# HC(S)08/RS08 and S12(X) Build Tools Utilities Manual

Revised: 12 August 2010

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# Introduction

## CodeWarrior IDE Utilities

The HC(S)08, RS08 and S12(X) Build Tools Utilities Manual describes the following five CodeWarrior IDE utilities:

- SmartLinker
- Burner Utility
- Libmaker
- Decoder
- Maker: The Make Tool

### SmartLinker

The CodeWarrior IDE SmartLinker utility merges the various object files of an application into one absolute file (or `.ABS` file) that can be converted to an S-Record or an Intel® Hex file, using the Burner program, or loaded into the target using the Downloader/Debugger.

This utility is a “smart linker”, linking only those objects that are actually used by your application. This linker is able to generate either Freescale or ELF absolute files.

### Burner Utility

The CodeWarrior IDE burner utility converts an `.ABS` file into a file that can be handled by an EPROM burner.

### Libmaker

The CodeWarrior IDE Libmaker utility creates and maintains object file libraries.

### Decoder

The CodeWarrior IDE ELF/Freescale Decoder utility disassembles object files, absolute files and libraries in the Freescale object file format or ELF/DWARF format, along with S-Record files.

## Maker: The Make Tool

The CodeWarrior IDE Maker utility implements the UNIX make command with a Graphical User Interface (GUI). In addition, you can use Maker to build Modula-2 applications as well as maintain C/C++ projects.

# Starting a CodeWarrior Utility

You can start all of the utilities described in this book from executable files located in the `prog` folder of your CodeWarrior IDE installation. The executable files are:

- `maker.exe` Maker: The Make Tool
- `burner.exe` The Burner Utility
- `decoder.exe` The Decoder
- `libmaker.exe` Libmaker
- `linker.exe` SmartLinker

A standard full installation of the HC(S)08/RS08 CodeWarrior IDE places the executable files in this location:

```
C:\Program Files\Freescale\CodeWarrior for Microcontrollers V6.2\Prog
```

A standard full installation of the HC(S)12 CodeWarrior IDE places the executable files in this location:

```
C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\Prog
```

To start any CodeWarrior Utility, click on the appropriate executable file (`*.exe`).

# SmartLinker

This chapter describes the SmartLinker utility. The linker merges the various object files of an application into one absolute file (or `.ABS` file). The file is called *absolute file* because it contains absolute, not relocatable cod. You can convert this `.ABS` file to an S-Record or an Intel Hex file using the Burner program or load the `.ABS` file into the target using the Downloader/Debugger.

The Linker is a smart linker. It links only those objects that are actually used by your application.

This linker is able to generate either Freescale or ELF absolute files. For compatibility purposes, the Freescale input syntax is also supported when ELF absolute files are generated.

## Purpose of a Linker

Linking is the process of assigning memory to all global objects (functions, global data, strings, and initialization data) needed for a given application and combining these objects into a format suitable for downloading into a target system or an emulator.

The linker is a smart linker: it links only those objects that are actually used by the application. Unused functions and variables won't occupy any memory in the target system. Other optimizations that reduce memory requirements include storing initialized parts of global variables in compact forms, and reserving memory only once for equal strings.

### Product Features

The most important features supported by the SmartLinker are:

- Complete control over the placement of objects in memory: it is possible to allocate different groups of functions or variables to different memory areas (Segmentation; see the *Segments* and *Sections* chapters).
- Linking to objects already allocated in a previous link session (ROM libraries).

**NOTE** The code for application startup is a separate file written in inline assembly and can be easily adapted to your particular needs. In this manual, the startup file is called `startup`. However, this is a generic file name that has to be replaced by the real target startup file name. See the `README.TXT` file in the appropriate subdirectory of the installation `LIB` directory for more details about memory models and associated startup codes.

- Mixed-language linking: Modula-2, assembly, and C object files can be mixed, even in the same application.
- Vector initialization.

## Section Contents

This section consists of the following chapters:

- SmartLinker User Interface — Describes the features of the SmartLinker user interface
- SmartLinker Files — Describes the input and output files used by the SmartLinker
- Linking Issues — Discusses linking features and issues
- SmartLinker Parameter File — Describes the requirements of the SmartLinker parameter file
- ELF Sections — Describes the use of sections and segments for ELF and provides examples using sections to control allocation of variables and functions
- Segments — Describes the use of sections and segments for Freescale
- Program Startup — Provides advanced material on using startup routines
- The Map File — Describes the contents of the map file produced by the link process
- ROM Libraries —Describes creating and using ROM libraries
- Initializing the Vector Table — Describes initializing the vector table

# Starting the SmartLinker Utility

All utilities described in this book may be started from executable files located in the `prog` folder of your IDE installation. The executable files are:

- `maker.exe` Maker: The Make Tool
- `burner.exe` The Burner Utility
- `decoder.exe` The Decoder
- `libmaker.exe` Libmaker

- `linker.exe` SmartLinker

With a standard full installation of the HC(S)08/RS08 CodeWarrior IDE, the executable files are located at:

```
C:\Program Files\Freescale\CodeWarrior for Microcontrollers V6.2\Prog
```

With a standard full installation of the HC(S)12 CodeWarrior IDE, the executable files are located at:

```
C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\Prog
```

To start the SmartLinker Utility, click on `linker.exe`.

# 1

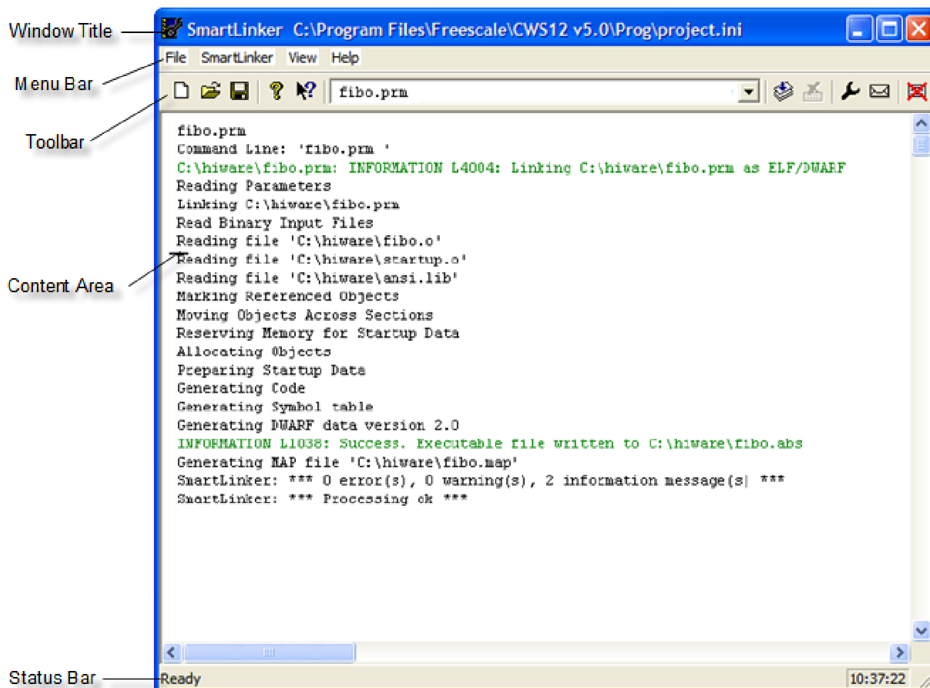
# SmartLinker User Interface

The SmartLinker runs under Win32. Start the linker from the CodeWarrior installation `prog` folder.

## SmartLinker Main Window

The SmartLinker Main window provides a window title, a menu bar, a toolbar, a content area, and a status bar, as shown in Figure 1.1.

**Figure 1.1 SmartLinker Main Window**



# Window Title

The window title displays the project name. If currently no project is loaded, **Default Configuration** appears in the title. A “*” after the configuration name indicates that some values have changed. The “*” appears as soon as an option, the editor configuration or the window appearance changes.

# Content Area

The Content Area is used as a text container where logging information about the link session is displayed. This logging information consists of:

- The name of the prm file which is being linked
- The whole name (including full path specification) of the files building the application
- The list of the errors, warnings and information messages generated

When you drop a file name into the SmartLinker window content area, the corresponding file loads as configuration if the file has the extension `.ini`. Otherwise, the file links with the current option settings (see Specifying the Input File).

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

- A file name including a position inside of a file
- A message number

File context information is available for all output lines where a file name is displayed. There are two ways to open the file specified in the file context information in the editor specified in the editor configuration:

- If a file context is available for a line, double click on a line containing file context information.
- Click with the right mouse at a line and select “Open”.

If a file cannot be opened although a context menu entry is present, the editor configuration information is not correct (see the section Editor Settings Tab).

Most messages appear with associated message numbers. 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.
- Right click the message text and select **Help on**. This entry is only available if a message number is available.

**NOTE** If the selected line or message text does not have a message number, using either F1 or Shift-F1 displays the main help page.

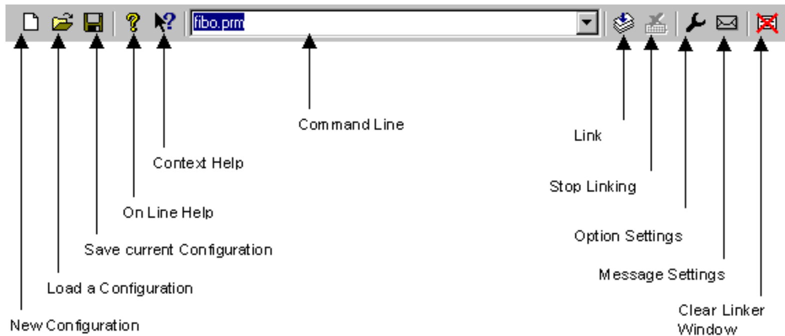
**NOTE** The **Help on** option is available only when a message number is available.

Messages are colored according to their kind. Errors are red, Fatal Errors are dark red, Warnings are blue, and Information Messages are green.

# Main Window Toolbar

Figure 1.2 shows the SmartLinker main window toolbar buttons.

**Figure 1.2 Toolbar Buttons**




The three buttons on the left correspond to File menu entries. Use these buttons to open a new configuration, load an existing configuration, and save the current configuration for the linker.

Use the Help and Context Help buttons to open the Help file and the Context Help. Pressing the context help button changes the cursor form and adds a question mark beside the arrow. Clicking any item calls the help for that item. Use the Context Help to get specific help on menus, toolbar buttons, or on the window area.

The command line history contains the list of the last commands executed. Once a command line has been selected or entered in this combo box, click the **Link** button to execute this command.

Use the **Stop Linking** button to abort the current link session. If no link session is running, this button is disabled (gray).

Use the **Option Settings** button to open the **Option Settings** dialog.

Use the **Message Settings** button to open the **Message Settings** dialog.

Use the **Clear** button to clear the SmartLinker window content area.

Activate the command line in the toolbar by using the F2 key.

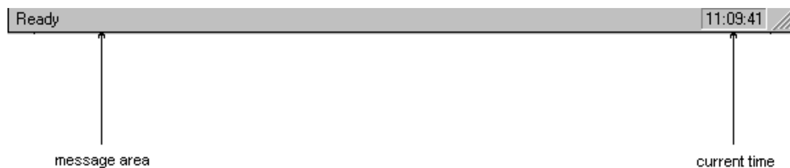
Use the right mouse button to display a context menu.

Messages are colored according to their Message Class.

# Main Window Status Bar

Figure 1.3 shows the SmartLinker main window status bar.

**Figure 1.3 Main Window Status Bar**




When pointing to a button in the toolbar or a menu entry, the message area displays the function of the button or menu entry.

# Main Window Menu Bar

The following menus are available in the menu bar:

**Table 1.1 Main Window Menus**

| | |
|---|---|
| File Menu | Contains entries to manage SmartLinker configuration files. |
| SmartLinker Menu | Contains entries to set SmartLinker options. |
| View Menu | Contains entries to customize the SmartLinker window output. |
| Help | A standard Windows Help menu. |

## File Menu

With the File menu, SmartLinker configuration files can be saved or loaded. A SmartLinker configuration file contains the following information:

- SmartLinker option settings specified in the SmartLinker dialog boxes.
- Message settings which specify which messages to display and which to treat as errors.
- List of the last command line executed and the current command line.

- Window position, size and font.
- Tips of the Day settings, including the enable at startup setting and the current entry.

Configuration files are text files, which have the standard extension `.ini`. You can define as many configuration files as required for your project, and switch between the different configuration files using the **File > Load Configuration** and **File > Save Configuration** menu entry or the corresponding toolbar buttons. Table 1.2 describes the menu items.

**Table 1.2 File Menu Item Description**

| Menu Item | Description |
|---|---|
| Link | Opens a standard Open File box, displaying the list of all the `.prm` files in the project directory. Select the input file using the features from the standard **Open File** box. The selected file links as soon as you close the **Open File** box by clicking **OK**. |
| New/Default Configuration | Resets the SmartLinker option settings to the default values. The SmartLinker options activate by default. |
| Load Configuration | Opens a standard **Open File** box, displaying the list of all the `.INI` files in the project directory. Select the configuration file using the features from the standard **Open File** box. Loads the configuration data stored in the selected file and uses it in a further link session. |
| Save Configuration | Saves the current settings in the configuration file specified on the title bar. |
| Save Configuration as | Opens a standard **Save As** box, displaying the list of all the `.INI` files in the project directory. Specify the name or location of the configuration file using the features from the standard **Save As** box. Saves the current settings in the specified file as soon as you close the **Save As** box by clicking **OK**. |
| Configuration | Opens the **Configuration** dialog box to specify the editor used for error feedback, which parts to save with a configuration, and environment variable settings. |
| 1. .... project.ini<br>2. .... | Recent project list. Access this list to reopen a recently opened project. |
| Exit | Closes the SmartLinker. |

## SmartLinker Menu

The SmartLinker menu allows you to customize the SmartLinker. You can graphically set or reset SmartLinker options or define the optimization level you want to reach. Table 1.3 describes the SmartLinker menu items.

**Table 1.3 SmartLinker Menu Item Description**

| Menu Item | Description |
|---|---|
| Options | Allows you to define the options which must be activated when linking an input file (see Option Settings Window). |
| Messages | Opens a dialog box in which you can map the different error, warning or information messages to another message class (see Message Settings Window). |
| Stop Linking | Stops the currently running linking process. This entry is only enabled (black) when a link process currently takes place. Otherwise, it is gray. |

## View Menu

The View menu allows you to customize the linker window. You can specify whether to display or hide the status bar and the toolbar. You can also define the font used in the window or clear the window. Table 1.4 describes the View menu items.

**Table 1.4 View Menu Item Description**

| Menu Item | Description |
|---|---|
| Tool Bar | Switches display from the toolbar in the SmartLinker window. |
| Status Bar | Switches display from the status bar in the SmartLinker window. |
| Log | Allows you to customize the output in the SmartLinker window content area. The following entries are available when **Log** is selected: |
| Change Font | Opens a standard font selection box. Applies the options selected in the font dialog box to the SmartLinker window content area. |
| Clear Log | Allows you to clear the SmartLinker window content area. |

# SmartLinker Configuration Window

The SmartLinker Configuration Window has three tabs. The following sections discuss each of the tabs.

