



**Freescale Semiconductor, Inc.**

MCUEZASM08/D

February 1998

**MCUez  
ASSEMBLER  
USER'S MANUAL**

**Freescale Semiconductor, Inc.**

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## CHAPTER 1

### GENERAL INFORMATION

#### 1.1 INTRODUCTION

Features of the ezASM Macro Assembler include:

- Graphical User Interface
- Online Help
- Support for absolute and relocatable assembler code
- 32-bit Application
- Compatible with MCUasm Release 5.3
- Conforms to Motorola Assembly Language Input Standard and ELF/DWARF 2.0 object code format

#### 1.2 STRUCTURE OF THIS MANUAL

- **Graphical User Interface:** description of the Macro Assembler GUI
- **Environment:** description of the Macro Assembler Environment Variables
- **Files:** description of file types associated with the MCUEz Assembler
- **Assembler Options:** detailed description of the full set of Assembler options
- **Sections:** explanation of the function and behavior of sections of code or data
- **Assembler Syntax:** description of the Macro Assembler Input File Syntax
- **Assembler Directives:** list of all directives supported by the assembler
- **Macros:** description of the function and use of Assembler macros
- **Assembler Listing File:** explanation of the files created during the assembly process
- **MCUASM Compatibility:** list of supported MCUASM operations and syntax
- **Operating Procedures:** description of MCUEz Assembler operating procedures
- **Assembler Messages:** description and examples produced by the Macro Assembler
- **Index**

## 1.3 GETTING STARTED

This section describes how to use the MCUEz tool chain. It provides instructions to:

- Write an assembly source file
- Assemble the assembly source file
- Link the application to generate an executable file

### 1.3.1 Write An Assembly Source File

Once the project has been configured, you can start writing your application. For example, your source code may be stored in a file named `test.asm` and may look as follows:

```

XDEF entry ; Make the symbol entry visible for external module.
           ; This is necessary to allow the linker to find the
           ; symbol and use it as the entry point for the
           ; application.

initStk: EQU $SAFE           ; Initial value for SP
cstSec:  SECTION            ; Define a constant relocatable section
var1:    DC.B 5              ; Assign 5 to the symbol var1
dataSec: SECTION            ; Define a data relocatable section
data:    DS.B 1              ; Define one byte variable in RAM
codeSec: SECTION            ; Define a code relocatable section
entry:

        LDHX #initStk ; Load stack pointer
        TXS

        LDA  var1

main:

        INCA
        STA  data
        BRA  main
  
```

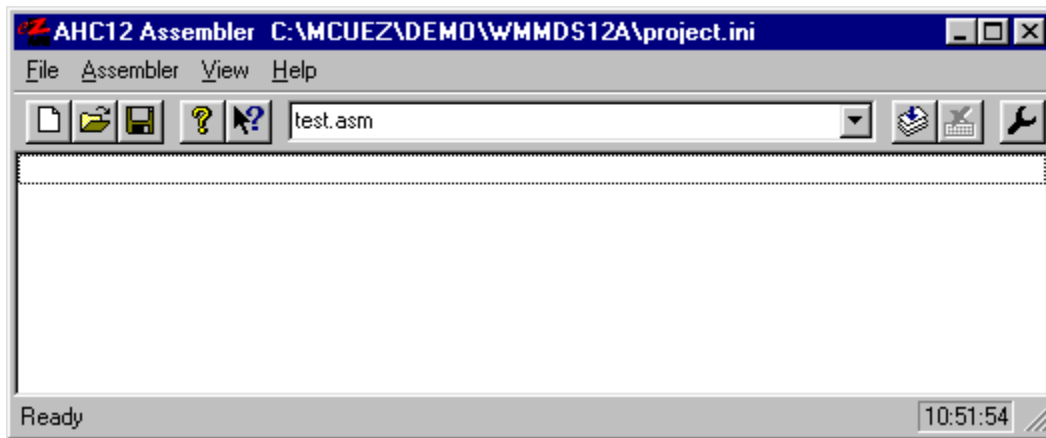
When writing assembly source code, pay special attention to the following points:

- All symbols referenced outside the current source file (in another source file or in the linker configuration file) must be externally visible. For this reason, we have inserted the assembly directive `XDEF entry`.
- In order to make debugging from the application easier, we strongly recommend you to define separate sections for code, constant data (defined with `DC`), and variables (defined with `DS`). This enables the symbols located in the variable or constant data sections to be displayed in the data window component of the Debugger.
- The stack pointer must be initialized when using `BSR` or `JSR` instructions in your application.

### 1.3.2 Assemble A Source File

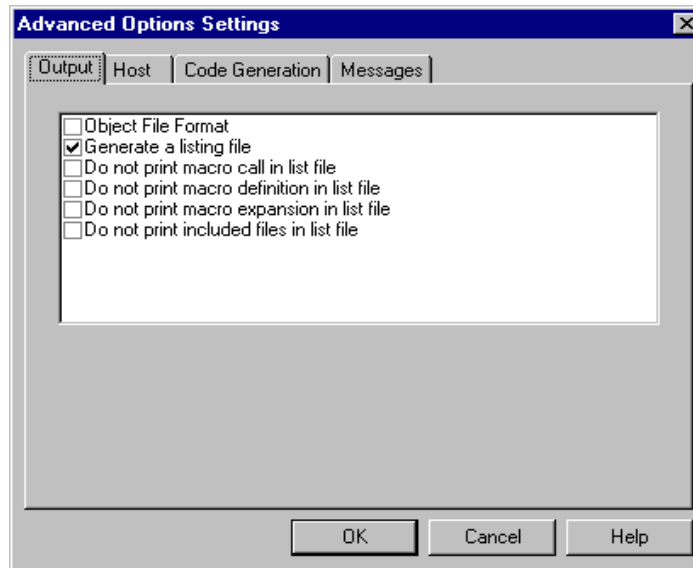
The following procedure describes how to assemble your source file.

1. Start the macro assembler using the eZASM button in the MCUEz shell. The figure below is an example. Your dialog will reflect the release number of your package. Enter the name of the file to be assembled in the editable combo box as shown below.



**Figure 1-1. Assembler Window**

2. To generate an Elf/Dwarf 2 object file, the Assembler must be correctly set. Select menu entry *Assembler/Advanced*. The Advanced Options Settings dialog is displayed:



**Figure 1-2. Advanced Options Settings Dialog Box**

- In the Output folder, select the check box in front of the label Object File Format. More information is displayed at the bottom of the dialog. Select the radio button ELF/DWARF 2.0 Object File Format and click OK. The Assembler is now ready to generate an Elf /Dwarf 2 object file.

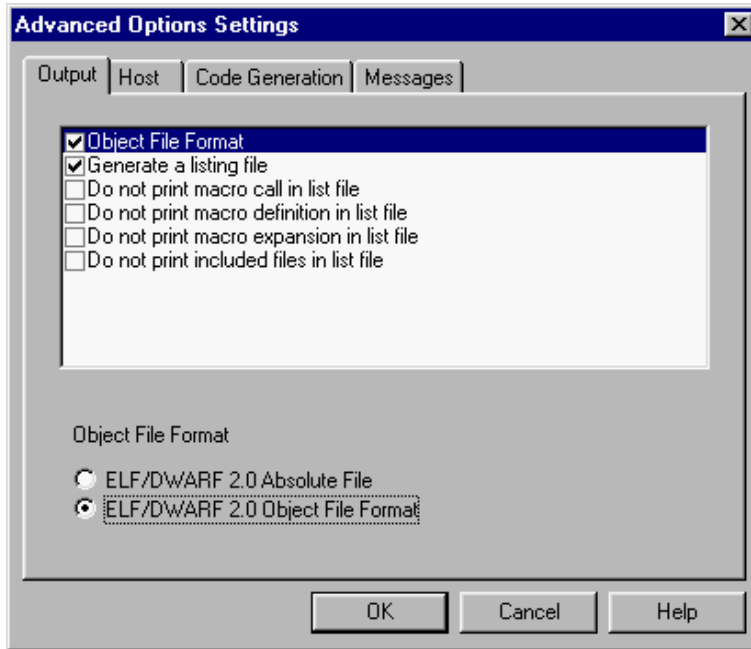


Figure 1-3. Selecting An Object File Format

- The file is assembled as soon as you click on the Assemble button:

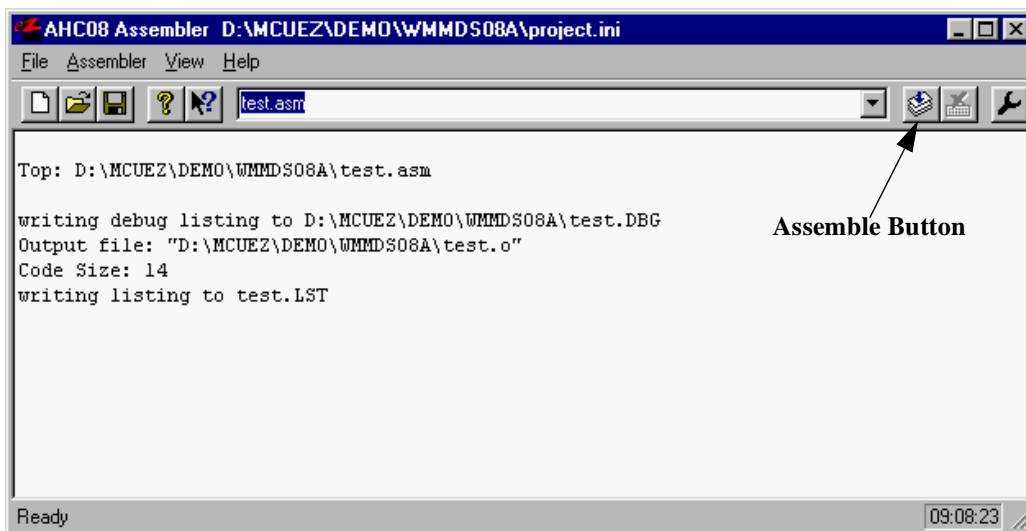


Figure 1-4. Assembling A File



The Macro Assembler indicates successful assembling session by printing the number of generated bytes of code. The message `Code Size: 14` indicates that `test.asm` was assembled without errors. The Macro Assembler generates a binary object file and a debug listing file for each source file. The binary object file has the same name as the input module with extension `.o`. The debug listing file has the same name as the input module, with extension `.dbg`.

When the assembly option `-L` is specified on the command line, the macro assembler generates a list file containing the source instruction and the corresponding hexadecimal code. The list file generated by the Macro Assembler looks as follows:

Abs.	Rel.	Loc	Obj.code	Source line	
----	----	-----	-----	-----	
1	1			XDEF entry	; Make the
2	2				; This is
3	3				; symbol and
4	4				; application.
5	5	0000	0AFE	initStk: EQU \$AFE	; Initial value
6	6				
7	7			cstSec: SECTION	; Define a
8	8	000000	05	var1: DC.B 5	; Assign 5 to
9	9				
10	10			dataSec: SECTION	; Define a data
11	11	000000		data: DS.B 1	; Define one
12	12				
13	13			codeSec: SECTION	; Define a code
14	14			entry:	
15	15	000000	45 0AFE	LDHX #initStk	; Load stack
16	16	000003	94	TXS	
17	17				
18	18	000004	C6 xxxx	LDA var1	
19	19			main:	
20	20	000007	4C	INCA	
21	21	000008	C7 xxxx	STA data	
22	22	00000B	20FA	BRA main	

### 1.3.3 Link An Application

The linker organizes the code and data sections according to the linker parameter file. Follow this procedure to link an application:

1. Start your editor and create linker parameter file. You can copy the file `fibco.prm` to `test.prm`.
2. In the file `test.prm`, change the name of the executable and object files to `test`. Modify start and end addresses for ROM and RAM memory areas. For `test.prm`:

```
LINK test.abs      /* Name of the executable file generated.*/
NAMES test.o END  /* Name of the object files in the application */
SEGMENTS
  MY_ROM  = READ_ONLY  0x800 TO 0x8FF; /* READ_ONLY memory area. */
  MY_RAM  = READ_WRITE 0x0B0 TO 0x0FF; /* READ_WRITE memory area. */
  MY_STK  = READ_WRITE 0xA00 TO 0xAFF; /* READ_WRITE memory area. */
END
PLACEMENT
  .data   INTO MY_RAM; /* Variables should be allocated in MY_RAM
*/
  .text   INTO MY_ROM; /* Code should be allocated in MY_ROM */
  .stack  INTO MY_STK; /* Stack will be allocated in MY_STK. */
END
INIT  entry /* entry is the entry point to the application. */
VECTOR ADDRESS 0xFFFFE entry /* initialization for Reset vector.*/
```

**NOTE**

Commands in the linker parameter file are described in the Linker manual.

3. Click the ezLink button in the MCUEz shell.
4. The Linker is started:

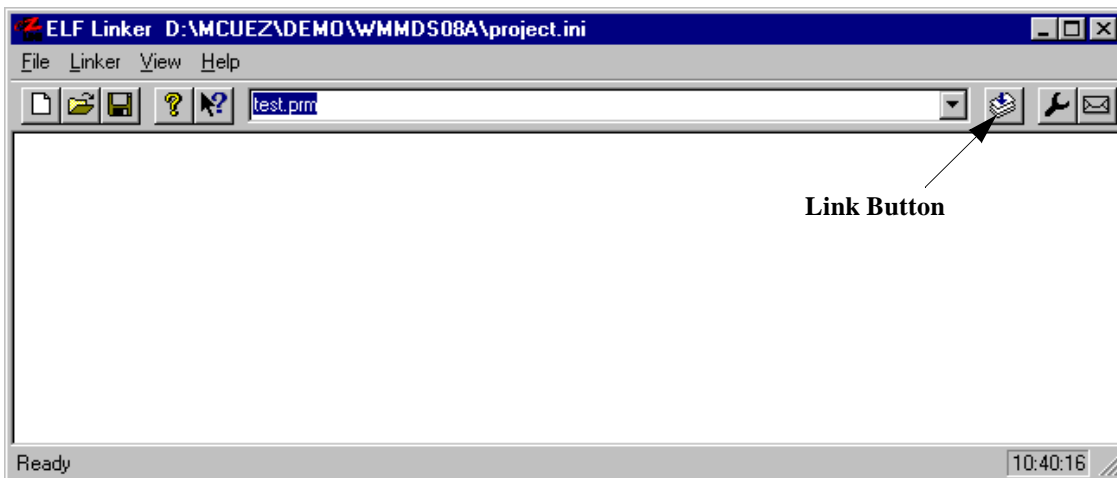
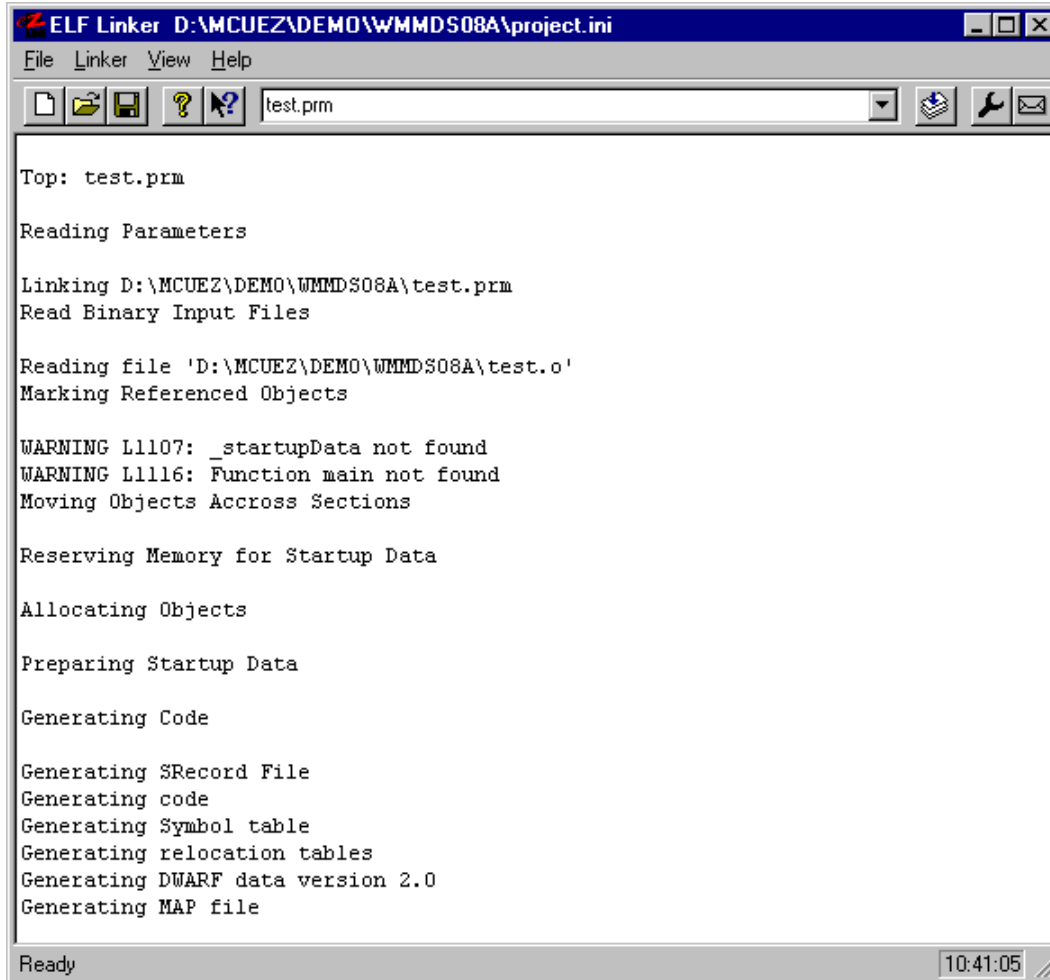


Figure 1-5. Linker Window

5. Type the name of the file to be linked in the editable combo box.
6. To start linking, press the Enter key or the Link button.

After you start the Linker, the window displays the link process:



The screenshot shows a window titled "ELF Linker D:\MCUEZ\DEMO\WMMDS08A\project.ini". The window has a menu bar with "File", "Linker", "View", and "Help". Below the menu bar is a toolbar with icons for file operations and a text input field containing "test.prm". The main area of the window displays the following text:

```
Top: test.prm
Reading Parameters
Linking D:\MCUEZ\DEMO\WMMDS08A\test.prm
Read Binary Input Files
Reading file 'D:\MCUEZ\DEMO\WMMDS08A\test.o'
Marking Referenced Objects
WARNING L1107: _startupData not found
WARNING L1116: Function main not found
Moving Objects Across Sections
Reserving Memory for Startup Data
Allocating Objects
Preparing Startup Data
Generating Code
Generating SRecord File
Generating code
Generating Symbol table
Generating relocation tables
Generating DWARF data version 2.0
Generating MAP file
```

The status bar at the bottom of the window shows "Ready" on the left and "10:41:05" on the right.

Figure 1-6. Link Process In Action





## CHAPTER 2

### GRAPHICAL USER INTERFACE

#### 2.1 INTRODUCTION

Run the assembler from the MCUEz shell by clicking the eZASM icon in the toolbar.

#### 2.2 STARTING THE MOTOROLA ASSEMBLER

When the assembler is started, a standard Tip of the Day window containing a helpful hint about using the assembler is displayed.

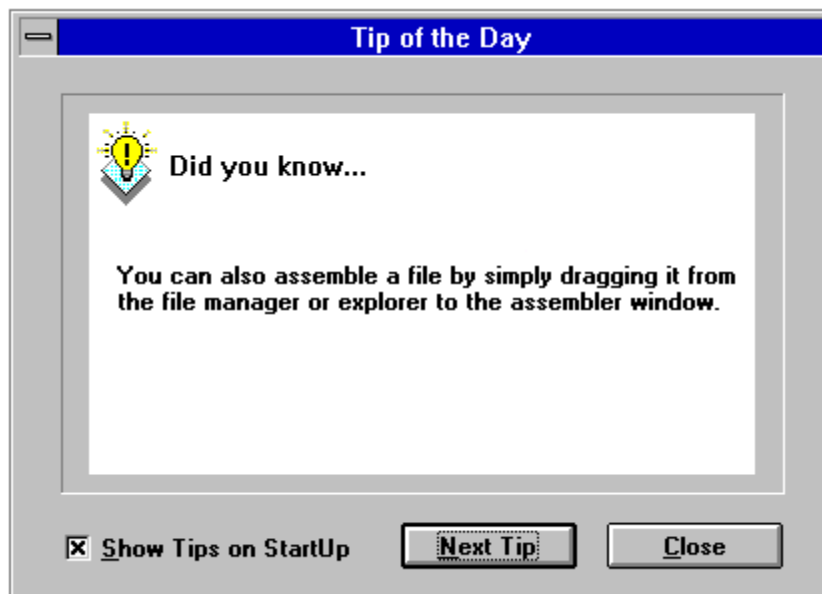


Figure 2-1. Tip Of The Day Window

Click **Next Tip** to see the next piece of information about the assembler. Click **Close** to close the Tip of the Day dialog.

If you do not want to automatically open the standard Tip of the Day window when the assembler is started, uncheck **Show Tips on StartUp**.

To re-enable the automatic display of this dialog at assembler start up, choose **Help/Tip of the Day...** The Tip of the Day dialog will be opened and you can check **Show Tips on StartUp**.

## 2.3 ASSEMBLER GRAPHICAL INTERFACE

When no file name has been specified while starting the assembler, the following window is displayed:

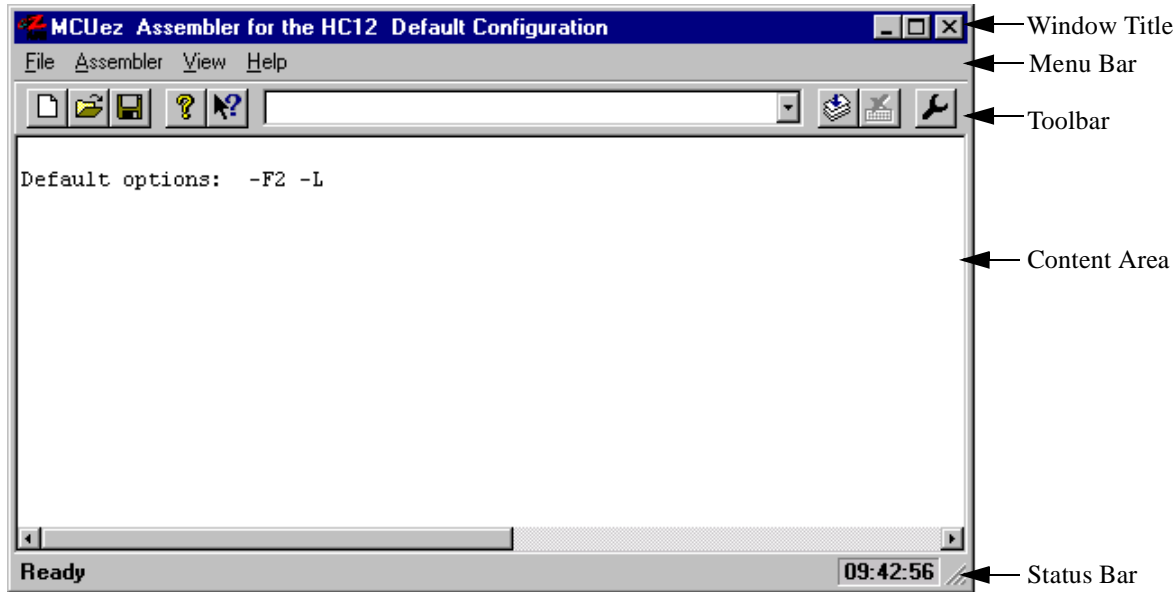


Figure 2-2. Assembler Window

This window is only visible on the screen when you do not specify a file name while starting the Assembler.

The Assembler window provides a window title, a menu bar, a toolbar, a content area, and a status bar.

### 2.3.1 Window Title

The window title displays the Assembler name and the project name. If no project is currently loaded, Default Configuration is displayed. A \* after the configuration name indicates that some values have been changed. The \* indicates changes in options, editor configuration, or appearance (window position, size, font,...).



### 2.3.2 Content Area

The Content Area is used as a text container where logging information about the assembly session is displayed. This logging information contains:

- Name of the file being assembled
- Complete name (including full path) of the files processed (main assembly file and all included files)
- List of errors, warnings, and information messages generated
- Size of the code generated during the assembly session

When a file name is dropped into the Assembly window content area, the corresponding file is either loaded as configuration or assembled. It is loaded as configuration if the file has the extension `.ini`. If not, the file is assembled with the current option settings (see the Specifying The Input File section in this chapter).

All text in the Assembler window content area can have context information. The context information consists of two items:

- File name including a position inside of a file
- Message number

File context information is available for all output lines where a file name is displayed. If a file context is available for a line, double-clicking on this line opens the appropriate file in the editor specified in your MCUEz configuration. Double-clicking the right mouse button also opens a context menu. The menu contains an “Open ..” entry if a file context is available. If a file can not be opened although a context menu entry is present, see the section Editor Settings Dialog.

The message number is available for any message output. There are three ways to open the corresponding entry in the help file:

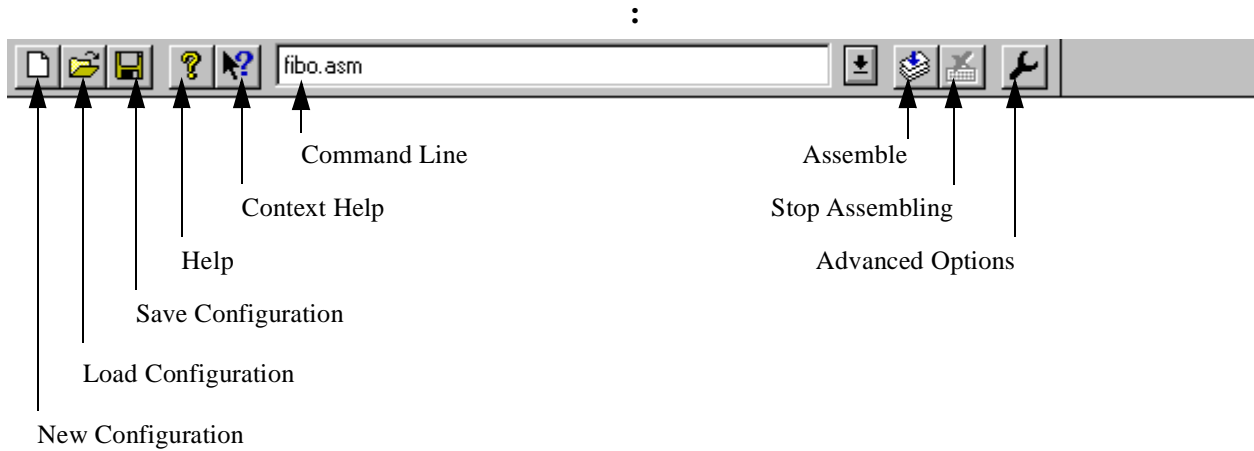
- Select one line of the message and press F1
- Press Shift-F1 and then click on the message text
- Click with the right mouse button at the message text and select `Help on . . .`

If you press F1 or Shift-F1 on a line that does not have a message number, the main Help file opens. The `Help on . . .` item does not appear in the the right mouse button menu if there is no message number associated with the message text.




Once an assembly session has completed, an error feedback can be performed automatically by double clicking on the message in the content area. To allow error feedback, the desired editor must be configured (see the Error Feedback section in this chapter).



### 2.3.3 Assembler Toolbar


The following figure shows the Assembler toolbar






**Figure 2-3. Assembler Toolbar**

The three buttons on the left are linked with the corresponding entries of the *File* menu. The *New Configuration* , the *Load Configuration*  and the *Save Configuration*  enable you to reset, load and save configuration files for the MCUez Assembler.

The *Help* button  and the *Context Help* button  enable you to open the Help file or the Context Help.

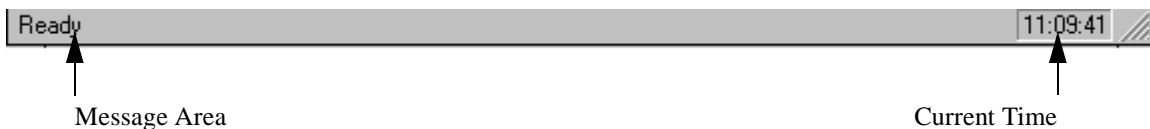
When pressing , the mouse cursor changes its form displaying a question mark beside the arrow. A help file is called for the next item which is clicked. Specific help on menus, toolbar buttons, or on the window areas are available.

The editable combo box contains the list of the last commands executed. Once a command line has been selected or entered in the combo box, click the *Assemble* button  to execute the command. The *Stop Assembling* button  enables you to abort the current assembly session.

The *Advanced Options* button  enables you to open the *Advanced Options* dialog.

### 2.3.4 Status Bar

The following figure shows the Assembler Status Bar:



**Figure 2-4. Assembler Status Bar**



When the mouse arrow is pointing to a button in the Toolbar or a menu entry, the Message Area will display information about the button or menu entry function.

### 2.3.5 Assembler Menu Bar

The following entries are available in the Menu Bar:

**Table 2-1. Menu Bar**

Menu entry	Description
File	Assembler Configuration File management.
Assembler	Assembler option settings.
View	Assembler window settings.
Help	Standard Windows Help menu.

#### 2.3.5.1 File Menu

An assembler Configuration File typically contains the following information:

- The Assembler option settings specified in the Assembler dialog boxes.
- The list of the last command line executed and the current command line.
- The window position, size and font.
- The editor, which is specifically associated with the Assembler.
- The Tips of the Day settings, including if enabled at start-up and which is the current entry

Assembler configuration information is stored in the specified configuration file. As many Configuration Files as required for a project can be defined. Switching between different Configuration Files is performed by choosing `File/Load Configuration` and `File/Save Configuration` in the Assembler Menu Bar or clicking the corresponding toolbar buttons.

