN , PRINT

## Example

```
'-----------------------------------------------------
'          (c) 2000 MCS Electronics
'                OPEN.BAS
'        demonstrates software UART
'-----------------------------------------------------
$crystal = 10000000                                    'change to the value of
the XTAL you have installed


Dim B As Byte

'Optional you can fine tune the calculated bit delay
'Why would you want to do that?
'Because chips that have an internal oscillator may not
'run at the speed specified. This depends on the voltage, temp etc.
'You can either change $CRYSTAL or you can use
'BAUD #1,9610

'In this example file we use the DT006 from www.simmstick.com
```

```
'This allows easy testing with the existing serial port
'The MAX232 is fitted for this example.
'Because we use the hardware UART pins we MAY NOT use the hardware UART
'The hardware UART is used when you use PRINT, INPUT or other related statements
'We will use the software UART.
Waitms 100

'open channel for output
Open "comd.1:19200,8,n,1" For Output As #1
Print #1 , "serial output"


'Now open a pin for input
Open "comd.0:19200,8,n,1" For Input As #2
'since there is no relation between the input and output pin
'there is NO ECHO while keys are typed
Print #1 , "Number"
'get a number
Input #2 , B
'print the number
Print #1 , B

'now loop until ESC is pressed
'With INKEY() we can check if there is data available
'To use it with the software UART you must provide the channel
Do
   'store in byte
   B = Inkey(#2)
   'when the value > 0 we got something
   If B > 0 Then
      Print #1 , Chr(b)                                    'print the character
   End If
Loop Until B = 27


Close #2
Close #1


'OPTIONAL you may use the HARDWARE UART
'The software UART will not work on the hardware UART pins
'so you must choose other pins
'use normal hardware UART for printing
'Print B


'When you dont want to use a level inverter such as the MAX-232
'You can specify ,INVERTED :
'Open "comd.0:300,8,n,1,inverted" For Input As #2
'Now the logic is inverted and there is no need for a level converter
'But the distance of the wires must be shorter with this
End
```

# CONFIG

The CONFIG statement is used to configure the hardware devices.

CONFIG 1WIRE

CONFIG ADC

CONFIG CLOCK

CONFIG DEBOUNCE

CONFIG GRAPHLCD

CONFIG I2CDELAY

# CONFIG 1WIRE

## Action

Configure the pin to use for 1WIRE statements and override the compiler setting.

## Syntax

**CONFIG 1WIRE =** pin

## Remarks

Pin The port pin to use such as PORTB.0

The CONFIG 1WIRE statement, only overrides the compiler setting.

You can have only one pin for the 1WIRE statements because the idea is that you can attach multiple 1WIRE devices to the 1WIRE bus.

## See also

1WRESET , 1WREAD , 1WWRITE

## Example

```
Config 1WIRE = PORTB.0  'PORTB.0 is used for the 1-wire bus
1WRESET                         'reset the bus
```

# CONFIG ADC

## Action

Configures the A/D converter.

## Syntax

**CONFIG ADC =** single, PRESCALER = AUTO, REFERENCE = opt

## Remarks

| | |
|---|---|
| ADC | Running mode. May be SINGLE or FREE. |
| PRESCALER | A numeric constant for the clock divider. Use AUTO to let the compiler generate the best value depending on the XTAL |
| REFERENCE | Some chips like the M163 have additional reference options. Value may be OFF , AVCC or INTERNAL. See the data sheets for the different modes. |

## See also

NONE

## ASM

The following ASM is generated

In _temp1,ADCSR ; get settings of ADC

Ori _temp1, XXX ; or with settings

Out ADCSR,_temp1 ; write back to ADC register

## Example

```
Config Adc = Single , Prescaler = Auto, Reference = Internal
```

# CONFIG CLOCK

## Action

Configures the timer to be used for the TIME$ and DATE$ variables.

## Syntax

**CONFIG CLOCK =** soft [, GOSUB = SECTIC]

## Remarks

| | |
|---|---|
| Soft | The only option available now. I2C based clocks might be added. |
| Sectic | This option allows to jump to a user routine with the label sectic. |
| | Since the interrupt occurs every second you may handle various tasks in the sectic label. It is important that you use the name SECTIC and that you return with a RETURN statement from this label. |
| | The usage of the optional SECTIC routine will use 30 bytes of the hardware stack. |

When you use the CONFIG CLOCK directive the compiler will DIM the following variables automatic : _sec , _min , _hour, _day , _month , _year

The variables TIME$ and DATE$ will also be dimensioned. These are special variables since they are treated different. See TIME$ and DATE$.

The _sec, _min and other internal variables can be changed by the user too.

But of course changing their values will change the DATE$/TIME$ variables.

The compiler also creates an ISR that gets updates once per second. This works only for the 8535, M163 and M103 and M603, or other AVR chips that have a timer that can work in asynchrony mode.

For the 8535, timer2 is used. It can not be used my the user anymore!

## See also

TIME$ , DATE$

## ASM

The following ASM routines are called from mcs.lib

_soft_clock. This is the ISR that gets called once per second.

## Example

```
'-----------------------------------------------------------
'                      MEGACLOCK.BAS
'                  (c) 2000-2001 MCS Electronics
'-----------------------------------------------------------
'This example shows the new TIME$ and DATE$ reserved variables
'With the 8535 and timer2 or the Mega103 and TIMER0 you can
'easily implement a clock by attaching a 32.768 KHz xtal to the timer
'And of course some BASCOM code

'This example is written for the STK300 with M103
Enable Interrupts

'[configure LCD]
$lcd = &HC000                           'address for E and RS
$lcdrs = &H8000                         'address for only E
Config Lcd = 20 * 4                     'nice display from bg micro
Config Lcdbus = 4                       'we run it in bus mode and I hooked up
only db4-db7
Config Lcdmode = Bus                    'tell about the bus mode

'[now init the clock]
Config Clock = Soft                     'this is how simple it is
'The above statement will bind in an ISR so you can not use the TIMER anymore!
'For the M103 in this case it means that TIMER0 can not be used by the user anymore

'assign the date to the reserved date$
'The format is MM/DD/YY
Date$ = "11/11/00"
```

```
'assign the time, format in hh:mm:ss military format(24 hours)
'You may not use 1:2:3 !! adding support for this would mean overhead
'But of course you can alter the library routines used

Time$ = "02:20:00"

'clear the LCD display
Cls

Do
  Home                                          'cursor home
  Lcd Date$ ; "   " ; Time$                     'show the date and time
Loop

'The clock routine does use the following internal variables:
'_day , _month, _year , _sec, _hour, _min
'These are all bytes. You can assign or use them directly
_day = 1
'For the _year variable only the year is stored, not the century
End
```

# CONFIG DEBOUNCE

## Action

Configures the delay time for the DEBOUNCE statement.

## Syntax

**CONFIG DEBOUNCE =** time

## Remarks

Time A numeric constant which specifies the delay time in mS.

When debounce time is not configured, 25 mS will be used as a default.

## See also

DEBOUNCE

## Example

```
'-----------------------------------------------------
```

```
'                DEBOUN.BAS
'           Demonstrates DEBOUNCE
'-----------------------------------------------------
Config Debounce = 30                                        'when the config
statement is not used a default of 25mS will be used


  'Debounce Pind.0 , 1 , Pr 'try this for branching when high(1)
  Debounce Pind.0 , 0 , Pr , Sub
  Debounce Pind.0 , 0 , Pr , Sub
  '                    ^----- label to branch to
  '               ^---------- Branch when P1.0 goes low(0)
  '          ^---------------- Examine P1.0

  'When Pind.0 goes low jump to subroutine Pr
  'Pind.0 must go high again before it jumps again
  'to the label Pr when Pind.0 is low

  Debounce Pind.0 , 1 , Pr                                  'no branch
  Debounce Pind.0 , 1 , Pr                                  'will result in a return
without gosub
End

Pr:
  Print "PIND.0 was/is low"
Return
```

# CONFIG GRAPHLCD

## Action

Configures the Graphical LCD display.

## Syntax

**Config GRAPHLCD** = type , **PORT** = mode, **CE** = pin , **CD** = cd , **COLS** = 30

## Remarks

| | |
|---|---|
| Type | This must be 240 * 64. Other types may be supported later. |
| Dataport | This is the name of the port that is used to put the data on the LCD data pins db0-db7.<br>PORTA for example. |
| Controlport | This is the name of the port that is used to control the LCD control pins.<br>PORTC for example |
| Ce | The pin number that is used to enable the chip on the LCD. |
| Cd | The pin number that is used to control the CD pin of the display. |
| WR | The pin number that is used to control the /WR pin of the display. |
| RD | The pin number that is used to control the /RD pin of the display. |

| | |
|---|---|
| FS | The pin number that is used to control the FS pin of the display. |
| RESET | The pin number that is used to control the RESET pin of the display. |
| Cols | The number of columns for use as text display. The current code is written for 30 columns only. |

This is a first implementation for Graphic support. It is based on the T6963C chip that is used in many displays. At the moment there is only support for pin mode. That is, the LCD is controlled by changing logic levels on the pins.

Memory mapped or bus mode will be added later. But pin mode can be used with any micro so that is why this is first implemented.

The following connections were used:

PORTA.0 to PORTA.7 to DB0-DB7 of the LCD

PORTC.5 to FS, font select of LCD

PORTC.2 to CE, chip enable of LCD

PORTC.3 to CD, code/data select of LCD

PORTC.0 to WR of LCD, write

PORTC.1 to RD of LCD, read

PORTC.4 to RESET of LCD, reset LCD

The LCD used from www.conrad.de needs a negative voltage for the contrast.

Two 9V batteries were used with a pot meter.

The T6963C displays have both a graphical area and a text area. They can be used together. The routines use the XOR mode to display both text and graphics layered over each other.

The statements that can be used with the graphical LCD are :

CLS, will clear the graphic display and the text display

**CLS GRAPH** will clear only the graphic part of the display

**CLS TEXT** will only clear the text part of the display

**LOCATE row,column** Will place the cursor at the specified row and column

The row may vary from 1 to 8 and the column from 1 to 30.

CURSOR **ON/OFF BLINK/NOBLINK** can be used the same way as for text displays.

LCD can also be the same way as for text displays.

New are:
SHOWPIC X, Y , Label where X and Y are the column and row and Label is the label where the picture info is placed.

PSET X, Y , color Will set or reset a pixel. X can range from 0-239 and Y from 9-63. When color is 0 the pixel will turned off. When it is 1 the pixel will be set on.

$BGF "file.bgf" 'inserts a BGF file at the current location

## See also

SHOWPIC , PSET , $BGF

## Example

```
'-----------------------------------------------------------------
'                     (c) 2001 MCS Electronics
'                  T6963C graphic display support demo
'-----------------------------------------------------------------

'The connections of the LCD used in this demo
'LCD pin                    connected to
' 1         GND             GND
 '2         GND             GND
 '3         +5V             +5V
 '4         -9V             -9V potmeter
 '5         /WR             PORTC.0
 '6         /RD             PORTC.1
 '7         /CE             PORTC.2
 '8         C/D             PORTC.3
 '9         NC              not conneted
 '10        RESET           PORTC.4
 '11-18     D0-D7            PA
 '19        FS              PORTC.5
 '20        NC              not connected


'First we define that we use a graphic LCD
' Only 240*64 supported yet
Config Graphlcd = 240 * 64 , Dataport = Porta , Controlport = Portc , Ce = 2 , Cd =
3 , Wr = 0 , Rd = 1 , Reset = 4 , Fs = 5
'The dataport is the portname that is connected to the data lines of the LCD
'The controlport is the portname which pins are used to control the lcd
'CE, CD etc. are the pin number of the CONTROLPORT.
' For example CE =2 because it is connected to PORTC.2


'Dim variables (y not used)
Dim X As Byte , Y As Byte
```

```
'Clear the screen will both clear text and graph display
Cls
'Other options are :
' CLS TEXT   to clear only the text display
' CLS GRAPH  to clear only the graphical part

'locate works like the normal LCD locate statement
' LOCATE LINE,COLUMN LINE can be 1-8 and column 0-30
Locate 1 , 1

'Show some text
Lcd "MCS Electronics"
'And some othe text on line 2
Locate 2 , 1 : Lcd "T6963c support"

'wait 1 sec
Wait 1


' draw a line using PSET X,Y, ON/OFF
' PSET on.off param is 0 to clear a pixel and any other value to turn it on
For X = 0 To 140
   Pset X , 20 , 255                                        ' set the pixel
Next

Wait 1


'Now it is time to show a picture
'SHOWPIC X,Y,label
'The label points to a label that holds the image data
Showpic 0 , 0 , Plaatje

Wait 1
Cls Text                                                    ' clear the text
End



'This label holds the mage data
Plaatje:
'$BGF will put the bitmap into the program at this location
$bgf "mcs.bgf"

'You could insert other picture data here
```

# CONFIG I2CDELAY

## Action

Compiler directive that overrides the internal I2C delay routine.

## Syntax

**CONFIG I2CDELAY =** value

## Remarks

value A numeric value in the range of 1-255.

A higher value means a slower I2C clock.

For the I2C routines the clock rate is calculated depending on the used crystal. In order to make it work for all I2C devices the slow mode is used. When you have faster I2C devices you can specify a low value.

## See also

CONFIG SCL , CONFIG SDA

## Example

```
CONFIG SDA = PORTB.7          'PORTB.7 is the SDA line
CONFIG I2CDELAY = 5
See I2C example for more details.
```

```
'-----------------------------------------------------------
'                     (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: I2C.BAS
'  demo: I2CSEND and I2CRECEIVE
'-----------------------------------------------------------
Declare Sub Write_eeprom(byval Adres As Byte , Byval Value As Byte)
Declare Sub Read_eeprom(byval Adres As Byte , Value As Byte)

Const Addressw = 174                                        'slave write address
Const Addressr = 175                                        'slave read address

Dim B1 As Byte , Adres As Byte , Value As Byte              'dim byte

Call Write_eeprom(1 , 3)                                    'write value of three
to address 1 of EEPROM


Call Read_eeprom(1 , Value) : Print Value                   'read it back
Call Read_eeprom(5 , Value) : Print Value                   'again for address 5


'-------- now write to a PCF8474 I/O expander -------
I2csend &H40 , 255                    'all outputs high
I2creceive &H40 , B1                  'retrieve input
Print "Received data " ; B1            'print it
End

Rem Note That The Slaveaddress Is Adjusted Automaticly With I2csend & I2creceive
Rem This Means You Can Specify The Baseaddress Of The Chip.



'sample of writing a byte to EEPROM AT2404
Sub Write_eeprom(byval Adres As Byte , Byval Value As Byte)
    I2cstart                                                'start condition
    I2cwbyte Addressw                                       'slave address
    I2cwbyte Adres                                          'asdress of EEPROM
    I2cwbyte Value                                          'value to write
    I2cstop                                                 'stop condition
    Waitms 10                                               'wait for 10
milliseconds
End Sub


'sample of reading a byte from EEPROM AT2404
Sub Read_eeprom(byval Adres As Byte , Value As Byte)
   I2cstart                                                 'generate start
   I2cwbyte Addressw                                        'slave adsress
```

```
    I2cwbyte Adres                                  'address of EEPROM
    I2cstart                                        'repeated start
    I2cwbyte Addressr                               'slave address (read)
    I2crbyte Value , Nack                           'read byte
    I2cstop                                         'generate stop
End Sub
```

# CONFIG INTx

## Action

Configures the way the interrupts 0,1 and 4-7 will be triggered.

## Syntax

**CONFIG INTx =** state

Where X can be 0,1 and 4 to 7 in the MEGA chips.

## Remarks

| | |
|---|---|
| state | LOW LEVEL to generate an interrupt while the pin is held low. Holding the pin low will generate an interrupt over and over again.<br><br>FALLING to generate an interrupt on the falling edge.<br><br>RISING to generate an interrupt on the rising edge.. |

The MEGA has also INT0-INT3. These are always low level triggered so there is no need /possibility for configuration.

The number of interrupt pins depend on the used chip. Most chips only have int0 and int1.

## Example

```
'-----------------------------------------------------------
'Sample for the MEGA103
Config INT4 = LOW LEVEL

End
```

# CONFIG KBD

## Action

Configure the GETKBD() function and tell which port to use.

## Syntax

**CONFIG** KBD = PORTx , DEBOUNCE = value

## Remarks

| | |
|---|---|
| PORTx | The name of the PORT to use such as PORTB or PORTD. |
| DEBOUNCE | By default the debounce value is 20. A higher value might be needed. The maximum is 255. |

The GETKBD() function can be used to read the pressed key from a matrix keypad attached to a port of the uP.

You can define the port with the CONFIG KBD statement.

## See also

GETKBD

# CONFIG KEYBOARD

## Action

Configure the GETATKBD() function and tell which port pins to use.

## Syntax

**CONFIG** KEYBOARD = PINX.y , DATA = PINX.y , KEYDATA = table

## Remarks

| | |
|---|---|
| KEYBOARD | The PIN that serves as the CLOCK input. |
| DATA | The PIN that serves as the DATA input. |
| KEYDATA | The label where the key translation can be found.<br>The AT keyboard returns scan codes instead of normal ASCII codes. So a translation table s needed to convert the keys. BASCOM allows the use of shifted keys too. Special keys like function keys are not supported. |

The AT keyboard can be connected with only 4 wires : clock,data, gnd and vcc.

Some info is displayed below. This is copied from an Atmel datasheet.

The INT0 or INT1 shown can be in fact any pin that can serve as an INPUT pin.

The application note from Atmel works in interrupt mode. For BASCOM I rewrote the code so that no interrupt is needed/used.

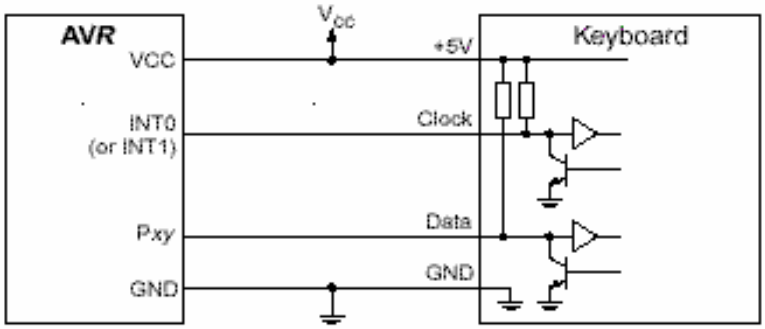



**Table 1.** AT Keyboard Connector Pin Assignments

| AT Computer |  |  |
|---|---|---|
| **Signals** | **DIN41524, Female at Computer, 5-pin DIN 180°** | **6-pin Mini DIN PS2 Style Female at Computer** |
| Clock | 1 | 5 |
| Data | 2 | 1 |
| nc | 3 | 2,6 |
| GND | 4 | 3 |
| +5V | 5 | 4 |
| Shield | Shell | Shell |

## See also

GETATKBD

# CONFIG LCD

## Action

Configure the LCD display and override the compiler setting.

## Syntax

**CONFIG** LCD = LCDtype

## Remarks

LCDtype The type of LCD display used. This can be :
40 * 4,16 * 1, 16 * 2, 16 * 4, 16 * 4, 20 * 2 or 20 * 4 or 16 * 1a
Default 16 * 2 is assumed.

When you have a 16 * 2 display, you don't have to use this statement.

The 16 * 1a is special. It is used for 2 * 8 displays that have the address of line 2, starting at location &H8.

## Example

```
Config Lcd = 40 * 4
Lcd "Hello"                                          'display on LCD
Fourthline                                           'select line 4
Lcd "4"                                              'display 4
End
```

# CONFIG LCDBUS

## Action

Configures the LCD data bus and overrides the compiler setting.

## Syntax

CONFIG LCDBUS = constant

## Remarks

Constant 4 for 4-bit operation, 8 for 8-bit mode (default)

Use this statement together with the $LCD = address statement.

When you use the LCD display in the bus mode the default is to connect all

the data lines. With the 4-bit mode, you only have to connect data lines d7-d4.

## See also

CONFIG LCD

## Example

```
$lcd = &HC000                                   'address of enable and RS
signal
$lcdrs = &H800                                  'address of enable signal
Config Lcdbus = 4                               '4 bit mode
Lcd "hello"
```

# CONFIG LCDMODE

## Action

Configures the LCD operation mode and overrides the compiler setting.

## Syntax

CONFIG LCDMODE = type

## Remarks

Type

**PORT** will drive the LCD in 4-bit port mode and is the default.
In PORT mode you can choose different PIN's from different PORT's to connect to the upper 4 data lines of the LCD display. The RS and E can also be connected to a user selectable pin. This is very flexible since you can use pins that are not used by your design and makes the board layout simple. On the other hand, more software is necessary to drive the pins.

**BUS** will drive the LCD in bus mode and in this mode is meant when you have external RAM and so have an address and data bus on your system. The RS and E line of the LCD display can be connected to an

address decoder. Simply writing to an external memory location select the LCD and the data is sent to the LCD display. This means the data-lines of the LCD display are fixed to the data-bus lines.

Use $LCD = address and $LCDRS = address, to specify the addresses that will enable the E and RS lines.

## See also

CONFIG LCD , $LCD , $LCDRS

## Example

```
Config LCDMODE = PORT    'the report will show the settings
Config LCDBUS = 4        '4 bit mode
LCD "hello"
```

# CONFIG LCDPIN

## Action

Override the LCD-PIN select options.

## Syntax

CONFIG LCDPIN = PIN , DB4= PN,DB5=PN, DB6=PN, DB7=PN, E=PN, RS=PN

## Remarks

| | |
|---|---|
| PN | The name of the PORT pin such as PORTB.2 for example. |
| DUM | Actually a dummy you can leave out as long as you don't forget to include the = sign. |

You can override the PIN selection from the Compiler Settings with this statement, so a second configuration lets you not choose more pins for a second LCD display.

## See also

CONFIG LCD

## Example

```
CONFIG LCDPIN = PIN ,DB4= PORTB.1,DB5=PORTB.2,DB6=PORTB.3,
DB7=PORTB.4,E=PORTB.5,RS=PORTB.6
```

The above example must be typed on one line.

# CONFIG PORT

## Action

Sets the port or a port pin to the right data direction.

## Syntax

**CONFIG PORTx =** state

**CONFIG PINx.y =** state

## Remarks

state — A constant that can be INPUT or OUTPUT.
INPUT will set the data direction register to input for port X.
OUTPUT will set the data direction to output for port X.
You can also use a number for state. &B0001111, will set the upper nibble to input and the lower nibble to output.

You can also set one port pin with the CONFIG PIN = state, statement.
Again, you can use INPUT, OUTPUT or a number. In this case the number can be only zero or one.

**state : Constant.**

The best way to set the data direction for more than 1 pin, is to use the CONFIG PORT, statement and not multiple lines with CONFIG PIN statements.

## Example

```
'-----------------------------------------------------------
'                 (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: PORT.BAS
'  demo: PortB and PortD
'-----------------------------------------------------------
Dim A As Byte , Count As Byte

'configure PORT D for input mode
Config Portd = Input

'reading the PORT, will read the latch, that is the value
'you have written to the PORT.
'This is not the same as reading the logical values on the pins!
'When you want to know the logical state of the attached hardware,
'you MUST use the PIN register.
A = Pind

'a port or SFR can be treated as a byte
A = A And Portd

Print A                                                 'print it

Bitwait Pind.7 , Reset                                  'wait until bit is low


'We will use port B for output
Config Portb = Output

'assign value
Portb = 10                                              'set port B to 10
Portb = Portb And 2

Set Portb.0                                             'set bit 0 of port B to
1

Incr Portb

'Now a light show on the STK200
Count = 0
Do
  Incr Count
  Portb = 1
  For A = 1 To 8
    Rotate Portb , Left                                 'rotate bits left
    Wait 1
  Next
  'the following 2 lines do the same as the previous loop
  'but there is no delay
'  Portb = 1
'  Rotate Portb , Left , 8
Loop Until Count = 10
Print "Ready"

'Again, note that the AVR port pins have a data direction register
'when you want to use a pin as an input it must be set low first
'you can do this by writing zeros to the DDRx:
'DDRB =&B11110000  'this will set portb1.0,portb.1,portb.2 and portb.3 to use as
inputs.

'So : when you want to use a pin as an input set it low first in the DDRx!
'     and read with PINx
'     and when you want to use the pin as output, write a 1 first
'     and write the value to PORTx

End
```

# CONFIG RC5

## Action

Overrides the RC5 pin assignment from the Option Compiler Settings.

## Syntax

**CONFIG RC5 =** pin [,TIMER=2]

## Remarks

| | |
|---|---|
| Pin | The port pin to which the RC5 receiver is connected. |
| TIMER | Must be 2. The micro must have a timer2 of course when you want to use this option. This additional parameter will cause that TIMER2 will be used instead of the default TIMER0. |

When you use different pins in different projects, you can use this statement to override the Options Compiler setting for the RC5 pin. This way you will remember which pin you used because it is in your code and you do not have to change the settings from the options. In BASCOM-AVR the settings are also stored in the project.CFG file.

## See also

GETRC5

## Example

```
CONFIG RC5 = PIND.5           'PORTD.5 is the RC5 input line
```

# CONFIG SCL

## Action

Overrides the SCL pin assignment from the Option Compiler Settings.

## Syntax

**CONFIG SCL =** pin

## Remarks

Pin The port pin to which the I2C-SCL line is connected.

When you use different pins in different projects, you can use this statement to override the Options Compiler setting for the SCL pin. This way you will remember which pin you used because it is in your code and you do not have to change the settings from the options. Of course BASCOM-AVR also stores the settings in a project.CFG file.

## See also

CONFIG SDA , CONFIG I2CDELAY

## Example

```
CONFIG SCL = PORTB.5          'PORTB.5 is the SCL line
```

# CONFIG SDA

## Action

Overrides the SDA pin assignment from the Option Compiler Settings.

## Syntax

**CONFIG SDA =** pin

## Remarks

Pin The port pin to which the I2C-SDA line is connected.

When you use different pins in different projects, you can use this statement to override the Options Compiler setting for the SDA pin. This way you will remember which pin you used because it is in your code and you do not have to change the settings from the options. In BASCOM-AVR the settings are also stored in the project.CFG file.

## See also

CONFIG SCL , CONFIG I2CDELAY

## Example

```
CONFIG SDA = PORTB.7          'PORTB.7 is the SDA line
See I2C example for more details.
```

# CONFIG SERIALIN

## Action

Configures the hardware UART to use a buffer for input

## Syntax

CONFIG SERIALIN = BUFFERED , SIZE = size

## Remarks

size A numeric constant that specifies how large the input buffer should be. The space is taken from the SRAM.

The following internal variables will be generated :
_WPOINTER BYTE , a pointer to the location of the buffer that was written last
_RPOINTER BYTE , a pointer to the location of the buffer that was read last
_WCOUNTER BYTE , a counter that holds the number of chars in the buffer calling _recChar0 will decrease this var , when a char is received it will be

increased
_RS232INBUF STRING , the actual buffer with the size of SIZE

## ASM

Routines called from MCS.LIB :
_GotChar. This is an ISR that gets called when ever a character is received.
When there is no room for the data it will not be stored.
So the buffer must be emptied peridic by reading from the serial port using the normal statements like INKEY() and INPUT.

Since URXC interrupt is used by _GotChar, you can not use this interrupt anymore. Unless you modify the _gotchar routine of course.

## See also

CONFIG SERIALOUT

## Example

```
'-----------------------------------------------------------
'                   RS232BUFFER.BAS
'              (c) 2000, MCS Electronics
' This example shows the difference between normal and buffered
' serial INPUT
'-----------------------------------------------------------
$crystal = 4000000
$baud = 9600

'first compile and run this program with the line below remarked
Config Serialin = Buffered , Size = 20


'dim a variable
Dim Name As String * 10

'the enabling of interrupts is not needed for the normal serial mode
'So the line below must be remarked to for the first test
Enable Interrupts

Print "Start"
Do
    'get a char from the UART
   Name = Inkey()

   If Name <> "" Then                                       'was there a char?
      Print Name                                            'print it
   End If

   Wait 1                                                   'wait 1 second
Loop

'You will see that when you slowly enter characters in the terminal emulator
'they will be received/displayed.
'When you enter them fast you will see that you loose some chars

'NOW remove the remarks from line 11 and 18
'and compile and program and run again
'This time the chars are received by an interrupt routine and are
'stored in a buffer. This way you will not loose characters providing that
```

```
'you empty the buffer
'So when you fast type abcdefg, they will be printed after each other with the
'1 second delay

'Using the CONFIG SERIAL=BUFFERED, SIZE = 10 for example will
'use some SRAM memory
'The following internal variables will be generated :
'_WPOINTER   BYTE , a pointer to the location of the buffer that was written last
'_RPOINTER   BYTE , a pointer to the location of the buffer that was read last
'_WCOUNTER   BYTE , a counter that holds the number of chars in the buffer
'calling _recChar0 will decrease this var , when a char is received it will be
increased
'_RS232INBUF STRING , the actual buffer with the size of SIZE
'-----------------------------------------------------
```

# CONFIG SERIALOUT

## Action

Configures the hardware UART to use a buffer for output

## Syntax

CONFIG SERIALOUT = BUFFERED , SIZE = size

## Remarks

size A numeric constant that specifies how large the output buffer should be. The space is taken from the SRAM.

The following internal variables will be used when you use CONFIG SERIALOUT

_wocounter , byte will hold the number of characters waiting in the buffer

_wrpointer , byte will point to the last read position in the buffer

_wopointer , byte will point to the last written location in the buffer

_rs232Outbuf string with the size of config SIZE parameter

## ASM

Routines called from MCS.LIB :

_CHECKSENDCHAR. This is an ISR that gets called when ever the trasmission buffer is empty.

Since URRE interrupt is used , you can not use this interrupt anymore. Unless you modify the _CheckSendChar routine of course.

When you use the PRINT statement to send data to the serial port, the UDRE interrupt will be enabled. And so the _CheckSendChar routine will send the data from the buffer. When there is no more data, the interrupt will be disabled.

## See also

CONFIG SERIALIN

## Example

```
'-----------------------------------------------------------------------------
'                           RS232BUFFEROUT.BAS
'                      (c) 2000 MCS ELectronics
'Sample demonstrates how to use a serial output buffer
'-----------------------------------------------------------------------------
$baud = 9600
$crystal = 4000000

'setup to use a serial output buffer
'and reserve 20 bytes for the buffer
Config Serialout = Buffered , Size = 20

'It is important since UDRE interrupt is used that you enable the interrupts
Enable Interrupts
Print "Hello world"
Do
 Wait 1
 'notice that using the UDRE interrupt will slown down execution of waiting loops like
waitms
 Print "test" ; _wrpointer
Loop
End

'The following internal variables will be used when you use CONFIG SERIALOUT
'_wocounter , byte will hold the number of characters waiting in the buffer
'_wrpointer , byte will point to the last read position in the buffer
'_wopointer , byte will point to the last written location in the buffer
'_rs232Outbuf string with the size of config SIZE paramter
```

# CONFIG SERVOS

## Action

Configures how much servo's will be controlled.