## Editor Settings Tab

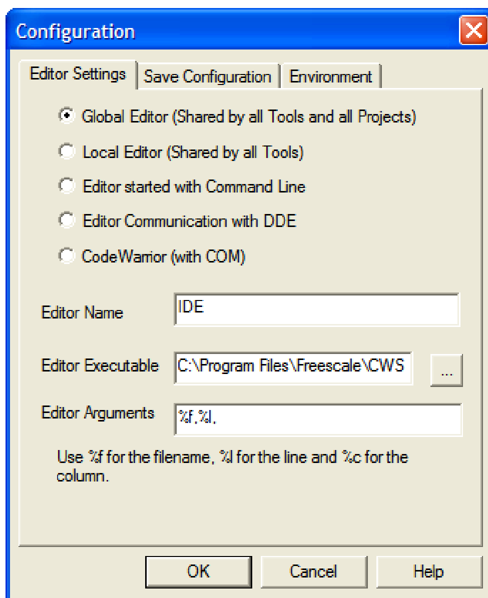
The Configuration Window Editor Settings Tab, as shown in Figure 1.4, has option buttons that let you select an editor type for SmartLinker, or for all Tools. Depending on the type of editor selected, the Editor Settings tab content changes.

### Global Editor Option

In the view below, the Global Editor option has been selected.

All tools and projects on one computer share the Global Editor. It is stored in the global initialization file `MCUTOOLS.INI` in the `[Editor]` section of the file. Some Modifiers (editor options) can be specified in the editor command line. Once these options are stored, the behavior of the other tools that use the same entry changes the next time you start the tool.

**Figure 1.4 Editor Settings Tab - Global Editor**



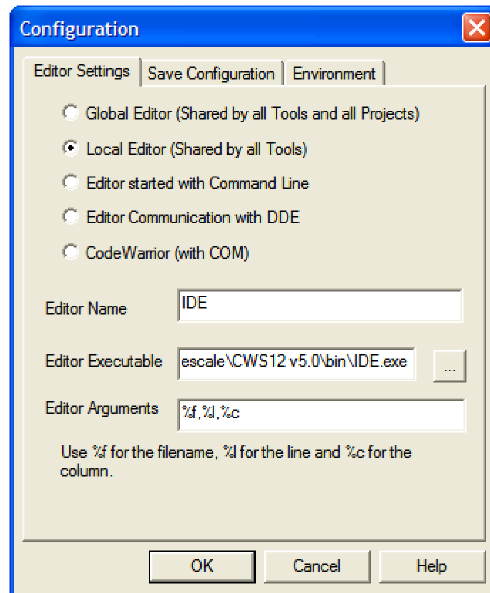

### Local Editor Option

Figure 1.5 shows the Configuration Window Editor Settings tab with the Local Editor option selected.

All tools using the same project file share the Local Editor. You can specify some Modifiers in the editor command line

Edit the Local Editor configuration with the linker. When these entries are stored, the behavior of the other tools using the same entry also changes the next time you start the tool.

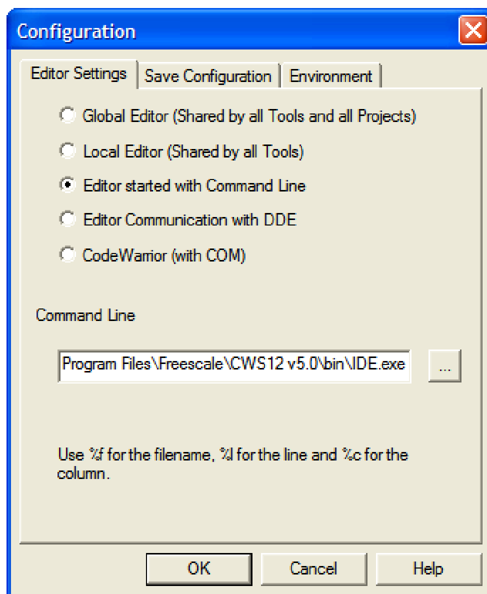
**Figure 1.5 Editor Settings Tab - Local Editor**




## Editor started with Command Line Option

Figure 1.6 shows the Configuration window Editor Settings tab with the Editor started with Command Line option selected.

**Figure 1.6 Editor Settings Tab - Editor started with Command Line**




Selecting this editor type associates a separate editor with the SmartLinker for error feedback. The editor configured in the Shell is not used for error feedback.

Enter the command that you want to use to start the editor. The format for the editor command depends on the syntax required to start the editor. You can specify some Modifiers in the editor command line to refer to a line number of the named file.

Example:

For Winedit 32-bit versions, use (with an adapted path to the `winedit.exe` file):

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

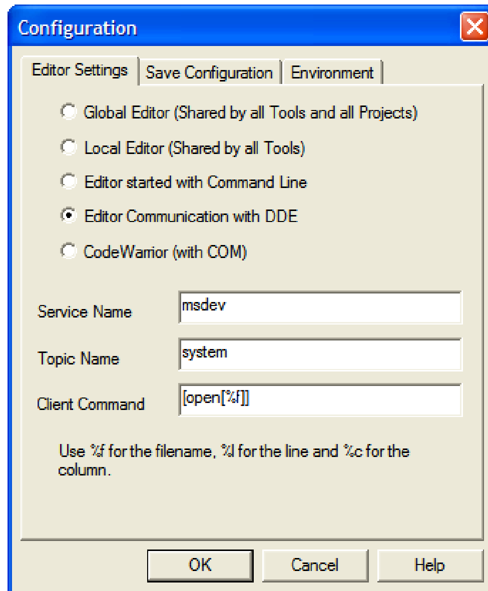
For `write.exe`, use (with an adapted path to the `write.exe` file, note that write does not support line numbers):

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

## Editor Communication with DDE Option

Figure 1.7 shows the Configuration window Editor Settings tab with the Editor Communication with DDE option selected.

**Figure 1.7 Editor Settings - Editor Communication with DDE**




You must enter the Service and Topic Name as well as the Client Command to be used for a DDE connection to the editor. All entries can have modifiers for file name and line number as explained in the *Modifiers* section below.

Example:

For Microsoft Developer Studio use the following setting:

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

### Modifiers

Include some modifiers in the configurations 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 was detected.

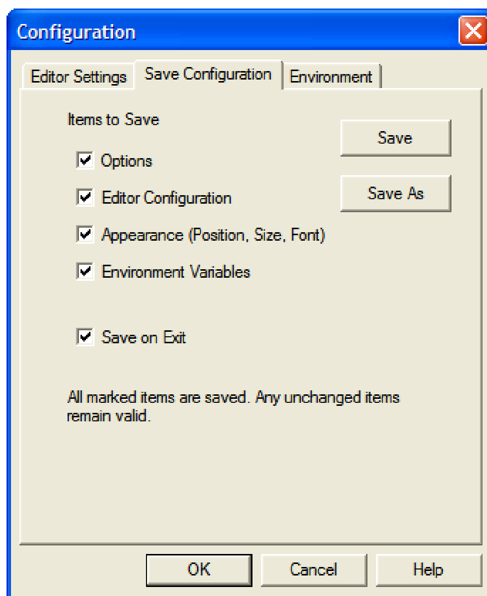
- The `%l` modifier refers to the line number where the message was detected.

**NOTE** Only use the `%l` modifier with an editor which can be started with a line number as a parameter. This is not the case for WinEdit version 3.1 or lower or for Notepad. When you work with such an editor, you can start it with the file name as a parameter and then select the menu entry **Go to** to jump to the line where the message was detected. In that case, the editor command looks like:
`C:\WINAPPS\WINEDIT\Winedit.EXE %f`
Check your editor documentation to determine which command line to use to start the editor.

## Configuration Window Save Configuration Tab

Figure 1.8 shows the Save Configuration tab of the Configuration Window, which contains all of the options for the Save operation.

**Figure 1.8 Save Configuration Tab**




In the **Save Configuration** tab, use the four checkboxes to choose which items to save to a project file when you save the configuration.

- **Options:** This item relates to the option and message settings. Setting this checkbox stores the current option and message settings in the project file when the

configuration is saved. By disabling this checkbox, changes to the option and message settings are not saved and the previous settings remain valid.

- **Editor Configuration:** This item relates to the editor settings. Setting this checkbox stores the current editor settings in the project file when the configuration is saved. By disabling this checkbox, the previous settings remain valid.
- **Appearance:** This item relates to many parts such as the window position (only loaded at startup time) and the command line content and history. Setting this checkbox stores these settings in the project file when the current configuration is saved. By disabling this checkbox, the previous settings remain valid.
- **Environment Variables:** This item relates to the environment variable settings on the Environment tab. Setting this checkbox stores the specified settings in the project file when the current configuration is saved. By disabling this checkbox, the previous settings remain valid.

**NOTE** Disabling specific options, prevents some parts of a configuration file from being written. For example, when the editor has been configured, the save Editor mark can be removed. Then future save commands no longer modify the options.

- **Save on Exit:** Setting this option makes the linker write the configuration on exit. No dialog box appears to confirm this operation. If this option is not set, the linker does not write the configuration at exit, even if options or other parts of the configuration have changed. No confirmation appears in any case when closing the linker.

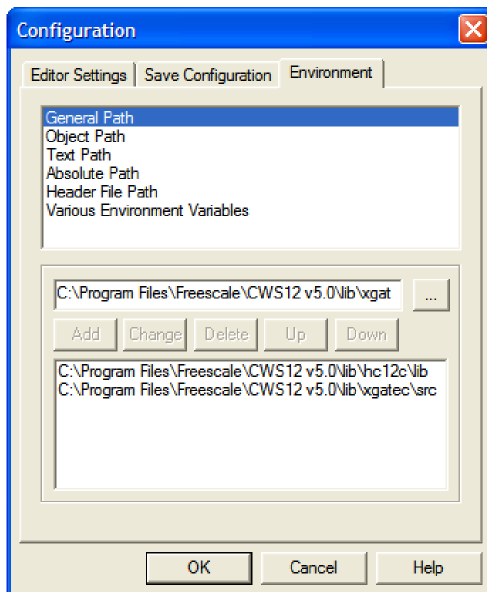
**NOTE** Most settings are stored only in the project configuration file. The only exceptions are:
- The recently used configuration list.
- All settings in this dialog.

**NOTE** The linker configurations coexist in the same file as the project configuration of the shell. When the shell configures an editor, the linker can read this content out of the project file, if present. The project configuration file of the shell is named `project.ini`. This file name is therefore suggested (but not mandatory) for the linker.

## Configuration Window Environment Tab

The Environment tab of the Configuration window, shown in Figure 1.9, contains all of the options for configuring environment variables.

**Figure 1.9 Environment Tab**

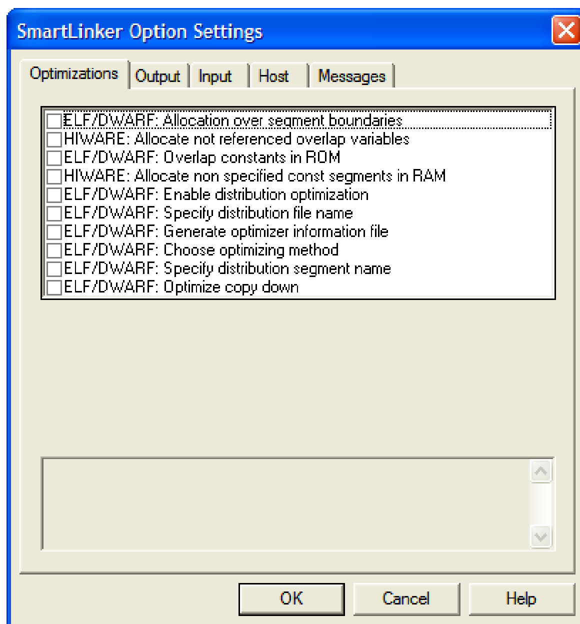



Define environment variables for the SmartLinker in the **Environment** tab. Click the **Add** button to add new entries, the **Change** button to change an existing entry, and the **Up** and **Down** button to change the order of the entries.

## Option Settings Window

The five tabs of the Options Settings window, shown in Figure 1.10, allow you to set or reset SmartLinker options.

**Figure 1.10 Option Settings Window**




In addition to the Optimization tab, a tab is provided for each of the four option groups. Table 1.5 describes these four tabs.

**Table 1.5 Option Settings Group Description**

| Group | Description |
|---|---|
| Output | Lists options related to the output files generation (what kind of files to generate). |
| Input | Lists options related to the input files. |
| Messages | Lists options controlling the generation of error messages. |
| Host | Lists host-specific options. |

Set a SmartLinker option by checking its checkbox. To obtain a more detailed explanation about a specific option, select the option and then press the key F1 or the help button. To select an option, click once on the option text. The option text is then highlighted.

When the window is opened, no options are selected. Pressing the F1 key or the help button shows the help for this window.

# Message Settings Window

The Message Settings window, shown in Figure 1.11, allows you to map messages to a different message class.

Depending on the message class, messages are shown in different colors in the main output area.

Each message has its own leading character (‘L’ for SmartLinker message) followed by a 4- or 5-digit number. This number allows an easy search for the message in both the manual and on-line help.

A tab is available for each error message class: Disabled, Information, Error, Warning and Fatal. To move a message from one class to another, highlight the message in the list box on the left side, then click the button on the right that corresponds to the new message class.

**Figure 1.11  Message Settings Window**

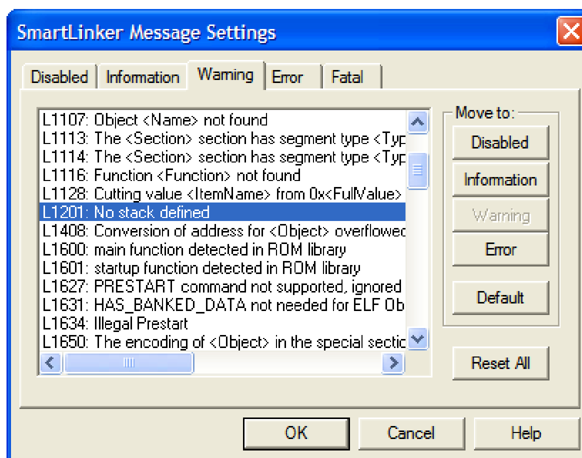


Table 1.6 describes the message classes available in the Message Settings dialog box.

**Table 1.6 Message Class Description**

| Message Class | Description | Color |
|---|---|---|
| Disabled | Lists all disabled messages. SmartLinker does not display these messages. | None |
| Information | Lists all information messages. Information messages inform about action taken by the SmartLinker. | Green |
| Warning | Lists all warning messages. When such a message is generated, linking of the input file continues and an absolute file is generated. | Blue |
| Error | Lists all error messages. When an error message is generated, linking of the input file continues but no absolute file is generated. | Red |
| Fatal | Lists all fatal error messages. When a fatal message is generated, linking of the input file stops immediately. Fatal messages cannot be changed. They are only listed to call context help. | Dark Red |

## Changing the Message Class

You can configure your own mapping of messages in the different classes using one of the buttons located on the right side of the dialog box. Each button refers to a message class. To change the class associated with a message, select the message in the list box and then click the button associated with the class to which you want to move the message.

### Example:

To define the warning message **L1201: No stack defined** as an error message:

- Click the **Warning** tab to display the list of all warning messages.
- Click on the string **L1201**: *No stack defined* in the list box to select the message.
- Click **Error** to define this message as an error message.

**NOTE** Messages cannot be moved from or to the fatal error class.

**NOTE** The **Move to** buttons are active only when all selected messages can be moved. Selecting a message which cannot be moved to a specific group disables (grays) the corresponding **Move to** button.

To validate the modifications you have made in the error message mapping, close the **Message Settings** dialog box with the **OK** button. If you close it using the **Cancel** button, the previous message mapping remains valid.

To reset messages to their default, select the messages and click the **Default** button. To reset all messages to the default, click the **Reset All** button.

# About Dialog Box

Open the **About** dialog box with the **Help > About** command.