- When choosing `File/Assemble` a standard Open File box is opened, displaying the list of all the `.ASM` files in the project directory. The input file can be selected using the features from the standard Open File box. The selected file is assembled as soon as the Open File box is closed by clicking OK.
- When choosing `File/New/Default Configuration` the assembler option settings are reset to the default values. The assembler options that are activated per default are specified in the Command Line Options chapter.

- When choosing File/Load Configuration a standard Open File box is opened, displaying the list of all the .INI files in the project directory. The configuration file can be selected using the features from the standard Open File box. The configuration data stored in the selected file is loaded and will be used by a further assembly session.
- When choosing File/Save Configuration the current settings are stored in the configuration file specified on the title bar.
- When choosing File/Save Configuration As... a standard Save As box is opened, displaying the list of all the .INI files in the project directory. The name or location of the configuration file can be specified using the features from the standard Save As box. The current settings are saved in the specified configuration file as soon as the Save As box is closed clicking OK.
- When choosing File/Configuration... the Configuration dialog box is opened. This dialog enables you to specify a specific editor, which should be used for error feedback and which information must be saved in the configuration file.

### 2.3.5.1.1 Editor Settings Dialog

The Editor Setting dialog has a main selection entry. Depending on the main type of editor selected, the content below changes.

There are the following main entries:

- Global Editor (Configured by the Shell)

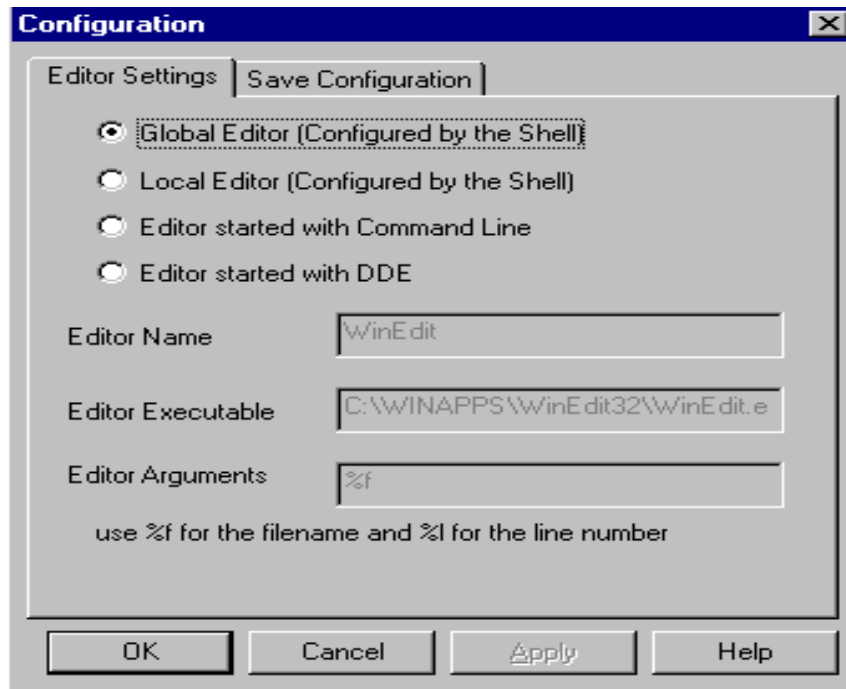
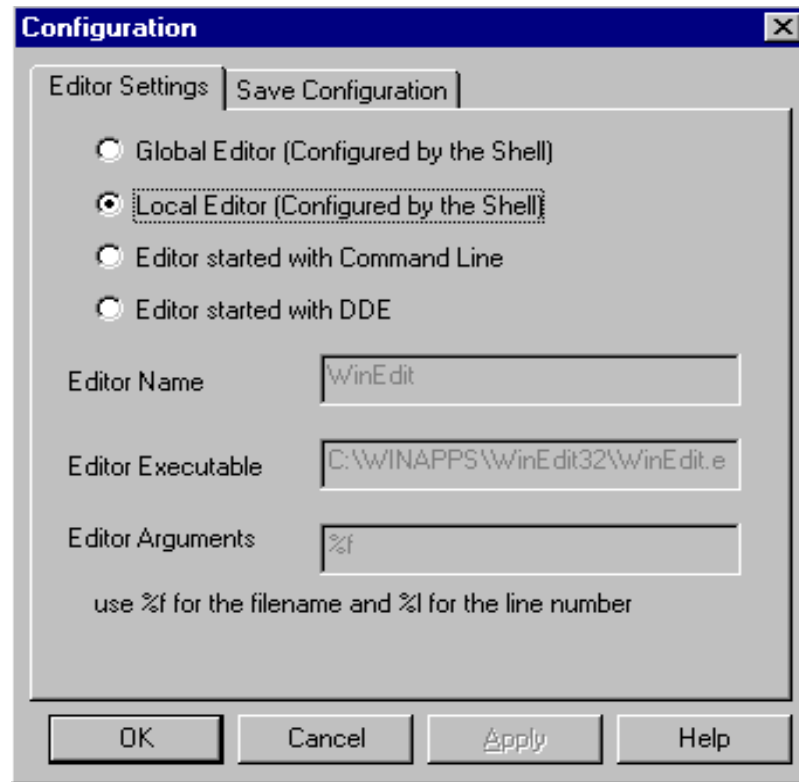


Figure 2-5. Starting The Global Editor



This entry is only enabled (black) when an editor is configured in the “[Editor]” section from the global initialization file MCUTOOLS . INI.

- Local Editor (Configured by the Shell)

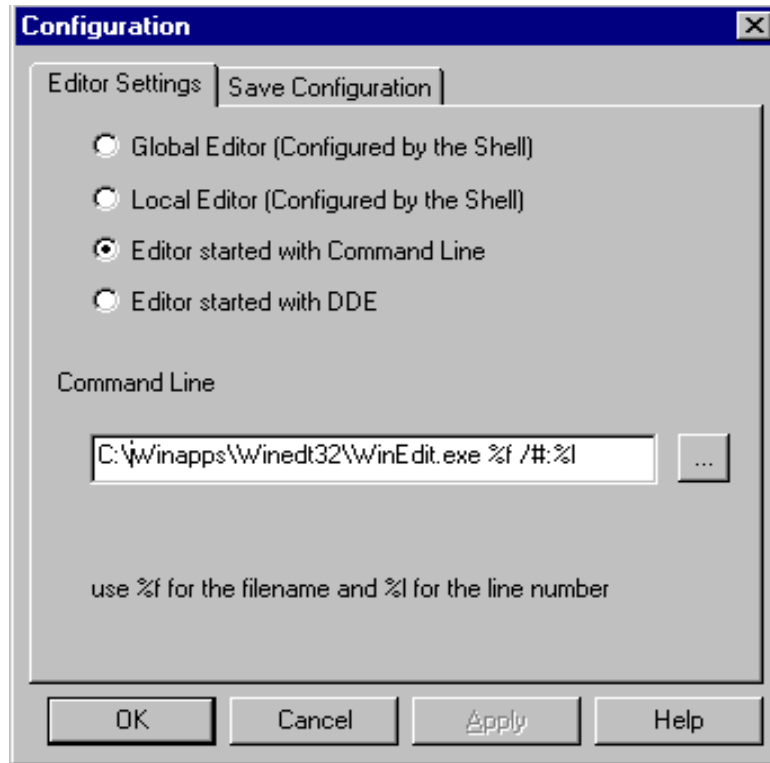


**Figure 2-6. Starting The Local Editor**

This entry is only enabled (black) when an editor is configured in the local configuration file, usually `project.ini` in the project directory.

The Global and Local Editor configurations can be read with the Assembler, but not edited. These entries can be configured with the MCUEz Shell.

- Editor started with Command Line



**Figure 2-7. Starting The Editor With The Command Line**

When this editor type is selected, a separate editor is associated with the Assembler for error feedback. The editor configured in the Shell is not used for error feedback.

Enter the command that should be used to start the editor. Modifier can be specified in the command line. See the note below for modifiers for file name and line number.

The format from the editor command depends on the syntax which should be used to start the editor.

Example:

For Winedit 32 bit version use (with an adapted path to the winedit.exe file)

```
C:\WinEdit32\WinEdit.exe %f /#:%l
```

For Write.exe use (with an adapted path to the write.exe file, note that write does not support line number).

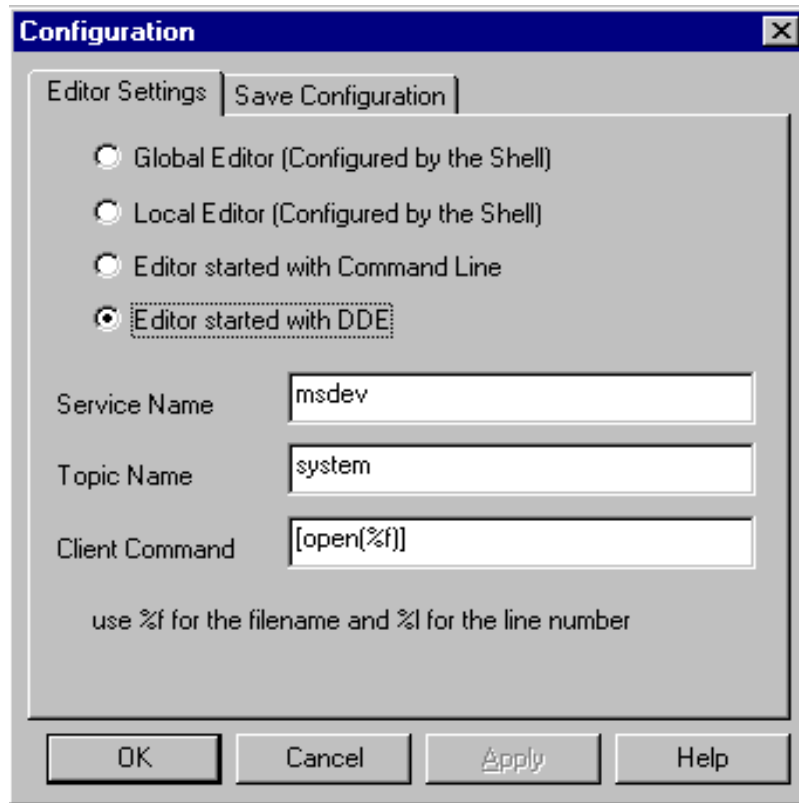
```
C:\Winnt\System32\Write.exe %f
```

For Motpad.exe use (with an adapted path to the Motpad.exe file, note that Motpad supports line number).



C:\TOOLS\MOTPAD\MOTPAD.exe %f::%l

- Editor started with DDE



**Figure 2-8. Starting The Editor With DDE**

Enter the service, topic, and client name to be used for a DDE connection to the editor. All entries can have modifiers for file name and line number as explained below.

Example:

For Microsoft Developer Studio use the following setting :

```
Service Name : "msdev"
Topic Name : "system"
ClientCommand : "[open(%f)]"
```

- Modifiers

When either entry 'Editor Started with the Command line' or 'Editor started with DDE' is selected, the configurations may contain some modifiers to tell the editor which file to open and at which line:

- The %f modifier refers to the name of the file (including path) where the error has been detected
- The %l modifier refers to the line number where the message has been detected

The format from the editor command depends on the syntax used to start the editor. Please check your editor manual to define the command line which should be used to start the editor.

### 2.3.5.1.2 Important Remarks

Caution should be taken using %l: this modifier can only be used with an editor which can be started with a line number as a parameter. Editors such as WinEdit version 3.1 or lower, and Notepad do not allow this kind of parameter. This kind of editor can be started using the file name as a parameter. Choosing the menu entry GO TO will jump to the line where the error has been detected.

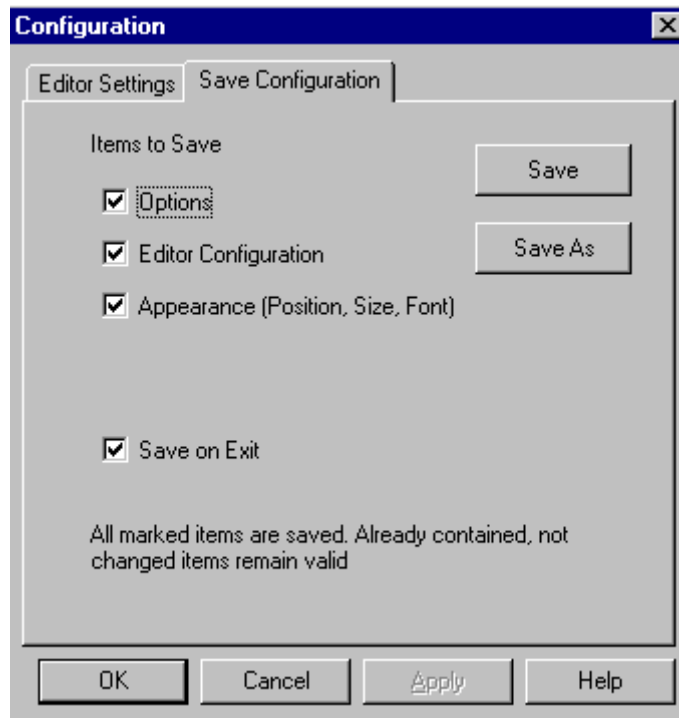
In that case the Command Line looks like: `C:\WINAPPS\WINEDIT\Winedit.EXE %f`  
 Check your editor manual to define the Command Line used to start the editor.

#### NOTE

If you are using a word processing editor (Microsoft Word, Wordpad,...), make sure you save your input file as ASCII text file, otherwise the Assembler will have trouble to process them.

### 2.3.5.1.3 Configuration Dialog

The following figure shows the Configuration dialog:



**Figure 2-9. Configuration Dialog**



---

---

Save operation options are contained on the Save Configuration page of the Configuration dialog. In the Save Configuration dialog, you can control the configuration items to be saved:

- **Options:** when this mark is set, the current option settings are stored in the configuration files. By disabling this option, the last saved settings remain valid
- **Editor Configuration:** when this mark is set, the current editor setting are stored in a configuration file. By disabling this options, the last saved content remains valid.
- **Appearance (Position, Size, Font):** When this mark is set, the window position (loaded at start-up), command line content, and command line history settings are saved in the configuration file. By disabling this option, the previous settings remains valid.

#### NOTE

By disabling selective options only some parts of a configuration file can be written. For example when the best Assembler options are found, the save option mark can be removed. Then future save commands will not modify the options any more.

- **Save on Exit:** If this option is set, the Assembler will write the configuration on exit. No question will appear to confirm this operation. If this option is not set, the Assembler will not write the configuration at exit, even if options or another part of the configuration has changed. No confirmation will appear in any case when closing the Assembler

#### NOTE

Most settings are stored in the configuration file, but the list of recently used configurations and the settings in the Save Configuration dialog are stored in the assembler section of MCUTOOLS . INI.

### 2.3.5.2 Assembler Menu

This menu allows you to customize and set Assembler options:

- Assembler/Advanced defines the options to be activated when assembling an input file.
- Assembler/Stop Assembly immediately stops the current assembly session.

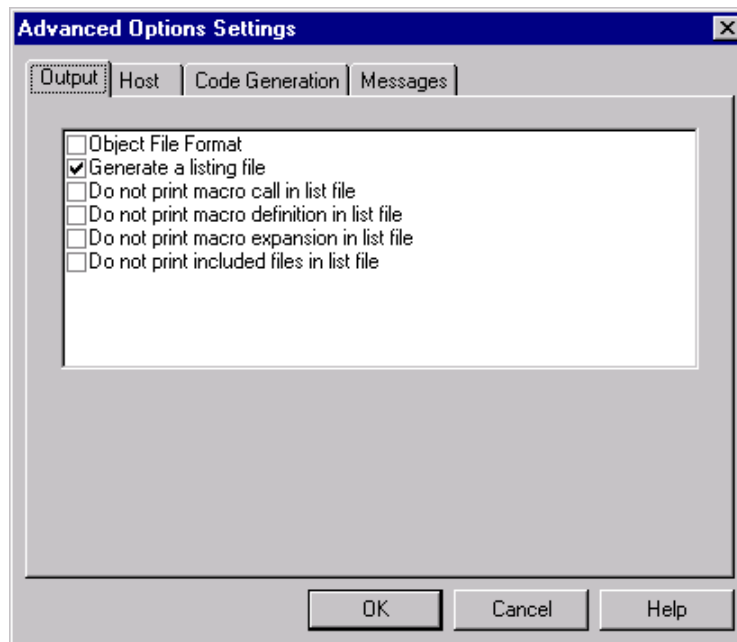
### 2.3.5.3 View Menu

This menu enables you to customize the Assembler window. You can hide or display the Status Bar and Toolbar, define the window font, and clear the window. Choose:

- View/Toolbar to hide or display the Assembler Window Toolbar
- View/Statusbar to hide or display the Assembler Window Status Bar
- View/Log... to customize the output in the Assembler Window Content Area
- View/Log.../Change Font to open a standard Font Selection box that changes the font in the Assembler Window Content Area
- View/Log.../Clear Log to clear the Assembler Window Content Area

### 2.3.6 Advanced Options Settings Dialog Box

This dialog box enables you to set/reset assembler options, as shown in the figure below:



**Figure 2-10. Advanced Options Settings Dialog Box**



The available options are arranged in different groups:

**Table 2-2. Advanced Options**

Option Group	Description
Output	Lists options related to the output files (type of files to be generated).
Input	Lists options related to the input file.
Host	Lists options related to the host.
Code Generation	Lists options related to code generation (memory models,...).
Messages	Lists options that control error message generation.

To set an assembly option, click the box to the left of the option. When you select an option that requires additional parameters, an edit box or subwindow opens and prompts you for the additional information.

The Assembler options specified in project files (using the MCUEz shell) are automatically displayed in the Advanced Options Settings dialog.

### 2.3.7 Specifying The Input File

The input file to be assembled can be specified in several ways. During the assembly session, the options will be set according to the configuration provided by the user in the Advanced Options Settings dialog box. Before assembling a file make sure you have associated a Project Directory with your assembler.

You can specify the input file through the Editable Combo box, the Assemble item in the File menu, or by using the “drag and drop” feature.

#### 2.3.7.1 Editable Combo Box

Use the Editable Combo Box in the Assembler Toolbar to:

- Assemble a new file - enter a new file name and Assembler options in the command line
- Assemble a previously assembled file - click the pull-down arrow to the right of the Editable Combo Box and choose from the list of previously assembled files that appears

To assemble the file you have indicated, select the Assemble button.

#### 2.3.7.2 File/Assemble

Choose **File/Assemble** to open a standard Open File box. Browse and select the desired file. When you click the **Open** button, the previous dialog is closed and the selected file is assembled.

### 2.3.7.3 Drag And Drop

Use the “drag and drop” feature to “drag” a file from an external source and “drop” it into the Assembler Window. A file dropped in the Assembler Window is immediately assembled unless the file has an “.ini” extension. Files with an “.ini” extension are considered configuration files and are immediately loaded, not assembled. To assemble a source file with an “.ini” extension, use the Editable Combo Box, or the Assemble item from the File Menu.

### 2.3.8 Error Feedback

After a source file has been assembled, you can view the detected errors and warnings in several ways. The error message format is:

```
'>> <FileName>, line <line number>, col <column number>, pos <absolute position in file>
<Portion of code generating the problem>
<message class> <message number>: <Message string>'
```

Example:

```
>> in "C:\DEMO\fiboerr.asm", line 76, col 20, pos 1932
    BRA label
        ^
ERROR A1104: Undeclared user defined symbol: label
```

#### 2.3.8.1 Error Feedback Using Information From The Assembler Window

Once a file has been assembled, the Assembler Window Content Area displays a list of all the errors or warnings detected. Any editor can be used to open the source file and correct errors.

#### 2.3.8.2 Error Feedback From A User-Defined Editor

The editor for Error Feedback must be configured through the MCUez Shell or the Configuration dialog box. The Error Feedback process differs from editor to editor, depending on the editor’s ability to start from a line number in the Command Line.

##### 2.3.8.2.1 Editors That Can Start With A Line Number On The Command Line

Editors like Motpad, WinEdit (v.95 or higher) or Codewright can be started with a line number in the command line. When these editors have been correctly configured, they can be activated automatically by double clicking on an error message. The configured editor will be started, the file where the error occurs is automatically opened and the cursor is placed on the line where the error was detected.



### 2.3.8.2.2 Editors That Cannot Start With A Line Number On The Command Line

Editors such as WinEdit (v.31 or lower), Notepad, and Wordpad cannot be started with a line number in the command line. When these editors have been correctly configured, they can be activated automatically by double-clicking an error message. The configured editor will be started, the file where the error occurs is automatically opened. To scroll to the position where the error was detected:

1. Activate the Assembler
2. Click the line that generated the message error (the line is highlighted on the screen)
3. Press Ctrl-C to copy the line
4. Activate the editor
5. Select Search/Find to open the Find dialog box
6. Press Ctrl-V to paste the line in the Edit box
7. Click Forward to jump to the error's position







## CHAPTER 3

### ENVIRONMENT

#### 3.1 INTRODUCTION

This part of the manual describes the environment variables used by the Assembler. Some of the environment variables are also used by other tools (e.g. Linker).

Various parameters of the Assembler may be set in an environment using environment variables. The syntax is always the same:

```
KeyName=ParamDef
```

Example:

```
GENPATH=C:\INSTALL\LIB;D:\PROJECTS\TEST
```

#### NOTE

*No* blanks are allowed before and after the “=” character in the definition of an environment variable.

These parameters may be defined in several ways:

- Using system environment variables supported by your operating system.
- Putting the definitions in a file called `DEFAULT.ENV` (`.hidefaults` for UNIX) in the default directory.
- Putting the definitions in a file set by the system environment variable `ENVIRONMENT`.

#### NOTE

The default directory can be set via environment variable `DEFAULTDIR`.

When looking for an environment variable, all programs first search the system environment, then the `DEFAULT.ENV` (`.hidefaults` for UNIX) file and finally the global environment file given by `ENVIRONMENT`. If no definition can be found, a default value is assumed.

#### NOTE

The environment may also be changed using the `-Env` Assembler option.



### 3.2 PATHS

Most environment variables contain path lists telling where to look for files. A path list is a list of directory names separated by semicolons following the syntax below:

```
PathList = DirSpec {";" DirSpec}.
DirSpec  = [{"*"}] DirectoryName.
```

Example:

```
GENPATH=C:\INSTALL\LIB;D:\PROJECTS\TESTS
```

If a directory name is preceded by an asterisk (“\*”), the programs recursively search the complete directory tree for a file, not just the given directory itself. The directories are searched in the order they appear in the path list.

Example:

```
LIBPATH=*C:\INSTALL\LIB
```

We strongly recommend working with MCUEz shell and setting the environment by means of a `DEFAULT.ENV` file in your project directory (This “`project dir.`” can be set in the MCUEz shell configure dialog box. This way, you can have different projects in different directories, each with its own environment.

Some environment variables have a synonym that may be used compatibly with older releases of the assembler.

### 3.3 LINE CONTINUATION

You can define an environment variable over different lines using the line continuation character, “\”:

```
ASMOPTIONS=\
-W2 \           is the same as:      ASMOPTIONS=-W2 -WmsgNe=10
-WmsgNe=10
```

Line Continuation may be dangerous when used with paths. The code:

```
GENPATH=. \
TEXTFILE=.\txt will result in:      GENPATH=.TEXTFILE=.\txt
```

To avoid such problems, use a semicolon, “;”, at the end of a path if there is a “\” at the end of the code line such as:

```
GENPATH=. \;
TEXTFILE=.\txt
```



### 3.4 ENVIRONMENT VARIABLES DESCRIPTIONS

The remainder of this section is devoted to describing each of the environment variables available for the Assembler. The environment variables are listed in alphabetical order and are divided into the sections described in the chart below.

Topic	Description
Synonym	For some environment variables a synonym also exists. Those synonyms may be used for older releases of the Assembler and will be removed in the future. A synonym has lower precedence than the environment variable.
Syntax	Specifies the syntax of the <a href="#">environment variable</a> in a EBNF format.
Arguments	Describes and lists optional and required arguments for the variable.
Default	Shows the default setting for the variable.
Description	Provides a detailed description of the <a href="#">environment variable</a> and how to use it.
Example	Gives an example of usage, and effects of the variable where possible. The examples show an entry in the <code>default.env</code> .
See Also	Names related sections.



### 3.4.1 ASMOPTIONS

Synonym: None

Syntax: “ASMOPTIONS=” {<option>}

Arguments: <option>: Assembler command line option

Description: If this environment variable is set, the Assembler appends its contents to its command line each time a file is assembled. It can be used to globally specify certain options that should always be set, so you don't have to specify them each time a file is assembled.

Options enumerated here must be valid assembler options and are separated by space characters.

Example: ASMOPTIONS=-W2 -L

See Also: Assembler Options chapter in this manual.

### 3.4.2 GENPATH

Synonym: HIPATH

Syntax: “GENPATH=” {<path>}

Arguments: <path>: Paths separated by semicolons, without spaces.

Description: The macro assembler will look for the source or included files first in the project directory, then in the directories listed in the environment variable GENPATH.

#### NOTE

If a directory specification in this environment variable starts with an asterisk (“\*”), the entire directory tree is searched recursively, i.e. all subdirectories and their subdirectories are searched. Within one level in the tree, search order of the subdirectories is indeterminate (not valid for Win32).

Example: GENPATH=\sources\include;...\..\headers;

See Also: None



### 3.4.3 ABSPATH

Synonym: None

Syntax: “ABSPATH=” { <path> }

Arguments: <path>: Paths separated by semicolons, without spaces.

Description: This environment variable is only relevant when absolute files are directly generated by the macro assembler instead of object files. When this environment variable is defined, the Assembler will store the absolute files it produces in the first directory specified. If ABSPATH is not set, the generated absolute files will be stored in the directory where the source file was found.

Example: `ABSPATH=\sources\bin;..\..\headers;`

See Also: None

### 3.4.4 OBJPATH

Synonym: None

Syntax: “OBJPATH=” { <path> }

Arguments: <path>: Paths separated by semicolons, without spaces.

Description: When this environment variable is defined, the assembler will store the object files it produces in the first directory specified. If OBJPATH is not set, the generated object files will be stored in the directory where the source file was found.

Example: `OBJPATH=\sources\bin;..\..\headers;`

See Also: None

### 3.4.5 TEXTPATH

Synonym: None

Syntax: “TEXTPATH=” { <path> }

Arguments: <path>: Paths separated by semicolons, without spaces.

Description: When this environment variable is defined, the assembler will store the listing files it produces in the first directory specified. If TEXTPATH is not set, the generated listing files will be stored in the directory where the source file was found.

Example: `TEXTPATH=\sources\txt;..\..\headers;`

See Also: None



### 3.4.6 SRECORD

Synonym: None

Syntax: "SRECORD=" <RecordType>

Arguments: <Record Type>: Force the type for the Motorola S record which must be generated. This parameter may take the value "S1", "S2", or "S3".

Description: This environment variable is only relevant when absolute files are directly generated by the macro assembler instead of object files. When this environment variable is defined, the Assembler will generate a Motorola S file containing records from the specified type (S1 records when S1 is specified, S2 records when S2 is specified and S3 records when S3 is specified).

When the SRECORD variable is not set, the type of S record generated will depend on the size of the target address space that is loaded. If the address space can be coded on 2 bytes, an S1 record is generated. If the address space is coded on 3 bytes, an S2 record is generated. Otherwise, an S3 record is generated.

#### NOTE

If the environment variable SRECORD is set, it is the user responsibility to specify the appropriate S record type. If you specify S1 while your code is loaded above 0xFFFF, the Motorola S file generated will not be correct, because the addresses will all be truncated to 2 byte values.

Example: SRECORD=S2

See Also: None

### 3.4.7 ERRORFILE

Synonym: None

Syntax: “ERRORFILE=” <filename>

Arguments: <filename>: File name with possible format specifiers.

Description: The environment variable ERRORFILE specifies the name for the error file (used by the Compiler or assembler).

Possible format specifiers are:

'%n': Substitute with the file name, without the path.

'%p': Substitute with the path of the source file.

'%f': Substitute with the path and name (the same as '%p%n').

In case of an illegal error file name, a notification box is shown.

Example: `ERRORFILE=MyErrors.err`

Lists all errors into the file “MyErrors.err” in the current directory.

`ERRORFILE=\tmp\errors`

Lists all errors into the file “errors” in the directory \tmp.

`ERRORFILE=%f.err`

Lists all errors into a file with the same name as the source file (with extension .err) into the same directory as the source file. For example, if you assemble a file \sources\test.asm, an error list file \sources\test.err will be generated.

`ERRORFILE=\dir1\%n.err`

Generates an error list file, file \dir1\test.err, for a source file test.asm.

`ERRORFILE=%p\errors.txt`

Generates an error list file, \dir1\dir2\errors.txt, for a source file \dir1\dir2\test.asm.

If the environment variable ERRORFILE is not set, the errors are written to the default error file. The default error file name is dependent upon how the assembler is configured and started. If a file name is provided in the assembler command line, errors are written to the EDOUT file (to the name-specified file) in the project directory. If no file name is provided, errors are written to the ERR.TXT file in the project directory.



Example: Another example shows the usage of this variable to support correct error feedback with the WinEdit Editor which looks for an error file called EDOUT:

```
Installation directory: E:\INSTALL\PROG  
Project sources: D:\MEPHISTO  
Common Sources for projects: E:\CLIB
```

```
Entry in default.env (D:\MEPHISTO\DEFAULT.ENV):  
ERRORFILE=E:\INSTALL\PROG\EDOUT
```

```
Entry in WINEDIT.INI (in Windows directory):  
OUTPUT=E:\INSTALL\PROG\EDOUT
```

See Also: None





### 3.4.8 INCLUDETIME: Creation Time In Object File

Synonym: None

Syntax: "INCLUDETIME=" ("ON" | "OFF")

Arguments: "ON": Include time information into object file.

"OFF": Do not include time information into object file.

Default: "ON"

Description: Normally each object file created contains a time stamp indicating the creation time and data as strings. So whenever a new file is created by one of the tools, the new file gets a new time stamp entry.