## Syntax

CONFIG SERVOS = X , Servo1 = Portb.0 , Servo2 = Portb.1 , Reload = rl

## Remarks

Servo's need a variable pulse in order to operate. The CONFIG SERVOS directive will se up a byte array with the servo pulse width values and will initialize an ISR that uses TIMER0.

| | |
|---|---|
| X | The number of servo's you want to control. Each used servo will use one byte of SRAM. |
| PORT | The port pin the servo is attached too. |
| RL | The reload value for the ISR in uS. |

When you use for example :

**Config Servos = 2 , Servo1 = Portb.0 , Servo2 = Portb.1 , Reload = 100**

The internal ISR will execute every 100 uS.

An arrays named SERVO() will be created and it can hold 2 bytes : servo(1) and servo(2).

By setting the value of the servo() array you control how long the positive pulse will last. After it has reached this value it will be reset to 0.

The PORT pins specified must be set to work as an output pin by the user.

CONFIG PINB.0 = OUTPUT

Will set a pin to output mode.

## Resources used

TIMER0 is used to create the ISR.

## ASM

NONE

## Example

```
'-----------------------------------------------------------
-----------------
'                           (c) 2001 MCS Electronics
'                             servo.bas demonstrates the
SERVO option
'-----------------------------------------------------------
```

```
----------------

'Servo's need a pulse in order to operate
'with the config statement CONFIG SERVOS we can specify
how many servo's we
'will use and which port pins are used
'A maximum of 16 servos might be used
'The SERVO statements use one byte for an interrupt
counter and the TIMER0
'This means that you can not use TIMER0 anymore
'The reload value specifies the interval of the timer
in uS
Config Servos = 2 , Servo1 = Portb.0 , Servo2 = Portb.1
, Reload = 100
'we use 2 servos with 100 uS resolution

'we must configure the port pins used to act as output
Config Portb = Output

'finally we must turn on the global interrupt
Enable Interrupts

'the servo() array is created automatic. You can used
it to set the
'time the servo must be on
Servo(1) = 10
'1000 uS on
Servo(2) = 20
' 2000 uS on


Dim I As Byte
Do
 For I = 1 To 20
   Servo(1) = I
   Waitms 1000
 Next

 For I = 20 To 1 Step -1
   Servo(1) = I
   Waitms 1000
 Next
Loop
End
```

## CONFIG SPI

Action

Configures the SPI related statements.

## Syntax for software SPI

CONFIG SPI = SOFT, DIN = PIN, DOUT = PIN , SS = PIN, CLOCK = PIN

## Syntax for hardware SPI

CONFIG SPI = HARD, DATA ORDER = LSB|MSB , MASTER = YES|NO , POLARITY = HIGH|LOW , PHASE = 0|1, CLOCKRATE = 4|16|64|128

## Remarks

| | |
|---|---|
| SPI | **SOFT** for software emulation of SPI, this lets you choose the PINS to use.<br><br>**HARD** for the internal SPI hardware, that will use fixed pins. |
| DIN | Data input or MISO. Pin is the pin number to use such as PINB.0 |
| DOUT | Data output or MOSI. Pin is the pin number to use such as PORTB.1 |
| SS | Slave Select. Pin is the pin number to use such as PORTB.2 |
| CLOCK | Clock. Pin is the pin number to use such as PORTB.3 |
| DATA ORDER | Selects if MSB or LSB is transferred first. |
| MASTER | Selects if the SPI is run in master or slave mode. |
| POLARITY | Select HIGH to make the CLOCK line high while the SPI is idle. LOW will make clock LOW while idle. |
| PHASE | Refer to a data sheet to learn about the different settings in combination with polarity. |
| CLOCKRATE | The clock rate selects the division of the of the oscillator frequency that serves as the SPI clock. So with 4 you will have a clockrate of 4.000000 / 4 = 1 MHz , when a 4 MHZ XTAL is used. |

The default setting for hardware SPI when set from the Compiler, Options, SPI menu is MSB first, POLARITY = HIGH, MASTER = YES, PHASE = 0, CLOCKRATE = 4

When you use CONFIG SPI = HARD alone without the other parameters, the SPI will only be enabled. It will work in slave mode then with CPOL =0 and

CPH=0.

In hardware mode the SPIINIT statement will set the SPI pins to :

```
sbi DDRB,7                    ; SCK output
cbi DDRB,6                    ; MISO input
sbi DDRB,5                    ; MOSI output
```

In softmode the SPIINIT statement will set the SPI pins for example to :

```
sbi PORTB,5                   ;set latch bit hi (inactive)SS
sbi DDRB,5                    ;make it an output SS
cbi PORTB,4                   ;set clk line lo
sbi DDRB,4                    ;make it an output
cbi PORTB,6                   ;set data-out lo MOSI
sbi DDRB,6                    ;make it an output MOSI
cbi DDRB,7                    ;MISO input
Ret
```

## See also

SPIIN , SPIOUT , SPIINIT

## Example

```
Config SPI = SOFT, DIN = PINB.0 , DOUT = PORTB.1, SS = PORTB.2, CLOCK
= PORTB.3
Dim var As Byte
SPIINIT           'Init SPI state and pins.
SPIOUT var , 1 'send 1 byte
```

# CONFIG TIMER0

## Action

Configure TIMER0.

## Syntax

**CONFIG** TIMER0 = COUNTER , EDGE=RISING/FALLING

**CONFIG** TIMER0 = TIMER , PRESCALE= 1|8|64|256|1024

## Remarks

TIMER0 is a 8 bit counter. See the hardware description of TIMER0.

When configured as a COUNTER:

EDGE You can select whether the TIMER will count on the falling or rising edge.

When configured as a TIMER:

PRESCALE The TIMER is connected to the system clock in this case. You can select the division of the system clock with this parameter. Valid values are 1 , 8, 64, 256 or 1024

When you use the CONFIG TIMER0 statement, the mode is stored by the compiler and the TCCRO register is set.

When you use the STOP TIMER0 statement, the TIMER is stopped.

When you use the START TIMER0 statement, the TIMER TCCR0 register is loaded with the last value that was configured with the CONFIG TIMER0 statement.

So before using the START and STOP TIMER0 statements, use the CONFIG statement first.

## Example

```
'-----------------------------------------------------------------------
'                     TIMER0.BAS
'     example that shows how to use TIMER0 related statements
'-----------------------------------------------------------------------

'First you must configure the timer to operate as a counter or as a timer
'Lets configure it as a COUNTER now
'You must also specify if it will count on a rising or falling edge

Config Timer0 = Counter , Edge = Rising
```

```
'Config Timer0 = Counter , Edge = falling
'unremark the line aboven to use timer0 to count on falling edge

'To get/set the value from the timer access the timer/counter register
'lets reset it to 0
Tcnt0 = 0

Do
  Print Tcnt0
Loop Until Tcnt0 >= 10
'when 10 pulses are count the loop is exited
'or use the special variable TIMER0
Timer0 = 0


'Now configire it as a TIMER
'The TIMER can have the systemclock as an input or the systemclock divided
'by 8,64,256 or 1024
'The prescale parameter excepts 1,8,64,256 or 1024
Config Timer0 = Timer , Prescale = 1

'The TIMER is started now automaticly
'You can STOP the timer with the following statement :
Stop Timer0

'Now the timer is stopped
'To START it again in the last configured mode, use :
Start Timer0

'Again you can access the value with the tcnt0 register
Print Tcnt0
'or
Print Timer0
'when the timer overflows, a flag named TOV0 in register TIFR is set
'You can use this to execute an ISR
'To reset the flag manual in non ISR mode you must write a 1 to the bit position
'in TIFR:
Set Tifr.1



'The following code shows how to use the TIMER0 in interrupt mode
'The code is block remarked with '(  en ')

'(

'Configute the timer to use the clock divided by 1024
Config Timer0 = Timer , Prescale = 1024

'Define the ISR handler
On Ovf0 Tim0_isr
'you may also use TIMER0 for OVF0, it is the same

Enable Timer0                                              ' enable the timer
interrupt
Enable Interrupts                                          'allow interrupts to
occur
Do
   'your program goes here
Loop

'the following code is executed when the timer rolls over
Tim0_isr:
  Print "*";
Return

')

End
```

## CONFIG TIMER1

### Action

Configure TIMER1.

## Syntax

**CONFIG** TIMER1 = COUNTER | TIMER | PWM ,
EDGE=RISING | FALLING , PRESCALE= 1|8|64|256|1024 ,
NOICE CANCEL=0 |1, CAPTURE EDGE = RISING | FALLING ,
COMPARE A = CLEAR | SET | TOGGLE I DISCONNECT ,
COMPARE B = CLEAR | SET | TOGGLE I DISCONNECT ,
PWM = 8 | 9 10 ,
COMPARE A PWM = CLEAR UP| CLEAR DOWN | DISCONNECT
COMPARE B PWM = CLEAR UP| CLEAR DOWN | DISCONNECT

## Remarks

The TIMER1 is a 16 bit counter. See the hardware description of TIMER1.

It depends on the chip if COMPARE B is available or not.

The syntax shown above must be on one line. Not all the options need to be selected.

Here is the effect of the various options.

| | |
|---|---|
| EDGE | You can select whether the TIMER will count on the falling or rising edge. Only for COUNTER mode. |
| CAPTURE EDGE | You can choose to capture the TIMER registers to the INPUT CAPTURE registers<br>With the CAPTURE EDGE = FALLING/RISING, you can specify to capture on the falling or rising edge of pin ICP |
| NOICE CANCELING | To allow noise canceling you can provide a value of 1. |
| PRESCALE | The TIMER is connected to the system clock in this case. You can select the division of the system clock with this parameter. Valid values are 1 , 8, 64, 256 or 1024 |

The TIMER1 also has two compare registers A and B

When the timer value matches a compare register, an action can be performed

COMPARE A — The action can be:
SET will set the OC1X pin
CLEAR will clear the OC1X pin
TOGGLE will toggle the OC1X pin
DISCONNECT will disconnect the TIMER from output pin OC1X

And the TIMER can be used in PWM mode

You have the choice between 8, 9 or 10 bit PWM mode

Also you can specify if the counter must count UP or down after a match

to the compare registers

Note that there are two compare registers A and B

PWM — Can be 8, 9 or 10.

COMPARE A PWM — PWM compare mode. Can be CLEAR UP or CLEAR DOWN

Using COMPARE A, COMPARE B, COMPARE A PWM or COMPARE B PWM will set the corresponding pin for output. When this is not wanted you can use the alternative NO_OUTPUT version that will not alter the output pin.

For example : COMPARE A NO_OUTPUT , COMPARE A PWM NO_OUTPUT

## Example

```
'-----------------------------------------------------------------------
'                       TIMER1.BAS  for the 8515
'-----------------------------------------------------------------------

Dim W As Word

'The TIMER1 is a versatile 16 bit TIMER.
'This example shows how to configure the TIMER

'First like TIMER0 , it can be set to act as a TIMER or COUNTER
'Lets configure it as a TIMER that means that it will count and that
'the input is provided by the internal clock.
'The internal clock can be divided by 1,8,64,256 or 1024
Config Timer1 = Timer , Prescale = 1024


'You can read or write to the timer with the COUNTER1 or TIMER1 variable
W = Timer1
Timer1 = W


'To use it as a COUNTER, you can choose on which edge it is triggered
Config Timer1 = Counter , Edge = Falling
'Config Timer1 = Counter , Edge = Rising

'Also you can choose to capture the TIMER registers to the INPUT CAPTURE registers
```

```
'With the CAPTURE EDGE = , you can specify to capture on the falling or rising edge of
pin ICP
Config Timer1 = Counter , Edge = Falling , Capture Edge = Falling
'Config Timer1 = Counter , Edge = Falling , Capture Edge = Rising

'To allow noise canceling you can also provide :
Config Timer1 = Counter , Edge = Falling , Capture Edge = Falling , Noice Cancel = 1

'to read the input capture register :
W = Capture1
'to write to the capture register :
Capture1 = W



'The TIMER also has two compare registers A and B
'When the timer value matches a compare register, an action can be performed
Config Timer1 = Counter , Edge = Falling , Compare A = Set , Compare B = Toggle
'SET , will set the OC1X pin
'CLEAR, will clear the OC1X pin
'TOGGLE, will toggle the OC1X pin
'DISCONNECT, will disconnect the TIMER from output pin OC1X


'To read write the compare registers, you can use the COMPARE1A and COMPARE1B
variables
Compare1a = W
W = Compare1a


'And the TIMER can be used in PWM mode
'You have the choice between 8,9 or 10 bit PWM mode
'Also you can specify if the counter must count UP or down after a match
'to the compare registers
'Note that there are two compare registers A and B
Config Timer1 = Pwm , Pwm = 8 , Compare A Pwm = Clear Up , Compare B Pwm = Clear Down

'to set the PWM registers, just assign a value to the compare A and B registers
Compare1a = 100
Compare1b = 200

'Or for better reading :
Pwm1a = 100
Pwm1b = 200

End
```

## CONFIG TIMER2

## Action

Configure TIMER2.

## Syntax for the 8535

**CONFIG** TIMER2 = TIMER | PWM , ASYNC=ON |OFF,

PRESCALE = 1 | 8 | 32 | 64 | 128 | 256 | 1024 ,

COMPARE = CLEAR | SET | TOGGLE I DISCONNECT ,

PWM = ON | OFF ,

COMPARE PWM = CLEAR UP| CLEAR DOWN | DISCONNECT

## Syntax for the M103

**CONFIG** TIMER2 = COUNTER| TIMER | PWM ,

EDGE= FALLING |RISING,

PRESCALE = 1 | 8 | 64 | 256 | 1024 ,

COMPARE = CLEAR | SET | TOGGLE I DISCONNECT ,

PWM = ON | OFF ,

COMPARE PWM = CLEAR UP| CLEAR DOWN | DISCONNECT

## Remarks

The TIMER2 is an 8 bit counter.

It depends on the chip if it can work as a counter or not.

The syntax shown above must be on one line. Not all the options need to be selected.

Here is the effect of the various options.

| | |
|---|---|
| EDGE | You can select whether the TIMER will count on the falling or rising edge. Only for COUNTER mode. |
| PRESCALE | The TIMER is connected to the system clock in this case. You can select the division of the system clock with this parameter. Valid values are 1 , 8, 64, 256 or 1024<br>or<br>1 , 8, 32 , 64 , 256 or 1024 for the M103 |

The TIMER2 also has a compare registers

When the timer value matches a compare register, an action can be performed

| | |
|---|---|
| COMPARE | The action can be:<br>SET will set the OC2 pin |

CLEAR will clear the OC2 pin
TOGGLE will toggle the OC2 pin
DISCONNECT will disconnect the TIMER from output pin OC2

And the TIMER can be used in 8 bit PWM mode

You can specify if the counter must count UP or down after a match

to the compare registers

COMPARE PWM PWM compare mode. Can be CLEAR UP or CLEAR DOWN

## Example

```
'-----------------------------------------------------------------------

Dim W As Byte

Config Timer2 = Timer , ASYNC = 1 , Prescale = 128
On TIMER2 Myisr
ENABLE INTERRUPTS
ENABLE TIMER2
DO

LOOP

MYISR:
'get here every second with a 32768 KHz xtal
RETURN

'You can read or write to the timer with the COUNTER2 or TIMER2
variable
W = Timer2
Timer2 = W
```

# CONFIG WAITSUART

## Action

Compiler directive that specifies that software UART waits after sending the

last byte.

## Syntax

**CONFIG WAITSUART =** value

## Remarks

value A numeric value in the range of 1-255.
A higher value means a longer delay in mS.

When the software UART routine are used in combination with serial LCD displays it can be convenient to specify a delay so the display can process the data.

## See also

OPEN

## Example

```
See OPEN example for more details.
```

# CONFIG WATCHDOG

## Action

Configures the watchdog timer.

## Syntax

**CONFIG WATCHDOG** = time

## Remarks

Time The interval constant in mS the watchdog timer will count to before it will reset your program.

Possible settings :
16 , 32, 64 , 128 , 256 , 512 , 1024 and 2048.

When the WD is started, a reset will occur after the specified number of mS.

With 2048, a reset will occur after 2 seconds, so you need to reset the WD in your programs periodically with the **RESET WATCHDOG** statement.

## See also

START WATCHDOG , STOP WATCHDOG , RESET WATCHDOG

## Example

```
'-----------------------------------------------------
'               (c) 1999 MCS Electronics
' WATCHD.BAS demonstrates the watchdog timer
'-----------------------------------------------------
Config Watchdog = 2048                                      'reset after 2048 mSec
Start Watchdog                                              'start the watchdog
timer
Dim I As Word
For I = 1 To 1000

  Print I                                 'print value
  'Reset Watchdog
  'you will notice that the for next doesnt finish because of the reset
  'when you unmark the RESET WATCHDOG statement it will finish because the
  'wd-timer is reset before it reaches 2048 msec
Next
End
```

# CONST

## Action

Declares a symbolic constant.

## Syntax

CONST symbol = numconst

CONST symbol = stringconst

CONST symbol = expression

## Remarks

| | |
|---|---|
| Symbol | The name of the symbol. |
| Numconst | The numeric value to assign to the symbol. |
| Stringconst | The string to assign to the symbol |
| Expression | An expression that returns a value to assign the constant |

Assigned constants consume no program memory because they only serve as a reference to the compiler.

The compiler will replace all occurrences of the symbol with the assigned value.

## See also

ALIAS

## Difference with BASCOM-8051

In BASCOM-8051 only numeric constants can be used.

## Example

```
'dimension some variables
Dim Z As String * 10
Dim B As Byte

'assign some constants
'constants dont use program memory
Const S = "test"
Const A = 5
'declare a as a constant
Const B1 = &B1001

'or use an expression to assign a constant
Const X = (b1 * 3) + 2
Const Ssingle = Sin(1)
```

# COUNTER0 and COUNTER1

## Action

Set or retrieve the internal 16 bit hardware register.

## Syntax

| | |
|---|---|
| COUNTER0 = var<br>var = COUNTER0 | TIMER0 can also be used |
| COUNTER1 = var<br>var = COUNTER1 | TIMER1 can also be used |
| CAPTURE1 = var<br>var = CAPTURE1 | TIMER1 capture register |
| COMPARE1A = var<br>var = COMPARE1A | TIMER1 COMPARE A register |
| COMARE1B = var<br>var = COMPARE1B | TIMER1 COMPARE B register |
| PWM1A = var<br>var = PWM1A | TIMER1 COMPAREA register. (Is used for PWM) |
| PWM1B = var<br>var = PRM1B | TIMER1 COMPARE B register. (Is used for PWM) |

## Remarks

Var A byte, Integer/Word variable or constant that is assigned to the register or is read from the register.

Because the above 16 bit register pairs must be accessed somewhat differently than you may expect, they are implemented as variables.

The exception is TIMER0/COUNTER0, this is a normal 8 bit register and is supplied for compatibility with the syntax.

When the CPU reads the low byte of the register, the data of the low byte is sent to the CPU and the data of the high byte is placed in a temp register. When the CPU reads the data in the high byte, the CPU receives the data in the temp register.

When the CPU writes to the high byte of the register pair, the written data is

placed in a temp register. Next when the CPU writes the low byte, this byte of data is combined with the byte data in the temp register and all 16 bits are written to the register pairs. So the MSB must be accessed first.

All of the above is handled automatically by BASCOM when accessing the above registers.

Note that the available registers may vary from chip to chip.

The BASCOM documentation used the 8515 to describe the different hardware registers.

## CPEEK

### Action

Returns a byte stored in code memory.

### Syntax

var **= CPEEK(** address **)**

### Remarks

| | |
|---|---|
| Var | Numeric variable that is assigned with the content of the program memory at address |
| Address | Numeric variable or constant with the address location |

There is no CPOKE statement because you can not write into program memory.

Cpeek(0) will return the first byte of the file. Cpeek(1) will return the second byte of the binary file.

### See also

PEEK , POKE , INP , OUT

## Example

```
'-----------------------------------------------------
'              (c) 1998-2000 MCS Electronics
'                   PEEK.BAS
' demonstrates PEEk, POKE, CPEEK, INP and OUT
'
'-----------------------------------------------------
Dim I As Integer , B1 As Byte
'dump internal memory
For I = 0 To 31                                 'only 32 registers in AVR
  B1 = Peek(i)                                  'get byte from internal memory
  Print Hex(b1) ; "  ";
  'Poke I , 1                                   'write a value into memory
Next
Print                                           'new line
'be careful when writing into internal memory !!

'now dump a part ofthe code-memory(program)
For I = 0 To 255
  B1 = Cpeek(i)                                 'get byte from internal memory
  Print Hex(b1) ; "  ";
Next
'note that you can not write into codememory!!

Out &H8000 , 1                                  'write 1 into XRAM at address 8000
B1 = INP(&H8000)                                'return value from XRAM
Print B1

End
```

# CPEEKH

## Action

Returns a byte stored in upper page of code memory of M103.

## Syntax

var **= CPEEKH(** address **)**

## Remarks

| | |
|---|---|
| Var | Numeric variable that is assigned with the content of the program memory at address |
| Address | Numeric variable or constant with the address location |

CpeekH(0) will return the first byte of the upper 64KB.

Since the M103 has 64K words of code space the LPM instruction can not

access the 64 upper Kbytes.

The CpeekH() function peeks in the upper 64 KB.

This function should be used with the M103 only.

## See also

PEEK , POKE , INP , OUT

## Example

```
'-----------------------------------------------------
'              (c) 1998-2000 MCS Electronics
'                   PEEK.BAS
' demonstrates PEEk, POKE, CPEEK, INP and OUT
'
'-----------------------------------------------------
Dim I As Integer , B1 As Byte
'dump internal memory
For I = 0 To 31                                             'only 32 registers in
AVR
  B1 = Peek(i)                                              'get byte from internal
memory
  Print Hex(b1) ; "  ";
  'Poke I , 1                              'write a value into memory
Next
Print                                     'new line
'be careful when writing into internal memory !!

'now dump a part ofthe code-memory(program)
For I = 0 To 255
  B1 = Cpeek(i)                           'get byte from internal memory
  Print Hex(b1) ; "  ";
Next
'note that you can not write into codememory!!

Out &H8000 , 1                            'write 1 into XRAM at address 8000
B1 = INP(&H8000)                          'return value from XRAM
Print B1

End
```

# CRC8

## Action

Returns the CRC8 value of a variable or array.

## Syntax

Var = **CRC8**( source , L)

## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the CRC8 of variable source. |
| Source | The source variable or first element of the array to get the CRC8 of. |
| L | The number of bytes to check. |

CRC8 is used in communication protocols to check if there are no transmission errors.

The 1wire for example returns a crc byte as the last byte from it's ID.

## See also

CHECKSUM

## ASM

The following routine is called from mcs.lib : _CRC8

The routine must be called with Z pointing to the data and R24 must contain the number of bytes to check.

On return, R16 contains the CRC8 value.

The used registers are : R16-R19, R25.

```
;##### X = Crc8(ar(1) , 7)
Ldi R24,$07                    ; number of bytes
Ldi R30,$64                    ; address of ar(1)
Ldi R31,$00                    ; load constant in register
Rcall _Crc8                    ; call routine
Ldi R26,$60                    ; address of X
St X,R16                       ; store crc8
```

## Example

```
Dim Ar(8) As Byte , X As Byte

'init array
Ar(1) = &H2
Ar(2) = &H1C
Ar(3) = &HB8
```

```
Ar(4) = 1
Ar(5) = 0
Ar(6) = 0
Ar(7) = 0

'get crc8 of array. Scan 7 bytes
X = Crc8(ar(1) , 7)
```

# CRYSTAL

## Action

Special byte variable that can be used with software UART routine to change the baudrate during runtime.

## Syntax

**CRYSTAL = var (old option do not use !!)**

**___CRYSTAL1 = var**

**BAUD #1, 2400**

## Remarks

With the software UART you can generate good baud rates. But chips such as the ATtiny22 have an internal 1 MHz clock. The clock frequency can change during runtime by influence of temperature or voltage.

The crystal variable can be changed during runtime to change the baud rate.

The above has been changed in version 1.11

Now you still can change the baud rate with the crystal variable.

But you dont need to dimension it. And the name has been changed:

___CRYSTALx where x is the channel number.

When you opened the channel with #1, the variable will be named ___CRYSTAL1

But a better way is provided now to change the baud rate of the software uart at run time. You can use the BAUD option now:

Baud #1 , 2400 'change baud rate to 2400 for channel 1

When you use the baud # option, you must specify the baud rate before you

print or use input on the channel. This will dimension the ___CRYSTALx variable and load it with the right value.

When you don't use the BAUD # option the value will be loaded from code and it will not use 2 bytes of your SRAM.

The ___CRYSTALx variable is hidden in the report file because it is a system variable. But you may assign a value to it after BAUD #x, zzzz has dimensioned it.

The old CRYSTAL variable does not exist anymore.

Some values for 1 MHz internal clock :

66 for 2400 baud

31 for 4800 baud

14 for 9600 baud

## See also

OPEN , CLOSE

## Example

```
Dim B as byte
Open "comd.1:9600,8,n,1,inverted" For Output As #1
Print #1 , B
Print #1 , "serial output"
baud #1, 4800 'use 4800 baud now
Print #1, "serial output"
___CRYSTAL1 = 255
Close #1
End
```

# CURSOR

## Action

Set the LCD Cursor State.

## Syntax

**CURSOR ON / OFF BLINK / NOBLINK**

## Remarks

You can use both the ON or OFF and BLINK or NOBLINK parameters.

At power up the cursor state is ON and NOBLINK.

## See also

DISPLAY , LCD

## Example

```
Dim a As Byte
a = 255
Lcd A
Cursor Off                                  'hide cursor
Wait 1                                      'wait 1 second
Cursor Blink                                'blink cursor
End
```

# DATA

## Action

Specifies constant values to be read by subsequent READ statements.

## Syntax

**DATA** var [, varn]

## Remarks

Var Numeric or string constant.

The DATA related statements use the internal registers pair R8 and R9 to store the data pointer.

To store a " sign on the data line, you can use :

DATA $34

The $-sign tells the compiler that the ASCII value will follow of the character.

You can also use this to store special characters that can't be written by the editor such as chr(7)

Because the DATA statements allows you to generate an EEP file to store in EEPROM, the $DATA and $EEPROM directives have been added. Read the description of these directives to learn more about the DATA statement.

The DATA statements must not be accessed by the flow of your program because the DATA statements are converted to the byte representation of the DATA.

When your program flow enters the DATA lines, unpredictable results will occur.

So as in QB, the DATA statement is best be placed at the end of your program or in a place that program flow will no enter.

For example this is fine:

```
Print "Hello"
Goto jump
DATA "test"

Jump:
'because we jump over the data lines there is no problem.
```

The following example will case some problems:

```
Dim S As String * 10
Print "Hello"
Restore lbl
Read S
DATA "test"
Print S
```

When the END statement is used it must be placed BEFORE the DATA lines.

## Difference with QB

Integer and Word constants must end with the **%** -sign.

Long constants must end with the **&**-sign.

Single constants must end with the **!**-sign.

## See also

READ , RESTORE , $DATA , $EEPROM

## Example

```
'-----------------------------------------------------------
'                    READDATA.BAS
'             Copyright 1999-2000 MCS Electronics
'-----------------------------------------------------------

Dim A As Integer , B1 As Byte , Count As Byte
Dim S As String * 15
Dim L As Long
Restore Dta1                                                'point to stored data
For Count = 1 To 3                                          'for number of data items
   Read B1 : Print Count ; "  " ; B1
Next

Restore Dta2                                                'point to stored data
For Count = 1 To 2                                          'for number of data items
   Read A : Print Count ; "  " ; A
Next

Restore Dta3
Read S : Print S
Read S : Print S


Restore Dta4
Read L : Print L                                              'long type

End


Dta1:
Data &B10 , &HFF , 10
Dta2:
Data 1000% , -1%

Dta3:
Data "Hello" , "World"
'Note that integer values (>255 or <0) must end with the %-sign
'also note that the data type must match the variable type that is
'used for the READ statement

Dta4:
Data 123456789&
'Note that LONG values must end with the &-sign
'Also note that the data type must match the variable type that is used
'for the READ statement
```

# DATE$

## Action

Internal variable that holds the date.

## Syntax

**DATE$ = "mm/dd/yy"**

**var = DATE$**

## Remarks

The DATE$ variable is used in combination with the CONFIG CLOCK directive.

The CONFIG CLOCK statement will use the TIMER0 or TIMER2 in async mode to create a 1 second interrupt. In this interrupt routine the _Sec, _Min and _Hour variables are updated. The _dat, month and _year variables are also updated. The date format is in the same format as for QB/VB.

When you assign DATE$ to a string variable these variables are assigned to the DATE$ variable.

When you assign the DATE$ variable with a constant or other variable, the _day, _month and _year variables will be changed to the new date.

The only difference with QB/VB is that all data must be provided when assigning the date. This is done for minimal code. You can change this behavior of course.

The async timer is only available in the M103, 90S8535, M163 and M32(3). For other chips it will not work.

## ASM

The following asm routines are called.

When assiging DATE$ : _set_date (calls _str2byte)

When reading DATE$ : _make_dt (calls _byte2str)

## See also

TIME$ , CONFIG CLOCK

## Example

```
'-----------------------------------------------------------
'                      MEGACLOCK.BAS
'                  (c) 2000-2001 MCS Electronics
'-----------------------------------------------------------
'This example shows the new TIME$ and DATE$ reserved variables
'With the 8535 and timer2 or the Mega103 and TIMER0 you can
'easily implement a clock by attaching a 32.768 KHz xtal to the timer
'And of course some BASCOM code

'This example is written for the STK300 with M103
Enable Interrupts

'[configure LCD]
$lcd = &HC000                           'address for E and RS
$lcdrs = &H8000                         'address for only E
Config Lcd = 20 * 4                     'nice display from bg micro
Config Lcdbus = 4                       'we run it in bus mode and I hooked up only
db4-db7
Config Lcdmode = Bus                    'tell about the bus mode

'[now init the clock]
Config Clock = Soft                     'this is how simple it is
'The above statement will bind in an ISR so you can not use the TIMER anymore!
'For the M103 in this case it means that TIMER0 can not be used by the user anymore

'assign the date to the reserved date$
'The format is MM/DD/YY
Date$ = "11/11/00"

'assign the time, format in hh:mm:ss military format(24 hours)
'You may not use 1:2:3 !! adding support for this would mean overhead
'But of course you can alter the library routines used

Time$ = "02:20:00"

'clear the LCD display
Cls

Do
  Home                                  'cursor home
  Lcd Date$ ; "   " ; Time$             'show the date and time
Loop

'The clock routine does use the following internal variables:
'_day , _month, _year , _sec, _hour, _min
'These are all bytes. You can assign or use them directly
_day = 1
'For the _year variable only the year is stored, not the century
End
```

# DEBOUNCE

## Action

Debounce a port pin connected to a switch.