The **About** box contains extensive information. The main linker version appears separately on top of the dialog and the current directory and the versions of subparts of the linker are shown.

In addition, the **About** box contains all information needed to create a permanent license. Copy and paste the contents of the About box using standard Windows® commands.

Click **OK** to close the dialog box.

During a linking session, the versions of linker subparts cannot be requested. They are displayed only when the linker currently is not processing.

# Retrieving Information about an Error Message

You can access information about each message displayed in the list box. Select the message in the list box and then click *Help* or the F1 key. An information box opens, which contains a more detailed description of the error message as well as a small example of code producing it. If you select several messages, help for the first is shown. Pressing the F1 key or the help button when no message is selected shows the help for this dialog.

# Specifying the Input File

There are different ways to specify the input file to link. During linking of a source file, the options are set according to the dialog box configuration settings and the options specified on the command line.

Before starting to link a file, make sure you have associated a working directory with your linker.

# Using the Command Line in the Toolbar to Link

This section provides information for using the command line in the toolbar to link files.

## Linking a New File

Enter a new file name and additional SmartLinker options in the command line. The specified file links as soon as you select the Link button in the toolbar or press the enter key.

## Linking a Previously Linked File

Display previously executed commands using the arrow on the right side of the command line. Select a command by clicking on it. It appears in the command line. The specified file links as soon as you select the Link button in the toolbar.

## Use the Entry File > Link

Select **File > Link** to display a standard file open file box with the list of all the `prm` files in the project directory. Browse to get the name of the file you want to link. Select the desired file. Click **Open** in the **Open File** box to link the selected file.

## Use Drag and Drop

You can drag a file name from an external software (for example the File Manager/ Explorer) and drop it into the SmartLinker window. The dropped file links as soon as you release the mouse button in the SmartLinker window. If a file being dragged is a `*.ini` file, it is considered a configuration file and loads immediately but does not link.

**NOTE** To link a `prm` file with the extension `*.ini` use one of the other methods. Do not use drag and drop.

# Message/Error Feedback

After linking there are several ways to check where different errors or warnings have been detected. By default, the format of the error message looks as follows:

```
>>in <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 "placemen\tstpla8.prm", line 23, col 0, pos 668
  fpm_data_sec              INTO  MY_RAM2;

END

^
ERROR L1110: MY_RAM2 appears twice in PLACEMENT block
```

See also SmartLinker options for different message formats.

# Use SmartLinker Window Information

Once you link a file, the SmartLinker window content area displays the list of all the errors or warnings detected.

Use your usual editor to open the source file and correct the errors.

# Use a User-Defined Editor

You must first configure the editor for *Error Feedback* in the *Configuration* window Editor Settings tab. Error feedback performance varies, depending on whether you can start the editor with a line number.

## Line Number Specified on Command Line

You can start an editor like WinEdit, V95 or higher, or Codewright with a line number in the command line. When these editors are configured correctly, you can activate them automatically by double clicking on an error message. The configured editor starts, the file where the error occurred opens automatically, and places the cursor on the line where the error was detected.

## Line Number Cannot Be Specified on Command Line

An editor like WinEdit V31 or lower, Notepad, or Wordpad cannot be started with a line number in the command line. When these editors are configured correctly, you can activate them automatically by double clicking on an error message. The configured editor starts and the file where the error occurs opens automatically. To scroll to the position where the error was detected:

1. Activate the assembler again.
2. Click the line on which the message was generated. This highlights the line on the screen.
3. Copy the line in the clipboard by pressing CTRL + C.

4. Activate the editor again.
5. Select **Search > Find**: the standard **Find** dialog box opens.
6. Copy the content of the clipboard in the Edit box by pressing CTRL + V.
7. Click **Forward** to jump to the position where the error was detected.

# 2

# SmartLinker Files

This chapter describes the input and output files used by the SmartLinker.

- Input Files
- Output Files

## Input Files

This section describes the input files used by the SmartLinker.

### Parameter File

The linker takes any file as input; it does not require the file name to have a special extension. However, we suggest that all your parameter file names have extension `.prm`. The SmartLinker searches for the parameter file first in the project directory and then in the directories enumerated in `GENPATH` (see GENPATH: Define Paths to Search for Input Files). The parameter file must be a strict ASCII text file.

### Object File

The link parameter file entry `NAMES` specifies the list of files to be linked. Specify additional object files with the `-Add` option (see -Add: Additional Object/Library File).

The linker looks for the object files first in the project directory, then in the directories enumerated in `OBJPATH` (see OBJPATH: Object File Path) and finally in the directories enumerated in `GENPATH` (see GENPATH: Define Paths to Search for Input Files). The binary files must be valid Freescale, ELF\DWARF 1.1 or 2.0 objects, absolute, or library files.

# Output Files

This section describes the output files used by the SmartLinker.

## Absolute Files

After a successful linking session, the SmartLinker generates an absolute file containing the target code as well as some debugging information. The SmartLinker writes this file to the directory given in the environment variable ABSPATH (see ABSPATH: Absolute Path). If ABSPATH contains more than one path, SmartLinker writes the absolute file in the first directory given; if ABSPATH is not set at all, SmartLinker writes the absolute file in the directory in which the parameter file was found. Absolute files always get the extension .abs.

## S-Record Files

After a successful linking session, and if the -B option is present (see -B: Generate S-Record file (SmartLinker)), the SmartLinker generates an S-Record file, which can be burnt into an EPROM. This file contains information stored in all the READ_ONLY sections in the application. The extension for the generated S-Record file depends on the setting from the SRECORD variable (see SRECORD: S Record File Format).

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

The SmartLinker writes this file to the directory given in the ABSPATH environment variable (see ABSPATH: Absolute Path). If ABSPATH contains more than one path, the SmartLinker writes the S-record file in the first directory given; if ABSPATH is not set at all, the SmartLinker writes the S-record file in the directory in which the parameter file was found.

## Map Files

After a successful linking session, the SmartLinker generates a map file containing information about the link process. The SmartLinker writes this file to the directory given in the TEXTPATH environment variable (see TEXTPATH: Text Path). If TEXTPATH contains more than one path, SmartLinker writes the map file in the first directory given; if TEXTPATH is not set at all, SmartLinker writes the map file in the directory in which the parameter file was found. Map files always get the extension .map.

## Dependency Information

The linker provides useful dependency information in the generated map file. The dependency information shows which objects are used by other objects (functions, variables, etc.).

The dependency information in the linker map file is based on fixups/relocations. That is if an object references another object by a relocation, the linker adds this object to the dependency list.

### Examples

```
int hrs;
void tim(void) {
  hrs = 0;
}
```

In `tim` in the above example, the compiler has generated a fixup/relocation to the object `hrs`, so the linker knows that `tim` uses `hrs`. For the next example, `tim` references `tim` itself, because in `tim` there is a fixup to `tim` as well:

```
void tim(void) {
  tim();
}
```

Now the compiler might perform a common code optimization, in which the compiler collects common code into a function to reduce the code size.

**NOTE** You can switch off this compiler common code optimization.

Example:

```
void tim(void) {
  if (hrs == 3) hrs = 0;
  ...
  if (hrs == 3) hrs = 0;
}
```

The compiler may optimize this to:

```
int tim(void) {
  bsr tim:Label:
  ...
  tim_Label:
    if (hrs == 3) hrs = 0;
```

```
    return;
}
```

Here the compiler generates a local branch inside `tim` to a local subroutine. This produces a relocation/fixup into `tim`, that is, for the linker, `tim` references itself.

# Error Listing File

If the SmartLinker detects any errors, it creates an error listing file instead of an absolute file. The SmartLinker generates this file into the directory in which the source file was found (see ERRORFILE: Error File Name Specification).

If the Linker window is open, it displays the full path of all binary files read. In case of error, the position and file name where the error occurs appears in the linker window.

If you started the SmartLinker from WinEdit (with `%f` given on the command line) or Codewright (with `%b%e` given on the command line), SmartLinker does not generate this error file. Instead it writes the error messages in a special format into a file called `EDOUT`, using the Microsoft format by default. Use WinEdit's **Next Error** or Codewright's **Find Next Error** command to see both error positions and the error messages.

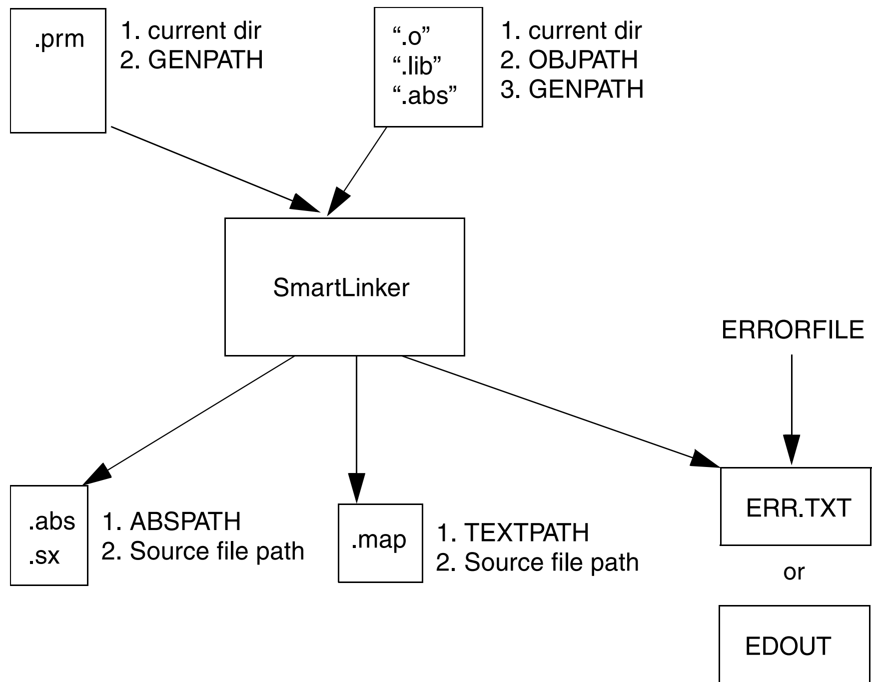
## Interactive Mode (SmartLinker Window Open)

If `ERRORFILE` is set, the SmartLinker creates a message file named as specified in this environment variable. If `ERRORFILE` is not set, the SmartLinker generates a default file named `ERR.TXT` in the current directory.

## Batch Mode (SmartLinker Window Not Open)

If `ERRORFILE` is set, the SmartLinker creates a message file named as specified in this environment variable. If `ERRORFILE` is not set, the SmartLinker generates a default file named `EDOUT` in the current directory.

**Figure 2.1 Error File Creation**



3

# Linking Issues

## Object Allocation

This chapter describes whole object allocation using The SEGMENTS Block (ELF) or Segments and PLACEMENT Block.

### The SEGMENTS Block (ELF)

The SEGMENTS Block is optional. It increases the readability of the linker input file and allows you to assign meaningful names to contiguous memory areas on the target board. Memory within such an area shares common attributes:

- Segment Qualifier
- Segment Alignment
- Segment Fill Pattern

You can define two types of segments:

- Physical Segments
- Virtual Segments

### Physical Segments

Physical segments are closely related to hardware memory areas.

For example, there may be one READ_ONLY segment for each bank of the target board ROM area and another segment covering the whole target board RAM area.

For a simple memory model, you can define a segment for the RAM area and another segment for the ROM area.

**Listing 3.1 Physical Segments Example**

```
LINK   test.abs
NAMES  test.o startup.o END
SEGMENTS
  RAM_AREA = READ_WRITE 0x00000 TO 0x07FFF;
  ROM_AREA = READ_ONLY  0x08000 TO 0x0FFFF;
END
```

```
PLACEMENT
    DEFAULT_RAM         INTO RAM_AREA;
    DEFAULT_ROM         INTO ROM_AREA;
END

STACKSIZE 0x50
```

For banked memory model you can define a segment for the RAM area, another for the non-banked ROM area and one for each target processor bank.

**Listing 3.2 Physical Segments Example 2**

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

SEGMENTS
  RAM_AREA        = READ_WRITE 0x00000 TO 0x07FFF;
  NON_BANKED_AREA = READ_ONLY  0x0C000 TO 0x0FFFF;
  BANK0_AREA      = READ_ONLY  0x08000 TO 0x0BFFF;
  BANK1_AREA      = READ_ONLY  0x18000 TO 0x1BFFF;
  BANK2_AREA      = READ_ONLY  0x28000 TO 0x2BFFF;
END

PLACEMENT
    DEFAULT_RAM        INTO RAM_AREA;
    _PRESTART, STARTUP,
    ROM_VAR,
    NON_BANKED, COPY   INTO NON_BANKED_AREA;
    DEFAULT_ROM        INTO BANK0_AREA, BANK1_AREA,
                            BANK2_AREA;
END

STACKSIZE 0x50
```

## Virtual Segments

You can split a physical segment into several virtual segments, allowing a better structuring of object allocation and allowing you to use some processor-specific properties.

For an HC12 small memory model, you can define a segment for the direct page area, another one for the rest of the RAM area, and another one for the ROM area.

**Listing 3.3 Virtual Segment Example**

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

SEGMENTS
  DIRECT_RAM = READ_WRITE 0x00000 TO 0x000FF;
  RAM_AREA   = READ_WRITE 0x00100 TO 0x07FFF;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
END

PLACEMENT
    myRegister          INTO DIRECT_RAM;
    DEFAULT_RAM         INTO RAM_AREA;
    DEFAULT_ROM         INTO ROM_AREA;
END

STACKSIZE 0x50
```

## Segment Qualifier

Different qualifiers are available for segments. Table 3.1 describes the available qualifiers:

**Table 3.1 Qualifiers and Descriptions**

| Qualifier | Description |
|---|---|
| READ_ONLY | Qualifies a segment that allow only read access. Initializes objects within the segment at application loading time. |
| READ_WRITE | Qualifies a segment that allows both read and write accesses. Initializes objects within such a segment at application startup. |
| NO_INIT | Qualifies a segment that allows both read and write accesses. Objects within such a segment remain unchanged during application startup. This qualifier may be used for segments referring to a battery-backed RAM. Sections placed in a NO_INIT segment should not contain any initialized variables (variable defined as `int c = 8`). |
| PAGED | Qualifies a segment that allows both read and write accesses. Objects within such a segment remain unchanged during application startup. Additionally, objects located in two PAGED segments may overlap. This qualifier is used for memory areas that require some user-defined page-switching mechanism. Sections placed in a PAGED segment should not contain any initialized variables (variable defined as `int c = 8`). |

**NOTE** For debugging purposes you may want to load code into RAM areas. Because this code should be loaded at load time, qualify such areas as READ_ONLY. For the linker, READ_ONLY means that such objects are initialized at program load time. The linker does not know (and does not care) if at runtime the target code writes to a READ_ONLY area.

**NOTE** Anything located in a READ_WRITE segment is initialized at application startup time. Locate the application code which does this initialization and any initialization data (init, zero out, copy down) in a READ_ONLY section. Do not locate the application code and the initialization data in a READ_WRITE section.
The program loader can, at program loading time, write the content of READ_ONLY sections into a RAM area.

**NOTE** If an application does not use any startup code to initialize READ_WRITE sections, then no such sections should be present in the `prm` file. Instead use NO_INIT sections.

## Segment Alignment

The default alignment rule depends on the processor and memory model used. The HC12 processors do not require any alignment for code or data objects. You can define your own alignment rule for a segment. The alignment rule defined for a segment block overrides the default alignment rules associated with the processor and memory model.