This behavior may be undesired if for SQA reasons a binary file compare has to be performed. Even if the informations in two object files are the same, the files do not match exactly because the time stamps are not the same. To avoid such problems this variable may be set to OFF. In this case the time stamp strings in the object file for date and time are "none" in the object file.

The time stamp may be retrieved from the object files using a decoder.

Example: INCLUDETIME=OFF

See also: Environment variable COPYRIGHT

Environment variable USERNAME

### 3.4.9 USERNAME: User Name In Object File

Synonym: None

Syntax: "USERNAME=" <user>

Arguments: <user>: Name of user.

Default: None

Description: Each object file contains an entry identifying the user who created the object file. This information may be retrieved from the object files using a decoder.

Example: USERNAME=HIWARE AG, CH-4058 Basel

See Also: Environment variable COPYRIGHT

Environment variable INCLUDETIME





## CHAPTER 4

### FILES

#### 4.1 INTRODUCTION

This chapter describes all file types associated with the MCUEz application.

#### 4.2 INPUT FILES

The Assembler accepts two forms of input files:

- Source Files
- Include Files

##### 4.2.1 Source Files

The macro assembler takes any file as input and does not require the file name to have a special extension. Source files will be searched first in the project directory and then in the GENPATH directory.

##### 4.2.2 Include File

The search for include files is governed by the environment variable GENPATH. Include files are searched first in the project directory, then in the directories given in the environment variable GENPATH. The project directory is set via MCUEz shell or the environment variable DEFAULTDIR.

#### 4.3 OUTPUT FILES

The Assembler produces six different types of output files:

- Object Files
- Absolute Files
- Motorola S Files
- Listing Files
- Debug Listing Files
- Error Listing Files

### 4.3.1 Object Files

After a successful assembling session, the Macro Assembler generates an object file containing the target code as well as some debugging information. This file is written to the directory given in the environment variable OBJPATH. If that variable contains more than one path, the object file is written in the first directory given. If this variable is not set, the object file is written in the directory the source file was found. Object files always get the extension `.o`.

### 4.3.2 Absolute Files

When an application is encoded in a single module and all the sections are absolute sections, the user can decide to generate an absolute file instead of an object file. This file is written to the directory given in the environment variable ABSPATH. If that variable contains more than one path, the absolute file is written in the first directory given. If this variable is not set, the absolute file is written in the directory the source file was found. Absolute files always get the extension `.abs`.

### 4.3.3 Motorola S Files

When an application is encoded in a single module and all the sections are absolute sections, the user can decide to generate an absolute file instead of an object file. In that case, a Motorola S record file is generated at the same time. This file can be burnt into an EPROM. It contains information stored in all READ\_ONLY sections in the application. The extension for the generated Motorola S record file depends on the setting from the variable SRECORD.

- If SRECORD = S1, the Motorola S record file gets the extension `.s1`.
- If SRECORD = S2, the Motorola S record file gets the extension `.s2`.
- If SRECORD = S3, the Motorola S record file gets the extension `.s3`.
- If SRECORD is not set, the Motorola S record file gets the extension `.sx`.

This file is written to the directory given in the environment variable ABSPATH. If that variable contains more than one path, the motorola S file is written in the first directory given. If this variable is not set, the file is written in the directory the source file was found.

### 4.3.4 Listing Files

After a successful assembling session, the Macro Assembler generates a listing file containing each assembly instruction with its associated hexadecimal code. This file is generated as soon as the option `-L` is activated, even when the macro assembler generates an absolute file. This file is written to the directory given in the environment variable TEXTPATH. If that variable contains more than one path, the listing file is written in the first directory given. If this variable is not set, the listing file is written in the directory the source file was found. Listing files always get the extension `.lst`. The Assembler Listing File chapter in this manual describes the format of this file.

### 4.3.5 Debug Listing Files

After a successful assembling session, the Macro Assembler generates a debug listing file, which will be used to debug the application. This file is always generated, even when the macro assembler generates an absolute file. The debug listing file is a duplicate of the source, where all the macros are expanded and the include files merged. This file is written to the directory given in the environment variable OBJPATH. If that variable contains more than one path, the debug listing file is written in the first directory given. If this variable is not set, the file is written in the directory the source file was found. Debug listing files always get the extension `.dbg`.

### 4.3.6 Error Listing File

If the Macro Assembler detects any errors, it does not create an object file but an error listing file. Name and location of this file depends on the settings from the environment variable ERRORFILE (also see Environment, Environment Variable ERRORFILE).

If the Macro assembler's window is open, it displays the full path of all include files read. After successful assembling, the number of code bytes generated and the number of global objects written to the object file is displayed. If an error has been detected while assembling the source file, an error listing file is generated.

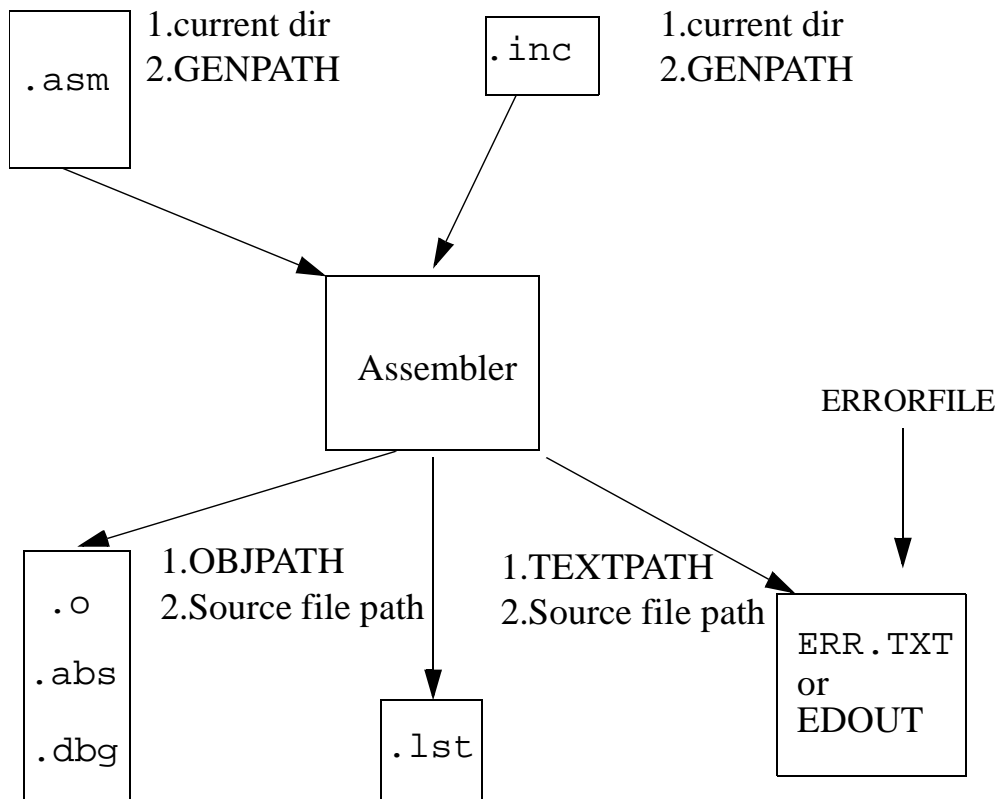


Figure 4-1. Assembler Input And Output Files





## CHAPTER 5

### ASSEMBLER OPTIONS

#### 5.1 INTRODUCTION

The Assembler offers a number of options that you can use to control the Assembler operation. Options are composed of a minus/dash, “-”, followed by one or more letters or digits. Anything not starting with a minus/dash is assumed to be the name of a source file to be assembled. Assembler options may be specified on the command line or in the ASMOPTIONS environment variable. Typically, each Assembler option is specified only once per assembling session.

#### NOTE

Arguments for an option must not exceed 128 characters.

Command line options are not case sensitive. “-Li” is the same as “-li”. To facilitate specifying several options belonging to the same group, e.g. “-LC” and “-Li”, the Assembler allows coalescing options in the same group, i.e. “-LCi” or “-LiC” instead of “-LC -Li”.

#### NOTE

It is not possible to coalesce options in different groups, e.g. “-LC -W1” cannot be abbreviated by the terms “-LC1” or “-LCW1”.

#### 5.2 ASMOPTIONS

If this environment variable is set, the Assembler appends its contents to its command line each time a file is assembled. It can be used to globally specify certain options that should always be set, so you don’t have to specify them each time a file is assembled. Assembler options are grouped as follows:


**Table 5-1. Assembler Option Groups**

Group	Description
HOST	Lists options related to the host.
OUTPUT	Lists options related to output file generation (which type of file to be generated).
INPUT	Lists options related to the input file
CODE	Lists options related to code generation (memory models, float format,...).
INPUT	Lists options related to input file processing (which type of file is processed).
MESSAGE	Lists options controlling generation of error messages.

The group corresponds to the property sheets of the graphical option settings.

Scope of each option:

**Table 5-2. Assembler Scope Groups**

Scope	Description
Application	The option has to be set for all files (Assembly Units) of an application. A typical example is an option to set the memory model. Mixing object files will have unpredictable results.
Assembly Unit	This option can be set differently for each assembling unit of an application. Mixing objects in an application is possible.
None	The option scope is not related to a specific code part. A typical example is options for the message management.

The available options are arranged into different groups, and a sheet is available for each of these groups. The content of the list box depends on the selected sheets.





### 5.3 ASSEMBLER OPTION DESCRIPTIONS

The remainder of this section describes each of the assembler options available for the assembler. The options are listed in alphabetical order and described by the following sections.

**Table 5-3. Assembler Option Details**

Topic	Description
Group	HOST, OUTPUT, CODE, INPUT, MESSAGE, or VARIOUS (options in the some of the groups cannot be selected through the Advanced Options Settings Dialog).
Scope	Application, Assembly Unit, or None.
Syntax	Specifies the syntax of the option in a EBNF format.
Arguments	Describes and lists optional and required arguments for the option.
Default	Shows the default setting for the option.
Description	Provides a detailed description of the option and how to use it.
Example	Gives an example of usage, and effects of the option where possible. Assembler settings, source code and/or Linker PRM files are displayed where applicable. The examples show an entry in the <code>default.env</code> for PC or in the <code>.hidefaults</code> for UNIX.
See Also	Related options.

### 5.3.1 -Ci

-CI: Set Case Sensivity On Label Names OFF

Group: INPUT

Scope: Assembly Unit

Syntax: "-CI" .

Arguments: None

Default: None

Description: This switches case sensitivity on label names OFF. When this option is activated, the assembler do not care about case sensitivity for label name.

This options can only be specified when the assembler generates directly absolute file (Option -FA2 must be activated).

Example: When case sensitivity on label names is switched off, the assembler will not generate any error message for following code:

```

    ORG $200
entry: NOP
    BRA Entry
  
```

The instruction 'BRA Entry' will branch on the label 'entry'. Per default, the assembler is case sensitive on label names. For the assembler the label 'Entry' and 'entry' are two distinct labels.

See also: P&E to MCUEZ Assembler Converter manual.

### 5.3.2 -Env

Set Environment Variable

Group: HOST

Scope: Assembly Unit

Syntax: "-Env" <EnvironmentVariable> "=" <VariableSetting>

Arguments: <EnvironmentVariable>: Environment variable to be set.  
<VariableSetting>: Variable setting.

Default: None

Description: Sets an environment variable.

Example: ASMOPTIONS=-EnvOBJPATH=\sources\obj

This is the same as:

```

OBJPATH=\sources\obj
in the default.env
  
```

See Also: Environment



### 5.3.3 -F2/-FA2

Object File Format

Group: OUTPUT

Scope: Application

Syntax: “-F2”/ “-FA2”).

Arguments: “-F2”: ELF/DWARF 2.0 object file format

“-FA2”: ELF/DWARF 2.0 absolute file format (default setting)

Default: -FA2

Description: Defines the format for the output file generated by the Assembler.

With the option -F2 set, the Assembler produces an ELF/DWARF object file.

With the option -FA2 set, the Assembler produces an ELF/DWARF absolute file.

Example: ASMOPTIONS=-FA2

See Also: None


**5.3.4 -H**

Short Help

Group: VARIOUS

Scope: None

Syntax: “-H”

Arguments: None

Default: None

Description: The -H option causes the Assembler to display a short list of available options.

Example: -H may produce the following list:

HOST:

-Env Set environment variable (-Env<envVar>=<value>)

OUTPUT:

- F Object File Format
  - FA2: ELF/DWARF 2.0 Absolute File
  - F2: ELF/DWARF 2.0 Object File Format
- L Generate a listing file
- Lc Do not print macro call in list file
- Ld Do not print macro definition in list file
- Le Do not print macro expansion in list file
- Li Do not print included files in list file

CODE:

- M Memory Model
  - Ms: Small Memory Model (default)

MESSAGE:

- N Show notification box in case of errors
- W1 Don't print INFORMATION messages
- W2 Don't print INFORMATION or WARNING messages
- WmsgFb Set message file format for batch mode
  - WmsgFbv: verbose format
  - WmsgFbm: Microsoft format (default)
- WmsgFi Set message format for interactive mode
  - WmsgFiv: Verbose format (default)
  - WmsgFim: Microsoft format
- WmsgNe Maximum number of errors (-WmsgNe<number>), default 50
- WmsgNi Maximum number of informations (-WmsgNi<number>), default 50
- WmsgNw Maximum number of warnings (-WmsgNw<number>), default 50
- WmsgSd Set message to disable (-WmsgSd<number>)
- WmsgSe Set message to error (-WmsgSe<number>)
- WmsgSi Set message to information (-WmsgSi<number>)
- WmsgSw Set message to warning (-WmsgSw<number>)

VARIOUS:

- H Prints this list of options
- V Prints the assembler version

See Also: None



**5.3.5 -L**

-L: Generates a Listing File

Group: OUTPUT

Scope: Assembly unit

Syntax: "-L"

Arguments: none

Default: none

Description: Switches on generation of the listing file. This listing file will have the same name as the source file, but with the extension “.LST”. The listing file contains macro definition, invocation and expansion lines as well as expanded include files.

Example: ASMOPTIONS=-L

In the following example of assembly code, the macro cpChar accept two parameters. The macro copies the value of the first parameter to the second one.

When option -L is specified, the following portion of code

```

                XDEF Start
MyData: SECTION
char1: DS.B 1
char2: DS.B 1
                INCLUDE "macro.inc"
CodeSec: SECTION
Start:
                cpChar char1, char2
                NOP
    
```

Generates following output in the assembly listing file:

```

Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.   Loc   Obj. code   Source line
-----
    1     1
    2     2
    3     3   000000   char1: DS.B 1
    4     4   000001   char2: DS.B 1
    5     5
    6     5i          INCLUDE "macro.inc"
    7     6i          cpChar: MACRO
    8     7i          LDA \1
    9     8i          STA \2
   10     9i          ENDM
   11    10i
   12     6          CodeSec: SECTION
   13     7          Start:
    
```



```
14      8                                cpChar char1, char2
15     2m 000000 C6 xxxx      +          LDA char1
16     3m 000003 C7 xxxx      +          STA char2
17      9      000006 9D                                NOP
18     10      000007 9D                                NOP
```

Content of included files, as well as macro definition, invocation and expansion are stored in the listing file. Refer to Chapter 10, “Assembler Listing File,” for detailed information.

See also: Li, Lc, Ld, Le



**5.3.6 -Lc**

-Lc: No Macro Call in Listing File

Group: OUTPUT

Scope: Assembly unit

Syntax: "-Lc"

Arguments: none

Default: none

Description: Switches on generation of the listing file, but macro invocations are not present in the listing file. The listing file contains macro definition and expansion lines as well as expanded include files.

Example: ASMOPTIONS=-Lc

In the following example of assembly code, the macro cpChar accept two parameters. The macro copies the value of the first parameter to the second one.

When option -Lc is specified, following portion of code

```

cpChar: MACRO
        LDA \1
        STA \2
        ENDM
codeSec: SECTION
Start:
        cpChar char1, char2
        NOP
        NOP
    
```

generates following output in the assembly listing file:

```

5      5      cpChar:MACRO
6      6      LDA \1
7      7      STA \2
8      8      ENDM
9      9      CodeSec:SECTION
10     10     Start:
12     6m 000000 C6 xxxx + LDA char1
13     7m 000003 C7 xxxx + STA char2
14     12 000006 9D      NOP
15     13 000007 9D      NOP
    
```

Content of included files, macro definition and expansion are stored in the list file. The source line containing the invocation of the macro is not present in the listing file. Refer to Chapter 10, "Assembler Listing File," for detailed information.

See also: L


**5.3.7 -Ld**

-Ld: No Macro Definition in Listing File

Group: OUTPUT

Scope: Assembly unit

Syntax: "-Ld"

Arguments: none

Default: none

Description: Switches on generation of the listing file, but macro definitions are not present in the listing file. The listing file contains macro invocation and expansion lines as well as expanded include files.

Example: ASMOPTIONS=-Ld

In the following example of assembly code, the macro cpChar accept two parameters. The macro copies the value of the first parameter to the second one. When option -Ld is specified, the following portion of code

```

cpChar:  MACRO
          LDA  \1
          STA  \2
        ENDM
codeSec: SECTION
Start:
        cpChar char1, char2
        NOP
        NOP
main:   BRA  main
    
```

generates following output in the assembly listing file:

```

5      5      cpChar:  MACRO
9      9      codeSec: SECTION
10     10     Start:
11     11     cpChar char1, char2
12     6m    000000 C6 xxxx  +      LDA char1
13     7m    000003 C7 xxxx  +      STA char2
14     12    000006 9D      NOP
15     13    000007 9D      NOP
    
```

Content of included files, as well as macro invocation and expansion are stored in the listing file. The source code from the macro definition is not present in the listing file. Refer to Chapter 10, "Assembler Listing File," for detailed information.

See also: L





**5.3.8 -Le**

-Le: No Macro Expansion in Listing File

Group: OUTPUT

Scope: Assembly unit

Syntax: "-Le"

Arguments: none

Default: none

Description: Switches on generation of the listing file, but macro expansions are not present in the listing file. The listing file contains macro definition and invocation lines as well as expanded include files.

Example: ASMOPTIONS=-Le

In the following example of assembly code, the macro cpChar accept two parameters. The macro copies the value of the first parameter to the second one. When option -Le is specified, the following portion of code

```

cpChar: MACRO
        LDA \1
        STA \2
        ENDM
codeSec: SECTION
Start:
        cpChar char1, char2
        NOP
        NOP
    
```

generates following output in the assembly listing file:

```

5      5      cpChar:  MACRO
6      6      LDA \1
7      7      STA \2
8      8      ENDM
9      9      CodeSec: SECTION
10     10     Start:
11     11      cpChar char1, char2
14     12     000006 9D      NOP
15     13     000007 9D      NOP
    
```

Content of included files, as well as macro definition and invocation are stored in the listing file. The macro expansion lines are not present in the listing file. Refer to Chapter 10, "Assembler Listing File," for detailed information.

See also: L



### 5.3.9 -Li

-Li: No included File in Listing File

Group: OUTPUT

Scope: Assembly unit

Syntax: "-Li"

Arguments: none

Default: none

Description: Switches on generation of the listing file, but include files are not expanded in the listing file. The listing file contains macro definition, invocation and expansion lines.

Example: ASMOPTIONS=-Li

When option -Li is specified, the following portion of code

```

        INCLUDE "macro.inc"
codeSec: SECTION
Start:
        cpChar char1, char2
        NOP
    
```

generates following output in the assembly listing file:

```

5      5                                     INCLUDE "macro.inc"
10     6                                     CodeSec: SECTION
11     7                                     Start:
12     8                                     cpChar char1, char2
13     2m 000000 C6 xxxx +                   LDA char1
14     3m 000003 C7 xxxx +                   STA char2
15     9   000006 9D                           NOP
16    10   000007 9D                           NOP
    
```

Macro definition, invocation and expansion is stored in the listing file.

See also: L



### 5.3.10 -Ms/-Mb

Memory Model

Group: CODE

Scope: Application

Syntax: “-Ms” / “-Mb”

Arguments: “-Ms”: small memory model.  
“-Mb”: banked memory model.

Default: -Ms

Description: The Assembler for the MC68HC08 supports two different memory models. Default is the small memory model, which corresponds to the normal setup, i.e. a 64kB code-address space. If you use some code memory expansion scheme, you may use banked memory model.

Example: ASMOPTIONS=-Ms

See Also: None

**5.3.11 -N**

Display Notify Box

Group: MESSAGE

Scope: Function

Syntax: “-N”

Arguments: None

Default: None

Description: Makes the Assembler display an alert box if there was an error during assembling. This is useful when running a makefile, since the Assembler waits for the user to acknowledge the message, thus suspending makefile processing. (“N” stands for “Notify”)

Example: `ASMOPTIONS=-N`

If an error occurs during assembling, a dialog box indicating that an error occurred is opened as shown below:



See Also: None

**5.3.12 -V**

Display Assembler Version

Group: VARIOUS

Scope: None

Syntax: “-V”

Arguments: None

Default: None

Description: Prints the Assembler version and the current directory. This option is useful to determine the current directory of the Assembler.

Example: -V produces the following list:

```
Directory: C:\MCUEZ\DEMO\WMMDS08A
CCPP User Interface Module, V-1.0.4, Date Jul 10 1997
Assembler Target, V-1.0.11, Date Jul 11 1997
```

See Also: None

**5.3.13 -W1**

Block Information Messages

Group: MESSAGE

Scope: Assembly Unit

Syntax: “-W1”

Arguments: None

Default: None

Description: Blocks INFORMATION messages. WARNING and ERROR messages are still active.

Example: ASMOPTIONS=-W1

See Also: None

**5.3.14 -W2**

Block Information and Warning Messages

Group: MESSAGE

Scope: Assembly Unit

Syntax: “-W2”

Arguments: None

Default: None

Description: Blocks INFORMATION and WARNING messages. Only ERROR messages are active.

Example: ASMOPTIONS=-W2

See Also: None

**5.3.15 -WmsgNe**

Number of Error Messages

Group: MESSAGE

Scope: Assembly Unit

Syntax: “-WmsgNe” <number>

Arguments: <number>: Maximum number of error messages.

Default: 50

Description: Sets the number of errors that can be encountered before the Assembler stops processing.

Example: ASMOPTIONS=-WmsgNe 2

The Assembler stops assembling after two error messages.

See Also: -WmsgNi

-WmsgNw





### 5.3.16 -WmsgNi

Number of Information Messages

Group: MESSAGE

Scope: Assembly Unit

Syntax: “-WmsgNi” <number>

Arguments: <number>: Maximum number of information messages.

Default: 50

Description: Sets the maximum number of information messages to be logged.

Example: ASMOPTIONS=-WmsgNi 10

Only ten information messages can be logged.

See Also: -WmsgNe

-WmsgNw

**5.3.17 -WmsgNw**

Number of Warning Messages

Group: ASSEMBLY

Scope: Assembly Unit

Syntax: “-WmsgNw” <number>

Arguments: <number>: Maximum number of warning messages.

Default: 50

Description: Sets the maximum number of warning messages to be logged.

Example: ASMOPTIONS=-WmsgNw15

Only 15 warning messages can be logged.

See Also: -WmsgNe

-WmsgNi

### 5.3.18 -WmsgFbv/ -WmsgFbm

Set message file format for batch mode

Group: MESSAGE

Scope: Assembly Unit

Syntax: “-WmsgFbv”/ “-WmsgFbm”]

Arguments: “-WmsgFbv”: Verbose format.

“-WmsgFbm”: Microsoft format.

Default: -WmsgFbm

Description: The Assembler can be started with additional arguments (e.g. files to be assembled together with Assembler options). If the Assembler has been started with arguments (e.g. from the Make Tool or with the ‘%f’ argument from WinEdit), the Assembler assembles the files in a batch mode, that is no Assembler window is visible and the Assembler terminates after job completion.

If the assembler is in batch mode the assembler messages are written to a file instead to the screen. This file only contains the assembler messages. By default, the Assembler uses a Microsoft message format to write the Assembler messages (errors, warnings, information messages) if the assembler is in batch mode.

With this option, the default format may be changed from the Microsoft format to a more verbose error format with line, column, and source information.

Example:

```
var1:      equ    5
var2:      equ    5
    if (var1=var2)
        nop
    endif
endif
```

By default, the Assembler generates following error output in the Assembler window if it is running in batch mode:

```
X:\TW2.ASM(12):ERROR: conditional else not allowed here
```

Setting the format to verbose, more information is stored in the file:

```
ASMOPTIONS=-WmsgFbv
>> in "X:\TW2.ASM", line 12, col 0, pos 215
    endif
    endif
    ^
ERROR A1001: Conditional else not allowed here
```

See Also: -WmsgFi

### 5.3.19 -WmsgFiv/-WmsgFim

-WmsgFi: Set message file format for Interactive mode

Group: MESSAGE

Scope: Assembly Unit

Syntax: “-WmsgFiv” / “-WmsgFim”

Arguments: “-WmsgFiv”: Verbose format  
 “-WmsgFim”: Microsoft format

Default: -WmsgFiv

Description: If the Assembler is started without additional arguments (e.g. files to be assembled together with Assembler options), the Assembler is in the interactive mode (that is, a window is visible). By default, the Assembler uses the verbose errorfileformat to write the Assemble messages (errors, warnings, information messages). With this option, the default format may be changed from the verbose format (with source, line and column information) to the Microsoft format (only line information).

Example:

```
var1:      equ    5
var2:      equ    5
    if (var1=var2)
        nop
    endif
    endif
```

By default, the Assembler following error output in the Assembler window if it is running in interactive mode

```
>> in "X:\TWE.ASM", line 12, col 0, pos 215
    endif
    endif
^
```

ERROR A1001: Conditional else not allowed here

Setting the format to Microsoft, less information is displayed:

```
ASMOPTIONS=-WmsgFim
X:\TWE.ASM(12): ERROR: conditional else not allowed here
```

See Also: -WmsgFb



## CHAPTER 6

### SECTIONS

#### 6.1 INTRODUCTION

Sections are portions of code or data which cannot be split into smaller elements. Each section has a name, type, and attributes. Each assembly source file contains at least one section.

The number of sections in an assembly source file is limited only by the amount of available system memory available during assembly. If several sections with the same name are detected inside a single source file, the code is concatenated into one large section.

Sections that have the same name but come from different modules are combined into a single section when linked.

#### 6.2 SECTION ATTRIBUTE

According to content, an attribute is associated with each section. A section may be a:

- Data section
- Constant data section
- Code section

##### 6.2.1 Data Sections

A section containing variables (variable defined using the DS directive) is considered to be a data section. Data sections are always allocated in the target processor RAM area.

Empty sections, which do not contain any code or data declaration are also considered to be data sections.

##### 6.2.2 Constant Data Sections

A section containing only constant data definitions (variables defined using the DC or DCB directives) is considered to be a constant section. Constant sections should be allocated in the target processor ROM area, otherwise they cannot be initialized at application loading time.

We strongly recommend that you define separate sections for the definition of variables and constant variables. This will avoid any problems in the initialization of constant variables.



### 6.2.3 Code Sections

A section containing at least an instruction is considered to be a code section. Code sections are always allocated in the target processor ROM area.

Code sections should not contain any variable definition (variable defined using the DS directive). You will not have write access on variables defined in a code section. Additionally, these variables cannot be displayed in the debugger as data.

## 6.3 SECTION TYPE

First a programmer should decide whether he wants to use relocatable or absolute code in his application. The Assembler allows you to mix absolute and relocatable sections in a single application and also in a single source file. The main difference between absolute and relocatable sections is the way symbol addresses are determined.

### 6.3.1 Absolute Sections

Start address from an absolute section is well known at assembly time. An absolute section is defined through the directive ORG. The operand specified in the ORG directive determines the start address of the absolute section.

```

        XDEF entry
        ORG $040      ; Absolute constant data section.
cst1: DC.B    $26
cst2: DC.B    $BC
...
        ORG $080      ; Absolute data section.
var:  DS.B    1

        ORG $C00      ; Absolute code section.
entry:
        LDA  cst1      ; Load value in cst1
        ADD  cst2      ; Add value in cst2
        STA  var       ; Store in var
        BRA  entry
    
```

In the previous example, two bytes of storage are allocated starting at address \$040. Symbol “cst1” will be allocated at address \$040 and “cst2” will be allocated at address \$041. All subsequent instructions or data allocation directives will be located in the absolute section until another section is specified using the ORG or SECTION directive.

When using absolute sections, it is the user responsibility to ensure that there is no overlap between the different absolute sections defined in the application. In the previous example, the programmer should ensure that the size of the section starting at address \$040 is not bigger than \$40 bytes, otherwise the section starting at \$040 and section starting at \$080 will overlap.



When object files are generated, applications containing only absolute sections must be linked. In that case, there should not be any overlap between the address ranges from the absolute sections defined in the assembly file and the address ranges defined in the linker parameter file.

The PRM file used to link the example above, is defined as follows:

```
LINK test.abs /* Name of the executable file generated. */
NAMES
    test.o      /* Name of the object files in the application. */
END
SEGMENTS
/* READ_ONLY memory area. There should be no overlap between this
   memory area and the absolute sections defined in the assembly
   source file. */
MY_ROM = READ_ONLY 0x1000 TO 0x1FFF;
/* READ_WRITE memory area. There should be no overlap between this
   memory area and the absolute sections defined in the assembly
   source file. */
MY_RAM = READ_WRITE 0x2000 TO 0x2FFF;
END
PLACEMENT
/* Relocatable variable sections are allocated in MY_RAM. */
.data INTO MY_RAM;
/*Relocatable code and constant sections are allocated in MY_ROM. */
.text INTO MY_ROM;
END
INIT entry /* Application entry point. */
VECTOR ADDRESS 0xFFFFE entry /* initialization of the reset vector.
*/
```



The linker PRM file contains at least:

- The name of the absolute file (command LINK)
- The name of the object file which should be linked (command NAMES)
- The specification of a memory area where the sections containing variables must be allocated and at least the predefined section, “.data”, must be placed (command SEGMENTS and PLACEMENT)
- The specification of a memory area where the sections containing code or constants must be allocated and at least the predefined section, “.text”, must be placed (command SEGMENTS and PLACEMENT)
- The specification of the application entry point (command INIT)
- The definition of the reset vector (command VECTOR ADDRESS)

For applications containing only absolute sections, nothing will be allocated.