## Syntax

**DEBOUNCE** Px.y , state , label [ , SUB]

## Remarks

| | |
|---|---|
| Px.y | A port pin like PINB.0 , to examine. |
| State | 0 for jumping when PINx.y is low , 1 for jumping when PINx.y is high |
| Label | The label to GOTO when the specified state is detected |
| SUB | The label to GOSUB when the specified state is detected |

When you specify the optional parameter SUB, a GOSUB to label is performed instead of a GOTO.

The DEBOUNCE statements wait for a port pin to get high(1) or low(0).

When it does it waits 25 mS and checks again (eliminating bounce of a switch)

When the condition is still true and there was no branch before, it branches to the label.

When DEBOUNCE is executed again, the state of the switch must have gone back in the original position before it can perform another branch.

Each DEBOUNCE statement which use a different port uses 1 BIT of the internal memory to hold its state.

## See also

CONFIG DEBOUNCE

## Example

```
'-----------------------------------------------------
'                 DEBOUN.BAS
'           Demonstrates DEBOUNCE
'-----------------------------------------------------
Config Debounce = 30                                    'when the config
statement is not used a default of 25mS will be used
```

```
  'Debounce Pind.0 , 1 , Pr 'try this for branching when high(1)
  Debounce Pind.0 , 0 , Pr , Sub
  Debounce Pind.0 , 0 , Pr , Sub
  '                  ^----- label to branch to
  '               ^---------- Branch when P1.0 goes low(0)
  '          ^----------------- Examine P1.0

  'When Pind.0 goes low jump to subroutine Pr
  'Pind.0 must go high again before it jumps again
  'to the label Pr when Pind.0 is low

  Debounce Pind.0 , 1 , Pr                                    'no branch
  Debounce Pind.0 , 1 , Pr                                    'will result in a return
without gosub
End

Pr:
  Print "PIND.0 was/is low"
Return
```

# DECLARE FUNCTION

## Action

Declares a user function.

## Syntax

**DECLARE FUNCTION TEST[**( [BYREF/BYVAL] var as type)] As type

## Remarks

| | |
|---|---|
| test | Name of the function. |
| Var | Name of the variable(s). |
| Type | Type of the variable(s) and of the result. Byte,Word, Integer, Long, Single or String. |

When BYREF or BYVAL is not provided, the parameter will be passed by reference.

Use BYREF to pass a variable by reference with its address.

Use BYVAL to pass a copy of the variable.

See the CALL statement for more details.

You must declare each function before writing the function or calling the function.

Bits are global and can not be passed with functions or subs.

## See also

CALL, SUB

## Example

```
'-----------------------------------------------------------------------
'                      (c) 1999-2000 MCS Electronics
'                      Demonstration of user function
'-----------------------------------------------------------------------

'A user function must be declare before it can be used.
'A function must return a type
Declare Function Myfunction(byval I As Integer , S As String) As Integer
'The byval paramter will pass the parameter by value so the original value
'will not be changed by the function

Dim K As Integer
Dim Z As String * 10
Dim T As Integer
'assign the values
K = 5
Z = "123"

T = Myfunction(k , Z)
Print T
End


Function Myfunction(byval I As Integer , S As String) As Integer
  'you can use local variables in subs and functions
  Local P As Integer

  P = I

  'because I is passed by value, altering will not change the original
  'variable named k
  I = 10

  P = Val(s) + I

  'finally assign result
  'Note that the same data type must be used !
  'So when declared as an Integer function, the result can only be
  'assigned with an Integer in this case.
  Myfunction = P
End Function
```

# DECLARE SUB

## Action

Declares a subroutine.

## Syntax

**DECLARE SUB TEST[**( [BYREF/BYVAL] var as type)]

## Remarks

test Name of the procedure.

Var Name of the variable(s).

Type Type of the variable(s). Byte, Word, Integer, Long, Single or String.

When BYREF or BYVAL is not provided, the parameter will be passed by reference.

Use BYREF to pass a variable by reference with its address.

Use BYVAL to pass a copy of the variable.

See the CALL statement for more details.

You must declare each sub before writing or calling the sub procedure.

Bits are global and can not be passed to a sub or function.

## See also

CALL, SUB

## Example

```
Dim a As Byte, b1 As Byte, c As Byte
Declare Sub Test(a As Byte)
a = 1 : b1 = 2: c = 3

Print a ; b1 ; c

Call Test(b1)
Print a ;b1 ; c
End


Sub Test(a as byte)
  Print a ; b1 ; c
End Sub
```

# DECR

## Action

Decrements a variable by one.

## Syntax

**DECR** var

## Remarks

Var Variable to decrement.

**var : Byte, Integer, Word, Long, Single.**

There are often situations where you want a number to be decreased by 1.

The Decr statement is provided for compatibility with BASCOM-8051.

## See also

INCR

## Example

```
'-----------------------------------------------------------
'                     (c) 2000 MCS Electronics
'-----------------------------------------------------------
'  file: DECR.BAS
'  Demo: DECR
'-----------------------------------------------------------
Dim A As Byte , I As Integer

A = 5                                   'assign value to a
Decr A                                  'decrease (by one)
Print A                                 'print it


I = 1000
Decr I
Print I
End
```

# DEFxxx

## Action

Declares all variables that are not dimensioned of the DefXXX type.

## Syntax

| | |
|---|---|
| DEFBIT b | Define BIT |
| DEFBYTE c | Define BYTE |
| DEFINT I | Define INTEGER |
| DEFWORD x | Define WORD |
| DEFLNG I | Define LONG |
| DEFSNG s | Define SINGLE |

### Difference with QB

QB allows you to specify a range like DEFINT A - D. BASCOM doesn't support this.

## Example

```
Defbit b : DefInt c      'default type for bit and integers
Set b1                   'set bit to 1
c = 10                   'let c = 10
```

# DEFLCDCHAR

## Action

Define a custom LCD character.

## Syntax

**DEFLCDCHAR char,r1,r2,r3,r4,r5,r6,r7,r8**

## Remarks

| | |
|---|---|
| char | Constant representing the character (0-7). |
| r1-r8 | The row values for the character. |

You can use the LCD designer to build the characters.

It is important that a CLS follows the DEFLCDCHAR statement(s).

Special characters can be printed with the Chr() function.

## See also

Tools LCD designer

## Example

```
Deflcdchar 0 , 1 , 2 , 3 , 4 , 5 , 6 , 7 , 8              'define special character
Cls                                                       'select LCD DATA RAM
Lcd Chr(0)                                                'show the character
End
```

# DELAY

## Action

Delay program execution for a short time.

## Syntax

DELAY

## Remarks

Use DELAY to wait for a short time.

The delay time is ca. 1000 microseconds.

## See also

WAIT , WAITMS

## Example

```
Portb = 5
Delay
```

# DIM

## Action

Dimension a variable.

## Syntax

**DIM** var **AS [XRAM/SRAM/ERAM]** type [AT location]

## Remarks

| | |
|---|---|
| Var | Any valid variable name such as b1, i or longname. var can also be an array : ar(10) for example. |
| Type | Bit, Byte, Word, Integer, Long, Single or String |
| XRAM | Specify XRAM to store variable into external memory |
| SRAM | Specify SRAM to store variable into internal memory (default) |
| ERAM | Specify ERAM to store the variable into EEPROM |

A string variable needs an additional length parameter:

Dim s As XRAM **String * 10**

In this case, the string can have a maximum length of 10 characters.

Note that BITS can only be stored in internal memory.

The optional AT parameter lets you specify where in memory the variable must be stored. When the memory location already is occupied, the first free memory location will be used.

### Difference with QB

In QB you don't need to dimension each variable before you use it. In BASCOM you must dimension each variable before you use it. This makes for safer code.

In addition, the XRAM/SRAM/ERAM options are not available in QB.

## See Also

CONST , LOCAL

## Example

```
'-----------------------------------------------------------
'                     (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: DIM.BAS
'  demo: DIM
'-----------------------------------------------------------
Dim B1 As Bit                                               'bit can be 0 or 1
Dim A As Byte                                               'byte range from 0-255
Dim C As Integer                                            'integer range from -
32767 - +32768
Dim L As Long
Dim W As Word
Dim S As String * 10                                        'length can be up to 10
characters

'new feature : you can specify the address of the variable
Dim K As Integer At 120
'the next dimensioned variable will be placed after variable s
Dim Kk As Integer


'Assign bits
B1 = 1                                  'or
Set B1                                  'use set

'Assign bytes
A = 12
A = A + 1

'Assign integer
C = -12
C = C + 100
Print C

W = 50000
Print W
```

```
'Assign long
L = 12345678
Print L

'Assign string
S = "Hello world"
Print S

End
```

# DISABLE

## Action

Disable specified interrupt.

## Syntax

**DISABLE** interrupt

## Remarks

| Interrupt | Description |
|---|---|
| INT0 | External Interrupt 0 |
| INT1 | External Interrupt 1 |
| OVF0,TIMER0, COUNTER0 | TIMER0 overflow interrupt |
| OVF1,TIMER1, COUNTER1 | TIMER1 overflow interrupt |
| CAPTURE1, ICP1 | INPUT CAPTURE TIMER1 interrupt |
| COMPARE1A,OC1A | TIMER1 OUTPUT COMPARE A interrupt |
| COMPARE1B,OC1B | TIMER1 OUTPUT COMPARE B interrupt |
| SPI | SPI interrupt |
| URXC | Serial RX complete interrupt |
| UDRE | Serial data register empty interrupt |
| UTXC | Serial TX complete interrupt |
| SERIAL | Disables URXC, UDRE and UTXC |
| ACI | Analog comparator interrupt |
| ADC | A/D converter interrupt |

By default all interrupts are disabled.

To disable all interrupts specify INTERRUPTS.

To enable the enabling and disabling of individual interrupts use ENABLE INTERRUPTS.

The interrupts that are available will depend on the used micro processor.

## See also

ENABLE

## Example

```
'-----------------------------------------------------------------------
'                      SERINT.BAS
'                  (c) 1999-2001 MCS Electronics
'  serial interrupt example for AVR
'-----------------------------------------------------------------------
'$regfile = "8535def.dat"
Const Cmaxchar = 20                                         'number of characters

Dim B As Bit                                                'a flag for signalling a
received character
Dim Bc As Byte                                              'byte counter
Dim Buf As String * Cmaxchar                                'serial buffer
Dim D As Byte

'Buf = Space(20)
'unremark line above for the MID() function in the ISR
'we need to fill the buffer with spaces otherwise it will contain garbage

Print "Start"

On Urxc Rec_isr                                             'define serial receive
ISR
Enable Urxc                                                 'enable receive isr



Enable Interrupts                                           'enable interrupts to
occur

Do
  If B = 1 Then                                             'we received something
     Disable Serial
     Print Buf                                              'print buffer
     Print Bc                                               'print character counter


     'now check for buffer full
     If Bc = Cmaxchar Then                                  'buffer full
        Buf = ""                                            'clear
        Bc = 0                                              'rest character counter
     End If

     Reset B                                                'reset receive flag
     Enable Serial
  End If
```

```
Loop

Rec_isr:
  Print "*"
  If Bc < Cmaxchar Then                                    'does it fit into the
buffer?
     Incr Bc                                               'increase buffer counter


     If Udr = 13 Then                                      'return?
        Buf = Buf + Chr(0)
        Bc = Cmaxchar
     Else
        Buf = Buf + Chr(udr)                               'add to buffer
     End If


    ' Mid(buf , Bc , 1) = Udr
    'unremark line above and remark the line with Chr() to place
    'the character into a certain position
     'B = 1                                                 'set flag
  End If
  B = 1                                                    'set flag
Return
```

# DISPLAY

## Action

Turn LCD display on or off.

## Syntax

**DISPLAY ON / OFF**

## Remarks

The display is turned on at power up.

## See also

LCD

## Example

```
Dim A As Byte
a = 255
Lcd A
Display Off
Wait 1
```

```
Display On
End
```

# DO-LOOP

## Action

Repeat a block of statements until condition is true.

## Syntax

**DO**

statements

**LOOP [ UNTIL** expression **]**

## Remarks

You can exit a DO..LOOP with the EXIT DO statement.

The DO-LOOP is always performed at least once.

## See also

EXIT , WHILE-WEND , FOR-NEXT

## Example

```
'-----------------------------------------------------------
'                     (c) 1999 MCS Electronics
'-----------------------------------------------------------
'  file: DO_LOOP.BAS
'  demo: DO, LOOP
'-----------------------------------------------------------
Dim a As Byte

A = 1                                                       'assign a var
Do                                                          'begin a do..loop
  Print A                                                   'print var
  Incr A                                                    'increase by one
Loop Until A = 10                                           'do until a=10
End
```

```
'You can write a never-ending loop with the following code
Do
  'Your code goes here
Loop
```

# DTMFOUT

## Action

Sends a DTMF tone to the compare1 output pin of timer 1.

## Syntax

**DTMFOUT** number, duration

**DTMFOUT** string , duration

## Remarks

| | |
|---|---|
| Number | A variable or numeric constant that is equivalent with the number of your phone keypad. |
| Duration | Time in mS the tone will be generated. |
| string | A string variable that holds the digits to be dialed. |

The DTMFOUT statement is based on an Atmel application note (314).

It uses TIMER1 to generate the dual tones. As a consequence, timer1 can not be used in interrupt mode by your application. You may use it for other tasks.

Since the TIMER1 is used in interrupt mode you must enable global interrupts with the statement ENABLE INTERRUPTS. The compiler could do this automatic but when you use other interrupts as well it makes more sense that you enable them.

The working range is from 4 MHz to 10 MHz system clock(xtal).

The DTMF output is available on the TIMER1 OCA1 pin. For a 2313 this is PORTB.3.

**Take precautions when connecting the output to your telephone line.**

**Ring voltage can be dangerous!**

## System Resources used

TIMER1 in interrupt mode

## See also

NONE

## ASM

The following routine is called from mcs.lib : _DTMFOUT

R16 holds the number of the tone to generate, R24-R25 hold the duration time in mS.

Uses R9,R10,R16-R23

The DTMF table is remarked in the source and shown for completeness, it is generated by the compiler however with taking the used crystal in consideration.

## Example

```
'-----------------------------------------------------
-----------------
'                           DTMFOUT.BAS
'      demonstrates DTMFOUT statement based on AN 314
from Atmel
' min osc.freq is 4 MHz, max freq is 10 MHz
'-----------------------------------------------------
-----------------

'since the DTMFOUT statement uses the TIMER1 interrupt
you must enable
'global interrupts
'This is not done by the compiler in case you have more
ISRs
Enable Interrupts


'the first sample does dtmfout in a loop
Dim Btmp As Byte

Do
 ' there are 16 dtmf tones
 For Btmp = 0 To 15
```

```
    Dtmfout Btmp , 500
' dtmf out on PORTB.3 for the 2313 for 500 mS
    'output is on the OC1A output pin
    Waitms 1000
' wait 1 sec
 Next
Loop
End

'the keypad of most phones looks like this :
'1  2  3    optional are A
'4  5  6                 B
'7  8  9                 C
'*  0  #                 D

'the DTMFOUT translates a numeric value from 0-15 into
:
' numeric value    phone key
'   0                0
'   1                1
'   2                2
'   3                3
' etc.
'   9                9
'  10                *
'  11                #
'  12                A
'  13                B
'  14                C
'  15                D
```

## ECHO

### Action

Turns the ECHO on or off while asking for serial INPUT.

### Syntax

**ECHO** value

### Remarks

| | |
|---|---|
| Value | ON to enable ECHO and OFF to disable ECHO. |

When you use INPUT to retrieve values for variables, all info you type can be echoed back. In this case you will see each character you enter. When ECHO is OFF, you wil not see the characters you enter.

In versions 1.11.6.2 and earlier the ECHO options were controlled by an additional paramter on the INPUT statement line like : INPUT "Hello " , var NOECHO

This would suppress the ECHO of the typed data. The new syntax works by setting ECHO ON and OFF. For backwards compatibility, using NOECHO on the INPUT statement line will also work. In effect it will turn echo off and on automatic.

By default, ECHO is always ON.

## See also

INPUT

## ASM

The called routines from mcs.lib are _ECHO_ON and _ECHO_OFF

The following ASM is generated when you turn ECHO OFF.

Rcall Echo_Off

This will set bit 3 in R6 that holds the ECHO state.

When you turn the echo ON the following code will be generated

Rcall Echo_On

## Example

```
Dim Var As Byte
'turn off echo
Echo Off
'when you enter the info you will not see it
Input Var
'turn it on again
Echo On
'now you will see what you enter !
Input Var
```

# ELSE

## Action

Executed if the IF-THEN expression is false.

## Syntax

**ELSE**

## Remarks

You don't have to use the ELSE statement in an IF THEN .. END IF structure.

You can use the ELSEIF statement to test for another condition.

IF a = 1 THEN

...

ELSEIF a = 2 THEN

..

ELSEIF b1 > a THEN

...

ELSE

...

END IF

## See also

IF , END IF , SELECT

## Example

```
Dim A As Byte
A = 10                                          'let a = 10
```

```
If A > 10 Then                                          'make a decision
   Print "  A >10"                                      'this will not be printed
Else                                                    'alternative
   Print " A not greater than 10"                       'this will be printed
END IF
```

# ENABLE

## Action

Enable specified interrupt.

## Syntax

**ENABLE** interrupt

## Remarks

| Interrupt | Description |
|---|---|
| INT0 | External Interrupt 0 |
| INT1 | External Interrupt 1 |
| OVF0,TIMER0, COUNTER0 | TIMER0 overflow interrupt |
| OVF1,TIMER1, COUNTER1 | TIMER1 overflow interrupt |
| CAPTURE1, ICP1 | INPUT CAPTURE TIMER1 interrupt |
| COMPARE1A,OC1A | TIMER1 OUTPUT COMPARE A interrupt |
| COMPARE1B,OC1B | TIMER1 OUTPUT COMPARE B interrupt |
| SPI | SPI interrupt |
| URXC | Serial RX complete interrupt |
| UDRE | Serial data register empty interrupt |
| UTXC | Serial TX complete interrupt |
| SERIAL | Disables URXC, UDRE and UTXC |
| ACI | Analog comparator interrupt |
| ADC | A/D converter interrupt |

By default all interrupts are disabled.

To enable the enabling and disabling of interrupts use ENABLE INTERRUPTS.

Other chips might have additional interrupt sources such as INT2, INT3 etc.

## See also

DISABLE

## Example

```
Enable Interrupts                       'allow interrupts to be
set
Enable Timer1                           'enables the TIMER1
interrupt
```

# END

## Action

Terminate program execution.

## Syntax

**END**

## Remarks

**STOP** can also be used to terminate a program.

When an END statement is encountered, all interrupts are disabled and a never-ending loop is generated. When a STOP is encountered the interrupts will not be disabled. Only a never ending loop will be created.

## See also

STOP

## Example

```
Print "Hello"                 'print this
End                           'end program execution and disable all interrupts
```

# EXIT

## Action

Exit a FOR..NEXT, DO..LOOP , WHILE ..WEND, SUB..END SUB or FUNCTION..END FUNCTION.

## Syntax

**EXIT FOR**

**EXIT DO**

**EXIT WHILE**

**EXIT SUB**

**EXIT FUNCTION**

## Remarks

With the EXIT statement you can exit a structure at any time.

## Example

```
'-----------------------------------------------------------
'                     (c) 2000 MCS Electronics
'-----------------------------------------------------------
'  file: EXIT.BAS
'  demo: EXIT
'-----------------------------------------------------------
Dim B1 As Byte , A As Byte
```

```
B1 = 50                                   'assign var
For A = 1 To 100                          'for next loop
   If A = B1 Then                         'decision
      Exit For                            'exit loop
   End If
Next
Print "Exit the FOR..NEXT when A was " ; A

A = 1
Do
  Incr A
  If A = 10 Then
     Exit Do
  End If
Loop
Print "Loop terminated"
End
```

# EXP

## Action

Returns e( the base of the natural logarithm) to the power of a single variable.

## Syntax

Target = **Exp**(source)

## Remarks

| | |
|---|---|
| Target | The single that is assigned with the Exp() of single target. |
| Source | The source single to get the Exp of. |

Exp() makes use of single variables that are generated automatic by the compiler.

The variables are named ___SNGTMP1 - ___SNGTMP4. These variables may be reused by your application.

## See also

LOG

## Example

```
Dim X As Single

X = Exp(1.1)
Print X
'prints 3.004166124
X = 1.1
```

```
X = Exp(x)
Print X
'prints 3.004164931
```

# FOR-NEXT

## Action

Execute a block of statements a number of times.

## Syntax

**FOR** var = start **TO** end [**STEP** value]

Note that in 1.11a downto was supported. This has been rewritten for better compatibility.

## Remarks

| | |
|---|---|
| var | The variable counter to use |
| start | The starting value of the variable var |
| end | The ending value of the variable var |
| value | The value var is increased/decreased with each time NEXT is encountered. |

For incremental loops, you must use TO.

For decremental loops, you must use a negative step size.

You must end a FOR structure with the NEXT statement.

The use of STEP is optional. By default, a value of 1 is used.

## See also

EXIT FOR

## Example

```
'-----------------------------------------------------------
'                     (c) 2000 MCS Electronics
'-----------------------------------------------------------
'  file: FOR_NEXT.BAS
'  demo: FOR, NEXT
'-----------------------------------------------------------
Dim A As Byte , B1 As Byte , C As Integer


For A = 1 To 10 Step 2
   Print "This is A " ; A
Next A

Print "Now lets count down"
For C = 10 To -5 Step -1
  Print "This is C " ; C
Next



Print "You can also nest FOR..NEXT statements."
For A = 1 To 10
  Print "This is A " ; A
  For B1 = 1 To 10
    Print "This is B1 " ; B1
  Next                                    ' note that you do not have to specify the
parameter
Next A


End
```

# FORMAT

## Action

Formats a numeric string.

## Syntax

**target = Format(source, "mask")**

## Remarks

| | |
|---|---|
| target | The string that is assigned with the formatted string. |
| source | The source string that holds the number. |
| mask | The mask for formatting the string.<br>When spaces are in the mask, leading spaces will be added when the length of the mask is longer than the source string.<br>"  " '8 spaces when source is "123" it will be "  123".<br>When a + is in the mask (after the spaces) a leading + will be assigned when the number does not start with the - sign. |

"+" with number "123" will be "+123".
When zero's are provided in the mask, the string will be filled with leading zero;s.
" +00000" with 123 will be " +00123"
An optional decimal point can be inserted too:
"000.00" will format the number 123 to "001.23"
Combinations can be made but the order must be : spaces, + , 0 an optional point and zero's.

## See also

FUSING

## Example

```
'-----------------------------------------------------------------------
'                    (c) 2000 MCS Electronics
'                         Format.bas
'-----------------------------------------------------------------------
Dim S As String * 10
Dim I As Integer

S = "12345"
S = Format(s , "+")
Print S

S = "123"
S = Format(s , "00000")
Print S

S = "12345"
S = Format(s , "000.00")
Print S

S = "12345"
S = Format(s , " +000.00")
Print S


End
```

# FOURTHLINE

## Action

Set LCD cursor to the start of the fourth line.

## Syntax

**FOURTHLINE**

## Remarks

Only valid for LCD displays with 4 lines.

## See also

HOME , UPPERLINE , LOWERLINE , THIRDLINE ,LOCATE

## Example

```
Dim a as byte
a = 255
Lcd A
Fourthline
Lcd A
Upperline
End
```

# FUSING

## Action

FUSING returns a formatted string of a single value.

## Syntax

**target = Fusing(source, "mask")**

## Remarks

| | |
|---|---|
| target | The string that is assigned with the formatted string. |
| source | The source variable of the type SINGLE that will be converted |
| mask | The mask for formatting the string.<br>The mask is a string constant that always must start with #.<br>After the decimal point you can provide the number of digits you want the string to have: |

#.### will give a result like 123.456. Rounding is used when you use the # sign. So 123.4567 will be converted into 123.457

When no rounding must be performed, you can use the & sign instead of the # sign. But only after the DP.
#.&&& will result in 123.456 when the single has the value 123.4567

When the single is zero, **0.0** will be returned, no matter how the mask is set up.

## See also

FORMAT , STR

## Example

```
'-----------------------------------------------------------------------
'                           FUSING.BAS
'                    (c) 2001 MCS ELectronics
'-----------------------------------------------------------------------

Dim S As Single , Z As String * 10

'now assign a value to the single
S = 123.45678
'when using str() you can convert a numeric value into a string
Z = Str(s)
Print Z                                                    'prints 123.456779477

Z = Fusing(s , "#.##")

'now use some formatting with 2 digits behind the decimal point with rounding
Print Fusing(s , "#.##")                                   'prints 123.46

'now use some formatting with 2 digits behind the decimal point without rounding
Print Fusing(s , "#.&&")                                   'prints 123.45

'The mask must start with #.
'It must have at least one # or & after the point.
'You may not mix & and # after the point.
End
```

# GETADC

## Action

Retrieves the analog value from channel 0-7.

## Syntax

var = GETADC(channel)

## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the A/D value |
| Channel | The channel to measure |

The GETADC() function is only intended for the AVR90S8535 or other chips that have a built-in A/D converter.

The pins of the A/D converter input can be used for digital I/O too.

But it is important that no I/O switching is done while using the A/D converter.

## See also

CONFIG ADC

## Example

```
'-----------------------------------------------------------------------
'                   ADC.BAS
'  demonstration of GETADC() function for 8535 micro
'-----------------------------------------------------------------------
$regfile = "m163def.dat"

'configure single mode and auto prescaler setting
'The single mode must be used with the GETADC() function

'The prescaler divides the internal clock by 2,4,8,15,32,64 or 128
'Because the ADC needs a clock from 50-200 KHz
'The AUTO feature, will select the highest clockrate possible
Config Adc = Single , Prescaler = Auto
'Now give power to the chip
Start Adc

'With STOP ADC, you can remove the power from the chip
'Stop Adc

Dim W As Word , Channel As Byte

Channel = 0
'now read A/D value from channel 0
Do
  W = Getadc(channel)
  Print "Channel " ; Channel ; " value " ; W
  Incr Channel
  If Channel > 7 Then Channel = 0
Loop
End

'The new M163 has options for the reference voltage
'For this chip you can use the additional param :
```

```
'Config Adc = Single , Prescaler = Auto, Reference = Internal
'The reference param may be :
'OFF      : AREF, internal reference turned off
'AVCC     : AVCC, with external capacitor at AREF pin
'INTERNAL : Internal 2.56 voltage reference with external capacitor ar AREF pin

'Using the additional param on chip that do not have the internal reference will have
no effect.
```

# GETATKBD

## Action

Reads a key from a PC AT keyboard.

## Syntax

var = GETATKBD()

## Remarks

| | |
|---|---|
| var | The variable that is assigned with the key read from the keyboard.<br>It may be a byte or a string variable.<br>When no key is pressed a 0 will be returned. |

The GETAKBD() function needs 2 input pins and a translation table for the keys. You can read more about this at the CONFIG KEYBOARD compiler directive.

## See also

CONFIG KEYBOARD

## Example

```
'-------------------------------------------------------------------------
'               PC AT-KEYBOARD Sample
'             (c) 2000 MCS Electronics
'-------------------------------------------------------------------------
'For this example :
```

```
'connect PC AT keyboard clock to PIND.2 on the 8535
'connect PC AT keyboard data to PIND.4 on the 8535

$regfile = "8535def.dat"

'The GetATKBD() function does not use an interrupt.
'But it waits until a key was pressed!

'configure the pins to use for the clock and data
'can be any pin that can serve as an input
'Keydata is the label of the key translation table
Config Keyboard = Pind.2 , Data = Pind.4 , Keydata = Keydata

'Dim some used variables
Dim S As String * 12
Dim B As Byte

'In this example we use SERIAL(COM) INPUT redirection
$serialinput = Kbdinput

'Show the program is running
Print "hello"

Do
  'The following code is remarked but show how to use the GetATKBD() function
  ' B = Getatkbd()      'get a byte and store it into byte variable
  'When no real key is pressed the result is 0
  'So test if the result was > 0
  ' If B > 0 Then
  '    Print B ; Chr(b)
  ' End If

  'The purpose of this sample was how to use a PC AT keyboard
  'The input that normally comes from the serial port is redirected to the
  'external keyboard so you use it to type
  Input "Name " , S
  'and show the result
  Print S
Loop
End

'Since we do a redirection we call the routine from the redirection routine
'
Kbdinput:
 'we come here when input is required from the COM port
 'So we pass the key into R24 with the GetATkbd function
' We need some ASM code to save the registers used by the function
$asm
 push r16           ; save used register
 push r25
 push r26
 push r27

Kbdinput1:
 rCall _getatkbd    ; call the function
 tst r24            ; check for zero
 breq Kbdinput1     ; yes so try again
 pop r27            ; we got a valid key so restore registers
 pop r26
 pop r25
 pop r16
 $end Asm
 'just return
Return

'The tricky part is that you MUST include a normal call to the routine
'otherwise you get an error
'This is no clean solution and will be changed
B = Getatkbd()

'This is the key translation table

Keydata:
'normal keys lower case
Data 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , &H5E , 0
Data 0 , 0 , 0 , 0 , 0 , 113 , 49 , 0 , 0 , 0 , 122 , 115 , 97 , 119 , 50 , 0
Data 0 , 99 , 120 , 100 , 101 , 52 , 51 , 0 , 0 , 32 , 118 , 102 , 116 , 114 , 53 , 0
Data 0 , 110 , 98 , 104 , 103 , 121 , 54 , 7 , 8 , 44 , 109 , 106 , 117 , 55 , 56 , 0
Data 0 , 44 , 107 , 105 , 111 , 48 , 57 , 0 , 0 , 46 , 45 , 108 , 48 , 112 , 43 , 0
Data 0 , 0 , 0 , 0 , 0 , 92 , 0 , 0 , 0 , 0 , 13 , 0 , 0 , 92 , 0 , 0
```

```
Data 0 , 60 , 0 , 0 , 0 , 0 , 8 , 0 , 0 , 49 , 0 , 52 , 55 , 0 , 0 , 0
Data 48 , 44 , 50 , 53 , 54 , 56 , 0 , 0 , 0 , 43 , 51 , 45 , 42 , 57 , 0 , 0

'shifted keys UPPER case
Data 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0
Data 0 , 0 , 0 , 0 , 0 , 81 , 33 , 0 , 0 , 0 , 90 , 83 , 65 , 87 , 34 , 0
Data 0 , 67 , 88 , 68 , 69 , 0 , 35 , 0 , 0 , 32 , 86 , 70 , 84 , 82 , 37 , 0
Data 0 , 78 , 66 , 72 , 71 , 89 , 38 , 0 , 0 , 76 , 77 , 74 , 85 , 47 , 40 , 0
Data 0 , 59 , 75 , 73 , 79 , 61 , 41 , 0 , 0 , 58 , 95 , 76 , 48 , 80 , 63 , 0
Data 0 , 0 , 0 , 0 , 0 , 96 , 0 , 0 , 0 , 0 , 13 , 94 , 0 , 42 , 0 , 0
Data 0 , 62 , 0 , 0 , 0 , 8 , 0 , 0 , 49 , 0 , 52 , 55 , 0 , 0 , 0 , 0
Data 48 , 44 , 50 , 53 , 54 , 56 , 0 , 0 , 0 , 43 , 51 , 45 , 42 , 57 , 0 , 0
```

# GETKBD

## Action

Scans a 4x4 matrix keyboard and return the value of the key pressed.