The alignment rule has the following format (see Table 3.2 for format information):

```
[defaultAlignment] {"["ObjSizeRange":"alignment"]"}
```

#### Table 3.2 Segment Alignment Format

| Format Type | Definition |
|---|---|
| defaultAlignment | Alignment value for all objects which do not match the conditions of any range defined afterward. |
| ObjSizeRange | Defines a certain condition. The condition follows the form:<br>`size`: Applies to objects whose size is equal to `size`.<br>`< size`: Applies to objects whose size is less than `size`.<br>`> size`: Applies to objects whose size is greater than `size`.<br>`<= size`: Applies to objects whose size is less than or equal to `size`.<br>`>= size`: Applies to objects whose size is greater than or equal to `size`<br>From `size1` to `size2`: Applies to objects whose size is greater than or equal to `size1` and less than or equal to `size2`. |
| alignment | Defines the alignment value for objects matching the condition defined in the current alignment block (enclosed in square bracket). |

#### Listing 3.4 Segment Alignment Example

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

SEGMENTS
  DIRECT_RAM = READ_WRITE 0x00000 TO 0x000FF
               ALIGN 2 [< 2: 1];
  RAM_AREA   = READ_WRITE 0x00100 TO 0x07FFF
               ALIGN [1:1] [2..3:2] [>=4:4];
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
END

PLACEMENT
    myRegister         INTO DIRECT_RAM;
    DEFAULT_RAM        INTO RAM_AREA;
    DEFAULT_ROM        INTO ROM_AREA;
END

STACKSIZE 0x50
```

The example above:

- Aligns objects in the DIRECT_RAM segment whose size is 1 byte on byte boundaries; aligns all other objects on 2-byte boundaries.
- Aligns objects in the RAM_AREA segment whose size is 1 byte on byte boundaries; aligns objects whose size is equal to 2 or 3 bytes on 2-byte boundaries; aligns all other objects on 4-byte boundaries.
- Default alignment rules apply in the ROM_AREA segment.

# Segment Fill Pattern

The default fill pattern for code and data segment is the null character. You can choose to define your own fill pattern for a segment. The fill pattern definition in the segment block overrides the default fill pattern. Note that the fill pattern is used to fill up a segment to the segment end boundary.

#### Listing 3.5 Segment Fill Pattern Example

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

SEGMENTS
  DIRECT_RAM = READ_WRITE 0x00000 TO 0x000FF
               FILL 0xAA;
  RAM_AREA   = READ_WRITE 0x00100 TO 0x07FFF
               FILL 0x22;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
END

PLACEMENT
    myRegister        INTO DIRECT_RAM;
    DEFAULT_RAM       INTO RAM_AREA;
    DEFAULT_ROM       INTO ROM_AREA;
END

STACKSIZE 0x50
```

The example above:

- Initializes alignment bytes between objects in DIRECT_RAM segment with 0xAA.
- Initializes alignment bytes between objects in RAM_AREA segment with 0x22.
- Initializes alignment bytes between objects in ROM_AREA segment with 0x00.

# The SECTIONS Block (Freescale + ELF)

The segments block is optional but increases the readability of the linker input file. It allows you to assign meaningful names to contiguous memory areas on the target board. Memory within such an area share the Segment Qualifier attribute:

Two types of segments can be defined:

- Physical Segments
- Virtual Segments

## Physical Segments

Physical segments are closely related to hardware memory areas. For example, there may be one READ_ONLY segment for each bank of the target board ROM area and another one covering the whole target board RAM area.

For a simple memory model you can define a segment for the RAM area and another one for the ROM area.

**Listing 3.6 Physical Segments Example**

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

SECTIONS
  RAM_AREA = READ_WRITE 0x00000 TO 0x07FFF;
  ROM_AREA = READ_ONLY  0x08000 TO 0x0FFFF;

PLACEMENT
    DEFAULT_RAM        INTO RAM_AREA;
    DEFAULT_ROM        INTO ROM_AREA;
END

STACKSIZE 0x50
```

For banked memory model you can define a segment for the RAM area, another for the non-banked ROM area and one for each target processor bank.

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

SECTIONS
  RAM_AREA        = READ_WRITE 0x00000 TO 0x07FFF;
  NON_BANKED_AREA = READ_ONLY  0x0C000 TO 0x0FFFF;
  BANK0_AREA      = READ_ONLY  0x08000 TO 0x0BFFF;
  BANK1_AREA      = READ_ONLY  0x18000 TO 0x1BFFF;
```

```
  BANK2_AREA      = READ_ONLY  0x28000 TO 0x2BFFF;

PLACEMENT
    DEFAULT_RAM       INTO RAM_AREA;
    _PRESTART, STARTUP,
    ROM_VAR,
    NON_BANKED, COPY  INTO NON_BANKED_AREA;
    DEFAULT_ROM       INTO BANK0_AREA, BANK1_AREA,
                           BANK2_AREA;

END
STACKSIZE 0x50
```

## Virtual Segments

A physical segment may be split into several virtual segments, allowing better structuring of object allocation and also allowing the user to take advantage of some processor-specific properties.

For an HC12 small memory model, you can define a segment for the direct page area, another for the rest of the RAM area and another for the ROM area.

**Listing 3.7  Virtual Segment Example**

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

SECTIONS
  DIRECT_RAM = READ_WRITE 0x00000 TO 0x000FF;
  RAM_AREA   = READ_WRITE 0x00100 TO 0x07FFF;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;

PLACEMENT
    myRegister        INTO DIRECT_RAM;
    DEFAULT_RAM       INTO RAM_AREA;
    DEFAULT_ROM       INTO ROM_AREA;
END

STACKSIZE 0x50
```

## Segment Qualifier

Table 3.1 describes the available segment qualifiers.

**Table 3.3 Qualifiers and Descriptions**

| Qualifier | Meaning |
|---|---|
| READ_ONLY | Qualifies a segment that allows only read accesses. Initializes objects within such a segment at application loading time. |
| CODE (ELF only) | Qualifies a code segment in a Harvard architecture in the ELF object file format. For cores with Von Neumann Architecture (combined code and data address space), or for the Freescale object file format, use READ_ONLY instead. |
| READ_WRITE | Qualifies a segment that allows read and write accesses. Initializes objects within such a segment at application startup. |
| NO_INIT | Qualifies a segment that allows read and write accesses. Objects within such a segment remain unchanged during application startup. This qualifier may be used for segments referring to a battery-backed RAM. Sections placed in a `NO_INIT` segment should not contain any initialized variables (variable defined as `int c = 8`). |
| PAGED | Qualifies a segment that allows read and write accesses. Objects within such a segment remain unchanged during application startup. Additionally, objects located in two PAGED segments may overlap. This qualifier is used for memory areas, where some user-defined page-switching mechanism is required. Sections placed in a PAGED segment should not contain any initialized variables (variable defined as `int c = 8`). |

**NOTE** For debugging purposes, you may want to load code into RAM areas. Because this code is loaded at load time, qualify such areas as `READ_ONLY`.
For the linker, `READ_ONLY` means that such objects are initialized at program load time. The linker does not know (and does not care) if at runtime the target code writes to a `READ_ONLY` area.

**NOTE** Anything located in a `READ_WRITE` segment is initialized at application startup time. Locate the application code which does this initialization and any initialization data (init, zero out, copy down) in a `READ_ONLY` section. Do not locate the application code and the initialization data in a `READ_WRITE` section.

The program loader can, at program loading time, write the content of READ_ONLY sections into a RAM area.

**NOTE** If an application does not use any startup code to initialize READ_WRITE sections, then no such sections should be present in the prm file. Instead use NO_INIT sections.

# PLACEMENT Block

The placement block allows the user to physically place each section from the application in a specific memory area (segment). The sections specified in a PLACEMENT block may be linker-predefined sections or user sections specified in one of the source file building the application.

Organize data into sections:

- Increases application structuring
- Groups common-purpose data together
- Takes advantage of target processor-specific addressing mode

## Specifying a List of Sections

When you specify several sections on a PLACEMENT statement, the linker allocates the sections in the order you specify.

**Listing 3.8 Sequence Enumeration Example**

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

SECTIONS
  RAM_AREA    = READ_WRITE 0x00100 TO 0x002FF;
  STK_AREA    = READ_WRITE 0x00300 TO 0x003FF;
  ROM_AREA    = READ_ONLY  0x08000 TO 0x0FFFF;

PLACEMENT
    DEFAULT_RAM, dataSec1,
     dataSec2             INTO RAM_AREA;
    DEFAULT_ROM, myCode INTO ROM_AREA;
    SSTACK                INTO STK_AREA;
END
```

In this example:

- Inside the RAM_AREA segment, the linker allocates the objects defined in the `.data` section first, then the objects defined in `dataSec1` section, then objects defined in `dataSec2` section.
- Inside the ROM_AREA segment, the linker allocates objects defined in `.text` section first, then the objects defined in section `myCode`.

**NOTE** Since the linker is case sensitive, the name of the section names specified in the PLACEMENT block must be valid predefined or user-defined section names. For the linker, `DataSec1` and `dataSec1` are two different sections.

## Specifying a List of Segments

When you specify several segments in a PLACEMENT statement, the segments are used in the order they are listed. The linker performs allocation in the first segment in the list until this segment is full. Then allocation continues on the next segment in the list, and so on, until all objects are allocated.

#### Listing 3.9 Sequence Enumeration - Further Example

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

 SECTIONS
   RAM_AREA         = READ_WRITE 0x00100 TO 0x002FF;
   STK_AREA         = READ_WRITE 0x00300 TO 0x003FF;
   NON_BANKED_AREA = READ_ONLY  0x0C000 TO 0x0FFFF;
   BANK0_AREA       = READ_ONLY  0x08000 TO 0x0BFFF;
   BANK1_AREA       = READ_ONLY  0x18000 TO 0x1BFFF;
   BANK2_AREA       = READ_ONLY  0x28000 TO 0x2BFFF;

 PLACEMENT
     DEFAULT_RAM          INTO RAM_AREA;
     SSTACK               INTO STK_AREA;
     _PRESTART, STARTUP,
     ROM_VAR,
     NON_BANKED, COPY     INTO NON_BANKED_AREA;
     DEFAULT_ROM          INTO BANK0_AREA, BANK1_AREA,
                                  BANK2_AREA;

 END
```

This example allocates functions implemented in the `.text` section first, into segment `BANK0_AREA`. When there is not enough memory available in this segment, allocation continues in segment `BANK1_AREA`, then in `BANK2_AREA`.

**NOTE** As the linker is case sensitive, the name of the segments specified in the PLACEMENT block must be valid segment names defined in the SEGMENTS block. For the linker, `Ram_Area` and `RAM_AREA` are two different segments.

## Allocating User-Defined Sections (ELF)

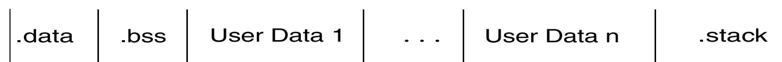
All sections do not need to be enumerated in the placement block. Segment allocation of sections which do not appear in the PLACEMENT Block depends on the section type.

- Sections containing data are allocated next to the `.data` section.
- Sections containing code, constant variables or string constants are allocated next to the section `.text`.

Allocation in the segment where `.data` is placed occurs as follows:

- Allocates objects from `.data` section
- Allocates objects from section `.bss` (if `.bss` is not specified in the PLACEMENT block).
- Allocates objects from the first user-defined data section not specified in the PLACEMENT block.
- Allocates objects from the next user-defined data section not specified in the PLACEMENT block. (This continues until all user-defined data sections are allocated.)
- If the section `.stack` is not specified in the PLACEMENT block and is defined with a STACKSIZE command, the stack is allocated then.

**Figure 3.1 User-Defined Sections (.stack)**




Allocation in the segment where `.text` is placed occurs as follows:

- Allocates objects from `.init` section (if `.init` is unspecified in the PLACEMENT block).
- Allocates objects from `.startData` section (if `.startData` is unspecified in the PLACEMENT block).
- Allocates objects from `.text` section.
- Allocates objects from `.rodata` section (if `.rodata` is unspecified in the PLACEMENT block).
- Allocates objects from `.rodata1` section (if `.rodata1` is unspecified in the PLACEMENT block).

- Allocates objects from the first user-defined code section which is unspecified in the PLACEMENT block.
- Allocates objects from the next user defined code section, which is unspecified in the PLACEMENT block. (This continues until all user defined code sections are allocated.)
- Allocates objects from `.copy` section (if `.copy` is unspecified in the PLACEMENT block).

**Figure 3.2 User Defined Sections (.txt)**

| .init | .startData | .text | .rodata | .rodata1 | User Code1 | ... | User Code n | .copy |
|---|---|---|---|---|---|---|---|---|

# Allocating User-Defined Sections (Freescale)

All sections do not need to be enumerated in the placement block. The segments where sections, which do not appear in the PLACEMENT block, are allocated depends on the type and attributes of the section. The Linker allocates these segments as follows:

- Sections containing code next to the DEFAULT_ROM section.
- Sections containing constants only next to the DEFAULT_ROM section. Change this behavior using the `-CRam` option (see -CRam: Allocate Non-specified Constant Segments in RAM (ELF)).
- Sections containing string constants next to the DEFAULT_ROM section.
- Sections containing data next to the section DEFAULT_RAM.

Allocation in the segment where DEFAULT_RAM is placed occurs as follows:

- Allocates objects from DEFAULT_RAM section
- If the `-CRam` option is specified, allocates objects from ROM_VAR section, unless ROM_VAR is mentioned in the PLACEMENT block.
- Allocates objects from user-defined data sections, which are not specified in the PLACEMENT block. If `-CRam` option is specified, allocates constant sections together with non-constant data sections.
- If the SSTACK section is not specified in the PLACEMENT block and is defined with a STACKSIZE command, allocates the stack then.

**Figure 3.3 User Defined Sections (DEFAULT_RAM)**

| DEFAULT_RAM | User Data 1 | ... | User Data n | SSTACK |
|---|---|---|---|---|

Allocation in the segment where DEFAULT_ROM is placed occurs as follows:

- Allocates objects from _PRESTART section (if _PRESTART is not specified in the PLACEMENT block).
- Allocates objects from STARTUP section (if STARTUP is not specified in the PLACEMENT block).
- Allocates objects from ROM_VAR section (if ROM_VAR is not specified in the PLACEMENT block). If -CRam option is specified, allocates ROM_VAR in the RAM.
- Allocates objects from SSTRING (string constants) section (if SSTRING is not specified in the PLACEMENT block).
- Allocates objects from DEFAULT_ROM section
- Allocates objects from all user-defined code sections and constant data sections, which are not specified in the PLACEMENT block.
- Allocates objects from COPY section (if .copy is not specified in the PLACEMENT block).

**Figure 3.4 User Defined Sections (DEFAULT_ROM)**

| _PRESTART | STARTUP | ROM_VAR | SSTRING | DEFAULT_ROM | User Code 1 | ... | User Code n | COPY |
|---|---|---|---|---|---|---|---|---|

# Initializing Vector Table

Use the VECTOR command to perform vector table initialization.

## VECTOR Command

This command is specially defined to initialize the vector table.

Use the syntax VECTOR <Number>. In this case, the linker allocates the vector depending on the target CPU. The vector number zero is usually the reset vector, but depends on the target. The Linker knows the default start location of the vector table for each target supported.

You can use the syntax VECTOR ADDRESS as well. The size of the entries in the vector table depend on the target processor.

Table 3.4 describes the VECTOR command syntax.

**Table 3.4 VECTOR Command Syntax and Descriptions**

| Command | Description |
|---|---|
| VECTOR ADDRESS 0xFFFE 0x1000 | Indicates that the value 0x1000 must be stored at address 0xFFFE |
| VECTOR ADDRESS 0xFFFE FName | Indicates that the address of the function `FName` must be stored at address 0xFFFE. |
| VECTOR ADDRESS 0xFFFE FName OFFSET 2 | Indicates that the address of the function `FName` incremented by 2 must be stored at address 0xFFFE |

The last syntax may be very useful when working with a common interrupt service routine.

# Smart Linking (ELF)

Because of smart linking, only the objects referenced are linked with the application. The application entry points are:

- The application `init` function
- The `main` function
- The function specified in a `VECTOR` command

Smart linking automatically links all previously enumerated entry points and the objects they referenced with the application.

You can specify additional entry points using the `ENTRIES` command (see ENTRIES: List of Objects to Link with Application) in the `prm` file.

## Mandatory Linking of an Object

You can choose to link some non-referenced objects in this application. This may be useful for ensuring that a software version number is linked with the application and stored in the final product EPROM.

This may also be useful for ensuring that a vector table which has been defined as a constant table of function pointers, is linked with the application.

**Listing 3.10 Mandatory Linking of an Object Example**