### 6.3.2 Relocatable Sections

Start address from a relocatable section is evaluated at linking time, according to the information stored in the linker parameter file. A relocatable section is defined through the directive SECTION.

```

                XDEF entry
constSec: SECTION      ; Relocatable constant data section.
cst1:      DC.B $A6
cst2:      DC.B $BC
...
dataSec:   SECTION      ; Relocatable data section.
var:       DS.B 1

codeSec:   SECTION      ; Relocatable code section.
entry:
    LDA  cst1  ; Load value in cst1
    ADD  cst2  ; Add value in cst2
    STA  var   ; Store in var
    BRA  entry
    
```

In the previous example, two bytes of storage are allocated in section “constSec”. Symbol “cst1” will be allocated at offset 0 and “cst2” at offset 1 from the beginning of the section. All subsequent instructions or data allocation directives will be located in the relocatable section “constSec” until another section is specified using the ORG or SECTION directive.





When using relocatable sections, the user does not need to care about overlapping sections. The linker will assign a start address to each section according to the input from the linker parameter file.

The customer can decide to define only one memory area for the code and constant sections and another one for the variable sections or to split sections over several memory areas. When all constant and code sections as well as data sections can be allocated consecutively, the PRM file used to assemble the example above, can be defined as follows:

```
LINK test.abs /*Name of the executable file generated. */
NAMES
    test.o      /*Name of the object files in the application. */
END
SEGMENTS
/* READ_ONLY memory area. */
    MY_ROM = READ_ONLY 0x0B00 TO 0x0BFF;
/* READ_WRITE memory area. */
    MY_RAM = READ_WRITE 0x0080 TO 0x008F;
END
PLACEMENT
/* Relocatable variable sections are allocated in MY_RAM. */
    .data      INTO MY_RAM;
/*Relocatable code and constant sections are allocated in
MY_ROM. */
    .text      INTO MY_ROM;
END
INIT entry          /* Application entry point. */
VECTOR ADDRESS 0xFFFFE entry /* initialization of the reset
vector. */
```

According to the PRM file above:

- The section “dataSec” will be allocated starting at 0x080
- The section “constSec” will be allocated starting at 0x0B00
- The section “codeSec” will be allocated next to the section “constSec”

When the constant, code, and data sections cannot be allocated consecutively, the PRM file used to link the example above, can be defined as follows:

```
LINK test.abs /* Name of the executable file generated. */
NAMES
    test.o /* Name of the object files in the application. */
END
SEGMENTS
    ROM_AREA_1= READ_ONLY 0xB00 TO 0xB7F; /*READ_ONLY memory area. */
    ROM_AREA_2= READ_ONLY 0xC00 TO 0xC7F; /*READ_ONLY memory area. */
    RAM_AREA_1= READ_WRITE 0x800 TO 0x87F; /*READ_WRITE memory area.*/
    RAM_AREA_2= READ_WRITE 0x900 TO 0x97F; /*READ_WRITE memory area.*/
END
PLACEMENT
/*Relocatable variable sections are allocated in MY_RAM. */
    dataSec INTO RAM_AREA_2;
    .data INTO RAM_AREA_1;
/*Relocatable code and constant sections are allocated in MY_ROM. */
    constSec INTO ROM_AREA_2;
    codeSec, .text INTO ROM_AREA_1;
END
INIT entry /* Application entry point. */
VECTOR ADDRESS 0xFFFFE entry /*initialization of the reset vector. */
```

According to the PRM file above:

- The section “dataSec” will be allocated starting at 0x0900
- The section “constsec” will be allocated starting at 0x0C00
- The section “codeSec” will be allocated starting at 0x0B00

### 6.3.3 Relocatable Versus Absolute Section

Generally we recommend developing an application using relocatable sections. Relocatable sections offer several advantages.

#### 6.3.3.1 Early Development

The application can be developed before the application memory map is known. Often the definitive application memoy map can only be determined once the size required for code and data can be evaluated. The size required for code or data can only be quantified once the major part of the application is implemented. When absolute sections are used, defining the definitive memory map is an iterative process of mapping and remapping the code. The assembly files must be edited, assembled and linked several times. When relocatable sections are used, this can be achieved by editing the PRM file and linking the application.



### 6.3.3.2 Enhanced Portability

As the memory map is not the same for all derivatives (MCU), using relocatable sections allow you to easily port the code for another MCU. When porting relocatable code to another target you only need to link the application again, with the appropriate memory map.

### 6.3.3.3 Tracking Overlaps

When using absolute sections, the programmer must ensure there is no overlap between sections. When using relocatable sections, the programmer does not need to be concerned about sections overlapping. The labels' offsets are all evaluated relative to the beginning of the section. Absolute addresses are then determined and assigned by the linker.

### 6.3.3.4 Reusability

When using relocatable sections, code implemented to handle a specific I/O device (serial communication device), can be reused in another application without any modification.





## CHAPTER 7

### ASSEMBLER SYNTAX

#### 7.1 INTRODUCTION

An assembler source program is a sequence of source statements. Each source statement is coded on one line of text and can be a:

- Comment line
- Source line

##### 7.1.1 Comment Line

A comment can occupy an entire line to explain the purpose and usage of a block of statements or to describe an algorithm. A comment line contains a semicolon followed by text. Comments are included in the assembly listing, but are not significant to the assembler.

An empty line is also considered to be a comment line.

Example:

```
; This is a comment line
```

##### 7.1.2 Source Line

Each source statement includes one or more of the following four fields:

- A label
- An operation field
- One or several operands
- A comment

Characters on the source line may be upper or lower case. Directives and instructions are case insensitive. Symbols are case-sensitive *except when the Ci*, an option specifying case-insensitivity for label names, is activated.

##### 7.1.3 Label Field

The label field is the first field in a source line. A label is a symbol followed by a colon. Labels can include letters, underscores, periods, and numbers. The first character must not be a number.



Labels are required on assembler directives that define the value of a symbol (SET or EQU). For these directives, labels are assigned the value corresponding to the expression in the operand field.

Labels specified in front of another directive, instruction or comment are assigned the value of the location counter in the current section.

**NOTE**

When the macro assembler expands a macro it generates internal symbols starting with an “\_”. Therefore, to avoid potential conflicts, user defined symbols should not begin with an underscore.

**NOTE**

For the macro assembler, a .B at the end of a label means “byte” and a .W at the end of a label means “word”. Therefore, to avoid potential conflicts, user defined symbols should not end with .B or .W.

### 7.1.4 Operation Field

The operation field follows the label field and is separated from it by a white space. The operation field must not begin in the first column. An entry in the operation field is one of the following:

- An instruction mnemonic
- A directive name
- A macro name

#### 7.1.4.1 Instruction

Executable instructions for the M68HC08 processor are defined in *CPU08 Reference Manual*, document number CPU08RM/AD.

#### 7.1.4.2 Directive

Assembler directives are described in the Assembler Directives chapter in this manual.

#### 7.1.4.3 Macro Name

A user-defined macro can be invoked in the assembler source program. This results in the expansion of the code defined in the macro. Defining and using macros are described in the Macros chapter in this manual.

### 7.1.5 Operand Field

The operand fields, when present, follows the operation field and is separated from it by a white space. When two or more operand subfields appear within a statement, a comma must separate them. The following addressing mode notations are allowed in the operand field:

**Table 7-1. Addressing Mode Notations**

Addressing Mode	Notation
Inherent	No operands
Direct	<8-bit address>
Extended	<16-bit address>
Relative	<PC relative offset>
Immediate	#<expression>
Indexed, no offset	,X
Indexed, 8-bit offset	<8-bit offset>,X
Indexed, 16-bit offset	<16-bit offset>,X
Stack pointer, 8-bit offset	<8-bit offset>,SP
Stack pointer, 16-bit offset	<16-bit offset>,SP
Memory to memory immediate to direct	#<expression>,<8-bit address>
Memory to memory direct to direct	<8-bit address>,<8-bit address>
Memory to memory indexed to direct with post-increment	X+,<8-bit address>

#### 7.1.5.1 Inherent

Instructions using this addressing mode don't have any instruction fetch associated. Some of them are acting on data in the CPU registers.

Example:

CLRA

DAA



### 7.1.5.2 Immediate

The opcode contains the value to use with the instruction rather than the address of this value. The “#” character is used to indicate an immediate addressing mode operand.

Example:

```

                XDEF Entry
initStack: EQU $0400

MyData:      SECTION
data:        DS.B 1

MyCode:      SECTION
Entry:
                LDHX #initStack ; init Stack Pointer
                TXS           ; with value $400-1 = $03FF

main:        LDA #$50
                BRA main
    
```

Hex value \$0400 is loaded in register HX and the decimal value \$50 is loaded in register A.

The immediate addressing mode can also be used to refer to the address of a symbol.

#### Example

```

                ORG $80
var1:          DC.B $45, $67
                ORG $800

main:
                LDX #var1
                BRA main
    
```

In this example, the address of the variable ‘var1’ (\$80) is loaded in register X. One very common programming error is to omit the # character. This cause the assembler to misinterpret the expression as an address rather than an explicit data.

#### Example

```
LDA $60
```

means load accumulator A with the value stored at address \$60.





### 7.1.5.3 Direct

The direct addressing mode is used to address operands in the direct page of the memory (location \$0000 to \$00FF). Access on this memory range (also called zero page) are faster and require less code than the extended addressing mode (see below). In order to speed up his application a programmer can decide to place the most commonly accessed data in this area of memory. For most of the direct instructions, only two bytes are required: the first byte is the opcode and the second byte is the operand address located in page zero.

Example:

```

                XDEF Entry
initStack: EQU $0400
MyData:      SECTION SHORT
data:        DS.B 1
MyCode:      SECTION
Entry:
                LDHX #initStack ; init Stack Pointer
                TXS             ; with value $400-1 = $03FF
main:         LDA #$55
                STA data
                BRA main

```

In this example, the value \$55 is stored in the variable data, which is located on the direct page. The section MyData must be allocated in the direct page in the linker parameter file.



#### 7.1.5.4 Extended

The extended addressing mode is used to access memory location located above the direct page in a 64-Kilobyte memory map. For the extended instructions, three bytes are required: the first byte is the opcode and the second and the third bytes are the most and least significant bytes of the operand address.

Example:

```

                XDEF Entry
initStack: EQU $0400
                ORG $B00
data:         DS.B 1
MyCode:      SECTION
Entry:
                LDHX #initStack ; init Stack Pointer
                TXS             ; with value $400-1 = $03FF
main:         LDA #$55
                STA data
                BRA main
    
```

In this example, the value \$55 is stored in the variable data. This variable is located at address \$0B00 in the memory map. The opcode of the instruction STA data is three bytes long.

#### 7.1.5.5 Indexed, No Offset

This addressing mode is used to access data with variable addresses through the index register HX of the HC08 controller. The index register X contains the least significant byte of the operand while index register H contains the most significant byte. Indexed, no offset instructions are one byte long.

Example:

```

...
Entry:
    ...
    LDHX #$0FFE
    STA    ,X
    ...
    JMP    ,X
    ...
    
```

The value stored in accumulator A is stored at the memory address pointed to by the index register X (\$0FFE). The JMP instruction causes the program to jump to the address pointed to by the HX register.



### 7.1.5.6 Indexed, 8-Bit Offset

This addressing mode is useful when selecting the kth element in an n-element table. The size of the table is limited to 256 bytes. Indexed, 8-bit offset instructions are two bytes long. The first byte contains the index register offset byte.

Example:

```

                XDEF Entry
initStack: EQU $0400
MyData:      SECTION SHORT
data:        DS.B 8
MyCode:      SECTION
Entry:

                LDHX #initStack ; init Stack Pointer
                TXS              ; with value $400-1 = $03FF

main:

                LDHX #data
                STA    5 ,X
                ...
                JMP    $FF,X

                ...
    
```

The value stored in accumulator A is stored at the memory address pointed to by the index register X + 5. The JMP instruction causes the program to jump to the address pointed to by the HX register + \$FF.



### 7.1.5.7 Indexed, 16-Bit Offset

This addressing mode is useful when selecting the kth element in an n-element table. The size of the table is limited to \$FFFF bytes. Indexed, 16-bit offset instructions are three bytes long. The first byte contains the opcode and the second and the third the high and low index register offset bytes.

Example:

```

                XDEF Entry
initStack: EQU $0400
MyData:      SECTION
data:        DS.B 8
MyCode:      SECTION
Entry:
                LDHX #initStack ; init Stack Pointer
                TXS              ; with value $400-1 = $03FF

main:
                LDHX #data
                STA    $500 ,X
                ...
                JMP   $1000,X
                ...
    
```

The value stored in accumulator A is stored at the memory address pointed to by the index register X + 500 . The JMP instruction causes the program to jump to the address pointed to by the HX register + \$1000.

### 7.1.5.8 Relative

This addressing mode is used by all branch instructions to determine the destination address. The signed byte following the opcode is added to the contents of the program counter.

As the offset is coded on a signed byte, the branching range is -127 to +128. The destination address of the branch instruction must be in this range.

Example:

```

main:
    NOP
    NOP
    BRA main
    
```



### 7.1.5.9 Stack Pointer, 8-Bit Offset

Stack Pointer, 8-bit offset instructions behave the same way than Indexed 8-bit offset instructions, except that the offset is added to the Stack Pointer SP in place of the Index register HX.

This addressing mode allow easy access of the data on the stack. If the interrupts are disabled, the Stack pointer can also be used as a second Index register.

In this example stack pointer, 8-bit offset mode is used to store the value \$40 in memory location \$54F.

Example:

```
entry:
    LDHX #$0500    ; init HX with $500
    TXS           ; Stack Pointer = HX-1 = $4FF

    LDA #$40
    STA $50, SP   ; Location $54F = $40
```

### 7.1.5.10 Stack Pointer, 16-Bit Offset

Stack Pointer, 16-bit offset instructions behave the same way than Indexed, 16-bit offset instructions, except that the offset is added to the Stack Pointer SP in place of the Index register HX. This addressing mode allow easy access of the data on the stack. If the interrupts are disabled, the Stack pointer can also be used as a second Index register.

In this example, stack pointer, 16-bit offset mode is used to store the value in memory location \$5FF in accumulator A.

Example:

```
entry:
    LDHX #$0100    ; init HX with $100
    TXS           ; Stack Pointer = HX-1 = $0FF

    LDA $0500, SP ; Content of memory location $05FF is loaded in A
```



### 7.1.5.11 Memory To Memory Immediate To Direct

This addressing mode is generally used to initialize variables and registers in page zero. The register A is not affected.

Example:

```
MyData: EQU $50
entry:
    MOV #20, MyData
```

The instruction `MOV #20, MyData` stores the value \$20 in memory location \$50 “MyData”.

### 7.1.5.12 Memory To Memory Direct To Direct

This addressing mode is generally used to transfer variables and registers in page zero. The register A is not affected.

Example:

```
MyData1: EQU $50
MyData2: EQU $51
entry:
    MOV #10, MyData1
    MOV MyData1, MyData2
```

The instruction `MOV #10, MyData1` stores the value \$10 in memory location \$50 “MyData1” using the memory to memory Immediate to Direct addressing mode. The `MOV MyData1, MyData2` instruction moves the content of MyData1 into MyData2 using memory to memory Direct to Direct addressing mode. The content of MyData2 (memory location \$51) is then \$10.



### 7.1.5.13 Memory To Memory Indexed To Direct With Post Increment

This addressing mode is generally used to transfer tables addressed by the index register to a register in page zero.

The operand addressed by index register HX is stored in the direct page location addressed by the byte following the opcode. The index register HX is automatically incremented. The register A is not affected.

Example:

```

                XDEF Entry

ConstSCT: SECTION
Const:        DC.B 1,11,21,31,192,12,0

DataSCT: SECTION SHORT
MyReg:        DS.B 1

CodeSCT: SECTION
Entry:        LDHX  #00FF
                TXS

main:

                LDHX #Const
LOOP:         MOV X+, MyReg
                BEQ main
                BRA LOOP
    
```

In this example, the table `Const` contains 7 bytes defined in a constant section in ROM. The last value of this table is zero. The register HX is initialised with the address of `Const`. All the values of this table are stored one after another in page zero memory location `MyReg` using the instruction `MOV X+, MyReg`. When the value 0 is encountered, the register HX is reset with the address of the first element of the table `#Const`.



### 7.1.5.14 Memory To Memory Direct To Indexed With Post Increment

This addressing mode is generally used to fill tables addressed by the index register from registers in page zero. The operand in the direct page location addressed by the byte following the opcode is stored in the memory location pointed to by the index register HX. The index register HX is automatically incremented. The register A is not affected.

Example:

```

                XDEF  entry
MyData:        SECTION SHORT
MyReg1:        DS.B  1
MyReg2:        DS.B  1
MyCode:        SECTION
entry:
                LDA   #$02
                STA   MyReg1
                INCA
                STA   MyReg2

                LDHX  #$1000
                MOV   MyReg1,X+
                MOV   MyReg2,X+
main:          BRA   main
    
```

The page zero memory location MyReg1 and MyReg2 are first respectively initialized with \$02 and \$03. The contents of those data are then written in memory location \$1000 and \$1001. The HX register points to memory location \$1002.





### 7.1.5.15 Indexed With Post Increment

The operand is addressed then the HX register is incremented. This addressing mode is useful for searches in tables. It is only used with instruction CBEQ.

Using this addressing mode, it is possible to scan the memory to find a location containing a specific value.

Example:

```

                XDEF Entry
                ORG $F000
data:          DC.B 1,11,21,31,$C0,12
CodeSCT:      SECTION
Entry:        LDHX  #$00FF
                TXS
main:
                LDA   #$C0

                LDHX #data
LOOP:         CBEQ  X+, IS_EQUAL  ;

                BRA   LOOP
IS_EQUAL:    ...

```

The value located at memory location pointed to by HX is compared to the value in register A. If the two values match, program branch to IS\_EQUAL. HX points to memory location next to the one containing the searched value.

In this example, the value \$C0 is searched starting at memory location \$F000. This value is found at memory location \$F004, the program branch to IS\_EQUAL and the register HX contains \$F005.



### 7.1.5.16 Indexed, 8-bit Offset With Post Increment

The address of the operand is the 8-bit offset added to the value in register HX. The operand is addressed then the HX register is incremented. This addressing mode is useful for searches in tables. It is only used with instruction CBEQ.

Using this addressing mode, it is possible to scan the memory to find a location containing a specific value starting at a specified location to which is added an offset.

Example:

```

        XDEF Entry
        ORG $F000
data:   DCB.B  $40,$00
        DC.B  1,11,21,31,$C0,12 ; $C0 is located at $F000+$40+4
CodeSCT: SECTION
Entry:  LDHX  # $00FF
        TXS
main:
        LDA  # $C0
        LDHX #data
LOOP:   CBEQ  $30,X+,IS_EQUAL ;
        BRA  LOOP
IS_EQUAL: ...
    
```

The value located at memory location pointed to by  $HX + \$30$  is compared to the value in register A. If the two values match, program branch to IS\_EQUAL. HX points to memory location next to the one containing the searched value.

In this example, the value \$C0 is searched starting at memory location  $\$F000 + \$30 = \$F030$ . This value is found at memory location \$F044, the program branch to IS\_EQUAL. The register HX contains the memory location of the searched value minus the offset, incremented by one:  $\$F044 - \$30 + 1 = \$F015$ .

### 7.1.5.17 Comment Field

The last field in a source statement is an optional comment field. A semicolon, “;”, is the first character in the comment field.

Example:

```
NOP ; Comment following an instruction
```



## 7.2 SYMBOLS

The following sections describe symbols used by the assembler.

### 7.2.1 User Defined Symbols

Symbols identify memory locations in program or data sections in an assembly module. A symbol has two attributes:

- The section, in which the memory location is defined
- The offset from the beginning of that section

Symbols can be defined with an absolute or relocatable value, depending on the section in which the labeled memory location is found. If the memory location is located within a relocatable section (defined with the SECTION directive), the label has a relocatable value relative to the section start address.

Symbols can be defined relocatable in the label field of an instruction or data definition source line.

```
Sec: SECTION
label1: DC.B 2 ; label1 is assigned offset 0 within Sec.
label2: DC.B 5 ; label2 is assigned offset 2 within Sec
label3: DC.B 1 ; label3 is assigned offset 7 within Sec
```

It is also possible to define a label with either an absolute or a previously defined relocatable value, using a SET or EQU directives.

Symbols with absolute values must be defined with constant expressions.

```
Sec: SECTION
label1: DC.B 2 ; label1 is assigned offset 0 within Sec.
label2: EQU 5 ; label2 is assigned value 5.
label3: EQU label1 ; label3 is assigned address of label1.
```

### 7.2.2 External Symbols

A symbol can be made external using the XDEF directive. In another source file an XREF or XREFB directive may reference it. Since its address is unknown in the referencing file, it is considered to be relocatable.

```
XREF extLabel ; symbol defined in an other module.
                ; extLabel is imported in the current module
XDEF label ; symbol is made external for other modules
                ; label is exported from the current module

constSec: SECTION
label: DC.W 1, extLabel
```

### 7.2.3 Undefined Symbols

If a label is neither defined in the source file nor declared external using XREF or XREFB, the assembler considers it to be undefined and generates an error.

```
codeSec: SECTION
entry:
    NOP
    BNE  entry
    NOP
    JMP  end
    JMP  label  <- Undeclared user defined symbol : label
end:RTS
    END
```

### 7.2.4 Reserved Symbols

Reserved symbols cannot be used for user defined symbols. Register names are reserved identifiers. The reserved identifiers for the HC08 microcontroller are:

A, B,CCR, H, X, SP

Additionally, the keyword LOW and HIGH are also reserved identifiers. They refer to the low and high byte of any specified memory location.

## 7.3 CONSTANTS

The assembler supports integer and ASCII string constants.

### 7.3.1 Integer Constants

The assembler supports four representations of integer constants:

- A decimal constant is defined by a sequence of decimal digits (0-9)  
Example: 5, 512, 1024
- A hexadecimal constant is defined by a dollar character, “\$”, followed by a sequence of hexadecimal digits (0-9, a-f, A-F)  
Example: \$5, \$200, \$400
- An octal constant is defined by the “at” character, “@)”, followed by a sequence of octal digits (0-7)  
Example: @5, @1000, @2000
- A binary constant is defined by a percent character, “%”, followed by a sequence of binary digits (0-1).  
Example: %101, %1000000000, %100000000000



The default base for integer constants is initially decimal, but it can be changed using the BASE directive. When the default base is not decimal, decimal values cannot be represented, because they do not have a prefix character.

### 7.3.2 String Constants

A string constant is a series of printable characters enclosed in single, `'`, or double quotes, `"`. Double quotes are only allowed within strings delimited by single quotes. Single quotes are only allowed within strings delimited by double quotes.

Example: `'ABCD'`, `"ABCD"`, `'A'`, `"'B"`, `"A'B"`, `'A"B'`

### 7.3.3 Floating-Point Constants

The macro assembler does not support floating-point constants.

## 7.4 OPERATORS

This section describes the operators that the Assembler recognizes.

### 7.4.1 Addition And Subtraction Operators (Binary)

Syntax:

```
Addition:    <operand> + <operand>
Subtraction:  <operand> - <operand>
```

Description:

The `+` operator adds two operands, whereas the `-` operator subtracts them. The operands can be any expression evaluating to an absolute or relocatable expression. Note that addition between two relocatable operands is not allowed.

Example:

```
$A3216 + $42 ; Addition of two absolute operands ( = $A3258).
label - $10  ; Subtraction with value of 'label'
```

### 7.4.2 Multiplication, Division And Modulo Operators (Binary)

Syntax:

```
Multiplication: <operand> * <operand>
Division:       <operand> / <operand>
Modulo:        <operand> % <operand>
```

Description:

The `*` operator multiplies two operands, the `/` operator performs an integer division of the two operands and returns the quotient of the operation. The `%` operator performs an integer division of the two operands and returns the remainder of the operation.



The operands can be any expression evaluating to an absolute expression. The second operand in a division or modulo operation cannot be zero.

Example:

```

23 * 4      ; multiplication ( = 92)
23 / 4      ; division ( = 5)
23 % 4      ; remainder( = 3)
    
```

### 7.4.3 Sign Operators (Unary)

Syntax:

```

Plus:      +<operand>
Minus:     -<operand>
    
```

Description:

The + operator does not change the operand, whereas the – operator changes the operand to its two complement. These operators are only valid for absolute expression operands.

Example:

```

+$32      ; ( = $32)
-$32      ; ( = $CE = -$32)
    
```

### 7.4.4 Shift Operators (Binary)

Syntax:

```

Shift left: <operand> << <count>
Shift right: <operand> >> <count>
    
```

Description:

The << operator shifts left operand left by the number of bytes specified in the count. The >> operator shifts left operand right by the number of bytes specified in the count. The operands can be any expression evaluating to an absolute expression.

Example:

```

$25 << 2    ; shift left ( = $94)
$A5 >> 3    ; shift right( = $14)
    
```

### 7.4.5 Bitwise Operators (Binary)

Syntax:

```

Bitwise AND:      <operand> & <operand>
Bitwise OR:       <operand> | <operand>
Bitwise XOR:      <operand> ^ <operand>
    
```



Description:

The `&` operator performs an AND between the two operands at the bit level.

The `|` operator performs an OR between the two operands at the bit level.

The `^` operator performs a XOR between the two operands at the bit level.

The operands can be any expression evaluating to an absolute expression.

Example:

```

$E & 3      ; = $2 (%1110 & %0011 = %0010)
$E | 3      ; = $F (%1110 | %0011 = %1111)
$E ^ 3      ; = $D (%1110 ^ %0011 = %1101)
    
```

#### 7.4.6 Bitwise Operators (Unary)

Syntax:

One's complement: `~<operand>`

Description:

The `~` operator evaluates the one's complement of the operand.

The operand can be any expression evaluating to an absolute expression.

Example:

```

~$C ; = $FFFFFFF3 (~%00000000 00000000 00000000 00001100
                  =%11111111 11111111 11111111 11110011)
    
```

#### 7.4.7 Logical Operators (Unary)

Syntax:

Logical NOT: `!<operand>`

Description:

The `!` operator returns 1 (true) if the operand is 0, otherwise it returns 0 (false).

The operand can be any expression evaluating to an absolute expression.

Example:

```

!(8<5)      ; = $1 (TRUE)
    
```



### 7.4.8 Relational Operators (Binary)

Syntax:

```

Equal:    <operand> = <operand>
          <operand> == <operand>
Not equal:    <operand> != <operand>
             <operand> <> <operand>
Less than:    <operand> < <operand>
Less than or equal: <operand> <= <operand>
Greater than:    <operand> > <operand>
Greater than or equal: <operand> >= <operand>
    
```

Description:

These operators compare the two operands and return 1 if the condition is “true” or 0 if the condition is “false”.

The operands can be any expression evaluating to an absolute expression.

Example:

```

3 >= 4      ; = 0 (FALSE)
label = 4 ; = 1 (TRUE) if label is 4, 0 (FALSE) otherwise.
9 < $B      ; = 1 (TRUE)
    
```

### 7.4.9 HIGH Operator

Syntax:

```
High Byte: HIGH(<operand>)
```

Description:

This operator returns the high byte of the address of a memory location.

Example:

Assume `data1` is a word located at address `$1050` in the memory.

```
LDA #HIGH(data1)
```

This instruction will load the immediate value of the high byte of the address of `data1` (`$10`) in register A.

```
LDA HIGH(data1)
```

This instruction will load the direct value at memory location of the higher byte of the address of `data1` (i.e. the value in memory location `$10`) in register A.





### 7.4.10 LOW Operator

Syntax:

```
LOW Byte:  LOW(<operand>)
```

Description:

This operator returns the low byte of the address of a memory location.

Example:

Assume `data1` is a word located at address `$1050` in the memory.

```
LDA  #LOW(data1)
```

This instruction will load the immediate value of the lower byte of the address of `data1` (`$50`) in register A.

```
LDA  LOW(data1)
```

This instruction will load the direct value at memory location of the lower byte of the address of `data1` (i.e. the value in memory location `$50`) in register A.

### 7.4.11 Memory PAGE Operator (Unary)

Syntax:

```
Get allocation page:  PAGE(<operand>)
```

Description:

The `PAGE` operator returns the page number where the operand is allocated. For a value coded on 4 bytes, the `PAGE` operator returns the content of bit 19 to 16 of the value. The operand can be any expression evaluating to an absolute or relocatable expression.

When the page operator is used with an absolute expression, the assembler evaluates the page directly and the value is directly written to the output file.

Example:

```
PAGE($D)           ; = 0
PAGE($15A352)      ; = $5
PAGE(label)        ; = Page number label is allocated.
```



### 7.4.12 Force Operator (Unary)

Syntax:

```

8-bit address:  <<operand>
                  <operand>.B
16-bit address: >>operand>
                  <operand>.W
    
```

Description:

The < or .B operators force the operand to be an 8-bit operand, whereas the > or .W operators force the operand to be a 16-bit operand. < operator may be useful to force the 8-bit immediate, indexed or direct addressing mode for an instruction. < operator may be useful to force the 16-bit immediate, indexed or extended addressing mode for an instruction. The operand can be any expression evaluating to an absolute or relocatable expression.

Example:

```

<label          ; label is an 8-bit address.
label.B         ; label is an 8-bit address.
>label         ; label is a 16-bit address.
label.W        ; label is a 16-bit address.
    
```

Operator precedence follows the rules for ANSI-C operators.