## Syntax

var = GETKBD()

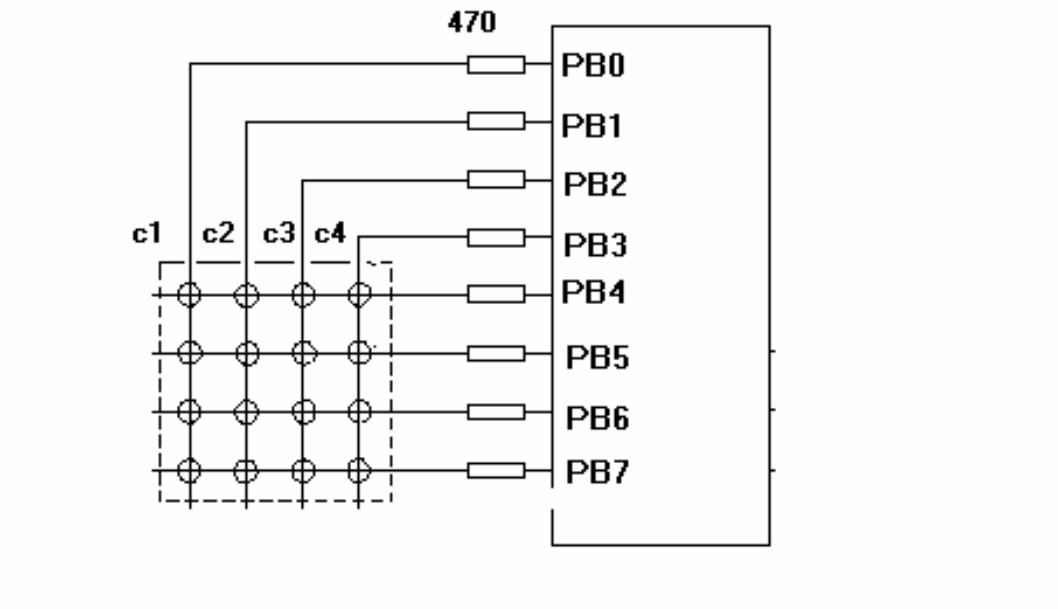
## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the value read from the keyboard |

The GETKBD() function can be attached to a port of the uP.

You can define the port with the CONFIG KBD statement.

A schematic for PORTB is shown below




Note that the port pins can be used for other tasks as well.

When no key is pressed 16 will be returned.

On the STK200 this might not work since other hardware is connected too that interferes.

You can use the Lookup() function to convert the byte into another value. This because the GetKBD() function does not return the same value as the key pressed. It will depend on which keyboard you use.

## See also

CONFIG KBD

## Example

```
'-----------------------------------------------
'               GETKBD.BAS
'          (c) 2000 MCS Electronics
'-----------------------------------------------
'specify which port must be used
'all 8 pins of the port are used
Config Kbd = Portb

'dimension a variable that receives the value of the pressed key
Dim B As Byte

'loop for ever
Do
  B = Getkbd()
  'look in the help file on how to connect the matrix keyboard
  Print B
  'when no key is pressed 16 will be returned
  'use the Lookup() function to translate the value to another one
```

```
' this because the returned value does not match the number on the keyboad
Loop
Lcd B
End
```

# GETRC

## Action

Retrieves the value of a resistor or a capacitor.

## Syntax

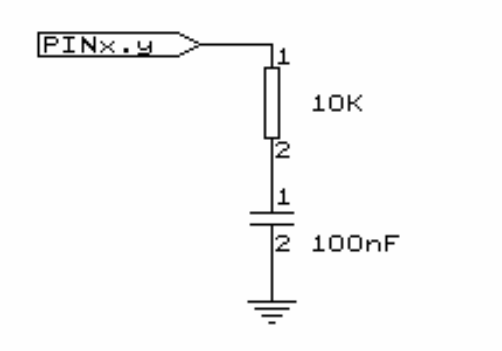
var = **GETRC**( pin , number )

## Remarks

| | |
|---|---|
| Var | The word variable that is assigned with the value. |
| Pin | The PIN name for the R/C is connection. |
| Number | The port pin for the R/C is connection. |

The name of the input port (PIND for example) must be passed even when all the other pins are configured for output. The pin number must also be passed. This may be a constant or a variable.

A circuit is shown below:




The capacitor is charged and the time it takes to discharge it is measured and stored in the variable. So when you vary either the resistor or the capacitor, different values will be returned. This function is intended to return a relative position of a resistor wiper, not to return the value of the resistor. But with some calculations it can be retrieved.

## See also

NONE

## Example

```
'-----------------------------------------------------------------------
'                     GETRC.BAS
'   demonstrates how to get the value of a resistor
' The library also shows how to pass a variable for use with individual port
' pins. This is only possible in the AVR architecture and not in the 8051
'-----------------------------------------------------------------------
'The function works by charging a capacitor and uncharge it little by little
'A word counter counts until the capacitor is uncharged.
'So the result is an indication of the position of a pot meter not the actual
'resistor value

'This example used the 8535 and a 10K ohm variable resistor connected to PIND.4
'The other side of the resistor is connected to a capacitor of 100nF.
'The other side of the capacitor is connected to ground.
'This is different than BASCOM-8051 GETRC! This because the architecture is different.

'The result of getrc() is a word so DIM one
Dim W As Word
Do
  'the first parameter is the PIN register.
  'the second parameter is the pin number the resistor/capacitor is connected to
  'it could also be a variable!
  W = Getrc(pind , 4)
  Print W
  Wait 1
Loop
```

# GETRC5

## Action

Retrieves the RC5 remote code from a IR transmitter.

## Syntax

GETRC5( address, command )

## Uses

TIMER0

## Remarks

address The RC5 address

command The RC5 command.

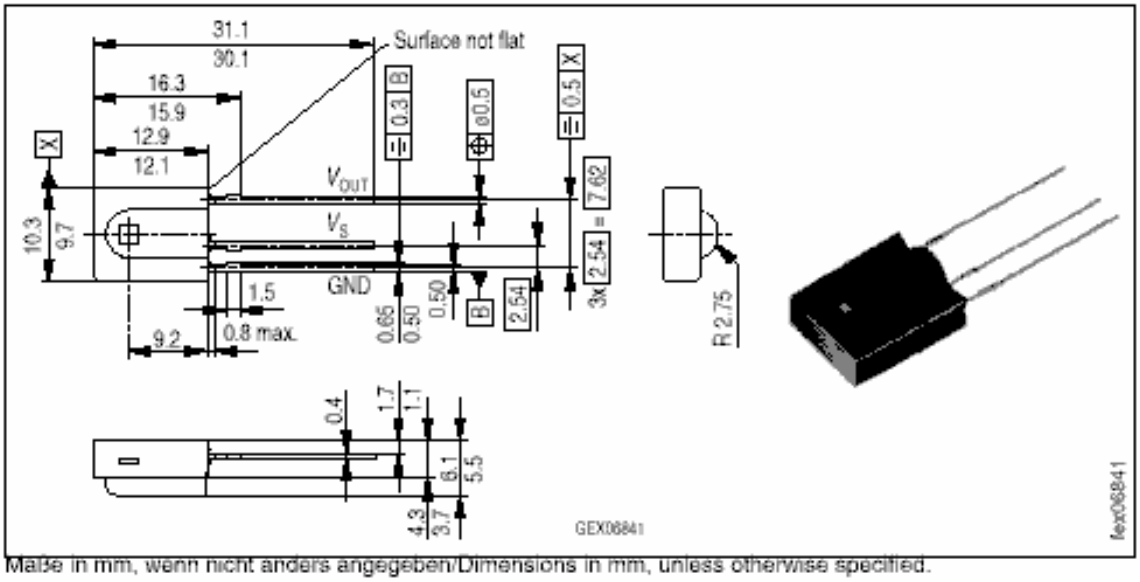
This statement used the AVR 410 application note. Since a timer is needed for accurate delays and background processing TIMER0 is used by this statement.

Also the interrupt of TIMER0 is used by this statement.

TIMER0 can be used by your application since the values are preserved by the statement but a delay can occur. The interrupt can not be reused.

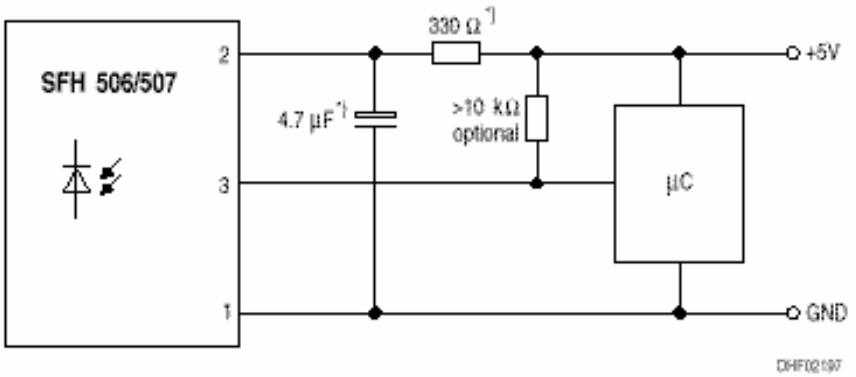
The SFH506-36 is used from Siemens. Other types can be used as well.

**IR-Empfänger/Demodulator-Baustein** **SFH 506**
**IR-Receiver/Demodulator Device**




Maße in mm, wenn nicht anders angegeben/Dimensions in mm, unless otherwise specified.

For a good operation use the following values for the filter.




*) only necessary to suppress power supply disturbances

Most audio and video systems are equipped with an infra-red remote control.

The RC5 code is a 14-bit word bi-phase coded signal.

The two first bits are start bits, always having the value 1.

The next bit is a control bit or toggle bit, which is inverted every time a button is pressed on the remote control transmitter.

Five system bits hold the system address so that only the right system responds to the code.

Usually, TV sets have the system address 0, VCRs the address 5 and so on. The command sequence is six bits long, allowing up to 64 different commands per address.

The bits are transmitted in bi-phase code (also known as Manchester code).

## See also

CONFIG RC5

## Example

```
'-----------------------------------------------------------------------
'                         RC5.BAS
'                (c) 1999-2000 MCS Electronics
'         based on Atmel AVR410 application note
'-----------------------------------------------------------------------
'use byte library for smaller code
$lib "mcsbyte.lbx"

'This example shows how to decode RC5 remote control signals
'with a SFH506-35 IR receiver.

'Connect to input to PIND.2 for this example
'The GETRC5 function uses TIMER0 and the TIMER0 interrupt.
'The TIMER0 settings are restored however so only the interrupt can not
'be used anymore for other tasks


'tell the compiler which pin we want to use for the receiver input

Config Rc5 = Pind.2

'the interrupt routine is inserted automatic but we need to make it occur
'so enable the interrupts
Enable Interrupts

'reserve space for variables
Dim Address As Byte , Command As Byte
Print "Waiting for RC5..."

Do
  'now check if a key on the remote is pressed
  'Note that at startup all pins are set for INPUT
  'so we dont set the direction here
  'If the pins is used for other input just unremark the next line
  'Config Pind.2 = Input
  Getrc5(address , Command)

  'we check for the TV address and that is 0
```

```
  If Address = 0 Then
     'clear the toggle bit
     'the toggle bit toggles on each new received command
     Command = Command And &B10111111
     Print Address ; "   " ; Command
  End If
Loop
End
```

# GOSUB

## Action

Branch to and execute subroutine.

## Syntax

**GOSUB** label

## Remarks

Label The name of the label where to branch to.

With GOSUB, your program jumps to the specified label, and continues execution at that label.

When it encounters a RETURN statement, program execution will continue after the GOSUB statement.

## See also

GOTO , CALL , RETURN

## Example

```
'-----------------------------------------------------------
'                (c) 1999 MCS Electronics
'-----------------------------------------------------------
'  file: GOSUB.BAS
'  demo: GOTO, GOSUB and RETURN
'-----------------------------------------------------------
```

```
Goto Continue
Print "This code will not be executed"

Continue:                                 'end a label with a colon
Print "We will start execution here"
Gosub Routine
Print "Back from Routine"
End



Routine:                                  'start a subroutine
  Print "This will be executed"
Return                                                  'return from subroutine
```

# GOTO

## Action

Jump to the specified label.

## Syntax

**GOTO** label

## Remarks

Labels can be up to 32 characters long.

When you use duplicate labels, the compiler will give you a warning.

## See also

GOSUB

## Example

```
Dim A As Byte
Start:                                                  'a label must end with a
colon
A = A + 1                                               'increment a
If A < 10 Then                                          'is it less than 10?
 Goto Start                                             'do it again
End If                                                  'close IF
```

```
Print "Ready"                                          'that is it
```

# HEX

## Action

Returns a string representation of a hexadecimal number.

## Syntax

var = Hex( x )

## Remarks

| | |
|---|---|
| var | A string variable. |
| X | A numeric variable of data type Byte, Integer, Word, Long or Single. |

## See also

HEXVAL , VAL , STR , BIN

## Example

```
Dim A As Byte , S As String * 2 , Sn As Single
a = 123
s  = Hex(a)
Print s
Print Hex(a)
Sn = 1.2
Print Hex(sn)
End
```

# HEXVAL

## Action

Convert string representing a hexadecimal number into a numeric variable.

## Syntax

var **= HEXVAL(** x **)**

## Remarks

| | |
|---|---|
| Var | The numeric variable that must be assigned. |
| X | The hexadecimal string that must be converted. |

## Difference with QB

In QB you can use the VAL() function to convert hexadecimal strings.

But since that would require an extra test for the leading &H signs that are required in QB, a separate function was designed.

## See also

HEX , VAL , STR , BIN

## Example

```
Dim A As Byte , S As String * 2 , Sn As Single
S = "A"
A = Hexval(s)
Print A ; Spc(10) ; Hex(a)
End
```

# HIGH

## Action

Retrieves the most significant byte of a variable.

## Syntax

var = HIGH( s )

## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the MSB of var S. |
| S | The source variable to get the MSB from. |

## See also

LOW , HIGHW

## Example

```
Dim I As Integer , Z As Byte
I = &H1001
Z = High(i)                                          ' is 10 hex or 16 dec
End
```

# HIGHW

## Action

Retrieves the most significant word of a long variable.

## Syntax

var = **HIGHW**( s )

## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the MS word of var S. |
| S | The source variable to get the MSB from. |

## See also

LOW , HIGH

## Example

```
Dim X As Word , L As Long
L = &H12345678
X = Highw(l)
Print Hex(x)
```

# HOME

## Action

Place the cursor at the specified line at location 1.

## Syntax

**HOME UPPER / LOWER /THIRD / FOURTH**

## Remarks

If only HOME is used than the cursor will be set to the upper line.

You can also specify the first letter of the line like: HOME U

## See also

CLS , LOCATE

## Example

```
Cls
```

```
Lowerline
Lcd "Hello"
Home Upper
Lcd "Upper"
End
```

# I2CRECEIVE

## Action

Receives data from an I2C serial device.

## Syntax

**I2CRECEIVE** slave, var

**I2CRECEIVE** slave, var ,b2W, b2R

## Remarks

| | |
|---|---|
| Slave | A byte, Word/Integer variable or constant with the slave address from the I2C-device. |
| Var | A byte or integer/word variable that will receive the information from the I2C-device. |
| b2W | The number of bytes to write.<br>Be cautious not to specify too many bytes! |
| b2R | The number of bytes to receive.<br>Be cautious not to specify too many bytes! |

You can specify the base address of the slave chip because the read/write bit is set/reset by the software.

## See also

I2CSEND , I2CSTART , I2CSTOP , I2CRBYTE , I2CWBYTE

## Example

```
Config Sda = Portb.5
Config Scl = Portb.7
Dim X As Byte , Slave As Byte
X = 0                                                    'reset variable
Slave = &H40                                             'slave address of a PCF
8574 I/O IC
I2creceive Slave , X                                     'get the value
Print X                                                  'print it


Dim Buf(10) As Byte
Buf(1) = 1 : Buf(2) = 2
I2creceive Slave , Buf(1) , 2 , 1                        'send two bytes and
receive one byte
Print Buf(1)                                             'print the received byte

End
```

# I2CSEND

## Action

Send data to an I2C-device.

## Syntax

**I2CSEND** slave, var

**I2CSEND** slave, var , bytes

## Remarks

| | |
|---|---|
| Slave | The slave address off the I2C-device. |
| Var | A byte, integer/word or numbers that holds the value, which will be, send to the I2C-device. |
| Bytes | The number of bytes to send. |

## See also

I2CRECEIVE , I2CSTART , I2CSTOP , I2CRBYTE , I2CWBYTE

## Example

```
Config Sda = Portb.5
Config Scl = Portb.7
Dim X As Byte , A As Byte , Bytes As Byte
x = 5     'assign variable to 5
Dim Ax(10) As Byte
Const Slave = &H40                                    'slave address of a PCF
8574 I/O IC
I2csend Slave , X                                     'send the value or


For a = 1 to 10
    ax(a) = a    'Fill dataspace
Next
Bytes = 10
I2csend Slave , Ax(1) , Bytes
END
```

# I2START,I2CSTOP, I2CRBYTE, I2CWBYTE

## Action

I2CSTART generates an I2C start condition.

I2CSTOP generates an I2C stop condition.

I2CRBYTE receives one byte from an I2C-device.

I2CWBYTE sends one byte to an I2C-device.

## Syntax

**I2CSTART**

**I2CSTOP**

**I2CRBYTE** var, ack/nack

**I2CWBYTE** val

## Remarks

| | |
|---|---|
| Var | A variable that receives the value from the I2C-device. |
| ack/nack | Specify ACK if there are more bytes to read.<br>Specify NACK if it is the last byte to read. |
| Val | A variable or constant to write to the I2C-device. |

These statements are provided as an addition to the I2CSEND and

I2CRECEIVE functions.

## See also

I2CSEND , I2CRECEIVE , I2CSTART , I2CSTOP , I2CRBYTE , I2CWBYTE

## Example

```
Config Sda = Portb.5
Config Scl = Portb.7
'-------- Writing and reading a byte to an EEPROM 2404 -----------------
Dim A As Byte
Const Adresw = 174     'write of 2404
Const Adresr = 175     'read address of 2404
I2cstart               'generate start
I2cwbyte Adresw        'send slave address
I2cwbyte 1             'send address of EEPROM
I2cwbyte 3             'send a value
I2cstop                'generate stop
Waitms 10              'wait 10 mS because that is the time that the chip needs to
write the data

'----------------now read the value back into the var a -------------------
I2cstart                          'generate start
I2cwbyte Adresw                   'write slave address
I2cwbyte 1                        'write address of EEPROM to read
I2cstart                          'generate repeated start
I2cwbyte Adresr                   'write slave address of EEPROM
I2crbyte A , Nack                 'receive value into a. nack means last byte to
receive
I2cstop                           'generate stop
Print A                           'print received value
End
```

# IDLE

## Action

Put the processor into the idle mode.

## Syntax

IDLE

## Remarks

In the idle mode, the system clock is removed from the CPU but not from the interrupt logic, the serial port or the timers/counters.

The idle mode is terminated either when an interrupt is received(from the watchdog, timers, external level triggered or ADC) or upon system reset through the RESET pin.

## See also

POWERDOWN

## Example

```
IDLE
```

# IF-THEN-ELSE-END IF

## Action

Allows conditional execution or branching, based on the evaluation of a Boolean expression.

## Syntax

**IF** expression **THEN**

[ **ELSEIF** expression **THEN** ]

[ **ELSE** ]

**END IF**

## Remarks

Expression Any expression that evaluates to true or false.

The one line version of IF can be used :

IF expression THEN statement [ ELSE statement ]

The use of [ELSE] is optional.

Tests like IF THEN can also be used with bits and bit indexes.

IF var.bit = 1 THEN

^--- bit is a variable or numeric constant in the range from 0-255

```
Dim Var As Byte , Idx As Byte
Var = 255
Idx = 1
If Var.idx = 1 Then
   Print "Bit 1 is 1"
End If
```

## See also

ELSE

## Example

```
Dim A As Integer
A = 10
If A = 10 Then                                          'test expression
  Print "This part is executed."                        'this will be printed
Else
  Print "This will never  be executed."                 'this not
End If
If A = 10 Then Print "New in BASCOM"
If A = 10 Then Goto Label1 Else Print "A<>10"
Label1:

Rem The following example shows enhanced use of IF THEN
If A.15 = 1 Then                                        'test for bit
   Print "BIT 15 IS SET"
End If
Rem the following example shows the 1 line use of IF THEN [ELSE]
If A.15 = 0 Then Print "BIT 15 is cleared" Else Print "BIT 15 is set"
```

# INCR

## Action

Increments a variable by one.

## Syntax

**INCR** var

## Remarks

Var Any numeric variable.

## See also

DECR

## Example

```
Dim A As Byte
Do                                                    'start loop
  Incr A                                              'increment a by 1
  Print A                                             'print a
Loop Until A > 10                                     'repeat until a is greater
than 10
Print A
```

# INKEY

## Action

Returns the ASCII value of the first character in the serial input buffer.

## Syntax

var = **INKEY()**

var = **INKEY(#channel)**

## Remarks

Var Byte, Integer, Word, Long or String variable.

Channel A constant number that identifies the opened channel if software UART mode

If there is no character waiting, a zero will be returned. The ERR variable will

be set to 1 if there no character waiting. ERR will be set to 0 when there is a character waiting.

This allows to receive 0 byte values too.

The INKEY routine can be used when you have a RS-232 interface on your uP.

The RS-232 interface can be connected to a comport of your computer.

## See also

WAITKEY

## Example

```
Dim A As Byte
Do                                                          'start loop
 A = Inkey()                                                'look for character
 If A > 0 Then                                              'is variable > 0?
    Print A                                                 'yes , so print it
 End If
Loop                                                        'loop forever
'The example above is for the HARDWARE UART

'The OPEN.BAS sample contains a sample for use with the software
UART.
```

# INP

## Action

Returns a byte read from a hardware port or any internal or external memory location.

## Syntax

var = **INP**(address)

## Remarks

| | |
|---|---|
| var | Numeric variable that receives the value. |

address The address where to read the value from. (0- **&H**FFFF)

The PEEK() function will read only the lowest 32 memory locations (registers).

The INP() function can read from any memory location since the AVR has a linear memory model.

When you want to read from XRAM memory you must enable external memory access in the Compiler Chip Options.

## See also

OUT PEEK

## Example

```
Dim A As Byte
A = Inp(&H8000)  'read value that is placed on databus(d0-d7) at hex address 8000
Print A
End
```

# INPUTBIN

## Action

Read binary data from the serial port.

## Syntax

**INPUTBIN** var1 [,var2]

**INPUTBIN** #channel , var1 [,var2]

## Remarks

var1 The variable that is assigned with the characters from the serial port.

var2 An optional second (or more) variable that is assigned with the data from the serial input stream.

The channel is for use with the software UART routine and must be used with OPEN and CLOSE.

The number of bytes to read depends on the variable you use.

When you use a byte variable, 1 character is read from the serial port.

An integer will wait for 2 characters and an array will wait until the whole array is filled.

Note that the INPUTBIN statement doesn't wait for a <RETURN> but just for the number of bytes.

## See also

PRINTBIN

## Example

```
Dim A As Byte , C As Integer
Inputbin A , C                                    'wait for 3 characters
End
```

# INPUTHEX

## Action

Allows hexadecimal input from the keyboard during program execution.

## Syntax

**INPUTHEX** [" prompt" ] , var [ , varn ]

## Remarks

| | |
|---|---|
| prompt | An optional string constant printed before the prompt character. |
| Var,varn | A numeric variable to accept the input value. |

The INPUTHEX routine can be used when you have a RS-232 interface on your uP.

The RS-232 interface can be connected to a serial communication port of your computer.

This way you can use a terminal emulator and the keyboard as input device.

You can also use the build in terminal emulator.

The input entered may be in lower or upper case (0-9 and A-F)

If var is a byte then the input can be maximum 2 characters long.

If var is an integer/word then the input can be maximum 4 characters long.

If var is a long then the input can be maximum 8 characters long.

## Difference with QB

In QB you can specify &H with INPUT so QB will recognize that a hexadecimal string is being used.

BASCOM implements a new statement: INPUTHEX.

## See also

INPUT , ECHO

## Example

```
Dim X As Byte
Echo On
Inputhex "Enter a number " , X                          'ask for input like AF
Echo Off
Inputhex "Enter a number " , X                          'ask for input like ab
Echo On
End
```

# INPUT

## Action

Allows input from the keyboard during program execution.

## Syntax

**INPUT** [" prompt" ] , var [ , varn ]

## Remarks

| | |
|---|---|
| Prompt | An optional string constant printed before the prompt character. |
| Var,varn | A variable to accept the input value or a string. |

The INPUT routine can be used when you have an RS-232 interface on your uP.

The RS-232 interface can be connected to a serial communication port of your computer.

This way you can use a terminal emulator and the keyboard as an input device.

You can also use the built-in terminal emulator.

## Difference with QB

In QB you can specify &H with INPUT so QB will recognize that a hexadecimal string is being used.

BASCOM implements a new statement : INPUTHEX.

## See also

INPUTHEX , PRINT , ECHO

## Example

```
'-----------------------------------------------------------
'                 (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: INPUT.BAS
'  demo: INPUT, INPUTHEX
'-----------------------------------------------------------
'To use another baudrate and crystalfrequency use the
'metastatements $BAUD =  and $CRYSTAL =
$baud = 9600                                                'try 1200 baud for
example
$crystal = 4000000                                          '12 MHz

Dim V As Byte , B1 As Byte
Dim C As Integer , D As Byte
Dim S As String * 15

Input "Use this to ask a question " , V
Input B1                                                    'leave out for no
question

Input "Enter integer " , C
Print C


Inputhex "Enter hex number (4 bytes) " , C
Print C
Inputhex "Enter hex byte (2 bytes) " , D
Print D

Input "More variables " , C , D
Print C ; " " ; D

Input C Noecho                          'supress echo

Input "Enter your name " , S
Print "Hello " ; S

Input S Noecho                          'without echo
Print S
End

Dim X As Byte
Echo On
Inputhex "Enter a number " , X                          'ask for input
Echo Off
Inputhex "Enter a number " , X                          'ask for input
Echo On
End
```

# INSTR

## Action

Returns the position of a sub string in a string.

## Syntax

var = **INSTR(** start , string , substr **)**

var = **INSTR(** string , substr **)**

## Remarks

| | |
|---|---|
| Var | Numeric variable that will be assigned with the position of the sub string in the string. Returns 0 when the sub string is not found. |
| Start | An optional numeric parameter that can be assigned with the first position where must be searched in the string. By default (when not used) the whole string is searched starting from position 1. |
| String | The string to search. |
| Substr | The search string. |

No constant can be used for string it must be a string.

Only substr can be either a string or a constant.

## See also

NONE

## Example

```
Dim S As String * 10 , Z As String * 5
Dim Bp As Byte
S = "This is a test"
Z = "is"
Bp = Instr(s , Z) : Print Bp                                    'should print 3
Bp = Instr(4 , S , Z) : Print Bp                                'should print 6
End
```

# LCASE

## Action

Converts a string in to all lower case characters.

## Syntax

Target = **Lcase**(source)

## Remarks

| | |
|---|---|
| Target | The string that is assigned with the lower case string of string target. |
| Source | The source string. |

## See also

UCASE

## ASM

The following ASM routines are called from MCS.LIB : _LCASE
The generated ASM code : (can be different depending on the micro used )

```
;##### Z = Lcase(s)
Ldi R30,$60
Ldi R31,$00             ; load constant in register
Ldi R26,$6D
Rcall _Lcase
```

## Example

```
Dim S As String * 12 , Z As String * 12
S = "Hello World"
Z = Lcase(s)
Print Z
Z = Ucase(s)
Print Z
End
```

# LCD

## Action

Send constant or variable to LCD display.

## Syntax

**LCD** x

## Remarks

X Variable or constant to display.

More variables can be displayed separated by the **;** -sign

LCD a ; b1 ; "constant"

The LCD statement behaves just like the PRINT statement. So SPC() can be used too.