```
ENTRIES
  myVar1 myVar2 myProc1 myProc2
END
```

This example specifies the variables `myVar1` and `myVar2` as well as the function `myProc1` and `myProc2` as additional entry points in the application.

**NOTE** As the linker is case sensitive, the name of the objects specified in the ENTRIES block must be objects defined somewhere in the application. For the linker, `MyVar1` and `myVar1` are two different objects.

## Mandatory Linking of all Objects Defined in Object File

You can choose to link all objects defined in a specified object file in your application.

**Listing 3.11 Mandatory Linking from All Objects Example**

```
ENTRIES
  myFile1.o:* myFile2.o:*
END
```

This example specifies all the objects (functions, variables, constant variables or string constants) defined in file `myFile1.o` and `myFile2.o` as additional entry points in the application.

## Switching OFF Smart Linking for the Application

You can choose to switch OFF smart linking. All objects are linked in the application.

**Listing 3.12 Switching Off SmartLinking Example**

```
ENTRIES
  *
END
```

This example switches OFF smart linking for the whole application. That means that all objects defined in one of the binary files building the application are linked with the application.

# Smart Linking (Freescale + ELF)

Because of smart linking, only the objects referenced are linked with the application. The application entry points are:

- The application `init` function
- The `main` function
- The function specified in a `VECTOR` command.

The SmartLinker automatically links all previously enumerated entry points and the objects they referenced with the application.

You can specify additional entry points using the ENTRIES command (see ENTRIES: List of Objects to Link with Application) in the `prm` file.

## Mandatory Linking from an Object

You can choose to link some non-referenced objects in your application. This may be useful for ensuring that a software version number is linked with the application and stored in the final product EPROM.

This may also be useful for ensuring that a vector table, which has been defined as a constant table of function pointers, is linked with the application.

**Listing 3.13 Mandatory Linking from an Object Example**

```
ENTRIES
  myVar1 myVar2 myProc1 myProc2
END
```

The example above specifies the variables `myVar1` and `myVar2` as well as the function `myProc1` and `myProc2` as additional entry points in the application

**NOTE** As the linker is case sensitive, the name of the objects specified in the ENTRIES block must be objects defined somewhere in the application. For the linker, `MyVar1` and `myVar1` are two different objects.

## Mandatory Linking from all Objects Defined in a File

You can choose to link all objects defined in a specified object file in your application. For that purpose, you need only to specify a '+' after the name of the module in the NAMES block.

**Listing 3.14 Mandatory Linking from All Objects Example:**

```
NAMES
  myFile1.o+ myFile2.o+ start.o ansi.lib
END
```

This example specifies all the objects (functions, variables, constant variables or string constants) defined in file `myFile1.o` and `myFile2.o` as additional entry points in the application.

# Binary Files Building an Application (ELF)

You can specify the names of the binary files building an application in the NAMES block or in the ENTRIES block. Usually a NAMES block is sufficient.

## NAMES Block

Usually you list all the binary files building the application in the NAMES block. You may specify additional binary files by the option -Add: Additional Object/Library File. If you specify all binary files by the command line option `-add`, then you must specify an empty NAMES block (just NAMES END).

**Listing 3.15 Names Block Example**

```
NAMES
  myFile1.o myFile2.o
END
```

In this example, the binary files `myFile1.o` and `myFile2.o` build the application.

## ENTRIES Block

If you specify a file name in the ENTRIES block, the linker considers the corresponding file as part of the application, even if it does not appear in the NAMES block. The file specified in the ENTRIES block may also be present in the NAMES block. Names from absolute, ROM library, or library files are not allowed in the ENTRIES block.

**Listing 3.16 Entries Block Example**

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

SEGMENTS
```

```
  DIRECT_RAM = READ_WRITE 0x00000 TO 0x000FF;
  STK_AREA   = READ_WRITE 0x00200 TO 0x002FF;
  RAM_AREA   = READ_WRITE 0x00300 TO 0x07FFF;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
END

PLACEMENT
    myRegister          INTO DIRECT_RAM;
    DEFAULT_RAM         INTO RAM_AREA;
    DEFAULT_ROM         INTO ROM_AREA;
    SSTACK              INTO STK_AREA;
END

ENTRIES
  test1.o:* test.o:*
END
```

In this example, the file `test.o`, `test1.o` and `startup.o` build the application. All objects defined in the module `test1.o` and `test.o` will be linked with the application.

# Binary Files Building an Application (Freescale)

You may specify the names of the binary files building an application in the NAMES block or in the ENTRIES block. Usually a NAMES block is sufficient.

## NAMES Block

Usually you list all the binary files building the application in the NAMES block. You may specify additional binary files using the `-Add` option (see -Add: Additional Object/ Library File). If you specify all binary files using the command line option `-Add`, then you must specify an empty NAMES block (just NAMES END).

**Listing 3.17 Names Block Example**

```
NAMES
  myFile1.o myFile2.o
END
```

In this example, the binary files `myFile1.o` and `myFile2.o` build the application.

# Allocating Variables in OVERLAYS

When your application consists of two distinct parts (or execution units) which are never activated at the same time, you can ask the linker to overlap the global variables of both parts. To do this in your application source files, you must:

- Define the global variable from the different parts in separate data segments. Do not use the same segment for both execution units.
- Initialize the global variables in both execution units using assignments in the application source code. Do not define global variables with the initializer.

In the `prm` file, you can then define two distinct memory areas with attribute PAGED. Memory areas with PAGED attributes are not initialized during startup. For this reason they cannot contain any variable defined with the initializer. The linker will not perform any overlap check on PAGED memory areas.

The example shown in Listing 3.18 illustrates this.

In your source code support you have two execution units: APPL_1 and APPL_2.

- All global variables from APPL_1 are defined in segment APPL1_DATA_SEG
- All global variables from APPL_2 are defined in segment DEFAULT_RAM and APPL2_DATA_SEG

The prm file looks as follows:

**Listing 3.18 .prm File Example**

```
LINK test.abs

NAMES  test.o appl1.o appl2.o startup.o END

SECTIONS
    MY_ROM   = READ_ONLY  0x800 TO 0x9FF;
    MY_RAM_1 = PAGED      0xA00 TO 0xAff;
    MY_RAM_2 = PAGED      0xA00 TO 0xAff;
    MY_STK   = READ_WRITE 0xB00 TO 0xBFF;

PLACEMENT
    DEFAULT_ROM      INTO  MY_ROM;
    DEFAULT_RAM,
    APPL2_DATA_SEG   INTO  MY_RAM_2;
    APPL1_DATA_SEG   INTO  MY_RAM_1;
    SSTACK           INTO  MY_STK;   /* Stack cannot be allocated in a
PAGED memory area. */
END
```

# Overlapping Locals

This section is only for targets which handle allocated local variables like global variables at fixed addresses.

Some small targets do not have a stack for local variables, so the compiler uses pseudo-static objects for local variables. In contrast to other targets which allocate such variables on the stack, the linker must allocate these variables. On the stack, multiple local variables are automatically allocated at the same address at different times. The linker implements a similar overlapping scheme to save memory for local variables.

#### Listing 3.19 Overlapping Locals Example

```
void f(void) { long fa; ....; }
void g(void) { long ga; ....; }
void main(void) { long lm; f(); g(); }
```

In this example, the functions `f` and `g` are never active at the same time, therefore the local variables `fa` and `ga` can be allocated at the same address.

**NOTE** When local variables are allocated at fixed addresses, the resulting code is not reentrant. Each function must be called only once. Take special care with interrupt functions: they must not call any function which might be active at the interrupt time. To be on the safe side, interrupt functions usually use a different set of functions than non-interrupt functions.

**NOTE** To the linker, parameter and spill objects are the same as local variables. All these objects are allocated together.

The linker analyzes the call graph of one root function at a time and allocates all local variables used by all dependent functions at this time. Variables depending on different root functions are allocated non-overlapping except in the case of an `OVERLAP_GROUP` (ELF).

## Algorithm

The algorithm for the overlap allocation is quite simple:

1. If current object depends on other objects, first allocate the dependents.
2. Calculate the maximum address used by any dependent object. If none exist, use the base reserved for the current root.
3. Allocate all locals starting at the maximum.

This algorithm is called for all roots. The base of the root is first calculated as the maximum used so far.

### Listing 3.20 Algorithm Example

```
void g(long g_par)  { }
void h(long l_par)  { }
void main(void)  {
  char ch;
  g(1);
  h(2);
}
void interrupt 1 inter(void) {
  long inter_loc;
}
```

The function `main` is a root because it is the application main function and `inter` is a root because it is called by an interrupt.

```
...
SECTIONS
...
  OVERLAP_RAM = NO_INIT 0x0060 TO 0x0068;
...
PLACEMENT
...
    _OVERLAP         INTO OVERLAP_RAM;
...
END
```

**NOTE** In the ELF object file format the name `_OVERLAP` is a synonym for the `.overlap` segment.

### Table 3.5 Algorithm Object File Format

| 0x60 | 0x61 | 0x62 | 0x63 | 0x64 | 0x65 | 0x66 | 0x67 | 0x68 |
|---|---|---|---|---|---|---|---|---|
| g_par | | | | ch | inter_loc | | | |
| l_par | | | | | | | | |

`main` starts the algorithm. As `h` and `g` depend on `main`, their parameters `g_par` and `l_par` are allocated starting at address 0x60 in the `_OVERLAP` segment. Next the local `ch` is allocated at 0x64 because all lower addresses are already used by dependents. After

main finishes, the base for the second root is calculated as 0x65, where inter_loc is also allocated.

The following items are considered as root points for the overlapping allocation in the ELF object file format:

- Objects specified in a DEPENDENCY ROOT block
- Objects specified in a OVERLAP_GROUP block
- Application main function (specified with prm file entry MAIN) and application entry point (specified with prm file entry INIT)
- Objects specified in a ENTRIES block
- Absolute objects
- Interrupt vectors
- All objects in non-SmartLinked object files

**NOTE** The main function (main) and the application entry point (_Startup) are implicitly defined as one OVERLAP_GROUP. In the startup code delivered with the compiler, this saves about 8 bytes because the locals of Init, Copy, and main overlap. When _Startup itself changes, it needs locals which must be active over the call to main. Define the _Startup function as a single entry in an OVERLAP_GROUP:
OVERLAP_GROUP _Startup END

The overlap _OVERLAP section (in ELF, this is also named .overlap) must be allocated in a NO_INIT area. The _OVERLAP section cannot be split into several areas.

# Name Mangling for Overlapping Locals

When parameters are passed on the stack, the linker performs caller and callee argument matching by their stack position. For overlapped locals (which include parameters not passed in registers as well), the linker does the matching using the parameter name.

Consider the following example:

```
void callee(long i);
void caller(void) {
  callee(1);
}
void callee(long k) {
}
```

The name i of the callee declaration does not match the name used in the definition. Actually, the declaration might not specify a name at all. Since the link between the caller

and callee argument uses the name, both must use the same name. Because of this, the compiler generates an artificial name for the callee's parameter: `_calleep0`. The compiler builds this name starting with an underscore ( _ ), appending the function name, appending a `p` and finally the argument number.

**NOTE** In ELF, there is a second name mangling needed to encode the name of the defining function into its name (see Name Mangling in ELF Object File Format).

Compiler users do not need to know about the name mangling at all. The compiler does it for them automatically.

However, to write functions with overlapping locals in assembler, you must do the name mangling yourself. This is especially important if you are calling C functions from assembler code or assembler functions from C code.

# Name Mangling in ELF Object File Format

The ELF Object File Format has no predefined way to specify the function to which an actual parameter belongs, so the compiler does some special name mangling. This adds the function name into the link time name.

In ELF, the name is built the following way:

- If the object is a function parameter, use a `p` followed by the argument number, instead of the object name given in the source file.
- Add the prefix `__OVL_`
- If the function name contains a underscore ( _ ), add the number of characters of the function name followed by a underscore ( _ ). Add nothing if the function name does not contain an underscore.
- Add the function name.
- Add an underscore ( _ ).
- If the object name contains a underscore ( _ ), add the number of characters of the object, followed by one underscore ( _ ). Add nothing if the object name does not contain an underscore.
- Add the object name.

Example (ELF):

```
void f(long p) {
  char a;
  char b_c;
}
```

This generates the following mangled names:

```
  p:    "__OVL_f_p0"    (HIWARE format: "_fp0")
  a:    "__OVL_f_a"     (HIWARE format: "a")
b_c:    "__OVL_f_3_b_c" (HIWARE format: "b_c")
```

# Defining a Function with Overlapping Parameters in Assembler

This section covers advanced topics which are important only if you plan to write assembler functions using a C calling convention with overlapping parameters.

For example, to define the callee function:

```
void callee(long k) {
  k= 0;
}
```

In assembler, we must first define the parameter with its mangled name. The parameter must be in the `_OVERLAP` section:

```
_OVERLAP: SECTION
callee_p1: DS 4
```

**NOTE** The `_OVERLAP` section is often allocated in a short segment. If so, use `_OVERLAP: SECTION SHORT` to specify this.

Next, define the function itself.

```
callee_code: SECTION
callee:
  CLEAR callee_p1,4
  RETURN
```

To avoid processor-specific examples, we assume that there is an assembler macro `CLEAR` which writes as many zero bytes as its second argument to the address specified by its first argument. The second macro `RETURN` generates a return instruction for the processor used. The implementation of these two macros are processor specific and not contained in this linker manual.

Finally, export the callee and its argument:

```
 XDEF callee
 XDEF callee_p1
```

The whole example in one block:

```
;Processor specific macro definition, please adapt to your target
CLEAR:        MACRO
              ...
              ENDM

RETURN:       MACRO
              ...
              ENDM

_OVERLAP:     SECTION
callee_p1:    DS 4

callee_code:  SECTION

callee:
              CLEAR callee_p1,4
              RETURN
; export function and parameter
              XDEF callee
              XDEF callee_p1
```

# Additional Points to Consider

In the ELF format, the name of the `p1` parameter must be `_OVL_callee_p1` instead of `callee_p1`.

Example for ELF:

```
_OVERLAP:        SECTION
_OVL_callee_p1: DS 4

callee_code:     SECTION
callee:
                 CLEAR _OVL_callee_p1,4
                 RETURN
; export function and parameter
              XDEF callee
              XDEF _OVL_callee_p1
```

Put every function defined in assembler in a separate section, as a linker section containing code corresponds to a compiler function.