**Table 7-2. Operator Precedence**

Operator	Description	Associativity
( )	Parenthesis	Right to Left
<	Force direct address, index or immediate value to 8 bits	Right to Left
>	Force direct address, index or immediate value to 16 bits	
.B	Force direct addressing mode for absolute address.	
.W	Force extended addressing mode for absolute address	
PAGE	Access 4-bit page number (bits 16-19 of 20-bit value).	
~	One's complement	Left to Right
+	Unary Plus	
-	Unary minus	
*	Integer multiplication	Left to Right
/	Integer division	
%	Integer modulo	
+	Integer addition	Left to Right
-	Integer subtraction	
<<	Shift Left	Left to Right
>>	Shift Right	
<	Less than	Left to Right
<=	Less or equal to	
>	Greater than	
>=	Greater or equal to	
=, ==	Equal to	Left to Right
!=, <>	Not Equal to	
&	Bitwise AND	Left to Right
^	Bitwise Exclusive OR	Left to Right
	Bitwise OR	Left to Right

## 7.5 EXPRESSION

An expression is composed of one or more symbols or constants, which are combined with unary or binary operators. Valid symbols in expressions are:

- User defined symbols
- External symbols
- The special symbol \* represents the value of the location counter at the beginning of the instruction or directive, even when several arguments are specified. In the following example, the asterisk represents the location counter at the beginning of the DC directive:

```
DC.W 1, 2, *-2
```

Once a valid expression has been fully evaluated by the assembler, it is reduced as one of the following types of expressions.

- Absolute expression: the expression has been reduced to an absolute value, which is independent of the start address of any relocatable section
- Simple relocatable expression: the expression evaluates to an absolute offset from the start of a single relocatable section
- Complex relocatable expression: the expression neither evaluates to an absolute expression nor to a simple relocatable expression (the Assembler does not support complex expressions)

All valid user-defined symbols representing memory locations are simple relocatable expressions. This includes labels specified in XREF directives, which are assumed to be relocatable symbols.

### 7.5.1 Absolute Expression

Expressions involving constants, known absolute labels, or expressions are absolute expressions. An expression containing an operation between an absolute expression and a constant value is also an absolute expression.

Example of absolute expression:

```
Base: SET $100
Label: EQU Base * $5 + 3
```

Expressions involving the difference between two relocatable symbols defined in the same file and in the same section evaluate to an absolute expression. The expression “label2-label1” can be translated as:

```
(<offset label2> + <start section address >) -
(<offset label1> + <start section address >)
```



This can be simplified as:

```
<offset label2> + <start section address > -
<offset label1> - <start section address>
= <offset label2> - <offset label1>
```

In the following example the expression “tabEnd-tabBegin” evaluates to an absolute expression, and is assigned the value of the difference between the offset of tabEnd and tabBegin in the section DataSec.

```
DataSec: SECTION
tabBegin: DS.B 5
tabEnd:   DS.B 1

CodeSec: SECTION
entry:
        LDD #tabEnd-tabBegin <- Absolute expression
```

### 7.5.2 Simple Relocatable Expression

A simple relocatable expression results from operation like:

- <relocatable expression> + <absolute expression>
- <relocatable expression> - <absolute expression>
- <absolute expression> + <relocatable expression>

Example:

```
                XREF XtrnLabel
DataSec: SECTION
tabBegin: DS.B 5
tabEnd:   DS.B 1

CodeSec: SECTION
entry:
        LDA tabBegin+2 <- Simple relocatable expression
        BRA *-3        <- Simple relocatable expression
        LDA XtrnLabel+6 <- Simple relocatable expression
```



The following table describes the type of an expression according to the operator in an unary operation:

**Table 7-3. Expression - Operator Relationship (unary)**

Operator	Operand	Expression
-, !, ~	absolute	absolute
-, !, ~	relocatable	complex
+	absolute	absolute
+	relocatable	relocatable

The following table describes the type of an expression according to left and right operators in a binary operation:

**Table 7-4. Expression - Operator Relationship (binary operation)**

Operator	Left Operand	Right Operand	Expression
-	absolute	absolute	absolute
-	relocatable	absolute	relocatable
-	absolute	relocatable	complex
-	relocatable	relocatable	absolute
+	absolute	absolute	absolute
+	relocatable	absolute	relocatable
+	absolute	relocatable	relocatable
+	relocatable	relocatable	complex
*, /, %, <<, >>,  , &, ^	absolute	absolute	absolute
*, /, %, <<, >>,  , &, ^	relocatable	absolute	complex
*, /, %, <<, >>,  , &, ^	absolute	relocatable	complex
*, /, %, <<, >>,  , &, ^	relocatable	relocatable	complex



## 7.6 TRANSLATION LIMITS

Following limitations apply to the macro assembler:

- Floating-point constants are not supported.
- Complex relocatable expressions are not supported.
- Lists of operands or symbols must be separated with a comma.
- Include may be nested up to 50.
- The maximum line length is 1023.





## CHAPTER 8

### ASSEMBLER DIRECTIVES

#### 8.1 INTRODUCTION

This chapter introduces the classes of assembler directives. Functional descriptions and usage examples of each directive are also provided.

#### 8.2 DIRECTIVE OVERVIEW

There are different classes of assembler directives. The following tables give you an overview of the different directives and their class.

##### 8.2.1 Section Definition Directives

These directives are used to define new sections.

**Table 8-1. Section Directives**

Directive	Description
ORG	Define an absolute section
SECTION	Define a relocatable section

##### 8.2.2 Constant Definition Directives

These directives are used to define assembly constants.

**Table 8-2. Constant Directives**

Directive	Description
EQU	Assign a name to an expression (cannot be redefined)
SET	Assign a name to an expression (can be redefined)

### 8.2.3 Data Allocation Directives

These directives are used to allocate variables.

**Table 8-3. Data Allocation Directives**

Directive	Description
DC	Define a constant variable
DCB	Define a constant block
DS	Define storage for a variable

### 8.2.4 Symbol Linkage Directives

These directives are used to export or import global symbols.

**Table 8-4. Symbol Linkage Directives**

Directive	Description
ABSENTRY	Specify the application entry point when an absolute file is generated
XDEF	Make a symbol public (Visible from outside)
XREF	Import reference to an external symbol.
XREFB	Import reference to an external symbol located on the direct page.

### 8.2.5 Assembly Control Directives

These directives are general purpose directives used to control the assembly process.

**Table 8-5. Assembly Control Directives**

Directive	Description
ALIGN	Define Alignment Constraint
BASE	Specify default base for constant definition
END	End of assembly unit
EVEN	Define 2 Byte alignment constraint
FAIL	Generate user defined error or warning messages
INCLUDE	Include text from another file.
LONGEVEN	Define 4 Byte alignment constraint



### 8.2.6 Listing File Control Directives

These directives control the generation of the assembler listing file.

**Table 8-6. Assembler List File Directives**

Directive	Description
CLIST	Specify if all instructions in a conditional assembly block must be inserted in the listing file or not.
LIST	Specify that all subsequent instructions must be inserted in the listing file.
LLEN	Define line length in assembly listing file.
MLIST	Specify if the macro expansions must be inserted in the listing file.
NOLIST	Specify that all subsequent instructions must not be inserted in the listing file.
NOPAGE	Disable paging in the assembly listing file.
PAGE	Insert page break.
PLEN	Define page length in the assembler listing file.
SPC	Insert an empty line in the assembly listing file.
TABS	Define number of characters to insert in the assembler listing file for a TAB character.
TITLE	Define the user defined title for the assembler listing file.

### 8.2.7 Macro Control Directives

These directives are used for the definition and expansion of macros.

**Table 8-7. Macro Directives**

Directive	Description
ENDM	End of user defined macro.
MACRO	Start of user defined macro.
MEXIT	Exit from macro expansion.



### 8.2.8 Conditional Assembly Directives

These directives are used for conditional assembling.

**Table 8-8. Conditional Assembly Directives**

Directive	Description
ELSE	Alternate of conditional block
ENDIF	End of conditional block
IF	Start of conditional block. A boolean expression follows this directive.
IFC	Test if two string expressions are equal.
IFDEF	Test if a symbol is defined.
IFEQ	Test if an expression is null.
IFGE	Test if an expression is greater than or equal to 0.
IFGT	Test if an expression is greater than 0.
IFLE	Test if an expression is less than or equal to 0.
IFLT	Test if an expression is less than 0.
IFNC	Test if two string expressions are different.
IFNDEF	Test if a symbol is undefined.
IFNE	Test if an expression is not null.



---

---

### 8.3 ABSENTRY - APPLICATION ENTRY POINT

**Syntax:**

```
ABSENTRY <label>
```

**Description:**

This directive allow to specify the application Entry Point in a directly generated absolute file (the option -FA2 ELF/DWARF 2.0 Absolute File must be enabled ).

Using this directive, the entry point of the assembly application is written in the header of the generated absolute file. When this file is loaded in the debugger, the line where the entry point label is defined is highlighted in the source window.

**Example:**

If the example below is assembled using the -FA2 option, an Elf/Dwarf 2.0 Absolute file is generated.

```
        ABSENTRY entry

        ORG $fffe
Reset:  DC.W entry

        ORG $70
entry:  NOP
        NOP
main:   LDHX #SAFE
        NOP
        BRA main
```

According to the ABSENTRY directive, the Entry Point will be set to the address of entry in the elf header of the absolute file.



## 8.4 ALIGN - ALIGN LOCATION COUNTER

Syntax:

```
ALIGN <n>
```

Description:

This directive forces the next instruction to a boundary that is a multiple of <n>, relative to the start of the section. The value of <n> must be a positive number between 1 and 32767. The ALIGN directive can force alignment to any size. The filling bytes inserted for alignment purpose are initialized with '\0'.

ALIGN can be used in code or data sections.

Example:

The following example aligns the HEX label to a location, which is a multiple of 16:

```
000000 4849 4748      DC.B  "HIGH"
000004 0000 0000      ALIGN 16
000008 0000 0000
00000C 0000 0000
000010 007F      HEX:  DC.W  127 ; HEX is allocated on an address
                                ; which is a multiple of 16.
```



## 8.5 BASE - SET NUMBER BASE

Syntax:

```
BASE <n>
```

Description:

This directive sets the default number base for constants to <n>. Valid values of <n> are 2, 8, 10, and 16. If no default base is specified using BASE, the default number base is decimal.

Example:

```

4      4      base      10      ; default base is decimal
5      5      000000 64      dc.b      100
6      6      base      16      ; default base is hex.
7      7      000001 0A      dc.b      0a
8      8      base      2       ; default base is binary
9      9      000002 04      dc.b      100
10     10     000003 04      dc.b      %100
11     11     base      @12    ; default base is decimal
12     12     000004 64      dc.b      100
13     13     base      $a     ; default base is decimal
14     14     000005 64      dc.b      100
15     15
16     16     base      8       ; default base is octal
17     17     000006 40      dc.b      100

```

### NOTE

Hexadecimal constants terminated by a “D” must be prefixed by the “\$” character, otherwise they are interpreted as decimal constants.

## 8.6 CLIST - LIST CONDITIONAL ASSEMBLY

Syntax:

```
CLIST [ON | OFF]
```

Description:

The CLIST directive controls the listing of subsequent conditional assembly blocks. It precedes the first directive of the conditional assembly block to which it applies, and remains effective until the next CLIST directive is read.

When the ON keyword is specified in a CLIST directive, the listing file includes all directives and instructions in the conditional assembly block, even those which do not generate code (which are skipped).

When the OFF keyword is specified, directives and instructions that generate code are listed.

As soon as the option -L is activated, the assembler defaults to CLIST ON.

Example listing file with CLIST OFF:

```

                CLIST OFF
Try:   EQU      0
        IFEQ    Try
        LDA    #103
        ELSE
        LDA    #0
        ENDIF

```

The corresponding listing file is:

```

Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.   Loc   Obj. code   Source line
-----
    2     2           0000 0000   Try:   EQU    0
    3     3           0000 0000           IFEQ   Try
    4     4   000000  A667           LDA   #103
    5     5           ELSE
    7     7           ENDIF
    8     8

```





Listing file with CLIST ON:

```

                CLIST ON
Try:           EQU    0
                IFEQ  Try
                LDA  #103
                ELSE
                LDA  #0
                ENDIF
    
```

The corresponding listing file is:

```

Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.   Loc   Obj. code   Source line
-----
    2     2           0000 0000   Try:    EQU    0
    3     3           0000 0000           IFEQ  Try
    4     4   000000 A667           LDA  #103
    5     5           ELSE
    6     6           LDA  #0
    7     7           ENDIF
    8     8
    
```



## 8.7 DC - DEFINE CONSTANT

Syntax:

```
[<label>:] DC [<size>] <expression> [, <expression>]...
```

where

```
<size> = B (default), W or L.
```

Description:

The DC directive defines constants in memory. It can have one or more <expression> operands, which are separated by commas. The <expression> can contain an actual value (binary, octal, decimal, hexadecimal or ASCII). Alternately, the <expression> can be a symbol or expression that can be evaluated by the assembler as an absolute or simple relocatable expression. One memory block is allocated and initialized for each expression.

The following rules apply to size specifications for DC directives:

- DC .B: One byte is allocated for numeric expressions, one byte is allocated per ASCII character for strings
- DC .W: Two bytes are allocated for numeric expressions, ASCII strings are right aligned on a two-byte boundary
- DC .L: Four bytes are allocated for numeric expressions, ASCII strings are right aligned on a four byte boundary

Example for DC .B:

```
000000 4142 4344 Label: DC.B "ABCDE"
000004 45
000005 0A0A 010A DC.B %1010, @12, 1, $A
000009 xx DC.B PAGE(Label)
```

Example for DC .W:

```
000000 0041 4243 Label: DC.W "ABCDE"
000004 4445
000006 000A 000A DC.W %1010, @12, 1, $A
00000A 0001 000A
00000E xxxx DC.W Label
```

Example for DC .L:

```
000000 0000 0041 Label: DC.L "ABCDE"
000004 4243 4445
000008 0000 000A DC.L %1010, @12, 1, $A
00000C 0000 000A
000010 0000 0001
```



```
000014 0000 000A
```

```
000018 xxxx xxxx          DC.L Label
```

If the value in an operand expression exceeds the size of the operand, the value is truncated and a warning message is generated.



## 8.8 DCB - DEFINE CONSTANT BLOCK

Syntax:

```
[<label>:] DCB [<size>] <count>, <value>
```

where

```
<size> = B (Default), W or L.
```

Description:

The DCB directive causes the assembler to allocate a memory block initialized with the specified <value>. The length of the block is <size> \* <count>.

<count> may not contain undefined, forward, or external references and may range from 1 to 4096. The value of each storage unit allocated is the sign-extended expression <value>, which may contain forward references. The <count> cannot be relocatable.

The following rules apply to size specifications for DCB directives:

- DCB . B: One byte is allocated for numeric expressions
- DCB . W: Two bytes are allocated for numeric expressions
- DCB . L: Four bytes are allocated for numeric expressions

Example:

```
000000 FFFF FF      Label: DCB.B 3, $FF
000003 FFFE FFFE          DCB.W 3, $FFFE
000007 FFFE
000009 0000 FFFE          DCB.L 3, $FFFE
00000D 0000 FFFE
000011 0000 FFFE
```



## 8.9 DS - DEFINE SPACE

Syntax :

```
[<label>:] DS [.<size>] <count>
```

where

```
<size> = B (Default), W or L.
```

Description:

The DS directive is used to reserve memory for variables. The content of the memory reserved is not initialized. The length of the block is  $\text{<size> * <count>}$ .

$\text{<count>}$  may not contain undefined, forward, or external references. It may range from 1 to 4096.

Example:

```
Counter: DS.B 2 ; 2 contiguous bytes in memory
          DS.B 2 ; 2 contiguous bytes in memory
          ; can only be accessed through the label Counter
          DS.L 5 ; 5 contiguous long words in memory
```

The label, `Counter`, references the lowest address of the defined storage area.

## 8.10 ELSE - CONDITIONAL ASSEMBLY

Syntax:

```
IF <condition>
  [<assembly language statements>]
[ELSE]
  [<assembly language statements>]
ENDIF
```

Description:

If <condition> is true, the statements between IF and the corresponding ELSE directive generate code.

If <condition> is false, the statements between ELSE and the corresponding ENDIF directive generate code. Nesting of conditional blocks is allowed. The maximum level of nesting is limited by the available memory at assembly time.

Example:

The following is an example of the use of conditional assembly directives:

```
Try: EQU 1
  IF Try != 0
    LDA #103
  ELSE
    LDA #0
  ENDIF
```

The value of *Try* determines the instruction which generates code. As shown, the LDA #103 instruction generates code. Changing the operand of the equ directive to zero, causes the LDA #0 instruction to generate code instead. The following shows the listing provided by the assembler for these lines of code:

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.  Loc   Obj. code  Source line
-----
1      1           0000 0001  Try: EQU 1
2      2           0000 0001      IF Try != 0
3      3  000000 A667           LDA #103
4      4
6      6           ENDIF
```



## 8.11 END - END ASSEMBLY

Syntax:

```
END
```

Description:

The END directive indicates the end of the source code. Subsequent source statements in this file are ignored. The END directive in included files skips only subsequent source statements in this include file. The assembly continues in the including file in a regular way.

Example:

When assembling the code:

```
Label: NOP
      NOP
      NOP
      END

      NOP ; No code generated
      NOP ; No code generated
```

The generated listing file is:

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.  Loc  Obj. code  Source line
-----
      1   1   000000 9D      Label: NOP
      2   2   000001 9D              NOP
      3   3   000002 9D              NOP
```



## 8.12 ENDIF - END CONDITIONAL ASSEMBLY

Syntax:

```
ENDIF
```

Description:

The `ENDIF` directive indicates the end of a conditional block. Nesting of conditional blocks is allowed. The maximum level of nesting is limited by the available memory.

See example of directive `IF`.





### 8.13 ENDM - END MACRO DEFINITION

Syntax:

```
ENDM
```

Description:

The ENDM directive terminates both the macro definition and the macro expansion.

Example:

```

5      5                               cpChar:  MACRO
6      6                               LDA  \1
7      7                               STA  \2
8      8                               ENDM
9      9                               CodeSec: SECTION
10     10                               Start:
11     11                               cpChar char1, char2
12     6m 000000 C6 xxxx +             LDA char1
13     7m 000003 C7 xxxx +             STA char2
14     12 000006 9D                     NOP
15     13 000007 9D                     NOP

```

## 8.14 EQU - EQUATE SYMBOL VALUE

Syntax:

```
<label>: EQU <expression>
```

Description:

The EQU directive assigns the value of the <expression> in the operand field to <label>. The <label> and <expression> fields are both required, and the <label> cannot be defined anywhere else in the program. The <expression> cannot include a symbol, which is undefined or not defined yet.

The EQU directive does not allow forward references.

Example:

```

0000 0014  MaxElement: EQU 20
0000 0050  MaxSize:    EQU MaxElement * 4

000000    Time:    DS.W 3
0000 0000  Hour:    EQU Time ; first word addr
0000 0002  Minute: EQU Time+2; second word addr
0000 0004  Second: EQU Time+4; third word addr

```



## 8.15 EVEN - FORCE WORD ALIGNMENT

Syntax:

```
EVEN
```

Description:

This directive forces the next instruction to the next even address relative to the start of the section. EVEN is an abbreviation for ALIGN 2. Some processors require word and long word operations to begin at even address boundaries. In such cases, the use of the EVEN directive ensures correct alignment, omission of the directive can result in an error message.

Example:

```

6      6      000000                                ds.w  2
; location count has an even value, no padding byte inserted.
7      7
8      8      000004                                ds.b  1
; location count has an odd value, one padding byte inserted.
9      9      000005 00                            even
10     10     000006                                ds.b  3
; location count has an odd value, one padding byte inserted.
11     11     000009 00                            even
12     12           0000 000A aaa:                 equ   10

```



## 8.16 FAIL - GENERATE ERROR MESSAGE

Syntax:

```
FAIL <arg> | <string>
```

Description:

Handling from the FAIL directive depends on the operand specified. If <arg> is in the range [500 – \$FFFFFFFF], the assembler generates a warning message, including the line number and argument of the directive.

Example:

```
cpChar: MACRO
    IFC "\1", ""
        FAIL 200
    MEXIT
ELSE
    LDA \1
ENDIF

    IFC "\2", ""
        FAIL 600
    ELSE
        STA \2
    ENDIF
ENDM
codSec: SECTION
Start:
    cpChar char1
```

Generates the following error message:

```
>> in "C:\MCUEZ\DEMO\ELF08A\test.asm", line 13, col 19, pos 226
```

```
    IFC "\2", ""
    FAIL 600
    ^
```

```
WARNING A2332: FAIL found
Macro Call : FAIL 600
```

If <arg> is in the range [0 – 499], the assembler generates an error message, including the line number and argument of the directive. The assembler does not generate any object file.

```
cpChar: MACRO
    IFC "\1", ""
        FAIL 200
    MEXIT
ELSE
    LDA \1
ENDIF
```



```

        IFC "\2", ""
        FAIL 600
    ELSE
        STA \2
    ENDIF
ENDM
codSec: SECTION
Start:
        cpChar ,char2

```

Generates the following error message:

```
>> in "C:\MCUEZ\DEMO\ELF08A\test.asm", line 6, col 19, pos 96
```

```

        IFC "\1", ""
        FAIL 200
            ^
ERROR A2329: FAIL found
Macro Call : FAIL 200

```

If a string is supplied as the operand, the assembler generates an error message, including the line number and the <string>. The assembler does not generate any object file.

Example:

```

cpChar: MACRO
        IFC "\1", ""
            FAIL "A character must be specified as first
parameter"
        MEXIT
    ELSE
        LDA \1
    ENDIF
    IFC "\2", ""
        FAIL 600
    ELSE
        STA \2
    ENDIF
ENDM
codeSec: SECTION
Start:
        cpChar , char2

```

Generates following error message:

```
>> in "C:\MCUEZ\DEMO\ELF08AC\test.asm", line 7, col 17, pos 110
```



```
IFC "\1", ""
```

```
    FAIL "A character must be specified as first parameter"
```

```
    ^
```

```
ERROR A2338: A character must be specified as first parameter
```

```
Macro Call : FAIL "A character must be specified as first  
parameter"
```

The FAIL directive is intended for use with conditional assembly to detect a user defined error or warning condition.



## 8.17 IF - CONDITIONAL ASSEMBLY

Syntax:

```
IF <condition>
  [<assembly language statements>]
[ELSE]
  [<assembly language statements>]
ENDIF
```

Description:

If <condition> is true, the statements immediately following the IF directive generate code. Assembly continues until the corresponding ELSE or ENDIF directive is reached. Then all statements until the corresponding ENDIF directive are ignored. Nesting of conditional blocks is allowed. The maximum level of nesting is limited by available memory at assembly time.

The expected syntax for <condition> is:

```
<condition> := <expression> <relation> <expression>
<relation> := "=" | "!=" | ">=" | ">" | "<=" | "<" | "<>"
```

The <expression> must be absolute (It must be known at assembly time).

Example:

The following is an example of the use of conditional assembly directives:

```
Try: EQU 0
    IF Try != 0
        LDA #103
    ELSE
        LDA #0
    ENDIF
```

The value of TRY determines the instruction which generates code. As shown, the LDA #0 instruction generates some code. Changing the operand of the EQU directive to one causes the LDA #103 instruction to generate code instead. The following shows the listing provided by the Assembler for these lines of code:

```

1      1      0000 0000    Try: EQU 0
2      2      0000 0000      IF Try != 0
4      4
5      5      000000 A600      LDA #0
6      6
                                ENDIF
```



## 8.18 IFCC - CONDITIONAL ASSEMBLY

Syntax:

```
IFcc <condition>
    [<assembly language statements>]
[ELSE]
    [<assembly language statements>]
ENDIF
```

Description:

These directives can be replaced by the IF directive. If IFCC <condition> is true, the statements immediately following the Ifcc directive are assembled. Assembly continues until the corresponding ELSE or ENDIF directive is reached, after which, assembly moves to the statements following the ENDIF directive. Nesting of conditional blocks is allowed. The maximum level of nesting is limited by the available memory at assembly time.

The following table lists the available conditional types:

**Table 8-9. Conditional Types**

<b>Ifcc</b>	<b>Condition</b>	<b>Meaning</b>
ifeq	<expression>	if <expression> == 0
ifne	<expression>	if <expression> != 0
iflt	<expression>	if <expression> < 0
ifle	<expression>	if <expression> <= 0
ifgt	<expression>	if <expression> > 0
ifge	<expression>	if <expression> >= 0
ifc	<string1>, <string2>	if <string1> == <string2>
ifnc	<string1>, <string2>	if <string1> != <string2>
ifdef	<label>	if <label> was defined
ifndef <label>		if <label> was not defined





Example:

The following is an example of the use of conditional assembly directives :

```
Try: EQU 0
      IFNE Try
          LDA #103
      ELSE
          LDA #0
      ENDIF
```

The value of TRY determines the instruction to be assembled in the program. As shown, the LDA #0 instruction generates some code. Changing the directive to IFEQ causes the LDA #103 instruction to generate code instead. The following shows the listing provided by the Assembler for these lines of code:

```

1      1      0000 0000      Try: EQU 0
2      2      0000 0000      IFNE Try
4      4      ELSE
5      5      000000 A600      LDA #0
6      6      ENDIF
```



---

---

## 8.19 INCLUDE - INCLUDE TEXT FROM ANOTHER FILE

Syntax:

```
INCLUDE <file specification>
```

Description:

This directive causes the included file to be inserted in the source input stream. The <file specification> is not case sensitive and must be enclosed in quotation marks.

The assembler attempts to open <file specification> relative to the current working directory. If the file is not found, then it is searched for in each path specified in the environment variable GENPATH.

Example:

```
INCLUDE "..\LIBRARY\macros.inc"
```



## 8.20 LIST - ENABLE LISTING

Syntax:

```
LIST
```

Description:

Specifies that the following instructions must be inserted in the listing and debug files. -The listing file is generated if option -L is specified.

The source text following the LIST directive is listed until NOLIST or END is reached.

This directive is not written to the listing and debug file. When neither the LIST nor the NOLIST directives are specified in a source file, all instruction are written to the list file.

Example:

```
aaa:    nop

        list
bbb:    nop
        nop

        nolist
ccc:    nop
        nop

        list
ddd:    nop
        nop
```

Generates following listing file:

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.  Loc   Obj. code  Source line
-----
      1     1   000000 9D      aaa:    nop
      2     2
      4     4   000001 9D      bbb:    nop
      5     5   000002 9D              nop
      6     6
     12    12
     13    13   000005 9D      ddd:    nop
     14    14   000006 9D              nop
     15    15
```

The gap in the location counter is due to instructions inside the NOLIST-LIST block.

See Also: NOLIST



## 8.21 LLEN - SET LINE LENGTH

Syntax:

```
LLEN <n>
```

Description:

Sets the number of characters, <n>, from the source line that are included on the listing line. The values allowed for <n> are in the range [0 – 132]. If a value smaller than 0 is specified, the line length is set to 0. If a value bigger than 132 is specified, the line length is set to 132.

Lines of the source file that exceed the specified number of characters are truncated in the listing file.

Example:

```
dc.b      5
llen     $20
dc.w     $4567, $2345
llen     $17
dc.w     $4567, $2345
even
nop
```

Generates following listing file:

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.  Loc   Obj. code  Source line
-----
   1    1   000000 05          dc.b      5
   3    3
   4    4   000001 4567 2345      dc.w     $4567, $2345
   5    5
   7    7   000005 4567 2345      dc.w     $4567
   8    8   000009 00          even
   9    9   00000A 9D          nop
  10   10
```

The LLEN \$17 directive causes the second dc.w \$4567, \$2345 to be truncated in the Assembler listing file. The generated code is correct.



## 8.22 LONGEVEN - FORCING LONG-WORD ALIGNMENT

Syntax:

LONGEVEN

Description:

This directive forces the next instruction to the next long-word address relative to the start of the section. LONGEVEN is an abbreviation for ALIGN 4.

Example:

```

2      2      000000 01                      dcb.b 1,1
        ; location counter is not a multiple of 4, 3 filling bytes
        ; are required.
3      3      000001 0000 00                  longeven
4      4      000004 0002 0002                dcb.w 2,2
        ; location counter is already a multiple of 4, no filling
        ; bytes are required.
5      5                                  longeven
6      6      000008 0202                      dcb.b 2,2
7      7                                  ; following is for text section
8      8                                  s27          SECTION 27
9      9      000000 A7                        nop
        ; location counter is not a multiple of 4, 3 filling bytes
        ; are required.
10     10     000001 0000 00                  longeven
11     11     000004 A7                        nop

```

### 8.23 MACRO - BEGIN MACRO DEFINITION

Syntax:

```
<label>: MACRO
```

Description:

The <label> of the MACRO directive is the name by which the macro is called. This name must not be a processor machine instruction or assembler directive name. For more information on macros, refer to the Macro chapter in this manual.