## See also

$LCD , $LCDRS , CONFIG LCD

## Example

```
'-----------------------------------------------------------
'                (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: LCD.BAS
'  demo: LCD, CLS, LOWERLINE, SHIFTLCD, SHIFTCURSOR, HOME
'        CURSOR, DISPLAY
'-----------------------------------------------------------

$sim
'REMOVE the above command for the real program !!
'$sim is used fr faster simulation


'note : tested in PIN mode with 4-bit

'Config Lcdpin = Pin , Db4 = Portb.1 , Db5 = Portb.2 , Db6 = Portb.3 , Db7 = Portb.4 ,
E = Portb.5 , Rs = Portb.6
Config Lcdpin = Pin , Db4 = Porta.4 , Db5 = Porta.5 , Db6 = Porta.6 , Db7 = Porta.7 ,
E = Portc.7 , Rs = Portc.6
'These settings are for the STK200 in PIN mode
'Connect only DB4 to DB7 of the LCD to the LCD connector of the STK D4-D7
'Connect the E-line of the LCD to A15 (PORTC.7) and NOT to the E line of the LCD
connector
'Connect the RS, V0, GND and =5V of the LCD to the STK LCD connector

Rem with the config lcdpin statement you can override the compiler settings


Dim A As Byte
Config Lcd = 16 * 2                                          'configure lcd screen
'other options are 16 * 4 and 20 * 4, 20 * 2 , 16 * 1a
'When you dont include this option 16 * 2 is assumed
'16 * 1a is intended for 16 character displays with split addresses over 2 lines

'$LCD = address will turn LCD into 8-bit databus mode
```

```
'       use this with uP with external RAM and/or ROM
'       because it aint need the port pins !

Cls                                                     'clear the LCD display
Lcd "Hello world."                                      'display this at the top
line
Wait 1
Lowerline                                               'select the lower line
Wait 1
Lcd "Shift this."                                       'display this at the
lower line
Wait 1
For A = 1 To 10
   Shiftlcd Right                                       'shift the text to the
right
   Wait 1                                               'wait a moment
Next

For A = 1 To 10
   Shiftlcd Left                                        'shift the text to the
left
   Wait 1                                               'wait a moment
Next

Locate 2 , 1                                            'set cursor position
Lcd "*"                                                 'display this
Wait 1                                                  'wait a moment

Shiftcursor Right                                       'shift the cursor
Lcd "@"                                                 'display this
Wait 1                                                  'wait a moment

Home Upper                                              'select line 1 and
return home
Lcd "Replaced."                                         'replace the text
Wait 1                                                  'wait a moment

Cursor Off Noblink                                      'hide cursor
Wait 1                                                  'wait a moment
Cursor On Blink                                         'show cursor
Wait 1                                                  'wait a moment
Display Off                                             'turn display off
Wait 1                                                  'wait a moment
Display On                                              'turn display on
'-----------------NEW support for 4-line LCD------
Thirdline
Lcd "Line 3"
Fourthline
Lcd "Line 4"
Home Third                                              'goto home on line three
Home Fourth
Home F                                                  'first letteer also
works
Locate 4 , 1 : Lcd "Line 4"
Wait 1

'Now lets build a special character
'the first number is the characternumber (0-7)
'The other numbers are the rowvalues
'Use the LCD tool to insert this line

Deflcdchar 1 , 225 , 227 , 226 , 226 , 226 , 242 , 234 , 228       ' replace ? with
number (0-7)
Deflcdchar 0 , 240 , 224 , 224 , 255 , 254 , 252 , 248 , 240       ' replace ? with
number (0-7)
Cls                                                     'select data RAM
Rem it is important that a CLS is following the deflcdchar statements because it will
set the controller back in datamode
Lcd Chr(0) ; Chr(1)                                     'print the special
character

'----------------- Now use an internal routine ------------
_temp1 = 1                                              'value into ACC
!rCall _write_lcd                                       'put it on LCD
End
```

# LEFT

## Action

Return the specified number of leftmost characters in a string.

## Syntax

var = **Left(**var1 , n **)**

## Remarks

| | |
|---|---|
| Var | The string that is assigned. |
| Var1 | The source string. |
| n | The number of characters to get from the source string. |

## See also

RIGHT , MID

## Example

```
Dim S As Xram String * 15 , Z As String * 15
S = "ABCDEFG"
Z = Left(s , 5)
Print Z                                                    'ABCDE
End
```

# LEN

## Action

Returns the length of a string.

## Syntax

var = **LEN**( string )

## Remarks

var A numeric variable that is assigned with the length of string.

string The string to calculate the length of.

Strings can be maximum 254 bytes long.

## Example

```
Dim S As String * 12
Dim A As Byte
S = "test"
A = Len(s)
Print A                                                    ' prints 4
Print Len(s)
```

# LOAD

## Action

Load specified TIMER with a reload value.

## Syntax

**LOAD** TIMER , value

## Remarks

TIMER TIMER0 , TIMER1 or TIMER2

Value The variable or value to load.

The TIMER0 does not have a reload mode. But when you want the timer to generate an interrupt after 10 ticks for example, you can use the RELOAD statement.

It will do the calculation. (256-value)

So LOAD TIMER0, 10 will load the TIMER0 with a value of 246 so that it will overflow after 10 ticks.

TIMER1 is a 16 bit counter so it will be loaded with the value of 65536-value.

# LOADADR

## Action

Loads the address of a variable into a register pair.

## Syntax

LOADADR var , reg

## Remarks

| | |
|---|---|
| var | A variable which address must be loaded into the register pair X, Y or Z. |
| reg | The register X, Y or Z. |

The LOADADR statement serves as an assembly helper routine.

## Example

```
Dim S As String * 12
Dim A As Byte
$ASM
  loadadr S , X  'load address into R26 and R27
  ld _temp1, X   'load value of location R26/R27 into R24(_temp1)
$END ASM
```

# LOCAL

## Action

Dimensions a variable LOCAL to the function or sub program.

## Syntax

**LOCAL** var **As** Type

## Remarks

Var The name of the variable

Type The data type of the variable.

There can be only LOCAL variables of the type BYTE, INTEGER, WORD, LONG, SINGLE or STRING.

A LOCAL variable is a temporary variable that is stored on the frame.

When the SUB or FUNCTION is terminated, the memory will be released back to the frame.

BIT variables are not possible because they are GLOBAL to the system.

The AT , ERAM, SRAM, XRAM directives can not be used with a local DIM statement. Also local arrays are not possible.

## See also

DIM

## ASM

NONE

## Example

```
'-----------------------------------------------------
'              (c) 2000 MCS Electronics
'             DECLARE.BAS
' Note that the usage of SUBS works different in BASCOM-8051
'-----------------------------------------------------
' First the SUB programs must be declared
```

```
'Try a SUB without parameters
Declare Sub Test2

'SUB with variable that can not be changed(A) and
'a variable that can be changed(B1), by the sub program
'When BYVAL is specified, the value is passed to the subprogram
'When BYREF is specified or nothing is specified, the address is passed to
'the subprogram

Declare Sub Test(byval A As Byte , B1 As Byte)
Declare Sub Testarray(byval A As Byte , B1 As Byte)
'All variable types that can be passed
'Notice that BIT variables can not be passed.
'BIT variables are GLOBAL to the application
Declare Sub Testvar(b As Byte , I As Integer , W As Word , L As Long , S As String)

'passing string arrays needs a different syntax because the length of the strings must
be passed by the compiler
'the empty () indicated that an array will be passed
Declare Sub Teststr(b As Byte , Dl() As String)

Dim Bb As Byte , I As Integer , W As Word , L As Long , S As String * 10       'dim
used variables
Dim Ar(10) As Byte
Dim Sar(10) As String * 8                                          'strng array

For Bb = 1 To 10
  Sar(bb) = Str(bb)                                                'fill the array
Next
Bb = 1
'now call the sub and notice that we always must pass the first address with index 1
Call Teststr(bb , Sar(1))


Call Test2                                                         'call sub
Test2                                                              'or use without CALL
'Note that when calling a sub without the statement CALL, the enclosing parentheses
must be left out
Bb = 1
Call Test(1 , Bb)                                                  'call sub with
parameters
Print Bb                                                           'print value that is
changed

'now test all the variable types
Call Testvar(bb , I , W , L , S )
Print Bb ; I ; W ; L ; S

'now pass an array
'note that it must be passed by reference
Testarray 2 , Ar(1)
Print "ar(1) = " ; Ar(1)
Print "ar(3) = " ; Ar(3)
End

'End your code with the subprograms
'Note that the same variables and names must be used as the declared ones

Sub Test(byval A As Byte , B1 As Byte)                             'start sub
    Print A ; " " ; B1                                             'print passed variables
    B1 = 3                                                         'change value
    'You can change A, but since a copy is passed to the SUB,
    'the change will not reflect to the calling variable
End Sub

Sub Test2                                                          'sub without parameters
    Print "No parameters"
End Sub


Sub Testvar(b As Byte , I As Integer , W As Word , L As Long , S As String)
    Local X As Byte

    X = 5                                                          'assign local

    B = X
    I = -1
    W = 40000
```

```
    L = 20000
    S = "test"
End Sub

Sub Testarray(byval A As Byte , B1 As Byte)                    'start sub
    Print A ; " " ; B1                                         'print passed variables
    B1 = 3                      'change value of element with index 1
    B1(1) = 3                   'specify the index which does the same as the line
above
    B1(3) = 3                                                  'modify other element of
array
    'You can change A, but since a copy is passed to the SUB,
    'the change will not reflect to the calling variable
End Sub

'notice the empty() to indicate that a string array is passed
Sub Teststr(b As Byte , Dl() As String)
  Dl(b) = Dl(b) + "add"
End Sub
```

# LOCATE

## Action

Moves the LCD cursor to the specified position.

## Syntax

**LOCATE** y , x

## Remarks

| | |
|---|---|
| X | Constant or variable with the position. (1-64*) |
| Y | Constant or variable with the line (1 - 4*) |

* Depending on the used display

## See also

CONFIG LCD , LCD , HOME , CLS

## Example

```
LCD "Hello"
Locate 1,10
```

```
LCD "*"
```

# LOG

## Action

Returns the natural logarithm of a single variable.

## Syntax

Target = **Log**(source)

## Remarks

| | |
|---|---|
| Target | The single that is assigned with the LOG() of single target. |
| Source | The source single to get the LOG of. |

Log() makes use of single variables that are generated automatic by the compiler.

The variables are named ___SNGTMP1 - ___SNGTMP4. These variables may be reused by your application.

The LOG() function can take a lot of time to execute. Especial when large numbers are used. When the number increases, the accuracy will get less.

## See also

EXP

## Example

```
Dim X As Single
X = Log(100)
Print X
'prints  4.605170
X = 100
X = Log(x)
Print X
'Prints 4.605098
```

```
X = Log(1.1)
Print X
'prints 0.095310147
X = 1.1
X = Log(x)
Print X
'prints 0.095310147

'So a smaller number is more precise and is calculated
faster
```

# LOOKDOWN

## Action

Returns the index of a series of data.

## Syntax

var **=LOOKDOWN(** value**,** label, entries **)**

## Remarks

| | |
|---|---|
| Var | The returned index value |
| Value | The value to search for |
| Label | The label where the data starts |
| entries | The number of entries that must be searched |

When you want to look in BYTE series the VALUE variable must be dimensioned as a BYTE. When you want to look in INTEGER or WORD series the VALUE variable must be dimensioned as an INTEGER.

The LookDown function is the counterpart of the LookUp function.

Lookdown will search the data for a value and will return the index when the value is found. It will return –1 when the data is not found.

## See also

LOOKUPSTR , LOOKUP

## Example

```
' -----------------------------------------------------------
'                     LOOKDOWN.BAS
'              (c) 2001 MCS Electronics
' -----------------------------------------------------------

Dim Idx as integer, search as byte,entries as byte

'we want to search for the value 3
Search = 3
'there are 5 entries in the table
Entries = 5

'lookup and return the index
Idx = Lookdown(search , Label , Entries)
Print Idx

Search = 1
Idx = Lookdown(search , Label , Entries)
Print Idx


Search = 100
Idx = Lookdown(search , Label , Entries)
Print Idx                                                    ' return -1 if not
found


'looking for integer or word data requires that the search variable is
'of the type integer !
Dim Isearch As Integer
Isearch = 400
Idx = Lookdown(isearch , Label2 , Entries)
Print Idx                                                    ' return 3

End


Label:
Data 1 , 2 , 3 , 4 , 5

Label2:
Data 1000% , 200% , 400% , 300%
```

# LOOKUP

## Action

Returns a value from a table.

## Syntax

var **=LOOKUP(** value**,** label **)**

## Remarks

| | |
|---|---|
| Var | The returned value |
| Value | A value with the index of the table |
| Label | The label where the data starts |

The value can be up to 65535. 0 will return the first entry.

## See also

LOOKUPSTR

## Example

```
Dim B1 As Byte , I As Integer
B1 = Lookup(2 , Dta)
Print B1                                          ' Prints 2 (zero based)

I = Lookup(0 , Dta2)                              ' print 1000
Print I
End


Dta:
Data 1 , 2 , 3 , 4 , 5
Dta2:
Data 1000% , 2000%
```

# LOOKUPSTR

## Action

Returns a string from a table.

## Syntax

var =LOOKUPSTR( value, label )

## Remarks

| | |
|---|---|
| Var | The string returned |
| Value | A value with the index of the table. The index is zero-based. That is, 0 will return the first element of the table. |
| Label | The label where the data starts |

The index value can have a maximum value of 255.

## See also

LOOKUP

## Example

```
Dim S As String * 4 , Idx As Byte
Idx = 0 : S = Lookupstr(idx , Sdata)
Print S                                                    'will print 'This'
End

Sdata:
Data "This" , "is" ,"a test"
```

# LOW

## Action

Retrieves the least significant byte of a variable.

## Syntax

var = **LOW**( s )

## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the LSB of var S. |

S The source variable to get the LSB from.

## See also

HIGH , HIGHW

## Example

```
Dim I As Integer , Z As Byte
I = &H1001
Z = Low(I)   ' is 1
End
```

# LOWERLINE

## Action

Reset the LCD cursor to the lower line.

## Syntax

**LOWERLINE**

## Remarks

NONE

## See also

UPPERLINE, THIRDLINE , FOURTHLINE , HOME

## Example

```
LCD "Test"
LOWERLINE
```

```
LCD "Hello"
End
```

## LTRIM

### Action

Returns a copy of a string with leading blanks removed

### Syntax

var = **LTRIM**( org )

### Remarks

| | |
|---|---|
| Var | String that receives the result. |
| Org | The string to remove the leading spaces from |

### See also

RTRIM , TRIM

### ASM

NONE

### Example

```
Dim S As String * 6
S = "  AB "
Print Ltrim(s)
Print Rtrim(s)
Print Trim(s)
End
```

## MAKEBCD

### Action

Convert a variable into its BCD value.

## Syntax

var1 = **MAKEBCD**(var2)

## Remarks

var1 Variable that will be assigned with the converted value.

Var2 Variable that holds the decimal value.

When you want to use an I2C clock device, which stores its values as BCD values you can use this function to convert variables from decimal to BCD.

For printing the bcd value of a variable, you can use the BCD() function which converts a BCD number into a BCD string.

## See also

MAKEDEC , BCD

## Example

```
Dim A As Byte
A = 65
Lcd A
Lowerline
Lcd Bcd(a)
A = Makebcd(a)
LCD "   "  ; a
End
```

# MAKEINT

## Action

Compact two bytes into a word or integer.

## Syntax

varn = MAKEINT(LSB , MSB)

## Remarks

Varn Variable that will be assigned with the converted value.

LSB Variable or constant with the LS Byte.

MSB Variable or constant with the MS Byte.

The equivalent code is:

varn = (256 * MSB) + LSB

## See also

LOW , HIGH

## Example

```
Dim a As Integer, I As Integer
A = 2
I = Makeint(a , 1)                                    'I = (1 * 256) + 2  = 258
End
```

# MAKEDEC

## Action

Convert a BCD byte or Integer/Word variable to its DECIMAL value.

## Syntax

var1 = **MAKEDEC**(var2)

## Remarks

var1 Variable that will be assigned with the converted value.

var2 Variable that holds the BCD value.

When you want to use an I2C clock device, which stores its values as BCD values you can use this function to convert variables from BCD to decimal.

## See also

MAKEBCD

## Example

```
Dim A As Byte
a = 65
Print A
Print Bcd(a)
A = Makedec(a)
Print Spc(3) ; A
End
```

# MID

## Action

The MID function returns part of a string (a sub string).

The MID statement replaces part of a string variable with another string.

## Syntax

var = **MID(**var1 ,st [, l] **)**

**MID(**var ,st [, l] **)** = var1

## Remarks

| | |
|---|---|
| var | The string that is assigned. |
| Var1 | The source string. |
| st | The starting position. |
| l | The number of characters to get/set. |

## See also

LEFT, RIGHT

## Example

```
Dim S As String * 15 , Z As String * 15
S = "ABCDEFG"
Z = Mid(s , 2 , 3)
Print Z                                                    'BCD
Z = "12345"
Mid(s , 2 , 2) = Z
Print S                                                    'A12DEFG
End
```

# ON INTERRUPT

## Action

Execute subroutine when a specified interrupt occurs.

## Syntax

**ON** interrupt label [NOSAVE]

## Remarks

| | |
|---|---|
| Interrupt | INT0, INT1, INT2, INT3, INT4,INT5, TIMER0 ,TIMER1, TIMER2, ADC , EEPROM , CAPTURE1, COMPARE1A, COMPARE1B,COMPARE1. Or you can use the AVR name convention :<br><br>OC2 , OVF2, ICP1, OC1A, OC1B, OVF1, OVF0, SPI, URXC, UDRE, UTXC, ADCC, ERDY and ACI. |

Label The label to jump to if the interrupt occurs.

NOSAVE When you specify NOSAVE, no registers are saved and restored in the interrupt routine. So when you use this option be sure to save and restore used registers.
When you omit NOSAVE all used registers will be saved. These are SREG , R31 to R16 and R11 to R0.

R12 – R15 are not saved. When you use floating point math in the ISR(not recommended) you must save and restore R12-R15 yourself in the ISR.

```
My_Isr:
  Push R12  ' save registers
  Push R13
  Push R14
  Push R15
  Single = single + 1 ' we use FP
 Pop R15   ' restore registers
 Pop  R14
 Pop R13
 Pop R12
RETURN
```

You must return from the interrupt routine with the RETURN statement.

The first RETURN statement that is encountered that is outside a condition will generate a RETI instruction. You may have only one such RETURN statement in your interrupt routine because the compiler restores the registers and generates a RETI instruction when it encounters a RETURN statement in the ISR. All other RETURN statements are converted to a RET instruction.

The possible interrupt names can be looked up in the selected microprocessor register file. 2313def.dat for example shows that for the compare interrupt the name is COMPARE1. (look at the bottom of the file)

What are interrupts good for?

An interrupt will halt your program and will jump to a specific part of your program. You can make a DO .. LOOP and poll the status of a pin for example to execute some code when the input on a pin changes.

But with an interrupt you can perform other tasks and when then pin input

changes a special part of your program will be executed. When you use INPUT "Name ", v for example to get a user name via the RS-232 interface it will wait until a RETURN is received. When you have an interrupt routine and the int occurs it will branch to the interrupt code and will execute the interrupt code. When it is finished it will return to the Input statement, waiting until a RETURN is entered.

Maybe a better example is writing a clock program. You could update a variable in your program that updates a second counter. But a better way is to use a TIMER interrupt and update a seconds variable in the TIMER interrupt handler.

There are multiple interrupt sources and it depends on the used chip which are available.

To allow the use of interrupts you must set the global interrupt switch with a ENABLE INTERRUPTS statement. This only allows that interrupts can be used. You must also set the individual interrupt switches on!

ENABLE TIMER0 for example allows the TIMER0 interrupt to occur.

With the DISABLE statement you turn off the switches.

When the processor must handle an interrupt it will branch to an address at the start of flash memory. These addresses can be found in the DAT files.

The compiler normally generates a RETI instruction on these addresses so that in the event that an interrupt occurs, it will return immediately.

When you use the ON ... LABEL statement, the compiler will generate code that jumps to the specified label. The SREG and other registers are saved at the LABEL location and when the RETURN is found the compiler restores the registers and generates the RETI so that the program will continue where it was at the time the interrupt occurred.

When an interrupt is services no other interrupts can occur because the processor(not the compiler) will disable all interrupts by clearing the master interrupt enable bit. When the interrupt is services the interrupt is also cleared so that it can occur again when the conditions are met that sets the interrupt.

It is not possible to give interrupts a priority. The interrupt with the lowest address has the highest interrupt!

Finally some tips :

* when you use a timer interrupt that occurs each 10 uS for example, be sure that the interrupt code can execute in 10 uS. Otherwise you would loose time.

* it is best to set just a simple flag in the interrupt routine and to determine it's status in the main program. This allows you to use the NOSAVE option that saves stack space and program space. You only have to Save and Restore R24 and SREG in that case.

## Example

```
Enable Interrupts
Enable Int0                                                 'enable the interrupt
On Int0 Label2 Nosave                                       'jump to label2 on INT0
Do                                                          'endless loop
  nop
Loop
End

Label2:
 Dim A As Byte
 If A > 1 Then
    Return              'generates a RET because it is inside a condition
 End If
Return                  'generates a RETI because it is the first RETURN
Return                  'generates a RET because it is the second RETURN
```

# ON VALUE

## Action

Branch to one of several specified labels, depending on the value of a variable.

## Syntax

**ON** var [**GOTO**] [**GOSUB**] label1 **[**, label2 **]**

## Remarks

| | |
|---|---|
| Var | The numeric variable to test.<br>This can also be a SFR such as PORTB. |
| label1, label2 | The labels to jump to depending on the value of *var*. |

Note that the value is zero based. So when var is 0, the first specified label is jumped/branched.

## ASM

The following code will be generated for a non-MEGA micro with ON value GOTO.

```
Ldi R26,$60                                    ; load
address of variable
Ldi R27,$00
; load constant in register
Ld R24,X
Clr R25
Ldi R30, Low(ON_1_ * 1)                        ; load Z
with address of the label
Ldi R31, High(ON_1_ * 1)
Add zl,r24                                     ; add value
to Z
Adc zh,r25
Ijmp                                       ; jump to address
stored in Z
ON_1_:
Rjmp lbl1                                  ; jump table
Rjmp lbl2
Rjmp lbl3
```

The following code will be generated for a non-MEGA micro with ON value GOSUB.

```
;##### On X Gosub L1 , L2
Ldi R30,Low(ON_1_EXIT * 1)
Ldi R31,High(ON_1_EXIT * 1)
Push R30
;push return address
Push R31
Ldi R30,Low(ON_1_ * 1)                                ;load
table address
Ldi R31,High(ON_1_ * 1)
Ldi R26,$60
Ld R24,X
Clr R25
```

```
Add zl,r24
; add to address of jump table
Adc zh,r25
Ijmp                                                    ; jump !!!
ON_1_:
Rjmp L1
Rjmp L2
ON_1_EXIT:
```

As you can see a jump is used to call the routine. Therefore the return address is first saved on the stack.

## Example

```
Dim X As Byte
X = 2                                                   'assign a variable
interrupt
On X Gosub Lbl1 , Lbl2 , Lbl3                           'jump to label lbl3
X = 0
On X Goto Lbl1 , Lbl2 , Lbl3
END

lbl3:
  Print "lbl3"
Return


Lbl1:
Print "lbl1"

Lbl2:
Print "lbl2"
```

# OPEN

## Action

Opens a device.

## Syntax

OPEN "device" for MODE As #channel

CLOSE #channel

## Remarks

device The default device is COM1 and you don't need to open a channel to use INPUT/OUTPUT on this device.
With the implementation of the software UART, the compiler must know to which pin/device you will send/receive the data.
So that is why the OPEN statement must be used. It tells the compiler about the pin you use for the serial input or output and the baud rate you want to use.
COMB.0:9600,8,N,2 will use PORT B.0 at 9600 baud with 2 stopbits.

The format for COM1 is : COM1:speed, where the speed is optional and will override the compiler settings for the speed.

The format for the software UART is:
COMpin:speed,8,N,stopbits[,INVERTED]
Where pin is the name of the PORT-pin.
Speed must be specified and stop bits can be 1 or 2.
7 bit data or 8 bit data may be used.
For parity N, O or E can be used.

An optional parameter ,INVERTED can be specified to use inverted RS-232.
Open "COMD.1:9600,8,N,1,INVERTED" For Output As #1 , will use pin PORTD.1 for output with 9600 baud, 1 stop bit and with inverted RS-232.

MODE You can use BINARY or RANDOM for COM1, but for the software UART pins, you must specify INPUT or OUTPUT.

channel The number of the channel to open. Must be a positive constant >0.

The statements that support the device are PRINT , INPUT , INPUTHEX , INKEY and WAITKEY

Every opened device must be closed using the CLOSE #channel statement.
Of course, you must use the same channel number.

The INPUT statement in combination with the software UART, will not echo characters back because there is no default associated pin for this.

## See also

CLOSE , CRYSTAL

## Example

```
'-----------------------------------------------------
'          (c) 2000 MCS Electronics
'                OPEN.BAS
'        demonstrates software UART
'-----------------------------------------------------
$crystal = 10000000                                         'change to the value of
the XTAL you have installed


Dim B As Byte

'Optional you can fine tune the calculated bit delay
'Why would you want to do that?
'Because chips that have an internal oscillator may not
'run at the speed specified. This depends on the voltage, temp etc.
'You can either change $CRYSTAL or you can use
'BAUD #1,9610

'In this example file we use the DT006 from www.simmstick.com
'This allows easy testing with the existing serial port
'The MAX232 is fitted for this example.
'Because we use the hardware UART pins we MAY NOT use the hardware UART
'The hardware UART is used when you use PRINT, INPUT or other related statements
'We will use the software UART.
Waitms 100

'open channel for output
Open "comd.1:19200,8,n,1" For Output As #1
Print #1 , "serial output"


'Now open a pin for input
Open "comd.0:19200,8,n,1" For Input As #2
'since there is no relation between the input and output pin
'there is NO ECHO while keys are typed
Print #1 , "Number"
'get a number
Input #2 , B
'print the number
Print #1 , B

'now loop until ESC is pressed
'With INKEY() we can check if there is data available
'To use it with the software UART you must provide the channel
Do
   'store in byte
   B = Inkey(#2)
   'when the value > 0 we got something
   If B > 0 Then
      Print #1 , Chr(b)                                     'print the character
   End If
Loop Until B = 27


Close #2
Close #1


'OPTIONAL you may use the HARDWARE UART
'The software UART will not work on the hardware UART pins
'so you must choose other pins
'use normal hardware UART for printing
'Print B


'When you dont want to use a level inverter such as the MAX-232
'You can specify ,INVERTED :
'Open "comd.0:300,8,n,1,inverted" For Input As #2
'Now the logic is inverted and there is no need for a level converter
'But the distance of the wires must be shorter with this
End
```

# OUT

## Action

Sends a byte to a hardware port or internal or external memory address.

## Syntax

**OUT** address, value

## Remarks

| | |
|---|---|
| Address | The address where to send the byte to in the range of 0-FFFF hex. |
| Value | The variable or value to send. |

The OUT statement can write a value to any AVR memory location.

It is advised to use Words for the address. An integer might have a negative value and will write of course to a word address. So it will be 32767 higher as supposed. This because an integer has it's most significant bit set when it is negative.

To write to XRAM locations you must enable the External RAM access in the Compiler Chip Options.

## See also

INP

## Example

```
Out &H8000 , 1            'send  1 to the databus(d0-d7) at hex address 8000
End
```

# PEEK

## Action

Returns the content of a register.

## Syntax

var **= PEEK(** address **)**

## Remarks

| | |
|---|---|
| Var | Numeric variable that is assigned with the content of the memory location address |
| Address | Numeric variable or constant with the address location.(0-31) |

Peek() will read the content of a register.

Inp() can read any memory location

## See also

POKE , CPEEK , INP , OUT

## Example

```
Dim A As Byte
A = Peek(0)                 'return the first byte of the internal memory (r0)
End
```

# POKE

## Action

Write a byte to an internal register.

## Syntax

**POKE** address , value

## Remarks

| | |
|---|---|
| Address | Numeric variable with the address of the memory location to set. (0-31) |
| Value | Value to assign. (0-255) |

## See also

PEEK , CPEEK , INP , OUT

## Example

```
Poke 1 , 1                                          'write 1 to R1
End
```

# POPALL

## Action

Restores all registers that might be used by BASCOM.

## Syntax

**POPALL**

## Remarks

When you are writing your own ASM routines and mix them with BASIC you are unable to tell which registers are used by BASCOM because it depends on the used statements and interrupt routines that can run on the background.

That is why Pushall saves all registers and POPALL restores all registers.

## See also

PUSHALL

# POWERDOWN

## Action

Put processor into power down mode.

## Syntax

POWERDOWN

## Remarks

In the power down mode, the external oscillator is stopped. The user can use the WATCHDOG to power up the processor when the watchdog timeout expires. Other possibilities to wake up the processor is to give an external reset or to generate an external level triggered interrupt.

## See also

IDLE , POWERSAVE

## Example

```
Powerdown
```

# POWERSAVE

## Action

Put processor into power save mode.

## Syntax

POWERSAVE

## Remarks

The POWERSAVE mode is only available on the 8535.

## See also

IDLE, POWERDOWN

## Example

```
Powersave
```

# PRINT

## Action

Send output to the RS-232 port.

## Syntax

**PRINT** var ; " constant"

## Remarks

Var The variable or constant to print.

You can use a semicolon (;) to print more than one variable at one line.

When you end a line with a semicolon, no linefeed will be added.

The PRINT routine can be used when you have a RS-232 interface on your uP.

The RS-232 interface can be connected to a serial communication port of your computer.

This way you can use a terminal emulator as an output device.

You can also use the build in terminal emulator.

## See also

INPUT ,OPEN , CLOSE , SPC

## Example

```
'-----------------------------------------------------------
'               (c) 1999-2000 MCS Electronics
'-----------------------------------------------------------
'  file: PRINT.BAS
'  demo: PRINT, HEX
'-----------------------------------------------------------
Dim A As Byte , B1 As Byte , C As Integer , S As String * 4
A = 1
Print "print variable a " ; A
Print                                                   'new line
Print "Text to print."                                  'constant to print


B1 = 10
Print Hex(b1)                                           'print in hexa notation
C = &HA000                                              'assign value to c%
Print Hex(c)                                            'print in hex notation
Print C                                                 'print in decimal
notation

C = -32000
Print C
Print Hex(c)
Rem Note That Integers Range From -32767 To 32768
End
```

# PRINTBIN

## Action

Print binary content of a variable to the serial port.

## Syntax

PRINTBIN var [ ; varn]

PRINTBIN #channel, var [; varn]

## Remarks

var The variable which value is send to the serial port.

varn Optional variables to send.

The channel is optional and for use with OPEN and CLOSE statements.

PRINTBIN is equivalent to PRINT CHR(var);

When you use a Long for example, 4 bytes are printed.

Multiple variables may be sent. They must be separated by the **;** sign.

## See also

INPUTBIN

## Example

```
Dim A(10) As Byte , C As Byte
For C = 1 To 10
  A(c) = A                              'fill array
Next
Printbin A(1)                           'print content of a(1). Not the whole array will
be sent!

End
```

# PSET

## Action

Sets or resets a single pixel.

## Syntax

**PSET** X , Y, value

## Remarks

| | |
|---|---|
| X | The X location of the pixel. In range from 0-239. |
| Y | The Y location of the pixel. In range from 0-63. |
| value | The value for the pixel. 0 will clear the pixel. 1 Will set the pixel. |

The PSET is handy to create a simple data logger or oscilloscope.