Example of two functions in one segment:

```
            XDEF callee0
            XDEF callee1
_OVERLAP:   SECTION
loc0:       DS 4
loc1:       DS 4

code_seg: SECTION
callee0:
            CLEAR loc0,4
            RETURN
callee1:   ; ERROR function should be in separate segment
            CLEAR loc1,4
            RETURN
```

Because `callee0` and `callee1` are in the same segment, the linker treats them as if they were two entry points of the same function. This prevents `loc0` and `loc1` from overlapping and generating additional dependencies.

To correct the problem, put the two functions into separate segments:

```
            XDEF callee0
            XDEF callee1
_OVERLAP:   SECTION
loc0:       DS 4
loc1:       DS 4

code_seg0: SECTION
callee0:
            CLEAR loc0,4
            RETURN
code_seg1: SECTION
callee1:
            CLEAR loc1,4
            RETURN
```

Exporting the function exports the corresponding parameter objects. Locals are usually not exported.

Example of an invalid non-exported parameter definition:

```
            XDEF callee
_OVERLAP:   SECTION
callee_p1:  DS 4
```

```
callee_code: SECTION

callee:
             CLEAR callee_p1,4
             RETURN
```

Because `callee_p1` is not exported, an external caller or callee will not use the correct parameter. (Actually, the application will not be able to link because of the unresolved external `callee_p1`).

To correct this, export `callee_p1` as well:

```
             XDEF callee
             XDEF callee_p1
_OVERLAP:    SECTION
callee_p1:   DS 4

callee_code: SECTION

callee:
             CLEAR callee_p1,4
             RETURN
```

Only use function parameters which are actually called. Do not use local variables of other functions. The assembler does not prevent the usage of locals, which is not possible in C. Such additional usages are not taken into account for the allocation and may not work as expected. As a rule, only access objects defined in the `_OVERLAP` section from one SECTION, unless the object is a parameter. Parameters can be safely accessed from all sections containing calls to the callee and from the section defining the callee.

Example of an invalid use of a local variable:

```
_OVERLAP:     SECTION
loc:          DS 4

callee0_code: SECTION
callee0:
             CLEAR loc,4 ; error:usage of local var loc from two functs
              RETURN

callee1_code: SECTION
callee1:
              CLEAR loc,4 ; error: usage of local var loc from two
functs
              RETURN
```

Instead, use two different locals for two different functions:

```
_OVERLAP:      SECTION
loc0:          DS 4; local var of function callee0
loc1:          DS 4; local var of function callee1

callee0_code: SECTION
callee0:
               CLEAR loc0,4 ; OK, only callee 0 uses loc0
               RETURN

callee1_code: SECTION
callee1:
               CLEAR loc1,4 ; OK, only callee 0 uses loc1
               RETURN
```

In Freescale format, functions defined in assembly *must* access all parameters and locals allocated in the _OVERLAP segment. There must be no unused parameters in the _OVERLAP segment, otherwise, the linker allocates the unused parameter in the overlap area of one of the callers. This object can then overlap with the local variables of other callers. In the ELF format, the binding to the defining function is done by name mangling, so this restriction does not exist.

The following example does not work in the Freescale format because callee_p1 is not accessed.

```
_OVERLAP:     SECTION
callee_p1:    DS 4; error: parameter MUST be accessed

callee_code: SECTION
callee:
  RETURN
```

To correct this, use the parameter even if it is not needed:

```
_OVERLAP:     SECTION
callee_p1:    DS 4; OK parameter is accessed

callee_code: SECTION
callee:
              CLEAR callee_p1,1
              RETURN
```

# DEPENDENCY TREE Section in Map File

The DEPENDENCY TREE section in the map file provides useful information about the overlapped allocation.

**Listing 3.21 DEPENDENCY TREE Example**

```
volatile int intPending; /* interrupt being handled? */

void interrupt 1 inter(void) {
  int oldIntPending=intPending;
  intPending=TRUE;
  while (0 == read((void*)0x1234)) {}
  intPending=oldIntPending;
}

unsigned char read(void* adr)  {
  return *(volatile char*)adr;
}
```

This code generates the following tree:

```
_Vector_1             : 0x808..0x80B
|
+* inter                 : 0x808..0x80B
   | +* oldIntPending        : 0x80A..0x80B
   |
   +* read                   : 0x808..0x809
        +* _readp0               : 0x808..0x809
```

`Vector_1` is for the interrupt vector 1 specified in the C source.

The parameter name `adr` is encoded to `_readp0`, because in C, parameter names may have different names in different declarations, or even no name as in the example.

`Vector_1`, `inter` and `read` all depend on the `adr` parameter of `read`, which is allocated at 0x808 to 0x809 (inclusive). This area is included for all these objects. Only `Vector_1` and `inter` depend on `oldIntPending`, so the area 0x80A to 0x80B is only contained in these functions.

# Optimizing the Overlap Size

The area of memory used by one function is the area of this function plus the maximum of the areas of all used functions. The branches with the maximum area are marked with an asterisk ( `*` ).

When a local variable is added to a function with an asterisk, the whole overlap area grows by the variable size. More useful, when you remove a variable of a function marked with an asterisk, then the size of the overlap may decrease, unless there are several functions with an asterisk on the same level. When a marked function is using some variables of its own, then splitting this function into several parts may also reduce the overlap area.

# Recursion Checks

Assume that, for the previous example, a second interrupt function exists:

**Listing 3.22 Recursion Checks Example**

```
void interrupt 2 inter2(void) {
  int oldIntPending=intPending;
  intPending=TRUE;
  while (0 == read((void*)0x1235)) {}
  intPending=oldIntPending;
}
```

Now, this produces two dependency trees in the map file:

```
 _Vector_2              : 0x808..0x80B
 |
 +* inter2                 : 0x808..0x80B
    | +* oldIntPending          : 0x80A..0x80B
    |
    +* read                   : 0x808..0x809
         +* _readp0               : 0x808..0x809

 _Vector_1              : 0x80C..0x80D
 |
 +* inter                  : 0x80C..0x80D
    | +* oldIntPending          : 0x80C..0x80D
    |
   +* read                    : 0x808..0x809 (see above) (object allocated
in area of another root)
```

The subtree of the `read` function prints only once. The second time, `(see above)` prints instead of the whole subtree. The second remark `(object allocated in area of another root)` is more serious. Both interrupt functions use the same `read` function. If one interrupt handler can interrupt the other handler, then the parameter of the read functions may be overwritten and the first handler can fail. If both interrupts are exclusive, which is common for small processors using overlapped variables, then add this information to the `prm` file to allow an optimal allocation.

**Listing 3.23 Example prm file**

```
DEPENDENCY
  ROOT inter inter2 END
END
```

The warning disappears and the same tree contains both `inter` and `inter2`:

```
 DEPENDECY ROOT
 |
+* inter2                : 0x808..0x80B
 |  | +* oldIntPending        : 0x80A..0x80B
 |  |
 |  +* read                 : 0x808..0x809
 |       +* _readp0              : 0x808..0x809
 |
+* inter                 : 0x808..0x80B
    | +* oldIntPending        : 0x80A..0x80B
    |
    +* read                 : 0x808..0x809 (see above)
```

Because `oldIntPending` of both handlers now overlap, this example saves 2 bytes

**NOTE** The linker still handles `Vector_1` and `Vector_2` as additional roots. Because they are allocated using the DEPENDENCY ROOT, they have no influence on the generated code. Although the DEPENDENCY TREE section in the map file still lists their trees, these trees can be safely ignored.

# Linker-Defined Objects

The linker supports defining special objects to get the address and size of sections at link time. Objects to be defined by the linker must have as a special prefix one of the strings below and must not be defined by the application at all.

**NOTE** Because the linker defines C variables automatically when their size is known, the usual variables declaration fails for this feature. For an `extern int __SEG_START_SSTACK;`, the linker allocates the size of an `int`, and does not define the object as address of the stack. Use the following syntax so that the compiler/linker has no size for the object:
`extern int __SEG_START_SSTACK[];`

Usual applications of this feature are the initialization of the stack pointer and retrieving the last address of an application to compute a code checksum at runtime.

The object name is built by using a special prefix and then the name of the symbol.

The following tree prefixes are supported:

- `__SEG_START_` : start address of the segment
- `__SEG_END_` : end address of the segment
- `__SEG_SIZE_` : size of the segment

**NOTE** The `__SEG_END_` end address is the address of the first byte behind the named segment.

The linker assumes the remaining text after the prefix to be the segment name. If the linker does not find such a segment, it issues a warning and takes 0 as the address of this object.

**NOTE** There is no warning issued for predefined segments like SSTACK or OVERLAP, even if these segments are empty and not explicitly allocated. The warning is only issued for user-defined segments.

Because identifiers in C must not contain a period in their name, the Freescale format aliases can be used for the special ELF names. Few of them are `SSTACK` instead of `.stack`, `DEFAULT_RAM` instead of `.data`, `DEFAULT_ROM` instead of `.text`, `COPY` instead of `.copy`, `ROM_VAR` instead of `.rodata`, `STRINGS` instead of `.rodata1`, `STARTUP` instead of `.startData`, `PRESTART` instead of `.init` , `_OVERLAP` instead of `.overlap`, `_OVERLAP2` instead of `.overlap2`. Also, `__DOT__` can be prefixed for objects whose names start with period character.

For example, `__SEG_START___DOT__common` can be used to get start address of `.common` section.

#### Listing 3.24 C Source Code

```
#define __SEG_START_REF(a)   __SEG_START_ ## a
#define __SEG_END_REF(a)     __SEG_END_   ## a
#define __SEG_SIZE_REF(a)    __SEG_SIZE_  ## a
#define __SEG_START_DEF(a)   extern char __SEG_START_REF(a) []
#define __SEG_END_DEF(a)     extern char __SEG_END_REF(  a) []
#define __SEG_SIZE_DEF(a)    extern char __SEG_SIZE_REF( a) []

/* To use this feature, first define the symbols to be used: */
  __SEG_START_DEF(SSTACK); // start of stack
  __SEG_END_DEF(SSTACK);   // end of stack
  __SEG_SIZE_DEF(SSTACK);  // size of stack
/* Then use the new symbols with the _REF macros: */
int error;
void main(void) {
  char* stackBottom= (char*)__SEG_START_REF(SSTACK);
```

```
  char* stackTop    = (char*)__SEG_END_REF(SSTACK);
  int stackSize= (int)__SEG_SIZE_REF(SSTACK);
  error=0;
  if (stackBottom+stackSize != stackTop) { // top is bottom + size
    error=1;
  }
  for (;;); /* wait here */
}
```

**Listing 3.25 .prm File**

```
LINK example.abs
  NAMES  example.o  END
SECTIONS
    MY_RAM = READ_WRITE 0x0800 TO 0x0FFF;
    MY_ROM = READ_ONLY  0x8000 TO 0xEFFF;
    MY_STACK = NO_INIT 0x400 TO 0x4ff;
END
PLACEMENT
    DEFAULT_ROM INTO MY_ROM;
    DEFAULT_RAM INTO MY_RAM;
    SSTACK      INTO MY_STACK;
END
INIT main
```

**Listing 3.26 Linker-Defined Symbols**

```
__SEG_START_SSTACK   0x400
__SEG_END_SSTACK     0x500
__SEG_SIZE_SSTACK    0x100
```

**NOTE** To use the same source code with other linkers or old linkers, define the symbols in a separate module for them.

**NOTE** In C, you must use the address as value, and not any value stored in the variable. So in the previous example, "`(int)__SEG_SIZE_REF(SSTACK)`" was used to get the size of the stack segment and not a C expression like "`__SEG_SIZE_REF(SSTACK)[0]`".

# Stack Consumption Computation

The stack consumption computation is a feature of the linker that helps compute the theoretical maximal amount of stack space an application requires at runtime. This estimation can be done for the whole application or for user-specified call sub-trees. The result of the estimation is printed out in the map file along with the corresponding call tree paths. This feature is controlled by the `-StackConsumption` (Listing 3.27) command line option. However, the specific information needed for this feature is issued by the compiler and encoded in the object file.

> **NOTE** Older versions of the compiler may not issue the information. Also, this feature is currently only supported for HC(S)08 derivatives.

## STACK_CONSUMPTION Block

When using `-StackConsumption` (Listing 3.27) the linker automatically computes the stack consumption estimation for the application's entry point. This includes, typically the `_Startup` function and the user-provided vector table entries (refer to the `VECTOR` command in Listing 3.28). Since it is not possible to determine at link-time control-flow dependencies between usual functions and interrupt handlers the linker will compute and print the stack consumption for each vector table entry separately.

The linker also supports advanced features to increase the precision of the estimation. These include:

- Adding edges to the call graph; the FUNCTION_PAIR directive (Refer Table 3.6).
- Specifying user-defined stack consumption for a function; the `CONSUMPTION` directive (Refer Table 3.6).
- Specifying a custom call sub-tree; the `ROOT` directive (Refer Table 3.6).
- Specifying that a specific interrupt can be raised during the execution of a function; the `INTERRUPT_FUNCTION` directive (Refer Table 3.6).
- Specifying the maximum recursion factor for a function; the `RECURSION_FACTOR` directive (Refer Table 3.6).

Following is the syntax of the STACK_CONSUMPTION block.

#### Listing 3.27 STACK_CONSUMPTION Block Syntax

```
STACK_CONSUMPTION
 ROOT <name1> : <filename>
   [Optional] RECURSION_FACTOR <name>:<filename>  <factor>;
   [Optional] INTERRUPT_FUNCTION <name>:<filename>
<ISR_name>:<filename> <stackSize>;
```

```
END
 [Optional]
 ROOT <name2> : <filename>
 [Optional]RECURSION_FACTOR (<name>)+<factor>;
 END
 [Optional] CONSUMPTION <function_name>:<filename> <number>;
 [Optional] FUNCTION_PAIR <caller>:<filename> <callee>:<filename>
<stackSize>;
END
```

**NOTE** `<filename>` is only required when the referred symbol has local binding. For example, a C static function. A single function (for example, plus +) or a chain of functions that induce a loop in the call graph.

Table 3.6 describes the STACK_CONSUMPTION block directives.

**Table 3.6 STACK_CONSUMPTION Block Directives**

| Descriptive | Description |
|---|---|
| `ROOT <name1> : <filename>` - `<name>` | Specifies the name of the function for which the total stack effect is to be computed. Object File name `<filename>` in which `ROOT` can also be defined. This directive is not mandatory. The application entry point is used as root if none is explicitly provided. Also, it is possible to specify multiple roots. |
| `RECURSION_FACTOR (<name>:<filename>)+ <factor>;` - `<factor>` | Specifies the recursive factor of the specified function that is the maximum number of recursive calls a function makes for one execution of its caller.<br>is an integer value used to<br>The functions that cause indirect recursivity can also be specified. This should exclude the last caller - callee pair causing recursion (Refer Section Example 2a). The scope of this directive is restricted to the ROOT in which it is defined. |

**Table 3.6 STACK_CONSUMPTION Block Directives (*continued*)**

| Descriptive | Description |
|---|---|
| INTERRUPT_FUNCTION <name>:<filename> <ISR_name>:<filename> <stackSize>; | Specifies that the interrupt handled ISR_name can be raised during execution of the function name. The amount of stack consumed by the function name up to the point where the interrupt occurs must be specified by the stackSize parameter (use the stack consumption of the name function if not sure). |
| CONSUMPTION <function_name>:<filename> <number>; | Specifies the stack size of function; is an integer value.This directive should be written after specifying all ROOT entries. The stack size mentioned with this directive for a function applies to whole application and overrides the value internally computed by the linker. |
| FUNCTION_PAIR <caller>:<filename> <callee>:<filename> <stackSize>; | Alters the linker-computed call graph by adding an edge between caller and callee. The cost of this edge will be stackSize. This parameter should contain the amount of stack consumed by caller up to the point where callee is called. An use case for this directive would be an application that contains function pointers being passed as arguments. The directive should be at the end after specifying all ROOT entries. The information given by this directive applies to whole application. |

# Limitations

Functions written in assembly language are not taken into account when computing the stack consumption. However, the stack usage information can be specified using the `CONSUMPTION PRM` directive.