Example:

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
Abs. Rel.   Loc   Obj. code   Source line
-----
   1     1
   2     2
   3     3   000000
   4     4   000001
   5     5
   6     6
   7     7
   8     8
   9     9
  10    10
  11    11
  12     6m 000000 C6 xxxx   +
  13     7m 000003 C7 xxxx   +
  14    12 000006 9D
  15    13 000007 9D
  16    14 000008 9D
  17    15

XDEF Start
MyData: SECTION
char1: DS.B 1
char2: DS.B 1
cpChar: MACRO
        LDA \1
        STA \2
ENDM
CodeSec: SECTION
Start:
cpChar char1, char2
        LDA char1
        STA char2
NOP
NOP
NOP
```

## 8.24 MEXIT - TERMINATE MACRO EXPANSION

Syntax:

```
MEXIT
```

Description:

MEXIT is usually used together with conditional assembly within a macro. In that case, the macro expansion might terminate prior to termination of the macro definition. The MEXIT directive causes macro expansion to skip any remaining source lines ahead of the ENDM directive.

Example:

Following portion of code:

```

                XDEF  entry
save:          MACRO                ; Start macro definition
                LDHX #storage
                LDA  \1
                STA  0,x             ; save first argument
                LDA  \2
                STA  2,x             ; save second argument
                IFC  '\3', ''       ; is there a 3rd argument?
                    MEXIT          ; no, exit from macro.
                ENDC
                LDA  \3             ; save third argument
                STA  4,X
                ENDM                ; End of macro definition
codSec:        SECTION
entry:
                save char1, char2
    
```

Generates following listing file:

```

16      16                                save char1, char2
17      2m  000000 45 xx00      +      LDHX #storage
18      3m  000003 C6 xxxxx     +      LDA  char1
19      4m  000006 E700         +      STA  0,x
                                           ; save first argument
20      5m  000008 C6 xxxxx     +      LDA  char2
21      6m  00000B E702         +      STA  2,x
                                           ; save second
argument
22      7m                                IFC  '', ''
    
```



```
                                ; is there a 3rd
argument?
24      8m                      +      MEXIT
                                ; no, exit from

macro.
25      9m                      +      ENDC
26      10m                     +      LDA
                                ; save third argument
27      11m                     +      STA 4,X
```





## 8.25 MLIST - LIST MACRO EXPANSIONS

Syntax:

```
MLIST [ON | OFF]
```

Description:

When the ON keyword is entered with an MLIST directive, the assembler includes the macro expansions in the listing and in the debug file. When the OFF keyword is entered, the macro expansions are omitted from the listing and debug files. This directive is not written to the listing and debug file, and the default value is ON.

Example:

The following listing shows a macro definition and expansion with MLIST ON:

```

                XDEF  entry
                MLIST ON
swap:          MACRO
                LDA   \1
                LDX   \2
                STA   \2
                STX   \1
                ENDM
codSec:        SECTION
entry:
                LDA   #$F0
                LDX   #$0F
main:
                STA   first
                STX   second
                swap  first, second
                NOP
                BRA   main
datSec:        SECTION
first:         DS.B 1
second:        DS.B 1

```



The Assembler listing file is:

```

1      1                                XDEF  entry
3      3                                swap: MACRO
4      4                                LDA   \1
5      5                                LDX   \2
6      6                                STA   \2
7      7                                STX   \1
8      8                                ENDM
9      9
10     10                                codSec: SECTION
11     11                                entry:
12     12      000000 A6F0                LDA   #$F0
13     13      000002 AE0F                LDX   #$0F
14     14                                main:
15     15      000004 C7 xxxx                STA   first
16     16      000007 CF xxxx                STX   second
17     17                                swap first, second
18     4m      00000A C6 xxxx      +      LDA   first
19     5m      00000D CE xxxx      +      LDX   second
20     6m      000010 C7 xxxx      +      STA   second
21     7m      000013 CF xxxx      +      STX   first
22     18      000016 9D                                NOP
23     19      000017 20EB                BRA   main
24     20
25     21                                datSec: SECTION
26     22      000000                first: DS.B 1
27     23      000001                second: DS.B 1

```



For the same code, with MLIST OFF, the listing file is:

```

1      1                                XDEF  entry
3      3                                swap: MACRO
4      4                                LDA   \1
5      5                                LDX   \2
6      6                                STA   \2
7      7                                STX   \1
8      8                                ENDM
9      9
10     10                               codSec: SECTION
11     11                               entry:
12     12      000000 A6F0                LDA   #$F0
13     13      000002 AE0F                LDX   #$0F
14     14      000004 C7 xxxx             STA   first
15     15      000007 CF xxxx             STX   second
16     16                               main:
17     17                               swap first, second
22     18      000016 9D                  NOP
23     19      000017 20F1               BRA   main
24     20
25     21                               datSec: SECTION
26     22      000000                    first: DS.B 1
27     23      000001                    second: DS.B 1

```

## 8.26 NOLIST - DISABLE LISTING

Syntax:

```
NOLIST
```

Description:

Suppresses printing of the following instructions in the assembly listing and debug files until a LIST directive is reached.

Example:

Following portion of code:

```
aaa:    nop
        list
bbb:    nop
        nop
        nolist
ccc:    nop
        nop
        list
ddd:    nop
        nop
```

generates following listing file:

```
1      1      000000 9D      aaa:    nop
3      3      000001 9D      bbb:    nop
4      4      000002 9D              nop
9      9      000005 9D      ddd:    nop
10     10     000006 9D              nop
11     11
```

The gap in the location counter is due to instructions defined inside a NOLIST block.



## 8.27 NOPAGE - DISABLE PAGING

Syntax:

NOPAGE

Description:

Disables paginating in the listing file. Program lines are listed continuously, without headings or top or bottom margins.



## 8.28 ORG - SET LOCATION COUNTER

Syntax:

```
ORG <expression>
```

Description:

The ORG directive sets the location counter to the value specified by <expression>. Subsequent statements are assigned memory locations starting with the new location counter value. The <expression> must be absolute and may not contain any forward, undefined, or external references. The ORG directive generates an internal section, which is absolute.

Example:

```
        org    $2000
b1:     nop
b2:     rts
```

Label b1 is located at address \$2000 and label b2 at address \$2001.



## 8.29 PAGE - INSERT PAGE BREAK

Syntax:

```
PAGE
```

Description:

Insert a page break in the assembly listing.

Example:

Following portion of code:

```
codeSec: SECTION
        nop
        nop
        page
        nop
        nop
```

Generates following listing file:

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
-----
1      1                               codeSec: SECTION
2      2      000000 9D                    NOP
3      3      000001 9D                    NOP
```

```
Motorola HC08-Assembler
(c) COPYRIGHT MOTOROLA 1991-1997
-----
5      5      000002 9D                    NOP
6      6      000003 9D                    NOP
7      7
```



### 8.30 PLEN - SET PAGE LENGTH

Syntax:

PLEN <n>

Description:

Sets the listings page length to <n> lines. <n> may range from 10 to 10000. If the number of lines already listed on the current page is greater than or equal to <n>, listing will continue on the next page with the new page length setting. The default page length is 65 lines.





### 8.31 SECTION - DECLARE RELOCATABLE SECTION

Syntax:

```
<name>: SECTION [SHORT][<number>]
```

Description:

This directive declares a relocatable section and initializes the location counter for the following code. The first SECTION directive for a section sets the location counter to zero. Subsequent SECTION directives for that section restore the location counter to the value that follows the address of the last code in the section.

<name> is the name assigned to the section. Two SECTION directives, where the same name is specified, refers to the same section.

<number> is optional and is only specified for compatibility with the MASM assembler.

A section is a code section as soon as it contains at least an assembly instruction. It is considered to be a constant section if it contains only DC or DCB directives. A section is considered to be a data section as soon as it contains at least a DS directive or if it is empty.

Example:

The following example demonstrates the definition of a section `aaa`, which is split into two blocks, with section `bbb` between them. The location counter associated with label `zz` is 1, because a NOP instruction was already defined in this section at label `xx`.

```

2      2      aaa:      section 4
3      3      000000 9D   xx:      nop
4      4      bbb:      section 5
5      5      000000 9D   yy:      nop
6      6      000001 9D           nop
7      7      000002 9D           nop
8      8      aaa:      section 4
9      9      000001 9D   zz:      nop

```

The optional qualifier `SHORT` specifies that the section is a short section. Objects defined there can be accessed using the direct addressing mode.

The following example demonstrates the definition and usage of a `SHORT` section. On line number 12, the symbol data is accessed using the direct addressing mode.

```

1      1      dataSec: SECTION  SHORT
2      2      000000      data:      DS.B 1
3      3
4      4      0000 0AFE   initSP:   EQU $AFE
5      5
6      6      codeSec: SECTION
7      7
8      8      entry:

```



9	9	000000 45 0AFE	LDHX #initSP
10	10	000003 94	TXS
11	11	000004 A600	LDA #0
12	12	000006 B7xx	STA data
13	13		



### 8.32 SET - SET SYMBOL VALUE

Syntax:

```
<label>: SET <expression>
```

Description:

Similar to the EQU directive, the SET directive assigns the value of the <expression> in the operand field to the symbol in the <label> field. The <expression> cannot include a symbol that is undefined or not yet defined. The <label> is an assembly time constant, SET does not generate any machine code.

The value is temporary; a subsequent SET directive can redefine it.

Example:

```

2      2      0000 0002      count: SET 2
3      3      000000 02      loop:  DC.B count
4      4      0000 0002      IFNE count
5      5      0000 0001      count: SET count - 1
6      6      ENDIF
7      7      000001 01      DC.B count
8      8      0000 0001      IFNE count
9      9      0000 0000      count: SET count - 1
10     10      ENDIF
11     11      000002 00      DC.B count
12     12      0000 0000      IFNE count

```

The value associated with the label count is decremented after each DC . B instruction.



### 8.33 SPC - INSERT BLANK LINES

Syntax:

SPC <count>

Description:

Inserts blank lines in the assembly listing. <count> may range from 0 to 65. This has the same effect as writing that number of blank lines in the assembly source.



### 8.34 TABS - SET TAB LENGTH

Syntax:

TABS <n>

Description:

Sets tab length to <n> spaces. The default tab length is eight. <n> may range from 0 to 128.



### 8.35 TITLE - PROVIDE LISTING TITLE

Syntax:

```
TITLE "title"
```

Description:

Prints the <title> on the head of each page of the listing file. This directive must be the first source code line. A title consists of a string of characters enclosed in quotes (").

The title specified will be written on the top of each page in the assembly listing file.

For compatibility purpose with MASM, a title can also be specified without quotes.



---

---

## 8.36 XDEF - EXTERNAL SYMBOL DEFINITION

Syntax:

```
XDEF [.<size>] <label>[,<label>]...
```

where

```
<size> = B, W(default) or L.
```

Description:

This directive specifies labels defined in the current module that are to be passed to the linker as labels that can be referenced by other modules linked to the current module.

The number of symbols in an XDEF directive is limited by the memory available.

Example:

```
XDEF Global ;Global can be referenced in other module
XDEF AnyCase ;Note that the linker and assembler are
; case sensitive to names.
```

```
GLOBAL: DS.B 4
```

```
...
```

```
AnyCase NOP
```



### 8.37 XREF - EXTERNAL SYMBOL REFERENCE

Syntax:

```
XREF [.<size>] <symbol>[,<symbol>]...
```

where

```
<size> = B, W(Default) or L.
```

Description:

This directive specifies symbols referenced in the current module but defined in another module. The list of symbols and corresponding 16-bit values is passed to the linker.

The number of symbols enumerated in a XREF directive is only limited by the memory available at assembly time.

Example:

```
XREF OtherGlobal; Reference "OtherGlobal" defined in another
           ; module (See XDEF directive example.)
```





## CHAPTER 9

### MACROS

#### 9.1 INTRODUCTION

This chapter describes the functionality and use of macros for the MCUEz Assembler.

#### 9.2 MACRO OVERVIEW

A macro is a template for a code sequence. After a macro is defined, later references to the macro name are replaced by its code sequence. A macro must be defined before it is called. When a macro is defined, it is given a name. The macro is called with this name.

The assembler expands the macro definition each time the macro is called. The macro call causes source statements to be generated, which may include macro arguments. A macro definition may contain any code or directive except nested macro definitions. Calling previously defined macros is also allowed. Source statements generated by a macro call are inserted in the source file at the position where the macro is invoked.

To call a macro, write the macro name in the operation field of a source statement. Place the arguments in the operand field. The macro may contain conditional assembly directives that cause the assembler to produce inline coding variations of the macro definition.

Macro calls produce inline code to perform a predefined function. Each time the macro is called, code is inserted in the normal flow of the program so that the generated instructions are executed in line with the rest of the program.

#### 9.3 DEFINING A MACRO

The definition of a macro consists of four parts:

- Header statement, a MACRO directive with a label that names the macro
- Body of the macro, sequential list of statements, possibly including argument placeholders
- ENDM directive, terminating the macro definition
- MEXIT directive that stops macro expansion

The body of a macro is a sequence of assembler source statements. Macro parameters are defined by parameter designators in the source statements. Valid macro definition statements include processor assembly language instructions, assembler directives, and calls to previously-defined macros. However, macro definitions may not be nested.

## 9.4 CALLING MACROS

The form of a macro call is :

```
[<label>:] <name>[.<sizearg>] [<argument> [, <argument>]...]
```

A macro may call another macro prior to its definition, but all macros must be defined before their first call. The name of the called macro must be in the source statement's operation field. Arguments appear in the source statement's operand field, separated by commas.

The macro call produces inline code at the location of the call, according to the macro definition and the arguments specified in the macro call. The source statements of the expanded macro are then assembled subject to the same conditions and restrictions affecting any source statement. Nested macro calls are also expanded at this time.

## 9.5 MACRO PARAMETERS

Up to 36 different parameters can be used in the source statements that constitute the body of a macro. The parameters are replaced by the corresponding arguments in a later macro calls.

A parameter designator consists of a backslash character (\), followed by a digit (0 - 9) or an uppercase letter (A - Z). Parameter designator \0 corresponds to a size argument that follows the macro name, separated by a period (.).

Example:

Consider the following macro definition:

```
MyMacro: MACRO
          DC.\0    \1, \2
          ENDM
```

When this macro is used in a program, e.g.:

```
MyMacro.B $10, $56
```

the assembler expands it to:

```
DC.B $10, $56
```

Arguments in the operand field of the macro call refer to parameter designator \1 through \9 and \A through \Z, in that order. The argument list (operand field) of a macro call cannot be extended onto additional lines.

Arguments from the macro call are literally substituted for parameter designators in the macro body. The string corresponding to an argument is substituted where that parameter designator occurs as the macro is expanded. Each statement generated is assembled inline.

It is possible to specify a null argument in a macro call by a comma with no character between the comma and the preceding macro name or comma that follows an argument. When a null argument itself is passed as an argument in a nested macro call, a null value is passed. All arguments have a default value of null at the time of a macro call.



## 9.6 LABELS INSIDE MACROS

To avoid multiple definitions for the same label from multiple calls to a macro with labels in its source statements, you can direct the assembler to generate unique labels on each call.

Assembler-generated labels include a string, `_nnnnn`, where `nnnnn` is a 5 digit value. Request an assembler-generated label by specifying `\@` in a label field in a macro body. Each successive label definition with a `\@` generates a successive value of `_nnnnn`, creating a unique label each call. A `\@` may preceded or follow additional characters for clarity.

Example:

```
clear: MACRO
        LDX     \1
        LDA     #16
    \@LOOP: CLR     0,X
        INCX
        DECA
        BNE     \@LOOP
    ENDM
clear    tempory
clear    data
```

The two macro calls of `clear` are expanded in the following manner:

```
clear    tempory
        LDX     tempory
        LDA     #16
_00001LOOP: CLR     0,X
        INCX
        DECA
        BNE     _00001LOOP
clear    data
        LDX     data
        LDA     #16
_00002LOOP: CLR     0,X
        INCX
        DECA
        BNE     _00002LOOP
```



## 9.7 MACRO EXPANSION

When the assembler reads a statement in a source program calling a previously defined macro, it processes the call as described in the following paragraphs.

The symbol table is searched for the macro name. If it is not in the symbol table, an undefined symbol error message is issued.

The rest of the line is scanned for arguments. Any argument in the macro call is saved as a literal or null value in one of the 35 possible parameter fields. When the number of arguments in the call is less than the number of parameters used in the macro the argument, which have not been defined at invocation time are initialize with "" (empty string).

Starting with the line following the MACRO directive, each line of the macro body is saved and is associated with the named macro. Each line is retrieved in turn, with parameter designators replaced by argument strings or assembler-generated label strings.

Once the macro is expanded, the source lines are evaluated and object code is produced.

## 9.8 NESTED MACROS

Macro expansion is performed at invocation time, which is also the case for nested macros. If the macro definition contains a nested macro call, the nested macro expansion takes place inline. Recursive macro call are also supported.

A macro call is limited to the length of one line, i.e. 1024 characters.



## CHAPTER 10

### ASSEMBLER LISTING FILE

#### 10.1 INTRODUCTION

The assembly listing file is the output file of the assembler, which contains information about the generated code. The listing file is generated as soon as the option `-L` is activated. When an error is detected during assembly, no listing file is generated.

The amount of information available depends on following assembly options:

`-Li`, `-Lc`, `-Ld`, `-Le`

The information in the listing file also depends on the following assembly directives:

`LIST`, `NOLIST`, `CLIST`, `MLIST`

The format of the listing file is influenced by the directives:

`PLEN`, `LLEN`, `TABS`, `SPC`, `PAGE`, `NOPAGE`, `TITLE`

The name of the generated listing file is `<base name>.lst`

#### 10.2 PAGE HEADER

The page header consists of 3 lines:

- The first line contains an optional user string defined in the directive `TITLE`
- The second line contains the vendor and target processor names (MOTOROLA/HC08)
- The third line contains a copyright notice

#### 10.3 SOURCE LISTING

The source listing is divided into 5 columns:

- `Abs .`
- `Rel .`
- `Loc`
- `Obj. code`
- `Source line`



### 10.3.1 Abs. Listing

This column contains the absolute line number for each instruction. The absolute line number is the line number in the DBG file, which contains all included files and where all macro calls have been expanded.

Example:

Abs.	Rel.	Loc	Obj. code	Source line
----	----	-----	-----	-----
1	1			;-----
2	2			; File: test.o
3	3			;-----
4	4			
5	5			INCLUDE "macro.inc"
6	1i			cpChar: MACRO
7	2i			LDD \1
8	3i			STD \2
9	4i			ENDM
10	5i			
11	6			codeSec: SECTION
12	7			Start:
13	8			cpChar ch1, ch2
14	2m	000000 FC xxxx	+	LDD ch1
15	3m	000003 7C xxxx	+	STD ch2
16	9	000006 A7		NOP
17	10	000007 A7		NOP



**10.3.2 Rel. Listing**

This column contains the relative line number for each instruction. The relative line number is the line number in the source file. For included files, the relative line number is the line number in the included file. For macro call expansion, the relative line number is the line number of the instruction in the macro definition.

An “i” suffix is appended to the relative line number, when the line comes from an included file. An “m” suffix is appended to the relative line number, when the line is generated by a macro call.

Example:

Abs.	Rel.	Loc	Obj. code	Source line
----	----	-----	-----	-----
1	1			;-----
2	2			; File: test.o
3	3			;-----
4	4			
5	5			INCLUDE "macro.inc"
6	1i			cpChar: MACRO
7	2i			LDD \1
8	3i			STD \2
9	4i			ENDM
10	5i			
11	6			codeSec: SECTION
12	7			Start:
13	8			cpChar ch1, ch2
14	2m	000000 FC	xxxx	+ LDD ch1
15	3m	000003 7C	xxxx	+ STD ch2
16	9	000006 A7		NOP
17	10	000007 A7		NOP

In the previous example, the line number displayed in the column “Rel.” represents the line number of the corresponding instruction in the source file. “1i” on absolute line number 6 denotes that the instruction “cpChar: MACRO” is located in an included file. “2m” on absolute line number 14 denotes that the instruction “LDD ch1” is generated by a macro expansion.

### 10.3.3 Loc Listing

This column contains the address of the instruction. For absolute sections, the address is preceded by the letter ‘a’ and contains the absolute address of the instruction. For relocatable sections, this address is the offset of the instruction from the beginning of the relocatable section. This offset is a hexadecimal number coded on 8 digits.

A value is written in this column in front of each instruction generating code or allocating storage. This column is empty in front of each instruction which does not generate code (for example, SECTION, XDEF, ...).

Example:

Abs.	Rel.	Loc	Obj. code	Source line
----	----	-----	-----	-----
1	1			;-----
2	2			; File: test.o
3	3			;-----
4	4			
5	5			INCLUDE "macro.inc"
6	1i			cpChar: MACRO
7	2i			LDD \1
8	3i			STD \2
9	4i			ENDM
10	5i			
11	6			codeSec: SECTION
12	7			Start:
13	8			cpChar ch1, ch2
14	2m	000000	FC xxxx	+ LDD ch1
15	3m	000003	7C xxxx	+ STD ch2
16	9	000006	A7	NOP
17	10	000007	A7	NOP

In the previous example, the hexadecimal number displayed in the column “LOC” is the offset of each instruction in the section “codeSec”. There is no location counter specified in front of the instruction “INCLUDE "macro.inc"” because this instruction does not generate code. The instruction “LDD ch1” is located at offset 0 from the section “codeSec” start address. The instruction “STD ch2” is located at offset 3 from the section “codeSec” start address.





### 10.3.4 Obj. Code Listing

This column contains the hexadecimal code of each instruction in hexadecimal format. This code is not identical to the code stored in the object file. The letter “x” is displayed at the position where the address of an external or relocatable label is expected. Code at position when “X” are written will be determined at link time.

Example:

Abs.	Rel.	Loc	Obj. code	Source Line
----	----	-----	-----	-----
1	1			;-----
2	2			; File: test.o
3	3			;-----
4	4			
5	5			INCLUDE "macro.inc"
6	1i			cpChar: MACRO
7	2i			LDD \1
8	3i			STD \2
9	4i			ENDM
10	5i			
11	6			codeSec: SECTION
12	7			Start:
13	8			cpChar ch1, ch2
14	2m	000000	FC xxxx	+ LDD ch1
15	3m	000003	7C xxxx	+ STD ch2
16	9	000006	A7	NOP
17	10	000007	A7	NOP



### 10.3.5 Source Line Listing

This column contains the source statement. This is a copy of the source line from the source module. For lines resulting from a macro expansion, the source line is the expanded line, where parameter substitution has been done.

Example:

Abs.	Rel.	Loc	Obj. code	Source line
----	----	-----	-----	-----
1	1			;-----
2	2			; File: test.o
3	3			;-----
4	4			
5	5			INCLUDE "macro.inc"
6	1i			cpChar: MACRO
7	2i			LDD \1
8	3i			STD \2
9	4i			ENDM
10	5i			
11	6			codeSec: SECTION
12	7			Start:
13	8			cpChar ch1, ch2
14	2m	000000	FC xxxx	+ LDD ch1
15	3m	000003	7C xxxx	+ STD ch2
16	9	000006	A7	NOP
17	10	000007	A7	NOP



## CHAPTER 11

### MCUASM COMPATIBILITY

#### 11.1 INTRODUCTION

The macro assembler has been extended to ensure compatibility with the MCUASM assembler 053.

#### 11.2 COMMENT LINE

A line starting with a “\*” character is considered to be a comment line by the assembler.

#### 11.3 CONSTANTS

For compatibility with MCUASM, these integer constant notations are supported:

- Decimal constants are a sequence of decimal digits (0-9) followed by “d” or “D”
- Hexadecimal constants are a sequence of hexadecimal digits (0-9, a-f, A-F) followed by “h” or “H”
- Octal constants are a sequence of octal digits (0-7) followed by “o”, “O”, “q”, or “Q”
- A binary constants are a sequence of binary digits (0-1) followed by “b” or “B”

Example:

```

512d      ; decimal representation
512D      ; decimal representation
200h      ; hexadecimal representation
200H      ; hexadecimal representation
1000o     ; octal representation
1000O     ; octal representation
1000q     ; octal representation
1000Q     ; octal representation
1000000000b ; binary representation
1000000000B ; binary representation

```



## 11.4 OPERATORS

For compatibility with the MCUASM assembler, the following operator notation is supported:

**Table 11-1. Operators**

Operator	Notation
Shift left	!<
Shift right	!>
Bitwise AND	!.
Bitwise OR	!+
Bitwise XOR	!x, !X

## 11.5 DIRECTIVES

The following table lists directives supported by MCUEz for compatibility with MCUASM:

**Table 11-2. Directives**

Operator	Notation
RMB	DS
ELSEC	ELSE
ENDC	ENDIF
NOL	NOLIST
TTL	TITLE
GLOBAL	XDEF
PUBLIC	XDEF
EXTERNAL	XREF
XREFB	XREF.B



## CHAPTER 12

### OPERATING PROCEDURES

#### 12.1 INTRODUCTION

This chapter provides operating procedures for the the MCUEz Assembler.

#### 12.2 WORKING WITH ABSOLUTE SECTIONS

An absolute section is a section in which the start address is known at assembly time (see modules `fiborg.asm` and `fiborg.prm` in the demo directory).

##### 12.2.1 Defining Absolute Sections In The Assembly Source File

Absolute sections are defined with the directive `ORG`. The Assembler makes pseudo-section `ORG_<index>`. The integer `<index>` is incremented when an absolute section is encountered.

Example:

Defining an absolute section containing data:

```

        ORG $A00      ; Absolute constant data section.
cst1:  DC.B    $A6
cst2:  DC.B    $BC
        ORG $800      ; Absolute data section.
var:   DS.B    1

```

The label `cst1` will be at address `$A00`, and `cst2` will be at address `$A01`.

Defining an absolute section containing code:

```

        ORG $C00      ; Absolute code section.
entry:
        LDA  cst1     ; Load value in cst1
        ADD  cst2     ; Add value in cst2
        STA  var      ; Store in var
        BRA  entry

```

The instruction `LDA` will be at address `$C00` and instruction `ADD` at address `$C03`.

To avoid problems during linking or execution, an assembly file should:

- Initialize the stack pointer: the instruction RSP can be used to initialize the stack pointer to \$00FF. To set the Stack Pointer anywhere else in the code, store first the initial value for the Stack Pointer in register HX using LDHX #initSP. You can then swap the content of HX in SP using the instruction TXS. The SP will then contain the value #initSP-1.
- Publish the application entry point using XDEF
- Ensure the addresses specified in the source file are valid addresses for the MCU in use

### 12.2.2 Linking An Application Containing Absolute Sections

Even applications with only absolute sections must be linked. A linker parameter file must:

- Name the absolute file
- Name the object file to be linked
- Specify the memory area where sections containing variables must be allocated
- Specify the memory area where code or constant sections must be allocated (nothing is allocated for applications that contain only absolute sections)
- Specify the application entry point
- Define the reset vector

The minimal linker parameter file will look as follows:

```
LINK test.abs /* Name of the executable file generated. */
NAMES
    test.o /* Name of the object files in the application. */
END
SEGMENTS
/* READ_ONLY memory area. There should be no overlap between this
   memory area and the absolute sections defined in the assembly
   source file. */
MY_ROM = READ_ONLY 0x1000 TO 0x1FFF;
/* READ_WRITE memory area. There should be no overlap between this
   memory area and the absolute sections defined in the assembly
   source file. */
MY_RAM = READ_WRITE 0x2000 TO 0x2FFF;
END
PLACEMENT
/* Relocatable variable sections are allocated in MY_RAM. */
.data    INTO MY_RAM;
/* Relocatable code and constant sections allocated in MY_ROM. */
.text    INTO MY_ROM;
END
INIT entry /* Application entry point. */
```



```
VECTOR ADDRESS 0xFFFFE entry /* initialization of reset vector. */
```

There should be no overlap between the absolute section defined in the assembly source file and the memory area defined in the PRM file.

The demo directory module `fiborg.asm` shows absolute sections in an application.

## 12.3 WORKING WITH RELOCATABLE SECTIONS

A relocatable section is a section whereby the start address is determined at linking time (see modules `fib0.asm` and `fib0.prm` in the demo directory).

### 12.3.1 Defining Relocatable Sections In The Assembly Source File

A relocatable section is defined using the directive `SECTION`.

Example:

Defining a relocatable section containing data:

```
constSec: SECTION ; Relocatable constant data section.
cst1: DC.B    $A6
cst2: DC.B    $BC

dataSec:  SECTION ; Relocatable data section.
var:  DS.B    1
```

In the previous portion of code, the label `cst1` will be located at offset 0 from the section `constSec` start address, and label `cst2` will be located at offset 1 from the section `constSec` start address.

Defining a relocatable section containing code:

```
codeSec:  SECTION ; Relocatable code section.
entry:
    LDA  cst1      ; Load value in cst1
    ADD  cst2      ; Add value in cst2
    STA  var       ; Store in var
    BRA  entry
```

In the previous portion of code, the instruction `LDA` will be located at offset 0 from the section `codeSec` start address, and instruction `ADD` at offset 3 from the section `codeSec` start address. In order to avoid problems during linking or executing an application, an assembly file must:

- Initialize the stack pointer: the instruction RSP can be used to initialize the stack pointer to \$00FF. To set the Stack Pointer anywhere else in the code, store first the initial value for the Stack Pointer in register HX using LDHX #initSP. You can then swap the content of HX in SP using the instruction TXS. The SP will then contain the value #initSP-1
- Publish the application entry point using XDEF

### 12.3.2 Linking An Application Containing Relocatable Sections

Applications containing relocatable sections must be linked. The linker parameter file must contain at least:

- The name of the absolute file
- The name of the object file which should be linked
- The specification of a memory area where the sections containing variables must be allocated
- The specification of a memory area where the sections containing code or constants must be allocated
- The specification of the application entry point
- The definition of the reset vector

The minimal linker parameter file will look as follows:

```
LINK test.abs /* Name of the executable file generated. */
NAMES
    test.o /* Name of the object files in the application. */
END
SEGMENTS
/* READ_ONLY memory area. */
    MY_ROM = READ_ONLY 0x0B00 TO 0x0BFF;
/* READ_WRITE memory area. */
    MY_RAM = READ_WRITE 0x0800 TO 0x08FF;
END
PLACEMENT
/* Relocatable variable sections are allocated in MY_RAM. */
    .data INTO MY_RAM;
/* Relocatable code and constant sections are allocated in MY_ROM.
*/
    .text INTO MY_ROM;
END
INIT entry /* Application entry point. */
VECTOR ADDRESS 0xFFFFE entry /* initialization of reset vector. */
```





**NOTE**

The programmer should ensure that the memory ranges specified in the SEGMENT block are valid addresses for the MCU being used.

The module fibo.asm located in the demo directory is a small example of using the relocatable sections in an application.

**12.4 INITIALIZING THE VECTOR TABLE**

The vector table is initialized in the assembly source file or in the linker parameter file. We recommend initializing it in the PRM file.