## See also

SHOWPIC , CONFIG GRAPHLCD

## Example

```
'-----------------------------------------------------------------
'                     (c) 2001 MCS Electronics
'                  T6963C graphic display support demo
'-----------------------------------------------------------------

'The connections of the LCD used in this demo
'LCD pin                    connected to
' 1         GND             GND
 '2         GND             GND
 '3         +5V             +5V
 '4         -9V             -9V potmeter
 '5         /WR             PORTC.0
 '6         /RD             PORTC.1
 '7         /CE             PORTC.2
 '8         C/D             PORTC.3
 '9         NC              not conneted
 '10        RESET           PORTC.4
 '11-18     D0-D7            PA
 '19        FS              PORTC.5
 '20        NC              not connected


'First we define that we use a graphic LCD
' Only 240*64 supported yet
Config Graphlcd = 240 * 64 , Dataport = Porta , Controlport = Portc , Ce = 2 , Cd =
3 , Wr = 0 , Rd = 1 , Reset = 4 , Fs = 5
'The dataport is the portname that is connected to the data lines of the LCD
'The controlport is the portname which pins are used to control the lcd
'CE, CD etc. are the pin number of the CONTROLPORT.
' For example CE =2 because it is connected to PORTC.2


'Dim variables (y not used)
Dim X As Byte , Y As Byte


'Clear the screen will both clear text and graph display
Cls
'Other options are :
' CLS TEXT   to clear only the text display
' CLS GRAPH  to clear only the graphical part

'locate works like the normal LCD locate statement
' LOCATE LINE,COLUMN LINE can be 1-8 and column 0-30
Locate 1 , 1

'Show some text
Lcd "MCS Electronics"
'And some othe text on line 2
Locate 2 , 1 : Lcd "T6963c support"
```

```
'wait 1 sec
Wait 1


' draw a line using PSET X,Y, ON/OFF
' PSET on.off param is 0 to clear a pixel and any other value to turn it on
For X = 0 To 140
   Pset X , 20 , 255                                          ' set the pixel
Next

Wait 1


'Now it is time to show a picture
'SHOWPIC X,Y,label
'The label points to a label that holds the image data
Showpic 0 , 0 , Plaatje

Wait 1
Cls Text                                                     ' clear the text
End



'This label holds the mage data
Plaatje:
'$BGF will put the bitmap into the program at this location
$bgf "mcs.bgf"

'You could insert other picture data here
```

# PULSEIN

## Action

Returns the number of units between two occurrences of an edge of a pulse.

## Syntax

**PULSEIN** var , PINX , PIN , STATE

## Remarks

| | |
|---|---|
| var | A word variable that is assigned with the result. |
| PINX | A PIN register like PIND |
| PIN | The pin number(0-7) to get the pulse time of. |
| STATE | May be 0 or 1.<br>0 means sample 0 to 1 transition.<br>1 means sample 1 to 0 transition. |

ERR variable will be set to 1 in case of a time out. A time out will occur after

65535 unit counts. With 10 uS units this will be after 655.35 mS.

You can add a bitwait statement to be sure that the PULSEIN statement will wait for the start condition. But when using the BITWAIT statement and the start condition will never occur, your program will stay in a loop.

The PULSIN statement will wait for the specified edge.

When state 0 is used, the routine will wait until the level on the specified input pin is 0. Then a counter is started and stopped until the input level gets 1.

No hardware timer is used. A 16 bit counter is used. It will increase in 10 uS units. But this depends on the XTAL. You can change the library routine to adjust the units.

## See also

PULSEOUT

## ASM

The following ASM routine is called from mcs.lib

_pulse_in (calls _adjust_pin)

On entry ZL points to the PINx register , R16 holds the state, R24 holds the pin number to sample.

On return XL + XH hold the 16 bit value.

## Example

```
Dim w As Byte
pulsein w , PIND , 1 , 0   'detect time from 0 to 1
print w
end
```

# PULSEOUT

## Action

Generates a pulse on a pin of a PORT of specified period in 1uS units for 4 MHz.

## Syntax

**PULSEOUT** PORT , PIN , PERIOD

## Remarks

| | |
|---|---|
| PORT | Name of the PORT. PORTB for example |
| PIN | Variable or constant with the pin number (0-7). |
| PERIOD | Number of periods the pulse will last. The periods are in uS when an XTAL of 4 MHz is used. |

The pulse is generated by toggling the pin twice, thus the initial state of the pin determines the polarity.

The PIN must be configured as an output pin before this statement can be used.

## See also

PULSEIN

## Example

```
Dim A As Byte
Config Portb = Output                                   'PORTB all output pins
Portb = 0                                               'all pins 0
Do
For A = 0 To 7
  Pulseout Portb , A , 60000                            'generate pulse
  Waitms 250                                            'wait a bit
Next
Loop                                                    'loop for ever
```

# PUSHALL

## Action

Saves all registers that might be used by BASCOM.

## Syntax

**PUSHALL**

## Remarks

When you are writing your own ASM routines and mix them with BASIC you are unable to tell which registers are used by BASCOM because it depends on the used statements and interrupt routines that can run on the background.

That is why Pushall saves all registers. Use POPALL to restore the registers.

## See also

POPALL

# READ

## Action

Reads those values and assigns them to variables.

## Syntax

**READ** var

## Remarks

Var Variable that is assigned data value.

It is best to place the DATA lines at the end of your program.

## Difference with QB

It is important that the variable is of the same type as the stored data.

## See also

DATA , RESTORE

## Example

```
'-----------------------------------------------------------
'                      READDATA.BAS
'             Copyright 1999-2000 MCS Electronics
'-----------------------------------------------------------

Dim A As Integer , B1 As Byte , Count As Byte
Dim S As String * 15
Dim L As Long
Restore Dta1                                                'point to stored data
For Count = 1 To 3                                          'for number of data items
   Read B1 : Print Count ; "  " ; B1
Next

Restore Dta2                                                'point to stored data
For Count = 1 To 2                                          'for number of data items
   Read A : Print Count ; "  " ; A
Next

Restore Dta3
Read S : Print S
Read S : Print S


Restore Dta4
Read L : Print L                                              'long type

End


Dta1:
Data &B10 , &HFF , 10
Dta2:
Data 1000% , -1%

Dta3:
Data "Hello" , "World"
'Note that integer values (>255 or <0) must end with the %-sign
'also note that the data type must match the variable type that is
'used for the READ statement

Dta4:
Data 123456789&
'Note that LONG values must end with the &-sign
'Also note that the data type must match the variable type that is used
'for the READ statement
```

# READEEPROM

## Action

Reads the content from the DATA EEPROM and stores it into a variable.

## Syntax

**READEEPROM** var , address

## Remarks

| | |
|---|---|
| Var | The name of the variable that must be stored |
| Address | The address in the EEPROM where the data must be read from. |

This statement is provided for compatibility with BASCOM-8051.

You can also use :

```
Dim V as Eram Byte 'store in EEPROM
Dim B As Byte              'normal variable
B = 10
V = B                 'store variable in EEPROM
B = V                 'read from EEPROM
```

When you use the assignment version, the datatypes must be equal!

According to a datasheet from ATMEL, the first location in the EEPROM with address 0, can be overwritten during a reset so don't use it.

You may also use ERAM variables as indexes. Like :

```
Dim ar(10) as Eram Byte
```

When you omit the address label in consecutive reads, you must use a new READEEPROM statement. It will not work in a loop:

```
Readeeprom B , Label1
Print B
 Do
  Readeeprom B
  Print B Loop
Until B = 5
```

This will not work since there is no pointer maintained. The way it will work :

```
ReadEEprom B , Label1 ' specify label
ReadEEPROM B ' read next address in EEPROM
ReadEEPROM B ' read next address in EEPROM
```

## See also

WRITEEEPROM , $EEPROM

## ASM

NONE

## Example

```
Dim B As Byte
Writeeeprom B , 0                                           'store at first position
Readeeprom B , 0                                            'read byte back
```

## Example 2

```
'-----------------------------------------------------------------
'                         EEPROM2.BAS
'   This example shows how to use labels with READEEPROM
'-----------------------------------------------------------------
'first dimension a variable
Dim B As Byte
Dim Yes As String * 1

'Usage for readeeprom and writeeprom :
'readeeprom var, address

'A new option is to use a label for the address of the data
'Since this data is in an external file and not in the code the eeprom data
'should be specified first. This in contrast with the normal DATA lines which must
'be placed at the end of your program!!

'first tell the compiler that we are using EEPROM to store the DATA
$eeprom
'specify a label
label1:
Data 1 , 2 , 3 , 4 , 5
Label2:
Data 10 , 20 , 30 , 40 , 50

'Switch back to normal data lines in case they are used
$data

'All the code above does not generate real object code
'It only creates a file with the EEP extension

'Use the new label option
Readeeprom B , Label1
Print B                                     'prints 1
'Succesive reads will read the next value
'But the first time the label must be specified so the start is known
Readeeprom B
Print B                                     'prints 2

Readeeprom B , Label2
Print B                                     'prints 10
Readeeprom B
Print B                                     'prints 20

'And it works for writing too :
'but since the programming can interfere we add a stop here
Input "Ready?" , Yes
B = 100
Writeeeprom B , Label1
B = 101
Writeeeprom B

'read it back
Readeeprom B , Label1
Print B                                     'prints 1
```

```
'Succesive reads will read the next value
'But the first time the label must be specified so the start is known
Readeeprom B
Print B                                    'prints 2


End
```

# READMAGCARD

## Action

Read data from a magnetic card.

## Syntax

**Readmagcard var , count , 5|7**

## Remarks

| | |
|---|---|
| Var | A byte array the receives the data. |
| Count | A byte variable that returns the number of bytes read. |
| 5\|7 | A numeric constant that specifies if 5 or 7 bit coding is used. |

There can be 3 tracks on a magnetic card.

Track 1 strores the data in 7 bit including the parity bit. This is handy to store alpha numeric data.

On track 2 and 3 the data is tored with 5 bit coding.

The ReadMagCard routine works with ISO7811-2  5 and 7 bit decoding.

The returned numbers for 5 bit coding are:

| Returned number | ISO characterT |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |

| | |
|---|---|
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |
| 10 | hardware control |
| 11 | start byte |
| 12 | hardware control |
| 13 | separator |
| 14 | hardware control |
| 15 | stop byte |

## Example

```
'-----------------------------------------------------------------------
'                           (c) 2000 MCS Electronics
'                               MAGCARD.BAS
'  This example show you how to read data from a magnetic card
'It was tested on the DT006 SimmStick.
'-----------------------------------------------------------------------
'[reserve some space]
Dim Ar(100) As Byte , B As Byte , A As Byte

'the magnetic card reader has 5 wires
'red      - connect to +5V
'black    - connect to GND
'yellow   - Card inserted signal CS
'green    - clock
'blue     - data

'You can find out for your reader which wires you have to use by connecting +5V
'And moving the card through the reader. CS gets low, the clock gives a clock pulse of
equal pulses
'and the data varies
'I have little knowledge about these cards and please dont contact me about magnectic
readers
'It is important however that you pull the card from the right direction as I was
doing it wrong for
'some time :-)
'On the DT006 remove all the jumpers that are connected to the LEDs

'[We use ALIAS to specify the pins and PIN register]
_mport Alias Pinb                                           'all pins are connected
to PINB
_mdata Alias 0                                              'data line (blue)
PORTB.0
_mcs Alias 1                                                'CS line (yellow)
PORTB.1
_mclock Alias 2                                             'clock line (green)
PORTB.2

Config Portb = Input                                        'we only need bit 0,1
and 2 for input
Portb = 255                                                 'make them high

Do
  Print "Insert magnetic card"                              'print a message
```

```
  Readmagcard Ar(1) , B , 5                                 'read the data
  Print B ; " bytes received"
  For A = 1 To B
    Print Ar(a);                                            'print the bytes
  Next
  Print
Loop

'By sepcifying 7 instead of 5 you can read 7 bit data
```

# REM

## Action

Instruct the compiler that comment will follow.

## Syntax

**REM** or **'**

## Remarks

You can and should comment your program for clarity and your later sanity.

You can use REM or **'** followed by your comment.

All statements after REM or **'** are treated as comments so you cannot use statements on the same line after a REM statement.

Block comments can be used too:

**'(** start block comment

print "This will not be compiled

**')** end block comment

## Example

```
REM  TEST.BAS version 1.00
PRINT a     '    " this is comment   :  PRINT " hello"
               ^--- this will not be executed!
```

# RESET

## Action

Reset a bit to zero.

## Syntax

**RESET** bit

**RESET** var.x

## Remarks

| | |
|---|---|
| bit | Can be a SFR such as PORTB.x, or any bit variable where x=0-7. |
| var | Can be a byte, integer word or long variable. |
| x | Constant of variable to reset.(0-7) for bytes and (0-15) for Integer/Word. For longs(0-31) |

## See also

SET

## Example

```
Dim b1 as bit, b2 as byte, I as Integer
Reset Portb.3                                   'reset bit 3 of port B
Reset B1                                        'bitvariable
Reset B2.0                                      'reset bit 0 of
bytevariable b2
Reset I.15                                      'reset MS bit from I
End
```

# RESTORE

## Action

Allows READ to reread values in specified DATA statements by setting data pointer to beginning of data statement.

## Syntax

**RESTORE** label

## Remarks

label The label of a DATA statement.

## See also

DATA , READ , LOOKUP

## Example

```
'-----------------------------------------------------------
'                      READDATA.BAS
'             Copyright 1999-2000 MCS Electronics
'-----------------------------------------------------------

Dim A As Integer , B1 As Byte , Count As Byte
Dim S As String * 15
Dim L As Long
Restore Dta1                                                'point to stored data
For Count = 1 To 3                                          'for number of data items
   Read B1 : Print Count ; "  " ; B1
Next

Restore Dta2                                                'point to stored data
For Count = 1 To 2                                          'for number of data items
   Read A : Print Count ; "  " ; A
Next

Restore Dta3
Read S : Print S
Read S : Print S


Restore Dta4
Read L : Print L                                              'long type

End


Dta1:
Data &B10 , &HFF , 10
Dta2:
Data 1000% , -1%

Dta3:
Data "Hello" , "World"
'Note that integer values (>255 or <0) must end with the %-sign
'also note that the data type must match the variable type that is
'used for the READ statement

Dta4:
Data 123456789&
'Note that LONG values must end with the &-sign
'Also note that the data type must match the variable type that is used
'for the READ statement
```

# RETURN

## Action

Return from a subroutine.

## Syntax

**RETURN**

## Remarks

Subroutines must be ended with a related RETURN statement.

Interrupt subroutines must also be terminated with the Return statement.

## See also

GOSUB

## Example

```
Dim Result As Byte , Y As Byte
Gosub Pr                                                    'jump to subroutine
Print Result                                                'print result
End                                                         'program ends

Pr:       'start subroutine with label
  Result = 5 * Y                                            'do something stupid
  Result = Result + 100                                     'add something to it
Return                                                      'return
```

# RIGHT

## Action

Return a specified number of rightmost characters in a string.

## Syntax

var = **RIGHT(**var1 ,n **)**

## Remarks

| | |
|---|---|
| var | The string that is assigned. |
| Var1 | The source string. |
| st | The number of bytes to copy from the right of the string. |

## See also

LEFT , MID

## Example

```
Dim S As String * 15 , Z As String * 15
S = "ABCDEFG"
Z = Right(s , 2)
Print Z                                                    'FG
End
```

# RND

## Action

Returns a random number.

## Syntax

var = RND( limit )

## Remarks

| | |
|---|---|
| Limit | Word that limits the returned random number. |
| Var | The variable that is assigned with the random number. |

The RND() function returns an Integer/Word and needs an internal storage of 2 bytes. (___RSEED). Each new call to Rnd() will give a new positive random number.

Notice that it is a software based generated number. And each time you will restart your program the same sequence will be created.

## See also

NONE

## Example

```
Dim I As Integer
Do
  I = Rnd(100)    'get random number from 0-99
  Print I
  Waitms 100
Loop
End
```

# ROTATE

## Action

Rotate all bits one place to the left or right.

## Syntax

**ROTATE** var **, LEFT/RIGHT** [ **,** shifts]

## Remarks

| | |
|---|---|
| Var | Byte, Integer/Word or Long variable. |
| Shifts | The number of shifts to perform. |

The ROTATE statement rotates all the bits in the variable to the left or right. All bits are preserved so no bits will be shifted out of the variable.

This means that after rotating a byte variable with a value of 1, eight times the variable will be unchanged.

When you want to shift out the MS bit or LS bit, use the SHIFT statement.

## See also

SHIFT , SHIFTIN , SHIFTOUT

## Example

```
Dim a as Byte
a = 128
Rotate A , Left , 2
Print a  '2
End
```

# RTRIM

## Action

Returns a copy of a string with trailing blanks removed

## Syntax

var = **RTRIM**( org )

## Remarks

| | |
|---|---|
| var | String that is assigned with the result. |
| org | The string to remove the trailing spaces from |

## See also

TRIM , LTRIM

## ASM

NONE

## Example

```
Dim S As String * 6
S = "  AB "
Print Ltrim(s)
Print Rtrim(s)
Print Trim(s)
End
```

# SELECT-CASE-END SELECT

## Action

Executes one of several statement blocks depending on the value of an expression.

## Syntax

**SELECT CASE** var

  **CASE** test1 **:** *statements*
  [**CASE** test2 **:** *statements* ]
  **CASE ELSE :** *statements*
**END SELECT**

## Remarks

| | |
|---|---|
| Var | Variable. to test |
| Test1 | Value to test for. |
| Test2 | Value to test for. |

You can test for conditions to like:

CASE IS > 2 :

Another option is to test for a range :

CASE 2 TO 5 :

## See also

IF THEN

## Example

```
Dim X As Byte

Do
  Input "X ? " , X
  Select Case X
    Case 1 To 3 : Print "1 , 2 or 3 will be ok"
    Case 4 : Print "4"
    Case Is > 10 : Print ">10"
    Case Else : Print "no"
  End Select
Loop

End
```

# SET

## Action

Set a bit to the value one.

## Syntax

**SET** bit

**SET** var.x

## Remarks

| | |
|---|---|
| Bit | Bitvariable. |
| Var | A byte, integer, word or long variable. |
| X | Bit of variable (0-7) to set. (0-15 for Integer/Word) and (0-31) for Long |

## See also

RESET

## Example

```
Dim B1 As Bit , B2 As Byte , C As Word , L As Long
Set Portb.1                                          'set bit 1 of  port B
Set B1                                               'bit variable
Set B2.1                                             'set bit 1 of var b2
Set C.15                                             'set highest bit of Word
Set L.31                                             'set MS bit of LONG
```

```
End
```

# SHIFT

## Action

Shift all bits one place to the left or right.

## Syntax

**SHIFT** var **, LEFT/RIGHT** [ **,** shifts]

## Remarks

| | |
|---|---|
| Var | Byte, Integer/Word or Long variable. |
| Shifts | The number of shifts to perform. |

The SHIFT statement rotates all the bits in the variable to the left or right.

When shifting LEFT the most significant bit, will be shifted out of the variable. The LS bit becomes zero. Shifting a variable to the left, multiplies the variable with a value of two.

When shifting to the RIGHT, the least significant bit will be shifted out of the variable. The MS bit becomes zero. Shifting a variable to the right, divides the variable by two.

## See also

ROTATE , SHIFTIN , SHIFTOUT

## Example

```
Dim a as Byte
a = 128
Shift A , Left , 2
Print a  '0
End
```

# SHIFTCURSOR

## Action

Shift the cursor of the LCD display left or right by one position.

## Syntax

**SHIFTCURSOR LEFT / RIGHT**

## See also

SHIFTLCD

## Example

```
LCD "Hello"
SHIFTCURSOR LEFT
End
```

# SHIFTIN

## Action

Shifts a bit stream into a variable.

## Syntax

SHIFTIN pin , pclock , var , option [, bits , delay ]

## Remarks

| | |
|---|---|
| Pin | The port pin which serves as an input.PINB.2 for example |
| Pclock | The port pin which generates the clock. |
| Var | The variable that is assigned. |
| Option | Option can be :<br>0 – MSB shifted in first when clock goes low<br>1 – MSB shifted in first when clock goes high<br>2 – LSB shifted in first when clock goes low<br>3 – LSB shifted in first when clock goes high<br>Adding 4 to the parameter indicates that an external clock signal is used for the clock. In this case the clock will not be generated. So using 4 will be the same a 0 (MSB shifted in first when clock goes low) but the clock must be generated by an external signal.<br>4 – MSB shifted in first when clock goes low with ext. clock<br>5 – MSB shifted in first when clock goes high with ext. clock<br>6 – LSB shifted in first when clock goes low with ext. clock<br>7 – LSB shifted in first when clock goes high with ext. clock |
| Bits | Optional number of bits to shift in. Maximum 255. |
| Delay | Optional delay in uS. When you specify the delay, the number of bits must also be specified. When the number of bits is default you can use NULL for the BITS parameter. |

If you do not specify the number of bits to shift, the number of shifts will depend on the type of the variable.

When you use a byte, 8 shifts will occur and for an integer, 16 shifts will occur. For a Long and Single 32 shifts will occur.

The SHIFTIN routine can be used to interface with all kind of chips.

The PIN is normally connected with the output of chip that will send information.

The PCLOCK pin can be used to clock the bits as a master, that is the clock pulses will be generated. Or it can sample a pin that generates these pulses.

The VARIABLE is a normal BASIC variable. And may be of any type except for BIT. The data read from the chip is stored in this variable.

The OPTIONS is a constant that specifies the direction of the bits. The chip that outputs the data may send the LS bit first or the MS bit first. It also controls on which edge of the clock signal the data must be stored.

When you add 4 to the constant you tell the compiler that the clock signal is not generated but that there is an external clock signal.

The number of bits may be specified. You may omit this info. In that case the number of bits of the element data type will be used.

The DELAY normally consists of 2 NOP instructions. When the clock is too fast you can specify a delay time(in uS).

## See also

SHIFTOUT , SHIFT

## Example

```
Dim A As Byte
Config Pinb.0 = Input                                   ' set pin to input
Config Pinb.1 = Output
Portb.0 = 1
Shiftin Pinb.0 , Portb.1 , A , 4 , 4 , 10               'shiftin 4 bits and use
external clock
Shift A , Right , 4                                     'adjust
Shiftin Pinb.0 , Portb.1 , A                            'read 8 bits

End
```

# SHIFTOUT

## Action

Shifts a bit stream out of a variable into a port pin .

## Syntax

SHIFTOUT pin , pclock , var , option [, bits , delay ]

## Remarks

| | |
|---|---|
| Pin | The port pin which serves as a data output. |
| Pclock | The port pin which generates the clock. |
| Var | The variable that is shifted out. |
| Option | Option can be :<br>0 – MSB shifted out first when clock goes low<br>1 – MSB shifted out first when clock goes high |

2 – LSB shifted out first when clock goes low
3 – LSB shifted out first when clock goes high

Bits — Optional number of bits to shift out.

Delay — Optional delay in uS. When you specify the delay, the number of bits must also be specified. When the default must be used you can also use NULL for the number of bits.

If you do not specify the number of bits to shift, the number of shifts will depend on the type of the variable.

When you use a byte, 8 shifts will occur and for an integer, 16 shifts will occur. For a Long and Single 32 shifts will occur.

The SHIFTIN routine can be used to interface with all kind of chips.

The PIN is normally connected with the input of a chip that will receive information.

The PCLOCK pin is used to clock the bits out of the chip.

The VARIABLE is a normal BASIC variable. And may be of any type except for BIT. The data that is stored in the variable is sent with PIN.

The OPTIONS is a constant that specifies the direction of the bits. The chip that reads the data may want the LS bit first or the MS bit first. It also controls on which edge of the clock signal the data is sent to PIN.

The number of bits may be specified. You may omit this info. In that case the number of bits of the element data type will be used.

The DELAY normally consists of 2 NOP instructions. When the clock is too fast you can specify a delay time(in uS).

## See also

SHIFTIN , SHIFT

## Example

```
Dim a as byte
Config Pinb.0 = Output
Config Pinb.1 = Input
Shiftout Portb.0 , Portb.1 , A , 3 , 4 , 10                 'shiftout 4 bits
Shiftin Pinb.0 , Portb.1 , A , 3                            'shiftout  8 bits
End
```

# SHIFTLCD

## Action

Shift the LCD display left or right by one position.

## Syntax

**SHIFTLCD LEFT / RIGHT**

## Remarks

NONE

## See also

SHIFTCURSOR

## Example

```
Cls
Lcd "Very long text"
Shiftlcd Left
Wait 1
Shiftlcd Right
End
```

# SHOWPIC

## Action

Shows a BGF file on the graphic display

## Syntax

**SHOWPIC x, y , label**

## Remarks

Showpic can display a converted BMP file. The BMP must be converted into a BGF file with the Tools Grahic Converter.

The X and Y parameters specify where the picture must be displayed. X and Y must be 0 or a multiple of 8. The picture height and width must also be a multiple of 8.

The label tells the compiler where the graphic data is located. It points to a label where you put the graphic data with the $BGF directive.

## See also

PSET , $BGF , CONFIG GRAPHLCD

## Example

```
'-----------------------------------------------------------------
'                     (c) 2001 MCS Electronics
'                  T6963C graphic display support demo
'-----------------------------------------------------------------

'The connections of the LCD used in this demo
'LCD pin                    connected to
' 1         GND             GND
 '2         GND             GND
 '3         +5V             +5V
 '4         -9V             -9V potmeter
 '5         /WR             PORTC.0
 '6         /RD             PORTC.1
 '7         /CE             PORTC.2
 '8         C/D             PORTC.3
 '9         NC              not conneted
 '10        RESET           PORTC.4
 '11-18     D0-D7            PA
 '19        FS              PORTC.5
 '20        NC              not connected


'First we define that we use a graphic LCD
' Only 240*64 supported yet
Config Graphlcd = 240 * 64 , Dataport = Porta , Controlport = Portc , Ce = 2 , Cd =
3 , Wr = 0 , Rd = 1 , Reset = 4 , Fs = 5
'The dataport is the portname that is connected to the data lines of the LCD
'The controlport is the portname which pins are used to control the lcd
'CE, CD etc. are the pin number of the CONTROLPORT.
' For example CE =2 because it is connected to PORTC.2


'Dim variables (y not used)
Dim X As Byte , Y As Byte


'Clear the screen will both clear text and graph display
Cls
'Other options are :
' CLS TEXT   to clear only the text display
' CLS GRAPH  to clear only the graphical part

'locate works like the normal LCD locate statement
```

```
' LOCATE LINE,COLUMN LINE can be 1-8 and column 0-30
Locate 1 , 1

'Show some text
Lcd "MCS Electronics"
'And some othe text on line 2
Locate 2 , 1 : Lcd "T6963c support"

'wait 1 sec
Wait 1


' draw a line using PSET X,Y, ON/OFF
' PSET on.off param is 0 to clear a pixel and any other value to turn it on
For X = 0 To 140
   Pset X , 20 , 255                                        ' set the pixel
Next

Wait 1


'Now it is time to show a picture
'SHOWPIC X,Y,label
'The label points to a label that holds the image data
Showpic 0 , 0 , Plaatje

Wait 1
Cls Text                                                    ' clear the text
End



'This label holds the mage data
Plaatje:
'$BGF will put the bitmap into the program at this location
$bgf "mcs.bgf"

'You could insert other picture data here
```

Label:

$BGF "mcs.bgf" 'data will be inserted here

# SOUND

## Action

Sends pulses to a port pin.

## Syntax

**SOUND** pin, duration, pulses

## Remarks

| | |
|---|---|
| Pin | Any I/O pin such as PORTB.0 etc. |
| Duration | The number of pulses to send. Byte, integer/word or constant. |
| Pulses | The time the pin is pulled low and high.<br>This is the value for a loop counter. |

When you connect a speaker or a buzzer to a port pin (see hardware) , you can use the SOUND statement to generate some tones.

The port pin is switched high and low for *pulses* times.

This loop is executed *duration* times.

The SOUND statement is not intended to generate accurate frequencies. Use a TIMER to do that.

## See also

NONE

## Example

```
SOUND PORTB.1 , 10000, 10           'BEEP
End
```

# SPACE

## Action

Returns a string that consists of spaces.

## Syntax

var = **SPACE(**x **)**

## Remarks

X The number of spaces.

Var The string that is assigned.

Using 0 for x will result in a string of 255 bytes because there is no check for a zero length assign.

## See also

STRING

## Example

```
Dim s as String * 15, z as String * 15
s = Space(5)
Print " {"  ;s ; " }"      '{     }

Dim A as Byte
A = 3
S = Space(a)

End
```

# SPC

## Action

Prints the number of specified spaces.

## Syntax

PRINT **SPC(**x **)**

## Remarks

X The number of spaces to print.

Using 0 for x will result in a string of 255 bytes because there is no check for a zero length assign.

SPC can be used with LCD too.

The difference with the SPACE function is that SPACE returns a number of

spaces while SPC() can only be used with printing. Using SPACE() with printing is also possible but it will use a temporary buffer while SPC does not use a temporary buffer.

## See also

SPACE

## Example

```
Dim s as String * 15, z as String * 15
Print "{"  ; SPC(5) ; "}"                          '{     }
LCD "{"  ; SPC(5) ; "}"                           '{     }
```

# SPIIN

## Action

Reads a value from the SPI-bus.

## Syntax

SPIIN  var, bytes

## Remarks

| | |
|---|---|
| Var | The variable which receives the value read from the SPI-bus. |
| Bytes | The number of bytes to read. |

## See also

SPIOUT,  SPIINIT, CONFIG SPI , SPIMOVE

## Example

```
Dim A(10) As Byte
Config Spi = Soft , Din = Pinb.0 , Dout = Portb.1 , Ss = Portb.2 , Clock = Portb.3
Spiinit
Spiin A(1) , 4    'read 4 bytes and store in a(1), a(2) , a(3) and a(4)

End
```

# SPIINIT

## Action

Initiate the SPI pins.

## Syntax

**SPIINIT**

## Remarks

After the configuration of the SPI pins, you must initialize the SPI pins to set them for the right data direction. When the pins are not used by other hardware/software, you only need to use SPIINIT once.

When other routines change the state of the SPI pins, use SPIINIT again before using SPIIN and SPIOUT.

## See also

SPIIN , SPIOUT

## ASM

Calls _init_spi

## Example

```
Dim A(10) As Byte
Config Spi = Soft , Din = Pinb.0 , Dout = Portb.1 , Ss = Portb.2 , Clock = Portb.3
Spiinit
Spiin A(1) , 4          'read 4 bytes and store in a(1), a(2) , a(3) and a(4)

End
```

# SPIMOVE

## Action

Sends and receives a value or a variable to the SPI-bus.

## Syntax

var = SPIMOVE( byte )

## Remarks

| | |
|---|---|
| Var | The variable that is assigned with the received byte(s) from the SPI-bus. |
| Byte | The variable or constant whose content must be send to the SPI-bus. |

## See also

SPIIN , SPIINIT , CONFIG SPI

## Example

```
CONFIG SPI = SOFT, DIN = PINB.0, DOUT = PORTB.1, SS=PORTB.2, CLOCK =
PORTB.3
SPIINIT
Dim a(10) as Byte , X As Byte
SPIOUT a(1) , 5    'send 5 bytes
SPIOUT X , 1           'send 1 byte
A(1) = SpiMove(5)              ' move 5 to SPI and store result in a(1)
End
```

# SPIOUT

## Action

Sends a value of a variable to the SPI-bus.