**NOTE** The assembly language here does not refer to inline assembly code, but to code written in assembly files, processed by the assembler tool.

# Example to Generate Stack Information

## Compilation

Consider `C` source: `./Sources/main.c`.

```
static int count = 0;
void call(void) { /* Recursive function */
   if (count == 10) {
     return;
   }
   count++;
   call();
}
void main(void) {
   call();
}
```

Table 3.7 lists the stack usage information generated by compiler in main.obj file.

**Table 3.7 Stack Usage Information**

| Caller | Callee | StackSize |
|---|---|---|
| main | aa | 6 |
| Main | - | 4 |
| Aa | Bb | 4 |
| Aa | - | 2 |
| Bb | Cc | 4 |
| bb | - | 2 |
| Cc | Aa | 6 |
| Cc | - | 4 |

## Link Process

1. Linker Option to be enabled: `-StackConsumption`
2. Stack Consumption directives included in PRM:

```
STACK_CONSUMPTION
ROOT main
```

```
RECURSION_FACTOR aa:./Sources/main.obj bb:./Sources/main.obj cc:./
Sources/main.obj 10;
END
END
..
VECTOR 0 _Startup
```

3. Link the application.
4. Partial map file output:

```
STACK CONSUMPTION COMPUTATION
1)
main = 146
-------------------------------------------------------
Maximum Stack Usage is calculated for following path:
-------------------------------------------------------
main
|
+-aa
  |
  +-bb
    |
    +-cc
2)
_Startup = 14
-------------------------------------------------------
Maximum Stack Usage is calculated for following path:
-------------------------------------------------------
_Startup
|
+-main
  |
  +-aa
    |
    +-bb
      |
      +-cc
```

The `RECURSION_FACTOR` directive specified in PRM is applicable only to ROOT entry main and not the default entry `_Startup` that is specified in VECTOR PRM directive.

## Example to Specify Stack COnsumption PRM Directives

### Recursive Functions — Test Case 1

```
void A() { /* This is a recursive function */
..
A();
}
Void main() {
A();
}
```

PRM Directive to be specified:

```
STACK_CONSUMPTION
ROOT main
RECURSION_FACTOR A 10; /* Correct */
RECURSION_FACTOR A A 10; /* Incorrect */
END
END
```

### Recursive Functions — Test Case 2

```
void A() {
..
B();
}

Void B() {
..
A();
}

Void main() {
..
A();
}
```

PRM Directive to be specified:

```
STACK_CONSUMPTION
ROOT main
RECURSION_FACTOR A B 10; /* Correct */
```

```
RECURSION_FACTOR A B A 10; /* Incorrect */
END
END
```

## Function Pointer Passed as Argument to Function — Test Case

```
double next_Div(double d) {
  return d/1.8;
}

Bool Comp_TrueLarger1(double a, double b) {
  return a+1.0 > b + 1.0;
}

void Test5_Do(double d0, double d1, Bool (*comp)(double a, double b),
double (*next)(double)) {
  while (d1 != 0) {
    if (comp(d0, d1)) {
..
    d0 = next(d0);
..
}

Void main() {
Test5_Do(1.0, 1.1, Comp_TrueLarger1, next_Div);
}
```

PRM Directive specification:

```
STACK_CONSUMPTION
ROOT main
END
FUNCTION_PAIR Test5_Do Comp_TrueLarger 12;
FUNCTION_PAIR Test5_Do next_Div 22;
END
```

## Usage of CONSUMPTION Directive — Test Case

```
Void main() {
  Asm_func(); /* Call to an assembly function defined in test.asm*/
}
```

Stack usage of main to `Asm_func` is given by compiler in object file but assembler does not provide stack usage of `Asm_func` routine.CONSUMPTION directive can be added to specify the stack usage of `Asm_func`.

PRM Directive specification:

```
STACK_CONSUMPTION
ROOT _Startup
END
CONSUMPTION Asm_func 100;
END
```

# Checksum Computation

The linker invokes the computation of a checksum in two ways:

- prm file-controlled checksum computation:

  The prm file specifies which kind of checksum to compute over which area and where to store the resulting checksum. This method gives full flexibility, but also requires more user-configuration effort. With this method the linker only computes the actual checksum value; the application code must ensure that the areas specified in the prm file match the areas computed at runtime.

- Automatic linker-controlled checksum computation:

  With this method, the linker generates a data structure containing all information to compute the checksum. The linker lists all ROM areas, computes the checksum and stores it, together with area and type information, in a data structure which can then be used at runtime to verify the code.

**Table 3.8 Comparison of Checksum Computation Methods**

| Attribute | prm File Controlled | Automatic Linker Controlled |
|---|---|---|
| Complexity | Needs some configuration<br>prm file needs adaptations | Easy to use<br>Call _Checksum_Check |
| Robustness | Values used in prm file and source code must match.<br>All areas to be checked must be listed in prm and source code. | Good.<br>Nothing (or few things) to configure |
| Control | Everything in full user control. | Poor. Can be controlled only when segment must be checked. |

**Table 3.8 Comparison of Checksum Computation Methods (*continued*)**

| Attribute | prm File Controlled | Automatic Linker Controlled |
|---|---|---|
| Target Memory Usage | Good. Only uses necessary memory. | Needs more memory because of control data structure. |
| Execution Time | Depends on method. Checks all areas as code size is unknown. | Depends on method. Checks only needed areas. |

# prm File-Controlled Checksum Computation

Special commands in the prm file can instruct the linker to compute the checksum over some explicitly specified areas. All necessary information for this is specified in the prm file (see Listing 3.28).

**Listing 3.28 Example prm file**

```
CHECKSUM
    CHECKSUM_ENTRY
        METHOD_CRC_CCITT
        OF       READ_ONLY   0xE020 TO 0xEEFF
        OF       READ_ONLY   0xEF00 TO 0xFEFF
        INTO     READ_ONLY   0xE010 SIZE 2
        UNDEFINED 0xff
    END
END
```

See the CHECKSUM: Checksum Computation (ELF) linker command description for the exact syntax to used in the prm file and also for more examples.

# Automatic Linker-Controlled Checksum Computation

The linker tracks all the memory areas used by an application, therefore this method uses this knowledge to generate a data structure, which then can be used at runtime to validate the complete code. The linker provides this information in the same way it provides copy down and zero out information.

The linker automatically generates the checksum data structure if the startup data structure has two have additional fields:

```
extern struct _tagStartup {
```

```
....
     struct __Checksum* checkSum;
     int nofCheckSums;
....
```

The header file `checksum.h` defines the structure `__Checksum`:

```
struct __Checksum {
    void* start;
    unsigned int len;
#if _CHECKSUM_CRC_CCITT
    _CheckSum2ByteType checkSumCRC_CCITT;
#endif
#if _CHECKSUM_CRC_16
    _CheckSum2ByteType checkSumCRC16;
#endif
#if _CHECKSUM_CRC_32
    _CheckSum4ByteType checkSumCRC32;
#endif
#if _CHECKSUM_ADD_BYTE
    _CheckSum1ByteType checkSumByteAdd;
#endif
#if _CHECKSUM_XOR_BYTE
    _CheckSum1ByteType checkSumByteXor;
#endif
};
```

The linker allocates `__checksum` structure in a `.checksum` section, placed after all the other code or constant sections. As the `.checksum` section itself must not be checked, it must be the last section in a SECTION list.

The linker issues `checksum` information for all used segments in the `prm` file. However, if some segments are filled with a FILL command, then this fill area is not included.

The linker derives `checksum` types to be computed by using the field names of the `__Checksum` structure. Usually only one alternative is present, but the linker can compute `checksum` in any combination of `checksum` methods.

## Automatic Structure Detection

The linker reads the debug information of the module containing `_tagStartup` to detect which checksums to generate and how to build the structure. This ensures that the structure used by the compiler always matches the structure the linker generates.

The linker knows the structure field names and the name `__Checksum` of the checksum structure. These names cannot be changed. Adapt the structure field types to your needs.

## .checksum Section

The `.checksum` section must be the last section in a placement. It may be after the `.copy` section. If it is not mentioned in the `prm` file, the linker automatically allocates space for the `.checksum` section when needed.

The `checksum` areas do not cover `.checksum` itself.

# Partial Fields

The `__Checksum` structure can also contain `checkSumWordAdd`, `checkSumLongAdd`, `checkSumWordXor` and `checkSumLongXor` fields to compute checksums with larger element sizes. However, as the FILL areas are not considered, the `len` field might not be a multiple of the element size. When this happens, assume the missing bytes are equal to zero. Because this is not handled in the provided example code, automatic generated word, long size add, or XOR checksums are not officially supported.

# Runtime Support

The `checksum.h` file contains functions, prototypes, and utilities to compute the various checksums. The corresponding source file is `checksum.c`. Look at `checksum.c` to find out how to compute the various checksums. The automatic generated checksum feature does not need any customer code.

To verify that the checksums are valid, perform the simple call:

```
_Checksum_Check(_startupData.checkSum,
_startupData.nofCheckSums);
```

Listing 3.29 shows a sample function call with required variable definitions needed in the customer code with the respective linker PRM. Use this as an example to verify that the prm file generated the checksums.

#### Listing 3.29  Checksum entry in linker PRM file

```
...
CHECKSUM
  CHECKSUM_ENTRY
    METHOD_CRC8
    OF READ_ONLY 0xF00C TO 0xF02B
    OF READ_ONLY 0xFE8000 TO 0xFE800F
    INTO READ_ONLY 0xF300 SIZE 1
    UNDEFINED 0xFF
  END
END
...
```

**Listing 3.30 Customer code**

```
const struct __ChecksumArea areas[] = {
   {(const void * __far)(0x7FF00C), 0x20} ,
   {(const void * __far)(0x7F8000), 0x10}
};

#define N_MEM_AREAS 2 /* Total number of memory areas present in const
struct __ChecksumArea areas[] */
#define DEFAULT_CRC8_POLY      0x9B
#define DEFAULT_CRC8_INIT      0xFF
#define CHECKSUM_STORAGE_CRC8          (*(unsigned char*)0x7FF300)

void main() {
...
  if (_Checksum_CheckAreasCRC8(areas , N_MEM_AREAS, DEFAULT_CRC8_POLY
,DEFAULT_CRC8_INIT ) == CHECKSUM_STORAGE_CRC8) {
    result = TRUE;
  }
...
}
```

`Checksum.c` file has routines prefixed with `_Checksum_CheckAreas` as utilities to compute a single checksum over multiple memory areas.

The following code adds the new data structure `__ChecksumArea` to `checksum.h` with respect to the calculation of single checksum for multiple memory areas.

**Listing 3.31 Code Adding __ChecksumArea to checksum.h**

```
struct __ChecksumArea {
  _CHECKSUM_ConstMemBytePtr start;
  unsigned int len;
};
```

# Linking an Assembly Application

Use the prm file or the SmartLinker to link an Assembly application, when warnings can be ignored.

## prm File

When an application consists of assembly files only, you can simplify the linker prm file. The simplified prm file requires:

- No startup structure.
- No stack initialization, because the source file directly initializes the stack.
- No main function.
- An entry point in the application.

**Listing 3.32 prm File Example**

```
LINK   test.abs
NAMES  test.o test2.o END
SECTIONS
  DIRECT_RAM = READ_WRITE 0x00000 TO 0x000FF;
  RAM_AREA   = READ_WRITE 0x00300 TO 0x07FFF;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
PLACEMENT
    myRegister        INTO DIRECT_RAM;
    DEFAULT_RAM       INTO RAM_AREA;
    DEFAULT_ROM       INTO ROM_AREA;
END
INIT Start                  ; Application entry point
VECTOR ADDRESS 0xFFFE Start ; Initialize Reset Vector
```

This example:

- Allocates all data sections defined in the assembly input files in the `RAM_AREA` segment.
- Allocates all code and constant sections defined in the assembly-input files in the `ROM_AREA` segment.
- Defines the `MyStart` function as the application entry point and also specifies it as a reset vector. `MyStart` must be XDEFed in the assembly source file.

## Warning Messages

An assembly application does not need any startup structure or root function.

You can ignore the following two warnings:

`WARNING: _startupData not found`

`WARNING: Function main not found`

# Smart Linking

When you link an assembly application, the linker performs smart linking on section level instead of object level. That links whole sections containing referenced objects with the application. An example of SmartLinking follows:

#### Listing 3.33 Assembly Source File

```
            XDEF entry
dataSec1:   SECTION
data1:      DS.W 1
dataSec2:   SECTION
data2:      DS.W 2
codeSec:    SECTION
entry:
            NOP
            NOP
            LDX   #data1
            LDD   #5645
            STD   0, X
loop:       BRA loop
```

#### Listing 3.34 SmartLinker prm File

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

SECTIONS
  RAM_AREA    = READ_WRITE 0x00300 TO 0x07FFF;
  ROM_AREA    = READ_ONLY  0x08000 TO 0x0FFFF;
PLACEMENT
    DEFAULT_RAM       INTO RAM_AREA;
    DEFAULT_ROM       INTO ROM_AREA;
END
INIT entry
VECTOR ADDRESS 0xFFE entry
```

This example:

- Defines the function `entry` as application entry point and also specifies it as a reset vector.
- Links the data section `dataSec1` defined in the assembly input file with the application because `data1` is referenced in `entry`. Allocates `dataSec1` in the `RAM_AREA` segment at address 0x300.

- Links the code section `codeSec` defined in the assembly-input file with the application because `entry` is the application entry point. Allocates `codeSec` in the `ROM_AREA` segment at address 0x8000.
- Does NOT link the data section `dataSec2` defined in the assembly input file with the application, because the `data2` symbol is never referenced.

You can switch smart linking OFF for your application. In that case all of the assembly code and all objects link with the application.

For the previous example, the following prm file switches smart linking OFF:

**Listing 3.35 ELF Format prm File**

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

SEGMENTS
  RAM_AREA   = READ_WRITE 0x00300 TO 0x07FFF;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
END
PLACEMENT
    DEFAULT_RAM        INTO RAM_AREA;
    DEFAULT_ROM        INTO ROM_AREA;
END
INIT entry
VECTOR ADDRESS 0xFFE entry
ENTRIES * END
```

**Listing 3.36 Freescale Format prm File**

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

SEGMENTS
  RAM_AREA   = READ_WRITE 0x00300 TO 0x07FFF;
  ROM_AREA   = READ_ONLY  0x08000 TO 0x0FFFF;
END
PLACEMENT
    DEFAULT_RAM        INTO RAM_AREA;
    DEFAULT_ROM        INTO ROM_AREA;
END
INIT entry
VECTOR ADDRESS 0xFFFE entry
```

These examples:

- Define the `entry` function as application entry point and specify it as a reset vector.

- Allocate the `dataSec1` data section defined in the assembly input file in the `RAM_AREA` segment at address 0x300.
- Allocate the `dataSec2` data section defined in the assembly input file next to the `dataSec1` section at address 0x302.
- Allocate the `codeSec` code section defined in the assembly-input file in the `ROM_AREA` segment at address 0x8000.

# LINK_INFO (ELF)

Some compilers support writing additional information into the ELF file. This information consists of a topic name and specific content.