The HC08 allows 128 entry in the vector table starting at memory locatin \$FF00 to memory location \$FFFF.

The Reset vector is located in \$FFFE, the SWI interrupt vector is located in \$FFFC. From \$FFFA down to \$FF00 are located interrupt IRQ[0] (\$FFFA), IRQ[1] (\$FFFA),..., IRQ[125] (\$FF00).

In the following examples, the Reset vector, the SWI interrupt and the IRQ[1] interrupt are initialized. The IRQ[0] interrupt is not used.

**12.4.1 Initializing Vector Table In The Linker PRM File**

Initializing the vector table from the PRM file allows you to initialize single entries in the table. The user can decide to initialize all the entries in the vector table or not.

The labels or functions, which should be inserted in the vector table, must be implemented in the assembly source file. All these labels must be published otherwise they cannot be addressed in the linker PRM file.

Example:

```

XDEF IRQ1Func, SWIFunc, ResetFunc
DataSec: SECTION
Data:    DS.W 5 ; Each interrupt increments an element of the table.
CodeSec: SECTION

; Implementation of the interrupt functions.
IRQ1Func:
    LDA #0
    BRA int
SWIFunc:
    LDA #4
    BRA int
ResetFunc:
    LDA #8
    
```

```

        BRA  entry
int:
        PSHH
        LDHX #Data ; Load address of symbol Data in X
        ; X <- address of the appropriate element in the tab
Offset:  TSTA
        BEQ  Offset3
Offset2:
        AIX  #$1
        DECA
        BNE  Offset2
Offset3:
        INC  0, X ; The table element is incremented
        PULH
        RTI
entry:
        LDHX #$0E00 ; Init Stack Pointer to $E00-$1=$DFE
        TXS
        CLRX
        CLRH

        CLI           ; Enables interrupts

loop:   BRA  loop
  
```

### NOTE

The functions “IRQFunc”, “XIRQFunc”, “SWIFunc”, “OpCodeFunc”, “ResetFunc” are published. This is required because they are referenced in the linker PRM file. The HC08 processor automatically pushes the PC, X, A, and CCR registers on the stack on occurrence of an interrupt. The interrupt function do not need to save and restore those registers. To maintain compatibility with the M6805 Family, the H register is not stacked, it is the user’s responsibility to save and restore it prior to returning. All Interrupt functions must be terminated with an RTI instruction.

The vector table is initialized using the linker command VECTOR ADDRESS.

Example:

```

LINK test.abs
NAMES
    test.o
END
  
```



```

SEGMENTS
  MY_ROM    = READ_ONLY  0x0800 TO 0x08FF;
  MY_RAM    = READ_WRITE 0x0B00 TO 0x0CFF;
  MY_STACK  = READ_WRITE 0x0D00 TO 0x0DFF;
END
PLACEMENT
  .data      INTO MY_RAM;
  .text      INTO MY_ROM;
  .stack     INTO MY_STACK;
END
INIT ResetFunc
VECTOR ADDRESS 0xFFFF8 IRQ1Func
VECTOR ADDRESS 0xFFFFC SWIFunc
VECTOR ADDRESS 0xFFFFE ResetFunc
  
```

### NOTE

The statement “INIT ResetFunc” defines the application entry point. Usually, this entry point is initialized with the same address as the reset vector. The statement “VECTOR ADDRESS 0xFFFFA IRQFunc” specifies that the address of function “IRQFunc” should be written at address 0xFFFFA.

#### 12.4.2 Initializing Vector Table In Assembly Source File Using A Relocatable Section

Initializing the vector table in the assembly source file requires that all the entries in the table are initialized. Interrupts, which are not used, must be associated with a standard handler.

The labels or functions, which should be inserted in the vector table must be implemented in the assembler source file or an external reference must be available for them. The vector table can be defined in an assembly source file in an additional section containing constant variables.

Example:

```

                XDEF ResetFunc
DataSec: SECTION
Data:    DS.W 5 ; Each interrupt increments an element of the table.
CodeSec: SECTION
; Implementation of the interrupt functions.
IRQ1Func:
        LDA    #0
        BRA    int
SWIFunc:
        LDA    #4
        BRA    int
  
```

```

ResetFunc:
    LDA    #8
    BRA    entry

DummyFunc:
    RTI

int:
    PSHH
    LDHX  #Data ; Load address of symbol Data in X
            ; X <- address of the appropriate element in the tab

Offset:   TSTA
          BEQ  Offset3

Offset2:
          AIX  #$1
          DECA
          BNE  Offset2

Offset3:
          INC  0, X ; The table element is incremented
          PULH
          RTI

entry:
          LDHX #0E00 ; Init Stack Pointer to $E00-$1=$DFE
          TXS
          CLRX
          CLRH

          CLI ; Enables interrupts

loop:    BRA  loop

VectorTable: SECTION
; Definition of the vector table.
IRQ1Int:    DC.W  IRQ1Func
IRQ0Int:    DC.W  DummyFunc
SWIInt:     DC.W  SWIFunc
ResetInt:   DC.W  ResetFunc
  
```

**NOTE**

The statement “INIT ResetFunc” defines the application entry point. Usually, this entry point is initialized with the same address as the reset vector. The statement “VECTOR ADDRESS 0xFFFFA IRQFunc” specifies that the address of function “IRQFunc” should be written at address 0xFFFFA.

The section should now be placed at the expected address. This is performed in the linker parameter file.

Example:

```
LINK test.abs
NAMES
    test.o
END
SEGMENTS
    MY_ROM    = READ_ONLY    0x0800 TO 0x08FF;
    MY_RAM    = READ_WRITE   0x0B00 TO 0x0CFF;
    MY_STACK  = READ_WRITE   0x0D00 TO 0x0DFF;
/* Define the memory range for the vector table */
    Vector    = READ_ONLY    0xFFFF8 TO 0xFFFF;
END
PLACEMENT
    .data      INTO MY_RAM;
    .text      INTO MY_ROM;
    .stack     INTO MY_STACK;
/* Place the section 'VectorTable' at the appropriated address. */
    VectorTable INTO Vector;
END
INIT ResetFunc
ENTRIES
    *
END
```

### NOTE

The statement “Vector = READ\_ONLY 0xFFFF8 TO 0xFFFF” defines the memory range for the vector table. The statement “VectorTable INTO Vector” specifies that the vector table should be loaded in the read only memory area Vector. This means, the constant “IRQ1Int” will be allocated at address 0xFFFF8, the constant “IRQ0Int” will be allocated at address 0xFFFFA, the constant “SWIInt” will be allocated at address 0xFFFFC, and the constant “ResetInt” will be allocated at address 0xFFFFE. The statement “ENTRIES \* END” switches smart linking OFF. If this statement is missing in the PRM file, the vector table will not be linked with the application, because it is never referenced. The smart linker only links the referenced objects in the absolute file.

### 12.4.3 Initializing Vector Table In Assembly Source File Using An Absolute Section

Initializing the vector table in the assembly source file requires that all the entries in the table are initialized. Interrupts, which are not used, must be associated with a standard handler.

The labels or functions, which should be inserted in the vector table must be implemented in the assembly source file or an external reference must be available for them. The vector table can be defined in an assembly source file in an additional section containing constant variables.

Example:

```

                XDEF ResetFunc
DataSec: SECTION
Data:          DS.W 5 ; Each interrupt increments an element of the table.
CodeSec: SECTION
; Implementation of the interrupt functions.
IRQ1Func:
                LDA    #0
                BRA    int
SWIFunc:
                LDA    #4
                BRA    int
ResetFunc:
                LDA    #8
                BRA    entry
DummyFunc:
                RTI
int:
                PSHH
                LDHX  #Data ; Load address of symbol Data in X
                ; X <- address of the appropriate element in the tab
Offset:       TSTA
                BEQ   Offset3
  
```



```

Offset2:
    AIX  #\$1
    DECA
    BNE  Offset2

Offset3:
    INC  0, X    ; The table element is incremented
    PULH
    RTI

entry:
    LDHX #\$0E00 ; Init Stack Pointer to \$E00-\$1=\$DFF
    TXS
    CLRX
    CLRH
    CLI          ; Enables interrupts

loop:    BRA loop

                ORG \$FFF8
; Definition of the vector table in an absolute section
; starting at address \$FFF8.
IRQ1Int:    DC.W IRQ1Func
IRQ0Int:    DC.W DummyFunc
SWIInt:     DC.W SWIFunc
ResetInt:   DC.W ResetFunc

```

**NOTE**

“Vector = READ\_ONLY 0xFFFF8 TO 0xFFFF” defines the memory range for the vector table. “VectorTable INTO Vector” specifies the vector table should be loaded in the read only memory area Vector. This means the constant “IRQ1Int” will be allocated at address 0xFFFF8, the constant “IRQ0Int” will be allocated at address 0xFFFFA, the constant “SWIInt” will be allocated at address 0xFFFFC, and the constant “ResetInt” will be allocated at address 0xFFFFE. The statement “ENTRIES \* END” switches smart linking OFF. If this statement is missing in the PRM file, the vector table will not be linked with the application, because it is never referenced. The smart linker only links the referenced objects in the absolute file.

The section should now be placed at the expected address using the linker parameter file.

**Example:**

```

LINK test.abs
NAMES
    test.o
END
SEGMENTS
    MY_ROM = READ_ONLY 0x0800 TO 0x08FF;
    MY_RAM = READ_WRITE 0x0B00 TO 0x0CFF;

```

```

MY_STACK = READ_WRITE 0x0D00 TO 0x0DFF;
END
PLACEMENT
.data      INTO MY_RAM;
.text     INTO MY_ROM;
.stack    INTO MY_STACK;
END
INIT ResetFunc
ENTRIES
*
END

```

**NOTE**

The statement “ENTRY \* END” switches smart linking OFF. If this statement is missing in the PRM file, the vector table will not be linked with the application, because it is never referenced. The smart linker only links the referenced objects in the absolute file.

**12.5 SPLITTING AN APPLICATION INTO DIFFERENT MODULES**

A complex application or application involving several programmers can be split into several simple modules. In order to avoid any problem when merging the different modules, for each assembly source file, one include file must be created containing the definition of the Symbols exported from this module. For the symbols referring to code label, a small description of the interface is required.

Example of Assembly File (Test1.asm):

```

XDEF AddSource
XDEF Source

initStack:EQU $AFF

DataSec: SECTION
Source:   DS.W 1
CodeSec: SECTION
AddSource:
    ADD Source
    STA Source
    RTS

```

Corresponding Include File (Test1.inc):

```

XREF AddSource
; The function AddSource adds the value stored in the variable
; Source to the content of register A.
; The result of the computation
; is stored in the variable Source.

```





```

;
; Input Parameter : register A contains the value, which should be
;                   added to the variable Source.
; Output Parameter: register A contains the result of the addition.

        XREF Source
; The variable Source is a word variable.
  
```

Each assembly module using one of the symbols defined in another assembly file should include the corresponding include file.

Example of Assembly File (Test2.asm):

```

        XDEF entry
        INCLUDE "Test1.inc"

initStack: EQU $AFE

CodeSec: SECTION
entry:   LDHX #initStack
        TXS
        LDA #$7
        JSR AddSource
        BRA entry
  
```

The application PRM file should list both object files building the application. When a section is present in the different object files, the object file sections are concatenated in a single absolute file section. The different object file sections are concatenated in the order the object files are specified in the PRM file.

Example of PRM File (Test2.prm):

```

LINK test2.abs      /* Name of the executable file generated. */
NAMES
  test1.o test2.o /*Name of object files building application.*/
END
SEGMENTS
  MY_ROM = READ_ONLY 0x0B00 TO 0x0BFF; /* READ_ONLY memory area
*/
  MY_RAM = READ_WRITE 0x0800 TO 0x08FF; /* READ_WRITE memory area
*/
END
PLACEMENT
  DataSec,.data INTO MY_RAM; /* variables are allocated in MY_RAM
*/
  CodeSec,.text INTO MY_ROM; /* code and constants */
                          /* are allocated in MY_ROM */
END
INIT entry             /* Definition of the application entry point. */
  
```

VECTOR ADDRESS 0xFFFFE entry/\* Definition of the reset vector. \*/

### NOTE

The statement “NAMES test1.o test2.o END” lists the object files building the application. A space character separates the object file names. The section “CodeSec” is defined in both object files. In “test1.o”, the section “CodeSec” contains the symbol “AddSource”. In “test2.o”, the section “CodeSec” contains the symbol “entry”. According to the order in which the object file are listed in the NAMES block, the function “AddSource” will be allocated first and symbol “entry” will be allocated next to it.

## 12.6 USING DIRECT ADDRESSING MODE TO ACCESS SYMBOLS

There are different ways to inform the assembler it should use direct addressing mode on a symbol.

### 12.6.1 Using Direct Addressing Mode To Access External Symbols

External symbols, which should be accessed using the direct addressing mode, must be declared using the directive XREF.B in place of XREF.

Example:

```
XREF.B ExternalDirLabel
XREF   ExternalExtLabel
...
LDA   ExternalDirLabel ; Direct addressing mode is used.
...
LDA   ExternalExtLabel ; Extended addressing mode is used.
```

### 12.6.2 Using Direct Addressing Mode To Access Exported Symbols

Symbols, which are exported using the directive XDEF.B, will be accessed using the direct addressing mode. Symbols, which are exported using the directive XDEF, are accessed using the extended addressing mode.

Example:

```
XDEF.B DirLabel
XDEF   ExtLabel
...
LDA   DirLabel ; Direct addressing mode is used.
...
LDA   ExtLabel ; Extended addressing mode is used.
```

### 12.6.3 Defining Symbols In The Direct Page

Symbols defined in the predefined section BSCT, are accessed with direct addressing mode.



Example:

```

...
    BSCT
DirLabel: DS.B 3
dataSec: SECTION
ExtLabel: DS.B 5
...
codeSec: SECTION
...
    LDA    DirLabel ; Direct addressing mode is used.
...
    LDA    ExtLabel ; Extended addressing mode is used.

```

### 12.6.4 Using A Force Operator

A force operator can be specified in an assembly instruction to force direct or extended addressing mode.

The supported force operators are:

- < or .B to force direct addressing mode
- > or .W to force extended addressing mode

Example:

```

...
dataSec: SECTION
label: DS.B 5
...
codeSec: SECTION
...
    LDA    <label ; Direct addressing mode is used.
    LDA    label.B; Direct addressing mode is used.
...
    LDA    >label ; Extended addressing mode is used.
    LDA    label.W ; Extended addressing mode is used.

```

### 12.6.5 Using SHORT Sections

Symbols, which are defined in a section defined with the qualifier SHORT are always accessed using the direct addressing mode.

Example:

```

...
shortSec: SECTION SHORT
DirLabel: DS.B 3

```



```

...
dataSec: SECTION
ExtLabel: DS.B 5
...
codeSec: SECTION
...
    LDA    DirLabel ; Direct addressing mode is used.
...
    LDA    ExtLabel ; Extended addressing mode is used.

```

## 12.7 DIRECTLY GENERATING AN .ABS FILE

The MCUEZ Assembler generates an .ABS file directly from your assembly source file. A Motorola S file is generated at the same time and can be directly burnt into an EPROM.

### 12.7.1 Assembler Source File

When an .ABS file is generated using the Assembler (as no linker is involved), the application must be implemented in a single assembly unit and contain only absolute sections. This is shown in the code example following the note below.

Example:

```

        ABSENTRY entry ; Specifies the application Entry point
iniStk: EQU $AFE        ; Initial value for SP
        ORG $FFFE      ; Reset vector definition
Reset:  DC.W entry
        ORG $40        ; Define an absolute constant section
var1:   DC.B 5         ; Assign 5 to the symbol var1
        ORG $80        ; Define an absolute data section
data:   DS.B 1         ; Define one byte variable in RAM address 40
        ORG $B00       ; Define an absolute code section
entry:
        LDHX #iniStk ; Load stack pointer
        TXS
        LDA  var1
main:
        INCA
        STA  data
        BRA  main

```

When writing your assembly source file for direct absolute file generation pay special attention to the following points:

- The directive `ABSENTRY` is used to write the entry point address in the generated absolute file. To set the entry point of the application on the label `entry` in the absolute file, the following code is needed: `ABSENTRY entry`
- The reset vector must be initialized in the assembly source file, specifying the application entry point. An absolute section is created at the reset vector address. This section contains the application entry point address. To set the entry point of the application at address `$FFFE` on the label `entry`, the following code is needed:

```

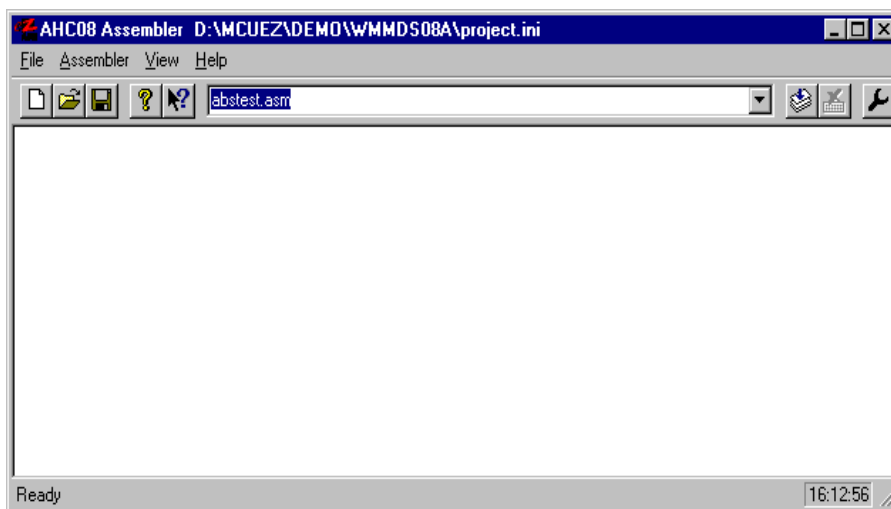
        ORG $FFFE      ; Reset vector definition
Reset:DC.W entry
    
```

- It is strongly recommended to use separate sections for code, data and constants. All sections used in the Assembler application must be absolute. They must be defined using the `ORG` directive. The address for constant or code sections has to be located in the ROM memory area, while the data sections have to be located in RAM area (according to the hardware which is used). It is the programmer responsibility to ensure that no sections overlaps occur.

### 12.7.2 Assembling And Generating The Application

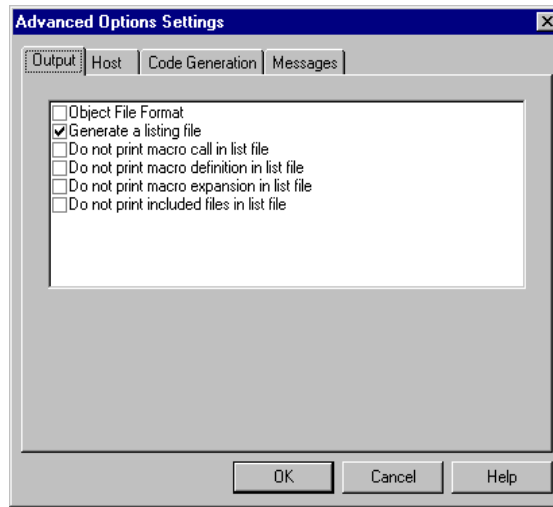
Once the source file is available, you can assemble it.

1. Start the Macro Assembler clicking the HC08 Assembler ezASM icon in the MCUEz shell tool bar. The MCUEz Assembler is started, shown in the following figure. Enter the name of the file to be assembled in the editable combo box, in our example `abstest.asm`.



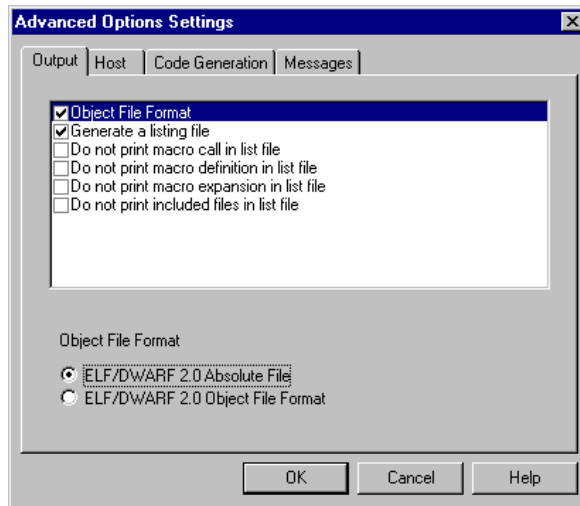
**Figure 12-1. Starting The MCUEz Assembler**

2. Select the menu entry *Assembler / Advanced*. The Advanced Options Settings dialog is displayed, shown in the following figure.



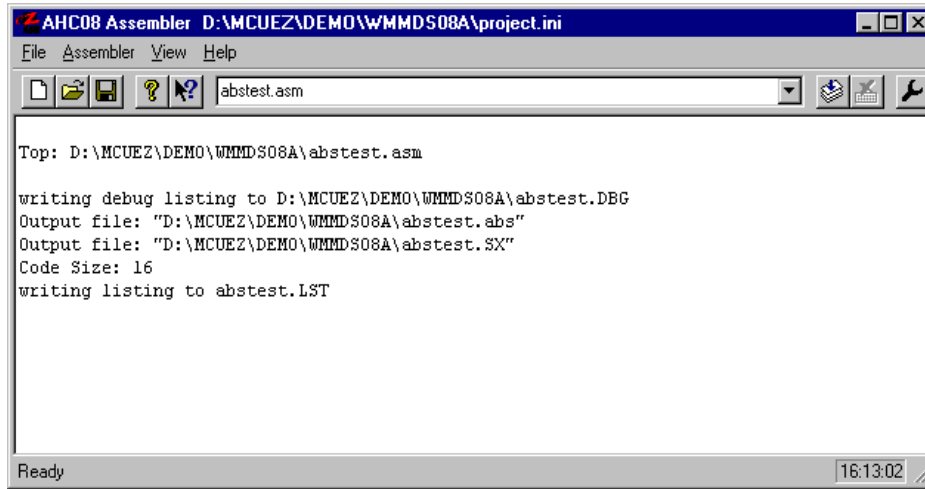
**Figure 12-2. Displaying The Advanced Options Setting Dialog**

3. In the Output folder, select the check box in front of the label *Object File Format*. More information is displayed at the bottom of the dialog, shown below:



**Figure 12-3. Selecting The Object File Format**

4. Select the radio button ELF/DWARF 2.0 Absolute File and click OK. The Assembler is now ready to generate an absolute file. The file is assembled as soon as you click on the *Assemble* button. The assembly process is shown in the following illustration:



**Figure 12-4. The Assembler Generating An .ABS File Directly**

The absolute that is generated is to be used with the HC08 target board or emulator uses the generated .abs file. You can download this file directly to the HC08 target. The target must be reset using menu entry MMDS0508 / Reset before running the application. The .sx file that is generated is a standard Motorola S record file. This file can be directly burnt into an EPROM.







## CHAPTER 13

### ASSEMBLER MESSAGES

#### 13.1 INTRODUCTION

The Assembler can generate three types of messages:

- Warning
- Error
- Fatal

##### 13.1.1 Warning

A message will be printed and assembling will continue. Warning messages are used to indicate possible programming errors to the user.

##### 13.1.2 Error

A message will be printed and assembling will be stopped. Error messages are used to indicate illegal language usage.

##### 13.1.3 Fatal

A message will be printed and assembling will be aborted. A fatal message indicates a severe error which will stop the assembling.

#### 13.2 MESSAGE CODES

If the Assembler prints out a message, the message contains a message code ('A' for Assembler) and a four to five digit number. This number may be used to search for the indicated message in the manual. All messages generated by the Assembler are documented in increasing order for easy and fast retrieval.

Each message also has a description and if available a short example with a possible solution or tips to fix a problem. For each message the type of message is also noted, e.g. [ERROR] indicates that the message is an error message.



### 13.2.1 A1000: Conditional Directive Not Closed

Type:

[ ERROR ]

Description:

One of the conditional blocks is not closed. A conditional block can be opened using one of the following directives:

IF, IFEQ, IFNE, IFLT, IFLE, IFGT, IFGE, IFC, IFNC, IFDEF, IFNDEF.

Example:

```

        IFEQ (defineConst)
const1: DC.B 1
const2: DC.B 2
    
```

Tips:

Close the conditional block with an ENDIF or ENDC directive.

Example:

```

        IFEQ (defineConst)
const1: DC.B 1
const2: DC.B 2
        ENDIF
    
```

Be careful:

A conditional block, which starts inside of a macro, must be closed within the same macro.

Example:

Following portion of code generates an error, because the conditional block “IFEQ” is opened within the macro “MyMacro” and is closed outside from the macro.

```

MyMacro: MACRO
        IFEQ (SaveRegs)
            NOP
            NOP
        ENDM
            NOP
        ENDIF
    
```



### 13.2.2 A1001: Conditional Else Not Allowed Here

Type:

[ ERROR ]

Description:

A second ELSE directive is detected in a conditional block.

Example:

```

        IFEQ (defineConst)
    ...
        ELSE
    ...
        ELSE
    ...
        ENDIF
    
```

Tips:

Remove the superfluous ELSE directive.

Example:

```

        IFEQ (defineConst)
    ...
        ELSE
    ...
        ENDIF
    
```



### 13.2.3 A1051: Zero Division In Expression

Type:

[ERROR]

Description:

A zero division is detected in an expression.

Example:

```
label: EQU 0;
label2: EQU $5000
...
        LDX #(label2/label)
```

Tips:

Modify the expression or specify it in a conditional assembly block.

Example:

```
label: EQU 0;
label2: EQU $5000
...
        IFNE (label)
            LDX #(label2/label)
        ELSE
            LDX #label2
        ENDIF
```



### 13.2.4 A1052: Right Parenthesis Expected

Type:

[ERROR]

Description:

A right parenthesis is missing in an assembly expression or in a expression containing an HIGH or LOW operator.

Example:

```
MyData: SECTION
variable: DS.B 1

label: EQU (2*4+6
label2: EQU PAGE (variable
label5: EQU HIGH (variable
```

Tips:

Insert the right parenthesis at the correct position.

Example:

```
MyData: SECTION
variable: DS.B 1

label: EQU (2*4)+6
label2: EQU PAGE(variable)
label5: EQU HIGH (variable)
```



### 13.2.5 A1053: Left Parenthesis Expected

Type:

[ ERROR ]

Description:

A left parenthesis is missing in an expression containing a reference to the page (bank) where an object is allocated.

Example:

```
MyData: SECTION
variable: DS.B 1
label3: EQU PAGE variable)
label5: EQU HIGH variable)
```

Tips:

Insert the left parenthesis at the correct position.

Example:

```
MyData: SECTION
variable: DS.B 1

label3: EQU PAGE (variable)
label5: EQU HIGH (variable)
```



**13.2.6 A1101: Illegal Label: Label Is Reserved**

Type:

[ ERROR ]

Description:

A reserved identifier is used as label. Reserved identifiers are:

- Mnemonics associated with target processor registers  
A, CCR, SP, and X
- Mnemonics associated with special target processor operator.  
HIGH and LOW

Example:

```
A:    NOP
      NOP
      RTS
```

Tips:

Modify the name of the label to a identifier which is not reserved.

Example:

```
ASub: NOP
      NOP
      RTS
```



### 13.2.7 A1103: Illegal Redefinition Of Label

Type:

[ ERROR ]

Description

The label specified in front of a comment or an assembly instruction or directive, is detected twice in a source file.

Example:

```

                                XDEF Entry

DataSec1: SECTION
DataLab1: DS.W 2
DataLab2: DS.L 2

CodeSec1: SECTION
MySub:   LDX #DataLab1
        CPX #$500
        BNE CodLab2
        NOP
        NOP
        NOP
CodLab2: RTS

Entry:   LDHX #$4000
        TXS

main:   BSR MySub
        BRA main
    
```





**13.2.8 A1104: Undeclared User Defined Symbol <SymbolName>**

Type:

[ERROR]

Description:

The label <symbolName> is referenced in the assembly file, but it is never defined.

Example:

```
Entry:
  LDA #56
  STA Variable
  RTS
```

Tips:

The label <symbolName> must be defined in the assembly file or made an external label.

Example:

```
      XREF Variable
...
Entry:
  LDA #56
  STA Variable
  RTS
```

**13.2.9 A2301: Label Is Missing**

Type:

[ERROR]

Description:

A label is missing from an assembly directive that requires a label (SECTION, EQU, SET).

Example:

```
SECTION 4
...
EQU $67
...
SET $77
```

Tips:

Insert a label in front of the directive.

Example:

```
codeSec: SECTION 4
...
myConst: EQU $67
...
mySetV: SET $77
```



**13.2.10 A2302: Macro Name Is Missing**

Type:

[ ERROR ]

Description:

A label name is missing on the front of a MACRO directive.

Example:

```
MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
```

Tips:

Insert a label in front of the MACRO directive.

Example:

```
AddM: MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
```



### 13.2.11 A2303: Endm Is Illegal

Type:

[ ERROR ]

Description:

An ENDM directive is detected outside of a macro.

Example:

```

AddM: MACRO
    LDA \1
    ADD \2
    STA \1
    ENDM
    NOP
    AddM data1, data2
    ENDM
    
```

Tips:

Remove the superfluous ENDM directive.

Example:

```

AddM: MACRO
    LDA \1
    ADD \2
    STA \1
    ENDM
    NOP
    AddM data1, data2
    
```



### 13.2.12 A2304: Macro Definition Within Definition

Type:

[ ERROR ]

Description:

A macro definition is detected inside of another macro definition. The macro assembler does not support this.

Example:

```

AddM: MACRO
AddX: MACRO
    LDX \1
    INX
    STX \1
ENDM
    LDA \1
    ADD \2
    STA \1
ENDM
    
```

Tips:

Define the second macro outside from the first one.