## Syntax

SPIOUT var , bytes

## Remarks

| | |
|---|---|
| var | The variable whose content must be send to the SPI-bus. |
| bytes | The number of bytes to send. |

## See also

SPIIN , SPIINIT , CONFIG SPI , SPIMOVE

## Example

```
Dim A(10) As Byte
Config Spi = Soft , Din = Pinb.0 , Dout = Portb.1 , Ss = Portb.2 , Clock = Portb.3
Spiinit
Spiout A(1) , 4          'write 4 bytes a(1), a(2) , a(3) and a(4)

End
```

# START

## Action

Start the specified device.

## Syntax

**START** device

## Remarks

Device TIMER0, TIMER1, COUNTER0 or COUNTER1, WATCHDOG, AC (Analog comparator power) or ADC(A/D converter power)
.

You must start a timer/counter in order for an interrupt to occur (when the external gate is disabled).

TIMER0 and COUNTER0 are the same device.

The AC and ADC parameters will switch power to the device and thus enabling it to work.

## See also

STOP

## Example

```
'-----------------------------------------------------------------------
'                    ADC.BAS
'  demonstration of GETADC() function for 8535 micro
'-----------------------------------------------------------------------
$regfile = "m163def.dat"

'configure single mode and auto prescaler setting
'The single mode must be used with the GETADC() function

'The prescaler divides the internal clock by 2,4,8,15,32,64 or 128
'Because the ADC needs a clock from 50-200 KHz
'The AUTO feature, will select the highest clockrate possible
Config Adc = Single , Prescaler = Auto
'Now give power to the chip
Start Adc

'With STOP ADC, you can remove the power from the chip
'Stop Adc

Dim W As Word , Channel As Byte

Channel = 0
'now read A/D value from channel 0
Do
  W = Getadc(channel)
  Print "Channel " ; Channel ; " value " ; W
  Incr Channel
  If Channel > 7 Then Channel = 0
Loop
End

'The new M163 has options for the reference voltage
'For this chip you can use the additional param :
'Config Adc = Single , Prescaler = Auto, Reference = Internal
'The reference param may be :
'OFF      : AREF, internal reference turned off
'AVCC     : AVCC, with external capacitor at AREF pin
'INTERNAL : Internal 2.56 voltage reference with external capacitor ar AREF pin

'Using the additional param on chip that do not have the internal reference will have
no effect.
```

# STCHECK

## Action

Calls a routine to check for various stack overflows. This routine is intended for debug purposes.

## Syntax

STCHECK

## Remarks

The different stack spaces used by BASCOM-AVR lead to lots of questions about them.

The STCHECK routine can help to determine if the stack size are trashed by your program. The program STACK.BAS is used to explain the different settings.

**Note that STCHECK should be removed form your final program.** That is once you tested your program and found out is works fine, you can remove the call to STCHECK since it costs time and code space.

The settings used are :

HW stack 8

Soft stack 2

Frame size 14

Below is a part of the memory of the 90S2313 used for the example:

```
C0 C1 C2 C3 C4 C5 C6 C7 C8 C9 CA CB CC CD CE CF
D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 DA DB DC DD DE DF
                        FR FR FR FR FR FR FR FR
FR FR FR FR FR FR YY YY SP SP SP SP SP SP SP SP
```

Since the last memory in SRAM is DF, the hardware stack is occupied by D8-DF(8 bytes)

When a call is made or a push is used the data is saved at the position the hardware stack pointer is pointing to. After this the stack pointer is decreased.

A call uses 2 bytes so SP will be SP-2. (DF-2) =DD

When 8 bytes are stored the SP will point to D7. Another call or push will thus destroy memory position D7 which is occupied by the soft stack.

The soft stack begins directly after the hardware stack and is also growing down.

The Y pointer(r28+r29) is used to point to this data.

Since the Y pointer is decreased first and then the data is saved, the pointer must point at start up to a position higher. That is D8, the end of the hardware space.

St -y,r24 will point to D8-1=D7 and will store R24 at location D7.

Since 2 bytes were allocated in this example we use D7 and D6 to store the data.

When the pointer is at D6 and another St -y,r24 is used, it will write to position D5 which

is the end of the frame space that is used as temporarily memory.

The frame starts at C8 and ends at D5. Writing beyond will overwrite the soft stack.

And when there is no soft stack needed, it will overwrite the hardware stack space.

The map above shows FR(frame), YY(soft stack data) and SP(hardware stack space)

How to determine the right values?

The stack check routine can be used to determine if there is an overflow.

It will check :

-if SP is below it's size. In this case below D8.

-if YY is below it’s size in this case when it is D5

-if the frame is above its size in this case D6

When is YY(soft stack) used? When you use a LOCAL variable inside a SUB or function. Each local variable will use 2 bytes.

When you pass variables to user Subroutines or functions it uses 2 bytes for each parameter.

call mysub(x,y) will use 2 * 2 = 4 bytes.

local z as byte ' will use another 2 bytes

This space is freed when the routine ends.

But when you call another sub inside the sub, you need more space.

sub mysub(x as byte,y as byte)

call testsub(r as byte) ' we must add another 2 bytes

When you use empty(no params) call like :

call mytest() , No space is used.

When do you need frame space?

When ever you use a num<>string conversion routine like:

Print b (where b is a byte variable)

Bytes will use 4 bytes max (123+0)

Integer will use 7 bytes max (-12345+0)c

Longs will use 16 bytes max

And the single will use 24 bytes max

When you add strings and use the original the value must be remembered by the compiler.

Consider this :

s$ = "abcd" + s$

Here you give s$ a new value. But you append the original value so the original value must be remembered until the operation has completed. This copy is stored in the frame too.

So when string s$ was dimmed with a length of 20, you need a frame space of 20+1(null byte)

When you pass a variable by VALUE (BYVAL) then you actually pass a copy of the variable.

When you pass a byte, 1 byte of frame space is used, a long will take 4 bytes.

When you use a LOCAL LONG, you also need 4 bytes of frame space to store the local long.

The frame space is reused and so is the soft stack space and hardware stack space.

So the hard part is to determine the right sizes!

The stack check routine must be called inside the deepest nested sub or function.

```
Gosub test

test:
  gosub test1
return

test1:
  ' this is the deepest level so check the stack here
  stcheck
return
```

Stcheck will use 1 variable named ERROR. You must dimension it yourself.

```
Dim Error As Byte
```

Error will be set to :

1: if hardware stack grows down into the soft stack space

2: if the soft stack space grows down into the frame space

3: if the frame space grows up into the soft stack space.

The last 2 errors are not necessarily bad when you consider that when the

soft stack is not used for passing data, it may be used by the frame space to store data. Confusing right.?

## ASM

Routines called by STCHECK :

_StackCheck : uses R24 and R25 but these are saved and restored.

Because the call uses 2 bytes of hardware stack space and the saving of R24 and R25 also costs 2 bytes, it uses 4 more bytes of hardware stack space than your final program would do that f course does not need to use STCHECK.

## Example

Here is the stack.bas sample that can be found in the samples dir.

It uses conditional compilation so you can test the various errors.

```
'this sample shows how to check for the stack sizes

'note that the called routine (_STACKCHECK) will use 4
bytes
'ofhardware stack space
'So when your program works, you may subtract the 4 bytes
of the needed hardware stack size
'in your final program that does not include the STCHECK

'testmode =0  will work
'testmode =1 will use too much hardware stack
'testmode =2 will use too much soft stack space
'testmode =3 will use too much frame space
Const Testmode = 0
'compile and test the program with testmode from 0-3


'you need to dim the ERROR byte !!
Dim Error As Byte

#if Testmode = 2
   Declare Sub Pass(z As Long , Byval K As Long)
#else
   Declare Sub Pass()
#endif



Dim I As Long
I = 2
```

```
Print I
'call the sub in your code at the deepest level
'normally within a function or sub


#if Testmode = 2
   Call Pass(i , 1)
#else
   Call Pass()
#endif
End



#if Testmode = 2
   Sub Pass(z As Long , Byval K As Long)
#else
  Sub Pass()
#endif
    #if Testmode = 3
       Local S As String * 13
    #else
       Local S As String * 8
    #endif

    Print I
    Gosub Test
End Sub


Test:
#if Testmode = 1
  push r0 ; eat some hardware stack space
  push r1
  push r2
#endif

  ' *** here we call the routine ***
  Stcheck
  ' *** when error <>0 then there is a problem ***
#if Testmode = 1
  pop r2
  pop r1
  pop r0
#endif

Return
```

# STOP

## Action

Stop the specified device. Or stop the program

## Syntax

**STOP** device

**STOP**

## Remarks

Device TIMER0, TIMER1, COUNTER0 or COUNTER1, WATCHDOG, AC (Analog comparator power) or ADC(A/D converter power)
.

The single STOP statement will end your program by generating a never ending loop. When END is used it will have the same effect but in addition it will disable all interrupts.

The STOP statement with one of the above parameters, will stop the specified device.

TIMER0 and COUNTER0 are the same device.

The AC and ADC parameters will switch power off the device to disable it and thus save power.

## See also

START , END

## Example

```
'-----------------------------------------------------------------------
'                    ADC.BAS
'  demonstration of GETADC() function for 8535 micro
'-----------------------------------------------------------------------
$regfile = "m163def.dat"

'configure single mode and auto prescaler setting
'The single mode must be used with the GETADC() function
```

```
'The prescaler divides the internal clock by 2,4,8,15,32,64 or 128
'Because the ADC needs a clock from 50-200 KHz
'The AUTO feature, will select the highest clockrate possible
Config Adc = Single , Prescaler = Auto
'Now give power to the chip
Start Adc

'With STOP ADC, you can remove the power from the chip
'Stop Adc

Dim W As Word , Channel As Byte

Channel = 0
'now read A/D value from channel 0
Do
  W = Getadc(channel)
  Print "Channel " ; Channel ; " value " ; W
  Incr Channel
  If Channel > 7 Then Channel = 0
Loop
End

'The new M163 has options for the reference voltage
'For this chip you can use the additional param :
'Config Adc = Single , Prescaler = Auto, Reference = Internal
'The reference param may be :
'OFF      : AREF, internal reference turned off
'AVCC     : AVCC, with external capacitor at AREF pin
'INTERNAL : Internal 2.56 voltage reference with external capacitor ar AREF pin

'Using the additional param on chip that do not have the internal reference will have
no effect.
```

# STR

## Action

Returns a string representation of a number.

## Syntax

var **= Str(** x **)**

## Remarks

| | |
|---|---|
| var | A string variable. |
| X | A numeric variable. |

The string must be big enough to store the result.

## See also

VAL , HEX , HEXVAL , MCSBYTE , BIN

## Difference with QB

In QB STR() returns a string with a leading space. BASCOM does not return a leading space.

## Example

```
Dim A As Byte , S As String * 10
A = 123
S = Str(a)
Print S                                                    ' 123
End
```

# STRING

## Action

Returns a string consisting of m repetitions of the character with ASCII

Code n.

## Syntax

var = **STRING(**m ,n **)**

## Remarks

| | |
|---|---|
| Var | The string that is assigned. |
| N | The ASCII-code that is assigned to the string. |
| M | The number of characters to assign. |

Since a string is terminated by a 0 byte, you can't use 0 for n.

Using 0 for m will result in a string of 255 bytes, because there is no check on a length assign of 0.

## See also

SPACE

## Example

```
Dim S As String * 15
S = String(5 , 65)
Print S                                                    'AAAAA
End
```

# SUB

## Action

Defines a Sub procedure.

## Syntax

**SUB Name[**(var1 , … )**]**

## Remarks

| | |
|---|---|
| Name | Name of the sub procedure, can be any non-reserved word. |
| var1 | The name of the parameter. |

You must end each subroutine with the END SUB statement.

You can copy the DECLARE SUB line and remove the DECLARE statement. This ensures that you have the right parameters.

See the DECLARE SUB topic for more details.

# SWAP

## Action

Exchange two variables of the same type.

## Syntax

**SWAP** var1, var2

## Remarks

| | |
|---|---|
| var1 | A variable of type bit, byte, integer, word, long or string. |
| var2 | A variable of the same type as var1. |

After the swap, var1 will hold the value of var2 and var2 will hold the value of var1.

## Example

```
Dim A As Integer , B1 As Integer
A = 1 : B1 = 2                                    'assign two integers
Swap A , B1                                       'swap them
Print A ; B1                                      'prints 21

End
```

# THIRDLINE

## Action

Reset LCD cursor to the third line.

## Syntax

**THIRDLINE**

## Remarks

NONE

## See also

UPPERLINE , LOWERLINE , FOURTHLINE

## Example

```
Dim A As Byte
A = 255
Cls
Lcd A
Thirdline
Lcd A
Upperline
End
```

# TIME$

## Action

Internal variable that holds the time.

## Syntax

**TIME$ = "hh:mm:ss"**

**var = TIME$**

## Remarks

The TIME$ variable is used in combination with the CONFIG CLOCK directive.

The CONFIG CLOCK statement will use the TIMER0 or TIMER2 in async mode to create a 1 second interrupt. In this interrupt routine the _Sec, _Min and _Hour variables are updated. The time format is 24 hours format.

When you assign TIME$ to a string variable these variables are assigned to the TIME$ variable.

When you assign the TIME$ variable with a constant or other variable, the _sec, _Hour and _Min variables will be changed to the new time.

The only difference with QB/VB is that all digits must be provided when assigning the time. This is done for minimal code. You can change this behavior of course.

## ASM

The following asm routines are called from mcs.lib.

When assiging TIME$ : _set_time (calls _str2byte)

When reading TIME$ : _make_dt (calls _byte2str)

## See also

DATE$ , CONFIG CLOCK

## Example

```
'-----------------------------------------------------------
'                     MEGACLOCK.BAS
'                 (c) 2000-2001 MCS Electronics
'-----------------------------------------------------------
'This example shows the new TIME$ and DATE$ reserved variables
'With the 8535 and timer2 or the Mega103 and TIMER0 you can
'easily implement a clock by attaching a 32.768 KHz xtal to the timer
'And of course some BASCOM code

'This example is written for the STK300 with M103
Enable Interrupts

'[configure LCD]
$lcd = &HC000                           'address for E and RS
$lcdrs = &H8000                         'address for only E
Config Lcd = 20 * 4                     'nice display from bg micro
Config Lcdbus = 4                       'we run it in bus mode and I hooked up only
db4-db7
Config Lcdmode = Bus                    'tell about the bus mode

'[now init the clock]
Config Clock = Soft                     'this is how simple it is
'The above statement will bind in an ISR so you can not use the TIMER anymore!
'For the M103 in this case it means that TIMER0 can not be used by the user anymore

'assign the date to the reserved date$
'The format is MM/DD/YY
Date$ = "11/11/00"

'assign the time, format in hh:mm:ss military format(24 hours)
'You may not use 1:2:3 !! adding support for this would mean overhead
'But of course you can alter the library routines used

Time$ = "02:20:00"

'clear the LCD display
Cls

Do
  Home                                  'cursor home
  Lcd Date$ ; "   " ; Time$             'show the date and time
Loop

'The clock routine does use the following internal variables:
'_day , _month, _year , _sec, _hour, _min
'These are all bytes. You can assign or use them directly
_day = 1
'For the _year variable only the year is stored, not the century
End
```

# TOGGLE

## Action

Toggles the state of an output pin or bit variable.

## Syntax

**TOGGLE** pin

## Remarks

| | |
|---|---|
| pin | Any port pin like PORTB.0 or bit variable. A port poin must be configured as an output pin before TOGGLE can be used. |

With TOGGLE you can simply invert the output state of a port pin.

When the pin is driving a relais for example and the relais is OFF, one TOGGLE statement will turn the relais ON. Another TOGGLE will turn the relais OFF again.

## See also

CONFIG PORT

## ASM

NONE

## Example

```
Dim Var As Byte
CONFIG PINB.0 = OUTPUT  ' portB.0 is an output now
TOGGLE PORTB.0 'toggle state
WAITMS 1000cho 'wait for 1 sec
TOGGLE PORTB.0 'toggle state again
```

# TRIM

## Action

Returns a copy of a string with leading and trailing blanks removed

## Syntax

var = **TRIM**( org )

## Remarks

| | |
|---|---|
| Var | String that receives the result. |
| Org | The string to remove the spaces from |

## See also

RTRIM , LTRIM

## ASM

NONE

## Example

```
Dim S As String * 6
S = "  AB "
Print Ltrim(s)
Print Rtrim(s)
Print Trim(s)
End
```

# UCASE

## Action

Converts a string in to all upper case characters.

## Syntax

Target = **Ucase**(source)

## Remarks

| | |
|---|---|
| Target | The string that is assigned with the upper case string of string target. |
| Source | The source string. |

## See also

LCASE

## ASM

The following ASM routines are called from MCS.LIB : _UCASE
X must point to the target string, Z must point to the source string.
The generated ASM code : (can be different depending on the micro used )

```
;##### Z = Ucase(s)
Ldi R30,$60
Ldi R31,$00          ; load constant in register
Ldi R26,$6D
Rcall _Ucase
```

## Example

```
Dim S As String * 12 , Z As String * 12
S = "Hello World"
Z = Lcase(s)
Print Z
Z = Ucase(s)
Print Z
End
```

# UPPERLINE

## Action

Reset LCD cursor to the upperline.

## Syntax

**UPPERLINE**

## Remarks

NONE

## See also

LOWERLINE , THIRDLINE , FOURTHLINE

## Example

```
Dim A As Byte
A = 255
Cls
Lcd A
Thirdline
Lcd A
Upperline
End
```

# VAL

## Action

Converts a string representation of a number into a number.

## Syntax

var **= Val(** s **)**

## Remarks

| | |
|---|---|
| Var | A numeric variable that is assigned with the value of s. |
| S | Variable of the string type. |

## See also

STR , HEXVAL , HEX , BIN

## Example

```
Dim a as byte, s As String * 10
s = "123"
a = Val(s)  'convert string
Print A                                                    ' 123
End
```

# VARPTR

## Action

Retrieves the memory-address of a variable.

## Syntax

var = **VARPTR**( var2 )

## Remarks

| | |
|---|---|
| Var | The variable that receives the address of var2. |
| Var2 | A variable to retrieve the address from. |

## See also

NONE

## Example

```
Dim W As Byte
Print Hex(varptr(w))                                       ' 0060
```

# WAIT

## Action

Suspends program execution for a given time.

## Syntax

WAIT seconds

## Remarks

seconds The number of seconds to wait.

No accurate timing is possible with this command.

When you use interrupts, the delay may be extended.

## See also

DELAY , WAITMS

## Example

```
WAIT 3              'wait for three seconds
Print "*"
```

# WAITKEY

## Action

Wait until a character is received in the serial buffer.

## Syntax

var = **WAITKEY()**

var = **WAITKEY(#channel)**

## Remarks

| | |
|---|---|
| var | Variable that receives the ASCII value of the serial buffer. |
| | Can be a numeric variable or a string variable. |
| #channel | The channel used for the software UART. |

## See also

INKEY

## Example

```
Dim A As Byte
A = Waitkey()            'wait for character
Print A
```

# WAITMS

## Action

Suspends program execution for a given time in mS.

## Syntax

WAITMS mS

## Remarks

| | |
|---|---|
| Ms | The number of milliseconds to wait. (1-65535) |

No accurate timing is possible with this command.

In addition, the use of interrupts can slow this routine.

When you write to an EEPROM you must wait for 10 mS after the write

instruction.

## See also

DELAY , WAIT , WAITUS

## ASM

WaitMS will call the routine _WAITMS. R24 and R25 are loaded with the number of milliseconds to wait.

Uses and saves R30 and R31.

Depending on the used XTAL the asm code can look like :

```
_WaitMS:

_WaitMS1F:

Push R30                                                ; save Z

Push R31

_WaitMS_1:

Ldi R30,$E8                                             ;delay  for 1 mS

Ldi R31,$03

_WaitMS_2:

Sbiw R30,1                                              ; -1

Brne _WaitMS_2                                          ; until 1 mS is ticked
away

Sbiw R24,1

Brne _WaitMS_1                                          ; for number of mS

Pop R31

Pop R30

Ret
```

## Example

```
WAITMS 10          'wait for 10 mS
Print "*"
```

# WAITUS

## Action

Suspends program execution for a given time in uS.

## Syntax

WAITUS uS

## Remarks

| | |
|---|---|
| US | The number of microseconds to wait. (1-255)<br>This must be a constant. Not a variable! |

No accurate timing is possible with this command.

In addition, the use of interrupts can slow this routine.

## See also

DELAY , WAIT , WAITMS

## Example

```
WAITUS 10          'wait for 10 uS
Print "*"
```

# WHILE-WEND

## Action

Executes a series of statements in a loop, as long as a given condition is true.

## Syntax

**WHILE** condition

statements

**WEND**

## Remarks

If the condition is true then any intervening statements are executed until the WEND statement is encountered.

BASCOM then returns to the WHILE statement and checks the condition.

If it is still true, the process is repeated.

If it is not true, execution resumes with the statement following the WEND statement.

So in contrast with the DO-LOOP structure, a WHILE-WEND condition is tested first so that if the condition fails, the statements in the WHILE-WEND structure are never executed.

## See also

DO-LOOP

## Example

```
Dim A As Byte
While A <= 10                                   'if a is smaller or equal
to 10
  Print A                                       'print variable a
  Incr A
Wend
```

# WRITEEEPROM

## Action

Write a variables content to the DATA EEPROM.

## Syntax

**WRITEEEPROM** var , address

## Remarks

| | |
|---|---|
| var | The name of the variable that must be stored |
| address | The address in the EEPROM where the variable must be stored. A new option is that you can provide a label name for the address. See example 2. |

This statement is provided for compatibility with BASCOM-8051.

You can also use :

Dim V as Eram Byte 'store in EEPROM

Dim B As Byte 'normal variable

B = 10

V = B 'store variable in EEPROM

When you use the assignment version, the data types must be the same!

According to a datasheet from ATMEL, the first location in the EEPROM with address 0, can be overwritten during a reset.

For security, register R23 is set to a magic value before the data is written to the EEPROM.

## See also

READEEPROM

## ASM

NONE

## Example

```
Dim B As Byte
WriteEEPROM B ,0  'store at first position
ReadEEPROM B, 0   'read byte back
```

## Example 2

```
'-----------------------------------------------------------------
'                         EEPROM2.BAS
'   This example shows how to use labels with READEEPROM
'-----------------------------------------------------------------
'first dimension a variable
Dim B As Byte
Dim Yes As String * 1

'Usage for readeeprom and writeeprom :
'readeeprom var, address

'A new option is to use a label for the address of the data
'Since this data is in an external file and not in the code the eeprom data
'should be specified first. This in contrast with the normal DATA lines which must
'be placed at the end of your program!!

'first tell the compiler that we are using EEPROM to store the DATA
$eeprom
'specify a label
label1:
Data 1 , 2 , 3 , 4 , 5
Label2:
Data 10 , 20 , 30 , 40 , 50

'Switch back to normal data lines in case they are used
$data

'All the code above does not generate real object code
'It only creates a file with the EEP extension

'Use the new label option
Readeeprom B , Label1
Print B                                 'prints 1
'Succesive reads will read the next value
'But the first time the label must be specified so the start is known
Readeeprom B
Print B                                 'prints 2

Readeeprom B , Label2
Print B                                 'prints 10
Readeeprom B
Print B                                 'prints 20

'And it works for writing too :
'but since the programming can interfere we add a stop here
Input "Ready?" , Yes
B = 100
Writeeeprom B , Label1
B = 101
Writeeeprom B

'read it back
Readeeprom B , Label1
Print B                                 'prints 1
'Succesive reads will read the next value
'But the first time the label must be specified so the start is known
Readeeprom B
Print B                                 'prints 2


End
```

## Changes compared to BASCOM-8051

The design goal was to make BASCOM-AVR compatible with BASCOM-

8051.

For the AVR compiler I had to remove some statements.

New statements are also added. And some statements were changed.

They need specific attention, but the changes to the syntax will be made available to BASCOM-8051 too in the future.

Statements that were removed

| STATEMENT | DESCRIPTION |
|---|---|
| $LARGE | Not needed anymore. |
| $ROMSTART | Code always starts at address 0 for the AVR. Added again in 1.11.6.2 |
| $LCDHEX | Use LCD Hex(var) instead. |
| $NOINIT | Not needed anymore. Added in 1.11.6.2 |
| $NOSP | Not needed anymore |
| $NOBREAK | Can't be used anymore because there is no object code that can be used for it. |
| $OBJ | Removed. |
| BREAK | Can't be used anymore because there is no object code that can be used for it. |
| PRIORITY | AVR does no allow setting priority of interrupts |
| PRINTHEX | You can use Print Hex(var) now |
| LCDHEX | You can use Lcd Hex(var) now |

Statements that were added

| STATEMENT | DESCRIPTION |
|---|---|
| FUNCTION | You can define your own user FUNCTIONS. |
| LOCAL | You can have LOCAL variables in SUB routines or FUNCTIONS. |
| ^ | New math statement. Var = 2 ^ 3 will return 2*2*2 |
| SHIFT | Because ROTATE was changed, I added the SHIFT statement. SHIFT works just like ROTATE, but when shifted left, the LS BIT is cleared and the carry doesn't go to the LS BIT. |
| LTRIM | LTRIM, trims the leftmost spaces of a string. |
| RTRIM | RTRIM, trims the rightmost spaces of a string. |
| TRIM | TRIM, trims both the leftmost and rightmost spaces of a string. |

Statements that behave differently

| STATEMENT | DESCRIPTION |
|---|---|
| ROTATE | Rotate now behaves like the ASM rotate, this means that the carry will go to the most significant bit of a variable or the least significant bit of a variable. |
| CONST | String were added to the CONST statement. I also changed it to be compatible with QB. |
| DECLARE | BYVAL has been added since real subprograms are now supported. |
| DIM | You can now specify the location in memory of the variable.<br>Dim v as byte AT 100, will use memory location 100. |

## Links

Here are some links to software or information that might be useful:

A WINZIP clone to ZIP and UNZIP software
http://ipsoft.cjb.net/

## Tips and tricks

This section describes tips and tricks received from users.

**Kyle Kronyak : Using all the RAM from an external RAM chip.**

I have found a way to use the 607 bytes of external SRAM that are normally not available when using hardware SRAM support with BASCOM-AVR. It's actually quite simple. Basically the user just has to disconnect A15 from /CE on the SRAM module, and tie /CE to ground. This makes the chip enabled all the time. Addresses 1-32768 will then be available! The reason is because normally when going above 32768, the A15 pin would go high, disabling the chip. When A15 is not connected to /CE, the chip is always enabled, and allows the address number to "roll over". Therefore address 32162 is actually 0, 32163 is actually 1, 32164 is actually 2, etc. I have only tested this on a 32k SRAM chip. It definitely won't work on a 64k

chip, and I believe it already works on any chip below 32k without modification of the circuit.

## Newbie problems

When you are using the AVR without knowledge of the architecture you can experience some problems.

**-I can not set a pin high or low**

**-I can not read the input on a pin**

The AVR has 3 registers for each port. A port normally consist of 8 pins. A port is named with a letter from A-F.

All parts have PORT**B**.

When you want to set a single pin high or low you can use the SET and RESET statements. But before you use them the AVR chip must know in which direction you are going to use the pins.

Therefore there is a register named DDRx for each port. In our sample it is named DDR**B**. When you write a 0 to the bit position of the pin you can use the pin as an input. When you write a 1 you can use it as output.

After the direction bit is set you must use either the PORTx register to set a logic level or the PINx register to READ a pin level.

Yes the third register is the PINx register. In our sample PINB.

For example :

```
DDRB = &B1111_0000 ' upper nibble is output, lower nibble is input
SET PORTB.7  'will set the MS bit to +5V
RESET PORTB.7 'will set MS bit to 0 V
```

To read a pin :

```
Print PINB.0 'will read LS bit and send it to the RS-232
```

You may also read from PORTx but it will return the value that was last written to it.

To read or write whole bytes use :

PORTB = 0 'write 0 to register making all pins low

PRINT PINB 'print input on pins

**I want to write a special character but they are not printed correct:**

Well this is not a newbie problem but I put it here so you could find it.

Some ASCII characters above 127 are interpreted wrong depending on country settings. To print the right value use : PRINT "Test{123}?"

The {xxx} will be replaced with the correct ascii character.

You must use 3 digits otherwise the compiler will think you want to print {12} for example. This should be {012}

## Supported Programmers

BASCOM supports the following programmers

AVR ICP910 based on the AVR910.ASM application note

STK200 ISP programmer from Atmel/Kanda

The PG302 programmer from Iguana Labs

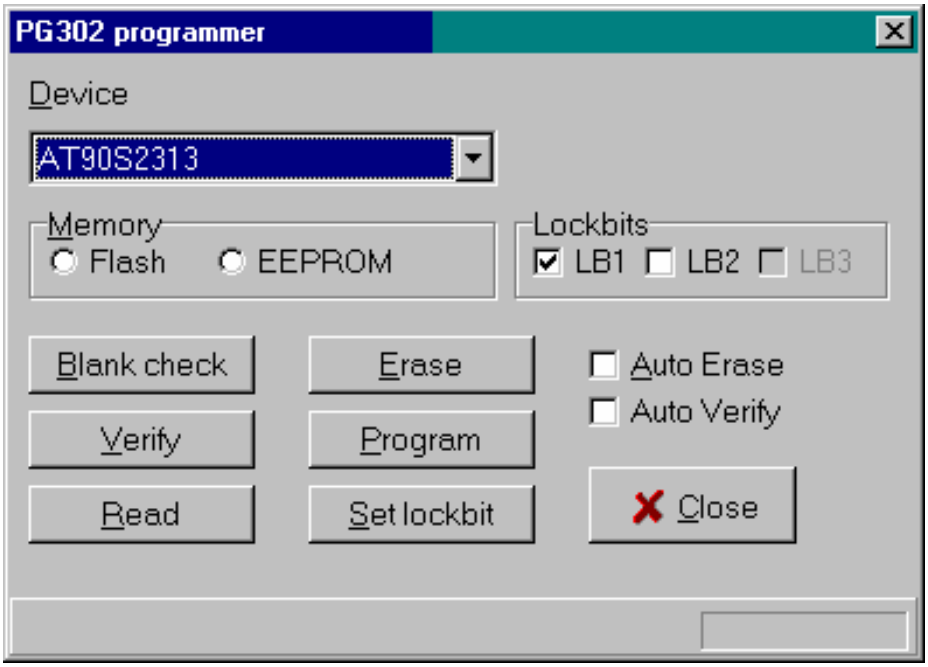
The simple cable programmer from Sample Electronics.

Eddie McMullen's SPI programmer.

KITSRUS KIT122 Programmer

## PG302 programmer

The PG302 is a serial programmer. It works and looks exactly as the original PG302 software.




Select the programmer from The Option Programmer menu or right click on the  button to show the Option Programmer menu.