Example:

```

AddX: MACRO
    LDX \1
    INX
    STX \1
ENDM
AddM: MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
    
```



### 13.2.13 A2305: Illegal Redefinition Of Instruction Or Directive Name

Type:

[ ERROR ]

Description:

An assembly directive or an instruction name has been used as macro name. This is not allowed to avoid any ambiguity when the symbol name is encountered afterward. The macro assembler cannot detect if the symbol refers to the macro or the instruction.

Example:

```
ADDD: MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
```

Tips:

Change the name of the macro to an unused identifier.

Example:

```
ADDM: MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
```



### 13.2.14 A2306: Macro Not Closed At End Of Source

Type:

[ ERROR ]

Description:

An ENDM directive is missing at the end of a macro. The end of the input file is detected before the end of the macro.

Example:

```
AddM: MACRO
    LDA \1
    ADD \2
    STA \1
    NOP
AddM data1, data2
```

Tips:

Insert the missing ENDM directive at the end of the macro.

Example:

```
AddM: MACRO
    LDA \1
    ADD \2
    STA \1
    ENDM
    NOP
AddM data1, data2
```



### 13.2.15 A2307: Macro Redefinition

Type:

[ ERROR ]

Description:

The input file contains the definition of two macros that have the same name.

Example:

```

AddM: MACRO
    LDX \1
    INX
    STX \1
ENDM

...
AddM: MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
    
```

Tips:

Change the name of one of the macros to generate unique identifiers.

Example:

```

AddX: MACRO
    LDX \1
    INX
    STX \1
ENDM

AddM: MACRO
    LDA \1
    ADD \2
    STA \1
ENDM
    
```



**13.2.16 A2308: File Name Expected**

Type:

[ERROR]

Description:

A file name is expected in an INCLUDE directive.

Example:

```
xxx: EQU $56
...
INCLUDE xxx
```

Tips:

Specify a file name after the include directive.

Example:

```
xxx: EQU $56
...
INCLUDE "xxx.inc"
```

**13.2.17 A2309: File Not Found**

Type:

[ERROR]

Description:

The macro assembler cannot locate a file with the name specified in the INCLUDE directive.

Tips:

If the file exists, check if the directory is specified in the GENPATH environment variable. First check if your project directory is correct. A file "default.env" should be located there, where the MCUEz environment variables are stored. The macro assembler looks for the included files in the project directory, then in the directory enumerated in the GENPATH environment variable. If the file does not exist, create it or remove the include directive.





### 13.2.18 A2310: Illegal Size Char

Type:

[ERROR]

Description:

An invalid size specification character is detected in a DCB, DC, DS, FCC, FCB, FDB, RMB, XDEF, or XREF directive.

For XDEF and XREF directives, valid size specification characters are:

- .B for symbols located in a section where direct addressing mode can be used
- .W for symbols located in a section where extended addressing mode must be used

For DCB, DC, DS, FCC, FCB, FDB, and RMB directives, valid size specification characters are:

- .B for Byte variables
- .W for Word variables
- .L for Long variables

Example:

```
DataSec: SECTION
label1: DS.Q 2
...
ConstSec: SECTION
label2: DC.I 3, 4, 6
```

Tips:

Change the size specification character to a valid one.

Example:

```
DataSec: SECTION
label1: DS.L 2
...
ConstSec: SECTION
label2: DC.W 3, 4, 6
```



### 13.2.19 A2311: Symbol Name Expected

Type:

[ERROR]

Description:

A symbol name is missing after a XDEF, XREF, IFDEF, or IFNDEF directive.

Example:

```

XDEF $5645
XREF ; This is a comment
CodeSec: SECTION
...
IFDEF $5634
    
```

Tips:

Insert a symbol name at the requested position.

Example:

```

XDEF exportedSymbol
XREF importedSymbol; This is a comment
CodeSec: SECTION
...
IFDEF changeBank
    
```

### 13.2.20 A2312: String Expected

Type:

[ERROR]

Description:

A character string is expected at the end of a FCC, IFC, or IFNC directive.

Example:

```

expr: EQU $5555
expr2: EQU 5555
DataSec: SECTION
label: FCC expr
...
CodeSec: SECTION
...
IFC expr, expr2
    
```

Tips:

Insert a character string at the requested position.

Example:

```

expr: EQU $5555
expr2: EQU 5555
DataSec: SECTION
label: FCC "This is a string"
...
    
```



**13.2.21 A2313: Nesting Of Include Files Exceeds 50**

Type:

[ ERROR ]

Description:

The maximum number of nested include files has been exceeded. The assembler supports up to 50 nested include files.

Tips:

Reduce the number of nested include file to 50.

**13.2.22 A2314: Expression Must Be Absolute**

Type:

[ ERROR ]

Description:

An absolute expression is expected at the specified position.

Assembler directives expecting an absolute value: OFFSET, ORG, ALIGN, SET, BASE, DS, LLEN, PLEN, SPC, TABS, IF, IFEQ, IFNE, IFLE, IFLT, IFGE, IFGT

The first operand in a DCB directive must be absolute:

Example:

```
DataSec: SECTION
label1: DS.W 1
label2: DS.W 2
label3: EQU 8
...
codeSec: SECTION
...
        BASE label1
...
        ALIGN label2
```

Tips:

Specify an absolute expression at the specified position.

Example:

```
DataSec: SECTION
label1: DS.W 1
label2: DS.W 2
label3: EQU 8
...
codeSec: SECTION
...
        BASE label3
...
        ALIGN 4
```

**13.2.23 A2316: Section Name Required**

Type:

[ ERROR ]

Description:

A SWITCH directive is not followed by a symbol name. Absolute expressions or strings are not allowed in a SWITCH directive.

The symbol specified in a SWITCH directive must refer to a previously defined section.

Example:

```

dataSec: SECTION
label1: DS.B 1
...
codeSec: SECTION
...
                SWITCH $A344
...

```

Tips:

Specify the name of a previously define section in the SWITCH instruction.

Example:

```

dataSec: SECTION
label1: DS.B 1
...
codeSec: SECTION
...
                SWITCH dataSec
...

```



### 13.2.24 A2317: Illegal Redefinition Of Section Name

Type:

[ ERROR ]

Description:

The name associated with a section is previously used as a label in a code or data section or is specified in a XDEF directive.

The macro assembler does not allow to export a section name, or to use the same name for a section and a label.

Example:

```

dataSec: SECTION
secLabel: DS.B 1
label1: DS.B 2
label2: DS.B 1
...
secLabel: SECTION
        LDA #1
...
    
```

Tips:

Change name of the section to a unique identifier.

Example:

```

dataSec: SECTION
data: DS.B 1
label1: DS.B 2
label2: DS.B 1
...
codeSec: SECTION
        LDA #1
...
    
```

**13.2.25 A2318: Section Not Declared**

Type:

[ ERROR ]

Description:

The label specified in a SWITCH directive is not associated with a section.

Example:

```
dataSec: SECTION
label1: DS.B 1
...
codeSec: SECTION
...
                SWITCH daatSec
...
```

Tips:

Specify the name of a previously defined section in the SWITCH instruction.

Example:

```
dataSec: SECTION
label1: DS.B 1
...
codeSec: SECTION
...
                SWITCH dataSec
...
```



### 13.2.26 A2320: Value Too Small

Type:

[ ERROR ]

Description:

The absolute expression specified in a directive is too small.

This message can be generated in following cases:

- The expression specified in an ALIGN, DCB, or DS directive is smaller than 1.
- The expression specified in a PLEN directive is smaller than 10. A header is generated on the top of each page from the listing file. This header contains at least 6 lines. So a page length smaller than 10 lines does not make many sense.
- The expression specified in a LLEN, SPC, or TABS directive is smaller than 0 (negative).

Example:

```

                PLEN    5
                LLEN   -4
dataSec: SECTION
                ALIGN   0
...
label1:  DS.W    0
...

```

Tips:

Modify the absolute expression to a value in the range specified above.

Example:

```

                PLEN    50
                LLEN    40
dataSec: SECTION
                ALIGN   8
...
label1:  DS.W    1
...

```

**13.2.27 A2321: Value Too Big**

Type:

[ ERROR ]

Description:

The absolute expression specified in a directive is too big.

This message can be generated in the following cases:

- The expression specified in an ALIGN directive is bigger than 32767.
- The expression specified in a DS or DCB directive is bigger than 4096.
- The expression specified in a PLEN directive is bigger than 10000.
- The expression specified in a LLEN directive is bigger than 132.
- The expression specified in a SPC directive is bigger than 65.
- The expression specified in a TABS directive is bigger than 128.

Example:

```

                PLEN    50000
                LLEN    200
dataSec: SECTION
                ALIGN   40000
...
label1:  DS.W    5000
...

```

Tips:

Modify the absolute expression to a value in the range specified above.

Example:

```

                PLEN    50
                LLEN    40
dataSec: SECTION
                ALIGN   8
...
label1:  DS.W    1
...

```





### 13.2.28 A2323: Label Is Ignored

[WARNING]

**Description:**

A label is specified in front of a directive that does not accept a label. The macro assembler ignores such labels.

These labels cannot not be referenced anywhere else in the application. Labels will be ignored in front of following directives:

ELSE, ENDF, END, ENDM, INCLUDE, CLIST, ALIST, FAIL, LIST, MEXIT, NOLIST, NOL, OFFSET, ORG, NOPAGE, PAGE, LLEN, PLEN, SPC, TABS, TITLE, TTL.

**Example:**

```
CodeSec: SECTION
        LDA #$5444
label:  PLEN 50
...
label2: LIST
...
```

**Tips:**

Remove the label which is not required. If you need a label at that position in a section, define the label on a separate line.

**Example:**

```
CodeSec: SECTION
        LDA #$5444
label:
        PLEN 50
...
label2:
        LIST
...
```

**13.2.29 A2324: Illegal Base (2,8,10,16)**

Type:

[ ERROR ]

Description:

An invalid base number follows a BASE directive. The valid base numbers are 2, 8, 10 or 16.

The expression specified in a BASE directive must be an absolute expression and must match one of the values enumerated above.

Example:

```

                BASE  67
...
dataSec: SECTION
label:   DS.B 8
...
                BASE  label
    
```

Tips:

Specify one of the valid value in the BASE directive.

Example:

```

                BASE  16
...
dataSec: SECTION
label:   EQU 8
...
                BASE  label
    
```



### 13.2.30 A2325: Comma Or Line End Expected

Type:

[ERROR]

Description:

An incorrect syntax has been detected in a DC, FCB, FDB, XDEF, PUBLIC, GLOBAL, XREF, or EXTERNAL directive. This error message is generated when the values enumerated in one of the directives listed above are not terminated by an end of line character, or when they are not separated by a “,” character.

Example:

```
XDEF  aa1 aa2 aa3 aa4
XREF  bb1, bb2, bb3, bb4      This is a comment

...
dataSec: SECTION
dataLab1: DC.B 2 | 4 | 6 | 8
dataLab2: FCB 45, 66, 88      label3:DC.B 4
```

Tips:

Use the “,” character as separator between the different items in the list or insert an end of line at the end of the enumeration.

Example:

```
XDEF  aa1, aa2, aa3, aa4
XREF  bb1, bb2, bb3, bb4      ;This is a comment

...
dataSec: SECTION
dataLab1: DC.B 2, 4, 6, 8
dataLab2: FCB 45, 66, 88
label3:   DC.B 4
```

### 13.2.31 A2326: Label Is Redefined

Type:

[ERROR]

Description:

A label redefinition has been detected. This message is issued when:

- The label specified in front of a DC, DS, DCB, FCC directive is already defined.
- One of the label names enumerated in a XREF directive is already defined.
- The label specified in front of an EQU directive is already defined.
- The label specified for a SET is already defined and not associated with another SET.
- A label with the same name as an external referenced symbol is defined in the source file.

Example:

```
DataSec: SECTION
label1: DS.W 4
...
          BSCT
label1: DS.W 1
```

Tips:

Modify your source code to use unique identifiers.

Example:

```
DataSec: SECTION
data_label1: DS.W 4
...
          BSCT
bsct_label1: DS.W 1
```

### 13.2.32 A2327: ON Or OFF Expected

Type:

[ERROR]

Description:

The MLIST or CLIST directive expect a unique operand with the value ON or OFF.

Example:

```
CodeSec: SECTION
...
          CLIST
...
```

Tips:

Specify either ON or OFF after the MLIST or CLIST directive.

Example:

```
CodeSec: SECTION
...
          CLIST ON
```



### 13.2.33 A2328: Value Is Truncated

[WARNING]

Description:

The size of one of the constants listed in a DC directive is bigger than the size specified in the DC directive.

Example:

```
DataSec: SECTION
cst1:    DC.B  $56, $784, $FF
cst2:    DC.w  $56, $784, $FF5634
```

Tips:

Reduce the value from the constant to a value fitting in the size specified in the DC directive.

Example:

```
DataSec: SECTION
cst1:    DC.B  $56, $7, $84, $FF
cst2:    DC.W  $56, $784, $FF, $5634
```

### 13.2.34 A2329: FAIL Found

Type:

[ERROR]

Description:

The FAIL directive followed by a number smaller than 500 has been detected in the source file. This is the normal behavior for the FAIL directive. The FAIL directive is intended for use with conditional assembly, to detect a user defined error or warning condition.

Example:

```
cpChar: MACRO
    IFC "\1", ""
        FAIL 200
        MEXIT
    ELSE
        LDA \1
    ENDF

    IFC "\2", ""
        FAIL 600
    ELSE
        STA \2
    ENDF
ENDM
codeSec: SECTION
Start:
    cpChar , char2
```

**13.2.35 A2330: String Is Not Allowed**

Type:

[ERROR]

Description:

A string has been specified as the initial value in a DCB directive. The initial value for a constant block can be any byte, word or long absolute expression as well as a simple relocatable expression.

Example:

```
CstSec: SECTION
label: DCB.B 10, "aaaaa"
```

Tips:

Specify the ASCII code associated with the characters in the string as initial value.

Example:

```
CstSec: SECTION
label: DCB.B 5, $61
```

**13.2.36 A2332: FAIL Found**

[WARNING]

Description:

The FAIL directive followed by a number bigger than 500 has been detected in the source file. This is the normal behavior for the FAIL directive. The FAIL directive is intended for use with conditional assembly, to detect a user defined error or warning condition.

Example:

```
cpChar: MACRO
    IFC "\1", ""
        FAIL 200
        MEXIT
    ELSE
        LDA \1
    ENDF

    IFC "\2", ""
        FAIL 600
    ELSE
        STA \2
    ENDF
ENDM
codeSec: SECTION
Start:
    cpChar char1
```



**13.2.37 A2333: Forward Reference Not Allowed**

Type:

[ERROR]

Description:

A forward reference has been detected in an EQU instruction. This is not allowed.

Example:

```
CstSec: SECTION
label: DCB.B 10, $61
equLab: EQU label2
...
label2: DC.W $6754
...
```

Tips:

Move the EQU after the definition of the label it refers to.

Example:

```
CstSec: SECTION
label: DCB.B 10, $61
...
label2: DC.W $6754
...
equLab: EQU label2 + 1
```

**13.2.38 A2334: Only Labels Defined In The Current Assembly Unit Can Be Referenced In An Equ Expression**

Type:

[ERROR]

Description:

One of the symbols specified in an EQU expression is an external symbol, which was previously specified in a XREF directive. This is not allowed due to a limitation in the ELF file format.

Example:

```

                XREF label
CstSec: SECTION
lab: DC.B 6
...
equLabel: EQU label+6
...

```

Tips:

EQU label containing a reference to an object must be defined in the same assembly module as the object they refer to. Then the EQU label can be exported to other modules in the application.

Example:

```

                XDEF label, equlabel
                ...
CstSec: SECTION
lab: DC.B 6
label: DC.W 6
...
equLabel: EQU label+6
...

```





**13.2.39 A2335: Exported Absolute EQU Label Is Not Supported**

Type:

[ERROR]

Description:

A label specified in front of an EQU directive and initialized with an absolute value was previously specified in a XDEF directive. This is not allowed due to a limitation in the ELF file format.

Example:

```

                XDEF equLabel
CstSec: SECTION
lab: DC.B 6
...
equLabel: EQU $77AA
...

```

Tips:

EQU labels initialized with absolute expression can be defined in a special file which can be included in each assembly file where the labels are referenced.

Example:

File const.inc

```

...
equLabel: EQU $77AA
...
File Test.asm
                INCLUDE "const.inc"
CstSec: SECTION
lab: DC.B 6
...

```

**13.2.40 A2336: Value Too Big**

[WARNING]

## Description:

The absolute expression set as initialization value for a block defined using DCB is too big. This message is sent when the initial value set in a DCB .B directive cannot be coded on a byte. In this case, the value used to initialize the constant block is truncated to a byte value.

## Example:

```
constSec: SECTION
...
label1: DCB.B 2, 312
```

In the previous example, the constant block is initialized with the value \$38 (= 312 & \$FF)

## Tips:

To avoid this warning, modify the initialization value to a byte value.

## Example:

```
constSec: SECTION
...
label1: DCB.B 2, 56
```

**13.2.41 A2338: <Message String>**

## Type:

[ERROR]

## Description:

The FAIL directive followed by a string has been detected in the source file. This is the normal behavior for the FAIL directive. The FAIL directive is intended for use with conditional assembly, to detect a user defined error or warning condition.

## Example:

```
cpChar: MACRO
    IFC "\1", ""
        FAIL "A char must be specified as first param."
    MEXIT
    ELSE
        LDA \1
    ENDIF

    IFC "\2", ""
        FAIL 600
    ELSE
        STA \2
    ENDIF
ENDM
codeSec: SECTION
Start:
    cpChar , char2
```



**13.2.42 A2341: Relocatable Section Not Allowed: an Absolute file is currently directly generated**

Type:

[ERROR]

Description:

A relocatable section has been detected while the assembler tries to generate an absolute file. This is not allowed.

Example:

```
DataSec: SECTION
data1: DS.W 1
        ORG $800

entry:
        LDX #data1
```

Tips:

When you are generating an absolute file, your application should be encoded in a single assembly unit, and should not contain any relocatable symbol.

So in order to avoid this message, define all your section as absolute section and remove all XREF directives from your source file.

Example:

```
        ORG $B00
data1: DS.W 1
        ORG $800

entry:
        LDX #data1
```

**13.2.43 A13001: Illegal Addressing Mode**

Type:

[ERROR]

Description:

An illegal addressing mode has been detected in an instruction. This message is generated when an incorrect encoding is used for an addressing mode.

Example:

```
LDA [D X]
LDA [D, X]
AND 0x$FA
```

Tips:

Use a valid notation for the addressing mode encoding.

Example:

```
LDA [D, X]
AND #$FA
```

### 13.2.44 A13005: Comma Expected

Type:

[ERROR]

Description:

A comma character is missing between two instructions or directive operands. This error occurs in a memory block definition using DCB or comparing strings using IFC or IFNC.

Example:

```
MemBlock: DCB.B 8 $00
or:
test:      MACRO
           IFC \1 "c"
           nop
           nop
           ENDF
           ENDM
```

Tips:

The comma (',') character is used as separator between instruction operands.

```
MemBlock: DCB.B 8,$00
or:
test:      MACRO
           IFC \1,"c"
           nop
           nop
           ENDF
           ENDM
```

### 13.2.45 A13007: Relative Branch With Illegal Target

Type:

[ERROR]

Description:

The offset specified in a PC relative addressing mode is a complex relocatable expression, a symbol defined in another section or an external defined symbol.

Example:

```
           XDEF Entry
           XREF MySubRoutine
DataSec:  SECTION
Data:    DS.B 1
Code1Sec: SECTION
Entry1:  NOP
```



```

                LDA #$60
                STA Data
CodeSec: SECTION
Entry:
                LDA Data
                CMP #$60
                NOP
                BNE Entry1
                NOP
                BSR MySubRoutine
                NOP
main:          BRA main
    
```

**Tips:**

If you need a branch on a symbol defined externally or in another section, use JMP or JSR. If the branch label and instruction are in the same module, define them in the same section.

```

                XDEF Entry
                XREF MySubRoutine
DataSec: SECTION
Data:         DS.B 1
CodeSec: SECTION
Entry1:
                NOP
                LDA #$60
                STA Data

Entry:
                LDA Data
                CMP #$60
                NOP
                BNE Entry1
                NOP
                JSR MySubRoutine
                NOP
main:          BRA main
    
```

**13.2.46 A13008: Illegal Expression**

Type:

[ERROR]

Description:

An illegal expression is specified in a PC relative addressing mode. The illegal expression may be generated in following cases:

Example:

```

CodeSec: SECTION
Entry:
                BRA #$200
    
```



Tips:

Change the expression to a valid expression.

### 13.2.47 A13101: Illegal Operand Format

Type:

[ERROR]

Description:

An operand used in the instruction is using an invalid addressing mode.

Example:

As an example, the following code generates the A13101 error message.

Entry:

```
ADC X+
```

Tips:

To solve this problem, use an allowed addressing mode for the instruction.

Entry:

```
ADC ,X
```

```
ADC X
```

```
ADC #$5
```



### 13.2.48 A13102: Operand Not Allowed

Type:

[ ERROR ]

Description:

This error message is issued for instruction BCLR or BRSET when the operand is not a DIRECT or an EXTENDED.

Example:

```
Entry:
        BRCLR 7, X
        BRCLR 7, SP
        BSET 7, X
```

Tips:

To solve this problem, use an allowed addressing mode for the instruction.

### 13.2.49 A13106: Illegal Size Specification For HC08-Instruction

Type:

[ ERROR ]

Description:

A size operator follows an HC08 instruction. Size operators are coded as semicolon character followed by single character.

Example:

```
MyData: SECTION
data: DS.B 1
MyCode: SECTION
entry:
        ADC.B data
        ADC.L data
        ADC.W data
        ADC.b data
        ADC.l data
        ADC.w data
```

Tips:

Remove the size specification following the HC08 instruction.

Example:

```
MyData: SECTION
data: DS.B 1
MyCode: SECTION
entry:
        ADC data
```



### 13.2.50 A13108: Illegal Character At The End Of Line

Type:

[ERROR]

Description:

An invalid character or sequence of character is detected at the end of an instruction. This message can be generated when:

- A comment, which does not start with the start of comment character (“;”), is specified after the instruction.
- A further operand is specified in the instruction.

Example:

```
MyData: SECTION
data:   DS.B 1

MyCode: SECTION
entry:
        LDA data, #$7
        CLRA A
        CLR 0,X This is a comment
```

Tips:

Remove the invalid character or sequence of characters from the line.

- Insert the start of comment character at the beginning of the comment.
- Remove the superfluous operand.

Example:

```
MyData: SECTION
data:   DS.B 1

MyCode: SECTION
entry:
        LDA data
        CLRA
        CLR 0,X ;This is a comment
```





**13.2.51 A13109: Positive Value Expected**

Type:

[ ERROR ]

Description:

When using the instruction BSET, BCLR, BRSET, and BRCLR, this error message is issued if the specified value for the bit number is negative.

Example:

```
MyData: SECTION
data: DS.B 1
NEG EQU -2
MyCode: SECTION
entry:
    BCLR -7, data
    BRCLR -4, data, entry
    BSET -3, data
    BRSET NEG, data, entry
```

Tip

Use a positive value for the bit number:

```
MyData: SECTION
data: DS.B 1
POS EQU 2
MyCode: SECTION
entry:
    BCLR 7, data
    BRCLR 4, data, entry
    BSET 3, data
    BRSET POS, data, entry
```



### 13.2.52 A13110: Mask Expected

Type:

[ ERROR ]

Description:

When using the instruction BSET, BCLR, BRSET, or BRCLR, this error message is issued if the specified value for the bit number is not an Direct or an Extended.

Example:

```
MyData: SECTION
data:   DS.B 1

MyCode: SECTION
entry:
BCLR #$7, data

BRCLR #$4, data, entry

BRSET #$3, data, entry

BSET  #$2, data
```

Tip

Use a correct value for the bit number: 0, 1, 2, 3, 4, 5, 6, 7

```
MyData: SECTION
data:   DS.B 1

MyCode: SECTION
entry:
BCLR 7, data

        BRCLR 4, data, entry
        BSET 3, data

BRSET 2, data, entry
```



**13.2.53 A13111: Value Out Of Range**

[WARNING]

Description:

When using the instruction BSET, BCLR, BRSET, or BRCLR, this error message is issued if the specified value for the bit number is greater than 7.

Example:

```
MyData: SECTION
data:   DS.B 1
```

```
MyCode: SECTION
entry:
BCLR 20, data

BRCLR 70, data, entry

BSET 9, data

BRSET 200, data, entry
```

Tip

Use a correct value for the bit number: 0, 1, 2, 3, 4, 5, 6, 7

Example:

```
MyData: SECTION
data:   DS.B 1
```

```
MyCode: SECTION
entry:
BCLR 7, data

BRCLR 4, data, entry
BSET 3, data
BRSET 2, data, entry
```



### 13.2.54 A13201: Lexical Error In First Or Second Field

Type:

[ERROR]

Description:

An incorrect assembly line is detected. This message may be generated when:

- An assembly instruction or directive start on column 1.
  - An invalid identifier has been detected in the assembly line label or instruction part. Characters allowed as first character in an identifier are:  
A..Z, a..z, \_, .
  - Characters allowed after the first character in a label, instruction or directive name are:  
A..Z, a..z, 0..9, \_, .

Example:

```
CodeSec: SECTION
...
LDA  #$20
...
@label:
...
_4label:
```

Tips:

Why a message has been generated determines which of the following actions can be taken:

- Insert at least one space in front of the directive or instruction
- Change the label, directive or instruction name to a valid identifier

Example:

```
CodeSec: SECTION
...
LDA  #$20
...
_label:
...
_4label:
```

### 13.2.55 A13203: Not An HC08 Instruction Or Directive

Type:

[ERROR]

Description:

The identifier detected in an assembly line instruction part is not an assembly directive, an HC08 instruction, or a user defined macro.

Example:

```
CodeSec: SECTION
...
```



LDAA #5510

Tips:

Change the identifier to an assembly directive, HC08 instruction, or user defined macro.

### 13.2.56 A13401: Value Out Of Range -128..127

Type:

[ERROR]

Description:

The offset between the current PC and the label specified as PC relative address is not in the range of a signed byte. An 8 bit signed PC relative offset is expected in:

- Branch instructions: BCC, BCS, BEQ, BGE, BGT, BHCC, BHCS, BHI, BHS, BIH, BIL, BLE, BLO, BLS, BLT, BMI, BMS, BNE, BPL, BRA, BRN, BSR
- Third operand in following instructions: BRCLR, BRSET

Example for branch instruction:

```
DataSec: SECTION
var1:   DS.B 1
var2:   DS.B 2
CodeSec: SECTION
entry:  LDA var1
        BNE label
dummyB1: DCB.B 200, $9D
label   STA var2
```

Tips:

If BRA or BSR is used, replace them with JMP or JSR. Otherwise, the conditional branch instructions should first branch on a jump instruction linked to the desired label.

Example:

```
DataSec: SECTION
var1:   DS.B 1
var2:   DS.B 2
CodeSec: SECTION
entry:
        LDA var1
        BNE label
        BRA dummyB1
label:  JMP label2
dummyB1: DCB.B 200, $9D
label2: STA var2
```



### 13.2.57 A13403: Complex Relocatable Expression Not Supported

Type:

[ ERROR ]

Description:

A complex relocatable expression has been detected. A complex relocatable expression is detected when the expression contains:

- An operation between labels located in two different sections.
- A multiplication, division or modulo operation between two labels.
- The addition of two labels located in the same section.

Example:

```
DataSec1: SECTION
DataLb11: DS.B 10
DataSec2: SECTION
DataLb12: DS.B 15
offset: EQU DataLb12 - DataLb11
```

Tips:

The Macro Assembler does not support complex relocatable expressions. The corresponding expression must be evaluated at execution time (this solution is only working for labels located on page zero).

Example:

```
DataSec1: SECTION
DataLb11: DS.B 10
DataSec2: SECTION
DataLb12: DS.B 15
offset: DS.B 1
....
MyCode: SECTION
....
EvalOffset:
        LDA #DataLb12
        SUB #DataLb11
        STA offset
```


**13.2.58 A13405: Code Size Per Section Is Limited To 32kb**

Type:

[ERROR]

Description:

One of the code or data section defined in the application is bigger than 32K. This is a limitation in the assembly version.

Example:

```
cstSec: SECTION
noptable: DCB.L 4000, $9D
          DCB.L 4000, $9D
          DCB.L 4000, $9D
          DCB.L 500, $9D
```

Tips:

Split the section into smaller ones, which are not bigger than 32K. The order of allocation of the sections can be specified in the linker PRM file. There you only have to specify that both sections must be allocated consecutively.

Example of assembly file:

```
XDEF entry
cstSec: SECTION
noptbl: DCB.L 4000, $9D
          DCB.L 4000, $9D
cstSec1: SECTION
noptbl1: DCB.L 4000, $9D
          DCB.L 500, $9D
entry:   BRA entry
```

Example of PRM file:

```
LINK
    test.abs

NAMES test.o END
SECTIONS
    MY_RAM = READ_WRITE 0x0051 TO 0x00BF;
    MY_ROM = READ_ONLY  0x8301 TO 0x8DFD;
    ROM_2  = READ_ONLY  0xC000 TO 0xC1FD;
PLACEMENT
    DEFAULT_ROM      INTO MY_ROM;
    DEFAULT_RAM      INTO MY_RAM;
    cstSec, cstSec1  INTO ROM_2;
END
INIT entry
VECTOR ADDRESS 0xFFFFE entry
```



**13.2.59 A13601: Error In Expression**

Type:

[ ERROR ]

Description:

An error has been detected by the Assembler while reading the expression.

Example:

```
MyCode: SECTION
entry:   BRA #$200
```

**13.2.60 A13602: Error At End Of Expression**

Type:

[ ERROR ]

Description:

An error has been detected by the Assembler at the end of the read expression.

Example:

```
label: EQU 2*4)+6
```



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