## KITSRUS Programmer

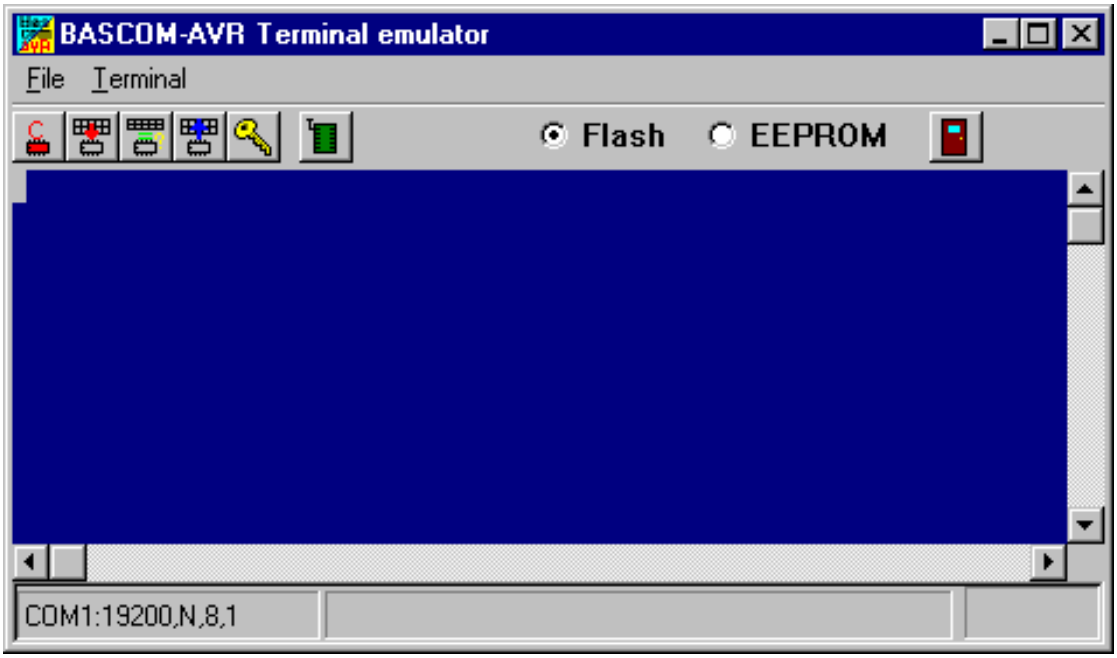
The K122 is a KIT from KITSRUS. (www.kitsrus.com)

The programmer supports the most popular 20 and 40 pins AVR chips.

On the Programmer Options tab you must select this programmer and the COM port it is connected to.

On the Monitor Options tab you must specify the upload speed of 9600, Monitor delay of 1 and Prefix delay 1.

When you press the Program button the Terminal Emulator screen will pop up:




A special toolbar is now visible.

You must press the Program enable button to enable the programmer.

When you enable the programmer the right baud rate will be set.

When you are finished you must press the Enable button again to disable it.

This way you can have a micro connected to your COM port that works with a different BAUD rate.

There is an option to select between FLASH and EEPROM.

The prompt will show the current mode which is set to FLASH by default.

The buttons on the toolbar allow you to :

ERASE, PROGRAM, VERIFY, DUMP and set the LOCK BITS.

When DUMP is selected you will be asked for a file name.

When the DUMP is ready you must CLOSE the LOGFILE where the data is stored. This can be done to select the CLOSE LOGFILE option form the menu.

## ISP programmer

BASCOM supports the STK200 and STK200+ and STK300 ISP programmer from Kanda.

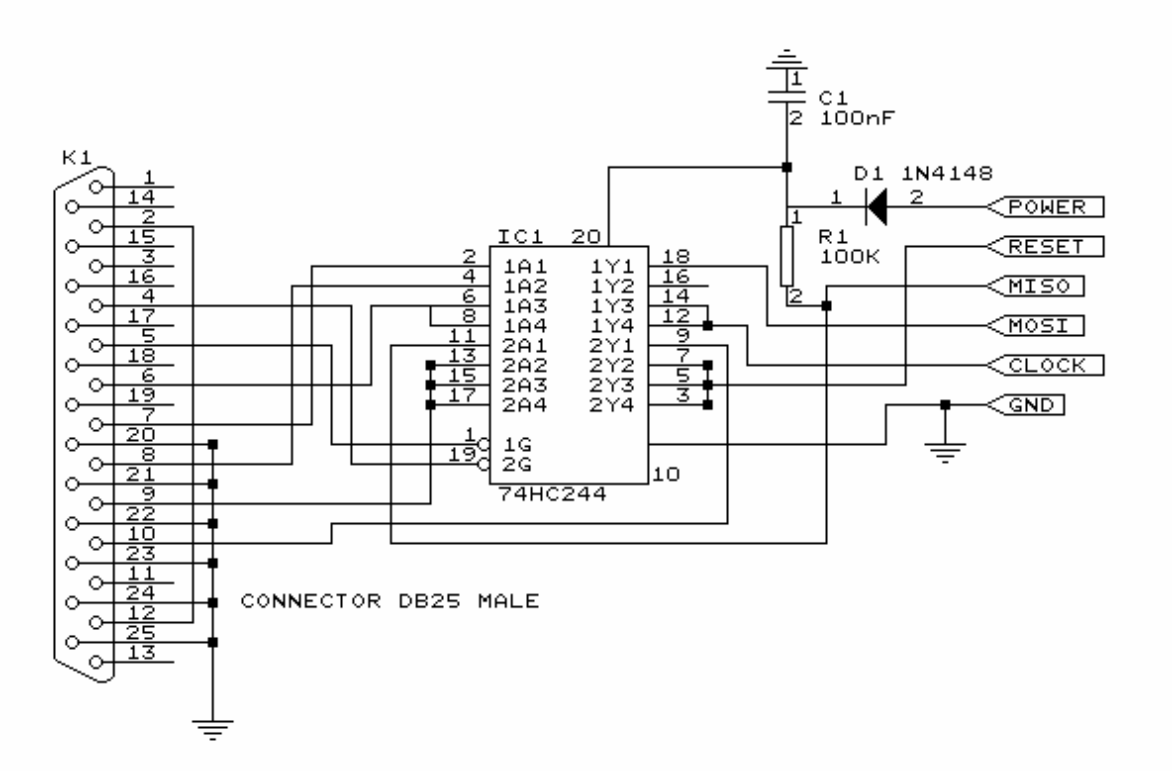
This is a very reliable parallel printer port programmer.

The STK200 ISP programmer is included in the STK200 starter kit.

All programs were tested with the STK200.

For those who don't have this kit and the programmer the following schematic shows how to make your own programmer:

The dongle has a chip with no identification but since the schematic is all over the web, I have included it. Kanda also sells a very cheap separate programmer dongle. So I suggest you buy this one!




**Sample Electronics cable programmer**

The simple cable programmer was submitted by Sample Electronics.

They produce professional programmers too. This simple programmer you can make yourself within a 10 minutes.

What you need is a DB25 centronics male connector, a flat cable and a connector that can be connected to the target MCU board.

The connections to make are as following:

| DB25 pin | Target MCU pin(AT90S8535) | Target MCU pin 8515 | DT104 |
|---|---|---|---|
| 2, D0 | MOSI, pin 6 | MOSI, 6 | J5, pin 4 |
| 4, D2 | RESET, pin 9 | RESET, 9 | J5, pin 8 |
| 5, D3 | CLOCK, pin 8 | CLOCK, 8 | J5, pin 6 |
| 11, BUSY | MISO, pin 7 | MISO, 7 | J5, pin 5 |
| 18-25,GND | GROUND | GND,20 | J5, pin 1 |

**The MCU pin numbers are shown for an 8535! And 8515**

Note that 18-25 means pins 18,19,20,21,22,23,24 and 25

You can use a small resistor of 100-220 ohm in series with the D0, D2 and D3 line in order not to short circuit your LPT port in the event the MCU pins are high.

But it was tested without these resistors and my PC still works :-)

**Tip** : when testing programmers etc. on the LPT it is best to buy an I/O card for your PC that has a LPT port. This way you dont destroy your LPT port that is on the motherboard in the event you make a mistake!

The following picture shows the connections to make. Both a setup for the DT104 and stand alone PCB are shown.

I received the following useful information :

*Hi Mark,*

*I have been having spurious success with the simple cable programmer from Sample Electronics for the AVR series.*

*After resorting to hooking up the CRO I have figured it out (I think). When trying to identify the chip, no response on the MISO pin indicates that the Programming Enable command has not been correctly received by the target. The SCK line Mark/Space times were okay but it looked a bit sad with a slow rise time but a rapid fall time. So I initially tried to improve the rise time with a pullup. No change ie still could not identify chip. I was about to add some buffers when I came across an Atmel app note for their serial programmer*

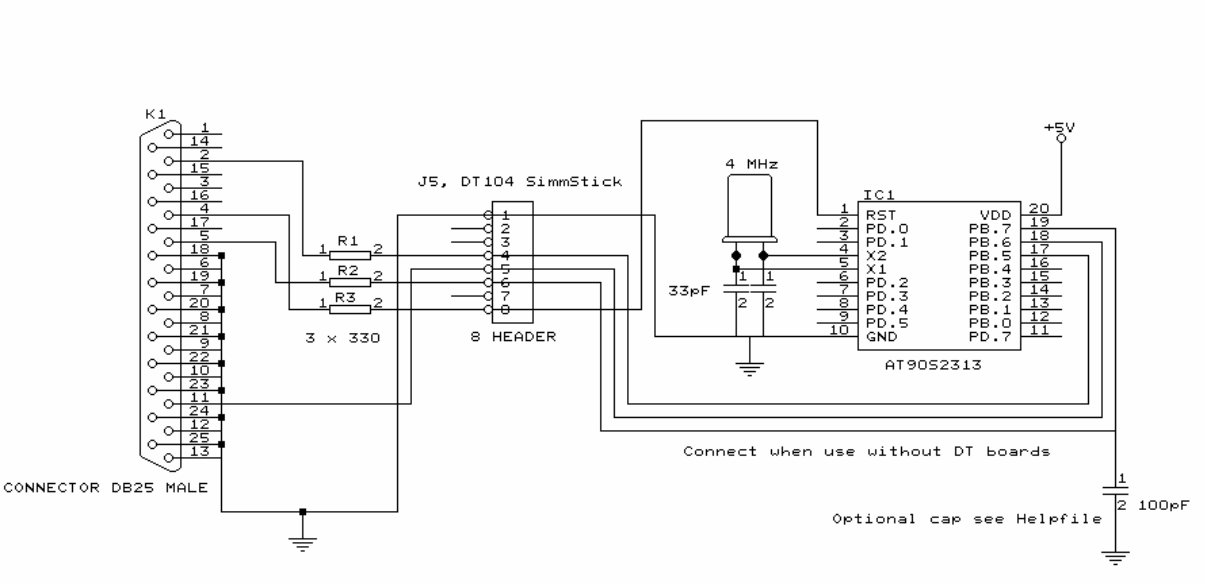
*"During this first phase of the programming cycle, keeping the SCK line free from pulses is critical, as pulses will cause the target AVR to loose syncronisation with the programmer. When syncronisation is lost, the only means of regaining syncronisation is to release the RESET line for more than 100ms."*

*I have added a 100pF cap from SCK to GND and works first time every time now. The SCK rise time is still sad but there must have been enough noise to corrupt the initial command despite using a 600mm shielded cable.*

*This may be useful to your users.*

*Regards,*

*Mark Hayne*




## Assembler mnemonics

BASCOM supports the mnemonics as defined by Atmel.

The Assembler accepts mnemonic instructions from the instruction set.

A summary of the instruction set mnemonics and their parameters is given here. For a detailed description of the Instruction set, refer to the AVR Data Book.

| Mnemonics | Operands | Description | Operation | Flags | Clock |
|---|---|---|---|---|---|
| ARITHMETIC AND LOGIC INSTRUCTIONS | | | | | |
| ADD | Rd, Rr | Add without Carry | Rd = Rd + Rr | Z,C,N,V,H | 1 |
| ADC | Rd, Rr | Add with Carry | Rd = Rd + Rr + C | Z,C,N,V,H | 1 |
| SUB | Rd, Rr | Subtract without Carry | Rd = Rd – Rr | Z,C,N,V,H | 1 |
| SUBI | Rd, K | Subtract Immediate | Rd = Rd – K | Z,C,N,V,H | 1 |
| SBC | Rd, Rr | Subtract with Carry | Rd = Rd - Rr - C | Z,C,N,V,H | 1 |
| SBCI | Rd, K | Subtract Immediate with Carry | Rd = Rd - K - C | Z,C,N,V,H | 1 |
| AND | Rd, Rr | Logical AND | Rd = Rd · Rr | Z,N,V | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ANDI | Rd, K | Logical AND with Immediate | Rd = Rd · K | Z,N,V | 1 | |
| OR | Rd, Rr | Logical OR | Rd = Rd v Rr | Z,N,V | 1 | |
| ORI | Rd, K | Logical OR with Immediate | Rd = Rd v K | Z,N,V | 1 | |
| EOR | Rd, Rr | Exclusive OR | Rd = Rd Å Rr | Z,N,V | 1 | |
| COM | Rd | Ones Complement | Rd = $FF - Rd | Z,C,N,V | 1 | |
| NEG | Rd | Twos Complement | Rd = $00 - Rd | Z,C,N,V,H | 1 | |
| SBR | Rd,K | Set Bit(s) in Register | Rd = Rd v K | Z,N,V | 1 | |
| CBR | Rd,K | Clear Bit(s) in Register | Rd = Rd · ($FFh - K) | Z,N,V | 1 | |
| INC | Rd | Increment | Rd = Rd + 1 | Z,N,V | 1 | |
| DEC | Rd | Decrement | Rd = Rd - 1 | Z,N,V | 1 | |
| TST | Rd | Test for Zero or Minus | Rd = Rd · Rd | Z,N,V | 1 | |
| CLR | Rd | Clear Register | Rd = Rd Å Rd | Z,N,V | 1 | |
| SER | Rd | Set Register | Rd = $FF | None | 1 | |
| ADIW | Rdl, K | Add Immediate to Word | Rdh:Rdl = Rdh:Rdl + K | None | 1 | |
| SBIW | Rdl, K | Subtract Immediate from Word | Rdh:Rdl = Rdh:Rdl - K | None | 1 | |
| MUL | Rd,Rr | Multiply Unsigned | R1, R0 = Rd * Rr | C | 2 | * |
| BRANCH INSTRUCTIONS | | | | | | |
| RJMP | k | Relative Jump | PC = PC + k + 1 | None | 2 | |
| IJMP | | Indirect Jump to (Z) | PC = Z | None | 2 | |
| JMP | k | Jump | PC = k | None | 3 | |
| RCALL | k | Relative Call Subroutine | PC = PC + k + 1 | None | 3 | |
| ICALL | | Indirect Call to (Z) | PC = Z | None | 3 | |
| CALL | k | Call Subroutine | PC = k | None | 4 | |
| RET | | Subroutine Return | PC = STACK | None | 4 | |
| RETI | | Interrupt Return | PC = STACK | I | 4 | |
| CPSE | Rd,Rr | Compare, Skip if Equal | if (Rd = Rr) PC = PC + 2 or 3 | None | 1 / 2 | |
| CP | Rd,Rr | Compare | Rd - Rr | Z,C,N,V,H, | 1 | |
| CPC | Rd,Rr | Compare with Carry | Rd - Rr - C | Z,C,N,V,H | 1 | |
| CPI | Rd,K | Compare with Immediate | Rd - K | Z,C,N,V,H | 1 | |
| SBRC | Rr, b | Skip if Bit in Register Cleared | If (Rr(b)=0) PC = PC + 2 or 3 | None | 1 / 2 | |
| SBRS | Rr, b | Skip if Bit in Register Set | If (Rr(b)=1) PC = PC + 2 or 3 | None | 1 / 2 | |

| | | | | | |
|---|---|---|---|---|---|
| SBIC | P, b | Skip if Bit in I/O Register Cleared | If(I/O(P,b)=0) PC = PC + 2 or 3 | None | 2 / 3 |
| SBIS | P, b | Skip if Bit in I/O Register Set | If(I/O(P,b)=1) PC = PC + 2 or 3 | None | 2 / 3 |
| BRBS | s, k | Branch if Status Flag Set | if (SREG(s) = 1) then PC=PC+k + 1 | None | 1 / 2 |
| BRBC | s, k | Branch if Status Flag Cleared | if (SREG(s) = 0) then PC=PC+k + 1 | None | 1 / 2 |
| BREQ | k | Branch if Equal | if (Z = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRNE | k | Branch if Not Equal | if (Z = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRCS | k | Branch if Carry Set | if (C = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRCC | k | Branch if Carry Cleared | if (C = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRSH | k | Branch if Same or Higher | if (C = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRLO | k | Branch if Lower | if (C = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRMI | k | Branch if Minus | if (N = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRPL | k | Branch if Plus | if (N = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRGE | k | Branch if Greater or Equal, Signed | if (N  V= 0) then PC = PC+ k + 1 | None | 1 / 2 |
| BRLT | k | Branch if Less Than, Signed | if (N  V= 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRHS | k | Branch if Half Carry Flag Set | if (H = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRHC | k | Branch if Half Carry Flag Cleared | if (H = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRTS | k | Branch if T Flag Set | if (T = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRTC | k | Branch if T Flag Cleared | if (T = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRVS | k | Branch if Overflow Flag is Set | if (V = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRVC | k | Branch if Overflow Flag is Cleared | if (V = 0) then PC = PC + k + 1 | None | 1 / 2 |
| BRIE | k | Branch if Interrupt Enabled | if ( I = 1) then PC = PC + k + 1 | None | 1 / 2 |
| BRID | k | Branch if Interrupt Disabled | if ( I = 0) then PC = PC + k + 1 | None | 1 / 2 |

DATA TRANSFER INSTRUCTIONS

| | | | | | |
|---|---|---|---|---|---|
| MOV | Rd, Rr | Copy Register | Rd = Rr | None | 1 |
| LDI | Rd, K | Load Immediate | Rd = K | None | 1 |
| LDS | Rd, k | Load Direct | Rd = (k) | None | 3 |
| LD | Rd, X | Load Indirect | Rd = (X) | None | 2 |
| LD | Rd, X+ | Load Indirect and Post-Increment | Rd = (X), X = X + 1 | None | 2 |
| LD | Rd, -X | Load Indirect and Pre-Decrement | X = X - 1, Rd =(X) | None | 2 |
| LD | Rd, Y | Load Indirect | Rd = (Y) | None | 2 |
| LD | Rd, Y+ | Load Indirect and Post-Increment | Rd = (Y), Y = Y + 1 | None | 2 |
| LD | Rd, -Y | Load Indirect and Pre-Decrement | Y = Y - 1, Rd = (Y) | None | 2 |
| LDD | Rd,Y+q | Load Indirect with Displacement | Rd = (Y + q) | None | 2 |
| LD | Rd, Z | Load Indirect | Rd = (Z) | None | 2 |
| LD | Rd, Z+ | Load Indirect and Post-Increment | Rd = (Z), Z = Z+1 | None | 2 |
| LD | Rd, -Z | Load Indirect and Pre-Decrement | Z = Z - 1, Rd = (Z) | None | 2 |
| LDD | Rd, Z+q | Load Indirect with Displacement | Rd = (Z + q) | None | 2 |
| STS | k, Rr | Store Direct | (k) = Rr | None | 3 |
| ST | X, Rr | Store Indirect | (X) = Rr | None | 2 |
| ST | X+, Rr | Store Indirect and Post-Increment | (X) = Rr, X = X + 1 | None | 2 |
| ST | -X, Rr | Store Indirect and Pre-Decrement | X = X - 1, (X) = Rr | None | 2 |
| ST | Y, Rr | Store Indirect | (Y) = Rr | None | 2 |
| ST | Y+, Rr | Store Indirect and Post-Increment | (Y) = Rr, Y = Y + 1 | None | 2 |
| ST | -Y, Rr | Store Indirect and Pre-Decrement | Y = Y - 1, (Y) = Rr | None | 2 |
| STD | Y+q,Rr | Store Indirect with Displacement | (Y + q) = Rr | None | 2 |
| ST | Z, Rr | Store Indirect | (Z) = Rr | None | 2 |
| ST | Z+, Rr | Store Indirect and Post-Increment | (Z) = Rr, Z = Z + 1 | None | 2 |
| ST | -Z, Rr | Store Indirect and Pre-Decrement | Z = Z - 1, (Z) = Rr | None | 2 |

| | | | | | |
|---|---|---|---|---|---|
| STD | Z+q,Rr | Store Indirect with Displacement | (Z + q) = Rr | None | 2 |
| LPM | | Load Program Memory | R0 =(Z) | None | 3 |
| IN | Rd, P | In Port | Rd = P | None | 1 |
| OUT | P, Rr | Out Port | P = Rr | None | 1 |
| PUSH | Rr | Push Register on Stack | STACK = Rr | None | 2 |
| POP | Rd | Pop Register from Stack | Rd = STACK | None | 2 |
| BIT AND BIT-TEST INSTRUCTIONS | | | | | |
| LSL | Rd | Logical Shift Left | Rd(n+1) =Rd(n),Rd(0)= 0,C=Rd(7) | Z,C,N,V,H | 1 |
| LSR | Rd | Logical Shift Right | Rd(n) = Rd(n+1), Rd(7) =0, C=Rd(0) | Z,C,N,V | 1 |
| ROL | Rd | Rotate Left Through Carry | Rd(0) =C, Rd(n+1) =Rd(n),C=Rd(7) | Z,C,N,V,H | 1 |
| ROR | Rd | Rotate Right Through Carry | Rd(7) =C,Rd(n) =Rd(n+1),C¬Rd(0) | Z,C,N,V | 1 |
| ASR | Rd | Arithmetic Shift Right | Rd(n) = Rd(n+1), n=0..6 | Z,C,N,V | 1 |
| SWAP | Rd | Swap Nibbles | Rd(3..0) « Rd(7..4) | None | 1 |
| BSET | s | Flag Set | SREG(s) = 1 | SREG(s) | 1 |
| BCLR | s | Flag Clear | SREG(s) = 0 | SREG(s) | 1 |
| SBI | P, b | Set Bit in I/O Register | I/O(P, b) = 1 | None | 2 |
| CBI | P, b | Clear Bit in I/O Register | I/O(P, b) = 0 | None | 2 |
| BST | Rr, b | Bit Store from Register to T | T = Rr(b) | T | 1 |
| BLD | Rd, b | Bit load from T to Register | Rd(b) = T | None | 1 |
| SEC | | Set Carry | C = 1 | C | 1 |
| CLC | | Clear Carry | C = 0 | C | 1 |
| SEN | | Set Negative Flag | N = 1 | N | 1 |
| CLN | | Clear Negative Flag | N = 0 | N | 1 |
| SEZ | | Set Zero Flag | Z = 1 | Z | 1 |
| CLZ | | Clear Zero Flag | Z = 0 | Z | 1 |
| SEI | | Global Interrupt Enable | I = 1 | I | 1 |
| CLI | | Global Interrupt Disable | I = 0 | I | 1 |
| SES | | Set Signed Test Flag | S = 1 | S | 1 |
| CLS | | Clear Signed Test Flag | S = 0 | S | 1 |
| SEV | | Set Twos Complement Overflow | V = 1 | V | 1 |

| | | | | |
|---|---|---|---|---|
| CLV | Clear Twos Complement Overflow | V = 0 | V | 1 |
| SET | Set T in SREG | T = 1 | T | 1 |
| CLT | Clear T in SREG | T = 0 | T | 1 |
| SHE | Set Half Carry Flag in SREG | H = 1 | H | 1 |
| CLH | Clear Half Carry Flag in SREG | H = 0 | H | 1 |
| NOP | No Operation | | None | 1 |
| SLEEP | Sleep | | None | 1 |
| WDR | Watchdog Reset | | None | 1 |

* ) Not available in base-line microcontrollers

The Assembler is not case sensitive.

The operands have the following forms:

Rd: R0-R31 or R16-R31 (depending on instruction)

Rr: R0-R31

b: Constant (0-7)

s: Constant (0-7)

P: Constant (0-31/63)

K: Constant (0-255)

k: Constant, value range depending on instruction.

q: Constant (0-63)

Rdl: R24, R26, R28, R30. For ADIW and SBIW instructions

## Mixing ASM and BASIC

BASCOM allows you to mix BASIC with assembly.

This can be very useful in some situations when you need full control of the generated code.

Almost all assembly mnemonics are recognized by the compiler. The

exceptions are : SUB, SWAP,CALL and OUT. These are BASIC reserved words and have priority over the ASM mnemonics. To use these mnemonics precede them with the **!** - sign.

For example :

```
Dim a As Byte At &H60      'A is stored at location &H60
Ldi R27 , $00              'Load R27 with MSB of address
Ldi R26 , $60              'Load R26 with LSB of address
Ld R1, X                   'load memory location $60 into R1
!SWAP R1                   'swap nibbles
```

As you can see the SWAP mnemonic is preceded by a ! sign.

Another option is to use the assembler block directives:

```
$ASM
    Ldi R27 , $00          'Load R27 with MSB of address
    Ldi R26 , $60          'Load R26 with LSB of address
    Ld R1, X               'load memory location $60 into R1
    SWAP R1                'swap nibbles
$END ASM
```

A special assembler helper function is provided to load the address into the register X or Z. Y can may not be used because it is used as the soft stack pointer.

```
Dim A As Byte              'reserve space
LOADADR a, X               'load address of variable named A into register pair
X
```

This has the same effect as :

```
Ldi R26 , $60  'for example !
Ldi R27, $00   'for example !
```

Some registers are used by BASCOM

R4 and R5 are used to point to the stack frame or the temp data storage

R6 is used to store some bit variables:

R6 bit 0 = flag for integer/word conversion

R6 bit 1 = temp bit space used for swapping bits

R6 bit 2 = error bit (ERR variable)

R6 bit 3 = show/noshow flag when using INPUT statement

R8 and R9 are used as a data pointer for the READ statement.

All other registers are used depending on the used statements.

To Load the address of a variable you must enclose them in brackets.

```
Dim B As Bit
Lds R16, {B} 'will replace {B} with the address of variable B
```

To refer to the bitnumber you must precede the variable name by BIT.

```
Sbrs R16 , BIT.B     'notice the point!
```

Since this was the first dimensioned bit the bit number is 7. Bits are stored in bytes and the first dimensioned bit goes in the LS bit.

To load an address of a label you must use :

```
LDI ZL,  Low(lbl * 1)
LDI ZH , High(lbl * 1)
```

Where ZL = R30 and may be R24, R26, R28 or R30

And ZH = R31 and may be R25, R27, R29 or R31.

These are so called register pairs that form a pointer.

When you want to use the LPM instruction to retrieve data you must multiply the address with 2 since the AVR object code consist of words.

```
LDI ZL,  Low(lbl * 2)
LDI ZH , High(lbl * 2)
LPM ; get data into R0
Lbl:
```

Atmel mnemonics must be used to program in assembly.

You can download the pdf from www.atmel.com that shows how the different mnemonics are used.

Some points of attention :

* All instructions that use a constant as a parameter only work on the upper 16 registers (r16-r31)

So LDI R15,12  WILL NOT WORK

* The instruction SBR register, K

will work with K from 0-255. So you can set multiple bits!

The instruction SBI port, K  will work with K from 0-7 and will set only ONE bit in a IO-port register.

The same applies to the CBR and CBI instructions.

**How to make your own libraries and call them from BASIC?**

The files for this sample can be found as libdemo.bas in the SAMPLES dir and as mylib.lib  in the LIB dir.

First determine the used parameters and their type.

Also consider if they are passed by reference or by value

For example the sub test has two parameters:

**x** which is passed by value (copy of the variable)

**y** which is passed by reference(address of the variable)

In both cases the address of the variable is put on the soft stack which is indexed by the Y pointer.

The first parameter (or a copy) is put on the soft stack first

To refer to the address you must use:

```
ldd r26 , y + 0
ldd r27 , y + 1
```

This loads the address into pointer X

The second parameter will also be put on the soft stack so :

The reference for the x variable will be changed :

To refer to the address of **x** you must use:

```
ldd r26 , y + 2
ldd r27 , y + 3
```

To refer to the last parameter **y** you must use

```
ldd r26 , y + 0
ldd r27 , y + 1
```

Write the sub routine as you are used too but include the name within brackets []

```
[test]
test:
  ldd r26,y+2   ; load address of x
  ldd r27,y+3
  ld r24,x      ; get value into r24
  inc r24       ; value + 1
  st x,r24      ; put back
  ldd r26,y+0   ; address of y
  ldd r27,y+1
  st x,r24      ; store
  ret           ; ready
[end]
```

To write a function goes the same way.
A function returns a result so a function has one additional parameter.
It is generated automatic and it has the name of the function.
This way you can assign the result to the function name
For example:

```
Declare Function Test(byval x as byte , y as byte) as byte
```

A virtual variable will be created with the name of the function in this case **test**.

It will be pushed on the softstack with the Y-pointer.

To reference to the result or name of the function (test) the address will be:

y + 0 and y + 1

The first variable **x** will bring that to y + 2 and y + 3

And the third variable will cause that 3 parameters are saved on the soft stack

To reference to test you must use :

```
ldd r26 , y + 4
ldd r27 , y + 5
```

To reference to x

```
ldd r26 , y + 2
ldd r27 , y + 3
```

And to reference y

```
ldd r26 , y + 0
ldd r27 , y + 1
```

When you use exit sub or exit function you also need to provide an additional label. It starts with **sub_** and must be completed with the function / sub routine name. In our example:

**sub_test:**

When you use local variables thing become more complicated.

Each local variable address will be put on the soft stack too

When you use 1 local variable its address will become

```
ldd r26,  y+0
ldd r27 , y + 1
```

All other parameters must be increased with 2 so the reference to y variable changes from

ldd r26 , y + 0 to ldd r26 , y + 2

ldd r27 , y + 1 to ldd r27 , y + 3

And of course also for the other variables.

When you have more local variables just add 2 for each.

Finally you save the file as a **.lib** file

Use the library manager to compile it into the lbx format.

The declare sub / function must be in the program where you use the sub / function.

The following is a copy of the libdemo.bas file :

```
'define the used library
$lib "mylib.lib"

'also define the used routines
$external Test

'this is needed so the parameters will be placed correct on the stack
Declare Sub Test(byval X As Byte , Y As Byte)



'reserve some space
Dim Z As Byte



'call our own sub routine
Call Test(1 , Z)

'z will be 2 in the used example
End
```

When you use ports in your library you must use **.equ** to specify the address:

.**equ EEDR=$1d**

In R24, **EEDR**

This way the library manager know the address of the port during compile time.

This chapter is not intended to learn you ASM programming. But when you find a topic is missing to interface BASCOM with ASM send me an email.

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