```
#pragma LINK_INFO BUILD_NUMBER “12345”
#pragma LINK_INFO BUILD_KIND “DEBUG”
```

The compiler then stores this information into the ELF object file. The linker checks if different object files contain the same topic name with different content. If so, the linker issues a warning.

Finally, the linker issues all LINK_INFOs into the generated output ELF file.

Use this feature to warn you about linking incompatible object files together. Also the debugger can use this feature to pass information from header files used by the compiler into the generated application.

The linker currently has no internal knowledge about specific topic names.

# 4

# SmartLinker Parameter File

The SmartLinker's parameter file is an ASCII text file. For each application you have to write such a file. It contains linker commands specifying how the linking is to be done. This section describes the parameter file in detail, giving examples you may use as templates for your own parameter files. You might also want to look at the parameter files for the examples included in your installation.

## Parameter File Syntax

The following is the EBNF syntax of the parameter file:

```
ParameterFile={Command}
Command= LINK NameOfABSFile [AS ROM_LIB]
| NAMES ObjFile {ObjFile} END
| SEGMENTS {SegmentDef} END
| PLACEMENT {Placement} END
| (STACKTOP | STACKSIZE) exp
| MAPFILE MapSecSpecList
| ENTRIES EntrySpec {EntrySpec} END
| VECTOR (InitByAddr | InitByNumber)
| INIT FuncName
| MAIN FuncName
| HAS_BANKED_DATA
| OVERLAP_GROUP {FuncName} END
| DEPENDENCY {Dependency} END
| CHECKSUM {ChecksumEntry} END
where:
NameOfABSFile= FileName
ObjFile= FileName ["-"]
ObjName= Ident
QualIden = FileName ":" Ident
FuncName= ObjName | QualIdent
MapSecSpecList= MapSecSpec "," {MapSecSpec}
EntrySpec= [FileName":"] (* | ObjName)
MapSecSpec= ALL | NONE | TARGET | FILE | STARTUP | SEC_ALLOC |
SORTED_OBJECT_LIST | OBJ_ALLOC | OBJ_DEP | OBJ_UNUSED | COPYDOWN |
OVERLAP_TREE | STATSTIC
Dependency= ROOT {ObjName} END
| ObjName USES {ObjName} END
| ObjName ADDUSE {ObjName} END
```

```
| ObjName DELUSE {ObjName} END
SegmentDef= SegmentName "=" SegmentSpec ";".
SegmentName= Ident.
SegmentSpec= StorageDevice Relocation Range [Alignment] [FILL
CharacterList] [OptimizeConstants].
ChecksumEntry= CHECKSUM_ENTRY
ChecksumMethod
[INIT Number]
[POLY Number]
OF MemoryArea
INTO MemoryArea
[UNDEFINED Number]
END
ChecksumMethod= METHOD_CRC_CCITT | METHOD_CRC8 | METHOD_CRC16 |
METHOD_CRC32 | METHOD_ADD [SIZE <Size>] | METHOD_XOR.
MemoryArea= StorageDevice Range  StorageDevice= READ_ONLY | CODE |
READ_WRITE | PAGED | NO_INIT.
Range= exp (TO | SIZE) exp
Relocation= RELOCATE_TO Address
Alignment= ALIGN [exp] {"["ObjSizeRange":" exp"]"}
ObjSizeRange= Number | Number TO Number | CompareOp Number
CompareOp= ("<" | "<=" | ">" | ">=")
CharacterList= HexByte {HexByte}
OptimizeConstants= {(DO_NOT_OVERLAP_CONSTS | DO_OVERLAP_CONSTS) {CODE
| DATA}}
Placement= SectionList (INTO | DISTRIBUTE_INTO) SegmentList ";"
SectionList= SectionName {"," SectionName}
SectionName= Ident
SegmentList= Segment {"," Segment}
Segment= SegmentName | SegmentSpec
InitByAddr= ADDRESS Address Vector
InitByNumber= VectorNumber Vector
Address= Number
VectorNumber= Number
Vector= (FuncName [OFFSET exp] | exp) ["," exp]
Ident= <any C style identifier>
FileName= <any file name>
exp= Number
Number= DecimalNumber | HexNumber | OctalNumber
HexNumber= 0xHexDigit{HexDigit}.
DecimalNumber= DecimalDigit{DecimalDigit}
HexByte= HexDigit HexDigit
HexDigit= "0" | "1"| "2" | "3" | "4" | "5" | "6" | "7" | "8" | "9"| "A"
| "B" | "C" | "D" | "E" | "F" | "a" | "b" | "c" | "d" | "e" | "f"
DecimalDigit= "0" | "1"| "2" | "3" | "4" | "5" | "6" | "7" | "8" | "9"
|
```

Comments can appear anywhere in a parameter file, except where file names are expected. You can use either C style comments or Modula-2 style comments.

To keep your sources portable, do not include paths in file names. Otherwise, if you copy the sources to some other directory, the linker might not find all files needed. The linker uses the paths in the environment variables GENPATH, OBJPATH, TEXTPATH and ABSPATH to decide where to look for files and where to write the output files.

The order of the commands in the parameter file does not matter. However, make sure that you specify the SEGMENTS block before the PLACEMENT block.

There are a some sections named `.data`, `.text`, `.stack`, `.copy`, `.rodata1`, `.rodata`, `.startData`, and `.init`. Information about these sections can be found in the chapter on predefined sections.

# Mandatory SmartLinker Commands

A linker parameter file must contain at least the entries for LINK (or using option `-O`), `NAMES`, and `PLACEMENT`. All other commands are optional. The following example shows the minimal parameter file:

```
LINK mini.abs  /* Name of resulting ABS file */
NAMES
  mini.o startup.o  /* Files to link */
END
STACKSIZE 0x20       /* in bytes */
PLACEMENT
  DEFAULT_ROM INTO READ_ONLY  0xA00 TO 0xBFF;
  DEFAULT_RAM INTO READ_WRITE 0x800 TO 0x8FF;
END
```

If the CodeWarrior software calls the linker, then the LINK command is not necessary. The CodeWarrior Plug-In passes the `-O` option with the destination file name directly to the linker. You can see this if you enable **Display generated command lines in message window** in the Linker preference panel in CodeWarrior IDE.

The first placement statement reserves the address range from `0xA00` to `0xBFF` for allocation of read only objects (hence the qualifier `READ_ONLY`).

```
DEFAULT_ROM INTO READ_ONLY 0xA00 TO 0xBFF;
```

The `.text` subsumes all linked functions, all constant variables, all string constants and all initialization parts of variables, and copies them to RAM at startup.

The second placement statement reserves the address range from `0x800` to `0x8FF` for allocation of variables.

```
DEFAULT_RAM INTO READ_WRITE 0x800 TO 0x8FF;
```

# The INCLUDE Directive

A special INCLUDE directive allows you to split a prm file into several text files, if needed, to separate a target-specific part of a prm file from a common part.

The syntax of the include directive is:

```
IncludeDir= "INCLUDE" FileName.
```

Because the INCLUDE directive may be everywhere in the prm file, it is not contained in the main EBNF.

### Listing 4.1 Include Directive Example

```
LINK mini.abs  /* Name of resulting ABS file */
NAMES
  startup.o  /* startup object file */
  INCLUDE objlist.txt
END
STACKSIZE 0x20       /* in bytes */
PLACEMENT
  DEFAULT_ROM INTO READ_ONLY  0xA00 TO 0xBFF;
  DEFAULT_RAM INTO READ_WRITE 0x800 TO 0x8FF;
END
with objlist.txt:
  mini0.o  /* user object file(s) */
  mini1.o
```

5

# ELF Sections

Using sections allows you complete control over object allocation in memory. A section is a named group of global objects (variables or functions) associated with a certain memory area that may be non-contiguous. The objects belonging to a section are allocated in its associated memory range. This chapter describes the use of sections in detail.

There are many different ways to use sections, the most important being:

- Distributing two or more groups of functions and other read-only objects to different ROMs.
- Allocating single functions or variables to a fixed absolute address (for example, to access processor ports using high-level language variables).
- Allocating variables into memory locations where special addressing modes may be used.

## Segments and Sections

A *Section* is a named group of global objects declared in the source file, that is, functions and global variables.

A *Segment* is a memory range, not necessarily contiguous.

In the linker's parameter file, each section is associated with a segment so the linker knows where to allocate the objects belonging to a section.

## Sections

A section definition always consists of two parts: the definition of the objects belonging to it, and the memory area(s) associated with it, called segments. The object definition is done in the application source files using pragmas or directives (see the *Compiler* or *Assembler* manual). The segment definition is done in the parameter file using the `SEGMENTS` and `PLACEMENT` commands.

# Predefined Sections

You can group predefined sections into sections according to the runtime routines:

- Sections for things other than variables and functions: `.rodata1`, `.copy`, `.stack`.
- Sections for grouping large sets of objects: `.data`, `.text`
- A section for placing objects initialized by the linker: `.startData`.
- A section to allocate read-only variables: `.rodata`

**NOTE** The `.data` and `.text` sections provide default sections for object allocation.

The following paragraphs describe each of these predefined sections.

## .rodata1

This predefined section contains all string literals. For example, `This is a string` is allocated in section `.rodata1`. If you associate this section with a segment qualified as `READ_WRITE`, the strings are copied from ROM to RAM at startup.

## .rodata

The `.rodata` section contains any constant variable (declared as `const` in a C module or as DC in an assembler module) which is not allocated in a user-defined section. Usually, the `.rodata` section is associated with a `READ_ONLY` segment.

If this section is not mentioned in the `PLACEMENT` block in the parameter file, these variables are allocated next to the `.text` section.

## .copy

Initialization data belongs to the `.copy` section. If a source file contains the declaration:

```
int a[] = {1, 2, 3};
```

the hex string `000100020003` (6 bytes), which is copied to a location in RAM at program startup, belongs to the `.copy` segment.

If you allocate the `.rodata1` section to a `READ_WRITE` segment, all strings also belong to the `.copy` section. Any objects in this section are copied at startup from ROM to RAM.

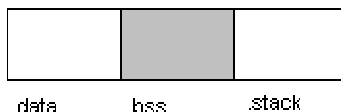
## .stack

The runtime stack has its own segment named `.stack`. Always allocate `.stack` to a `READ_WRITE` segment.

## .data

This predefined section is the default section for all objects normally allocated to RAM. It is used for variables not belonging to any section or to a section not assigned a segment in the `PLACEMENT` block in the linker's parameter file. If any of the `.bss` or `.stack` sections are not associated with a segment, these sections are included in the `.data` memory area in the following order:

**Figure 5.1 Memory Inclusion Order for .data**




## .text

This is the default section for all functions. If a function is not assigned to a certain section in the source code or if its section is not associated with a segment in the parameter file, it is automatically added to the `.text` section. If any of the `.rodata`, `.rodata1`, `.startData` or `.init` sections are not associated with a segment, these sections are included in the `.text` memory area.

## .startData

The startup description data initialized by the linker and used by the startup routine is allocated to segment `.startData`. This section must be allocated to a `READ_ONLY` segment.

## .init

The application entry point is stored in the `.init` section. This section also must be associated with a `READ_ONLY` segment.

### .overlap

Compilers using pseudo-static variables for locals allocate these variables in `.overlap`. Variables of functions not depending on each other may be allocated at the same place. This section must be associated with a `NO_INIT` segment.

**NOTE** The `.data` and `.text` sections must always be associated with a segment.

## Examples of Using Sections

Examples 1 and 2 illustrate the use of sections to precisely control allocation of variables and functions.

### Example 1

This example distributes code into two different ROMs:

```
LINK first.ABS
NAMES first.o strings.o startup.o END
STACKSIZE 0x200
SECTIONS
  ROM1 = READ_ONLY 0x4000 TO 0x4FFF;
  ROM2 = READ_ONLY 0x8000 TO 0x8FFF;
PLACEMENT
  DEFAULT_ROM INTO ROM1, ROM2;
  DEFAULT_RAM INTO READ_WRITE 0x1000 TO 0x1FFF;
END
```

### Example 2

This example allocates code into battery-buffered RAM:

```
/* Extract from source file "bufram.c" */
#pragma DATA_SEG Buffered_RAM
  int done;
  int status[100];
#pragma DATA_SEG DEFAULT
/* End of extract from "bufram.c" */
```

The following shows the associated SmartLinker parameter file:

```
LINK bufram.ABS
NAMES
  bufram.o startup.o
END
STACKSIZE 0x200
SECTIONS
  BatteryRAM = NO_INIT    0x1000 TO 0x13FF;
  MyRAM      = READ_WRITE 0x5000 TO 0x5FFF;
PLACEMENT
  DEFAULT_ROM  INTO READ_ONLY 0x2000 TO 0x2800;
  DEFAULT_RAM  INTO MyRAM;
  Buffered_RAM INTO BatteryRAM;
END
```

# 6

# Segments

Using segments allows you complete control over object allocation in memory. A segment is a named group of global objects (variables or functions) associated with a certain memory area that may be non-contiguous. The objects belonging to a segment are allocated in its associated memory range. This chapter describes the use of segmentation in detail.

There are many different ways to make use of the segment concept, the most important being:

- Distributing two or more groups of functions and other read-only objects to different ROMs.
- Allocating single functions or variables to a fixed absolute address (for example, to access processor ports using high-level language variables).
- Allocating variables in memory locations where special addressing modes may be used.

## Segments and Sections

A *Segment* is a named group of global objects declared in the source file, i.e. functions and global variables.

A *Section* is a memory range, not necessarily contiguous.

In the linker's parameter file, each segment is associated with a section so the linker knows where to allocate the objects belonging to a segment.

## Segment

A segment definition always consists of two parts: the definition of the objects belonging to it, and the memory area(s) associated with it, called sections. The object definition is done in the source files of the application using pragmas or directives (see the *Compiler* or *Assembler* manual). The section definition is done in the parameter file using the `SECTIONS` and `PLACEMENT` commands (see Parameter File Syntax).

# Predefined Segments

Predefined segment can be grouped into segments according to the runtime routines:

- Segments for things other than variables and functions: `STRINGS`, `COPY`, `SSTACK`
- Segments for grouping large sets of objects: `DEFAULT_RAM`, `DEFAULT_ROM`
- A segment for placing objects initialized by the linker: `STARTUP`
- A segment to allocate read-only variables: `ROM_VAR`

**NOTE** The segments `DEFAULT_RAM` and `DEFAULT_ROM` provide default segments for allocating objects.

The following paragraphs describe each of these predefined segments.

## STRINGS

This predefined segment contains all string literals (e.g. `This is a string`). Associate this segment with a segment qualified as `READ_WRITE` to copy the strings from ROM to RAM at startup.

## ROM_VAR

The `ROM_VAR` segment contains any constant variable (declared as `const` in a C module or as DC in an assembler module) which is not allocated in a user-defined segment. Usually, the `ROM_VAR` segment is associated with `READ_ONLY` section.

If this segment is not mentioned in the `PLACEMENT` block in the parameter file, the linker allocates these variables next to the `DEFAULT_ROM` segment.

## FUNCS

The `FUNCS` segment contains any function code not allocated in a user-defined segment. Usually, the `FUNCS` segment is associated with `READ_ONLY` section.

## COPY

Initialization data belongs to the `COPY` segment. If a source file contains the declaration:

```
int a[] = {1, 2, 3};
```

the hex string `000100020003` (6 bytes), which is copied to `a` location in RAM at program startup, belongs to segment `COPY`.

If the STRINGS segment is allocated to a READ_WRITE section, all strings also belong to the COPY segment. The linker copies any objects in this segment from ROM to RAM at startup.

## SSTACK

The runtime stack has its own segment named SSTACK. Always allocate SSTACK to a READ_WRITE section.

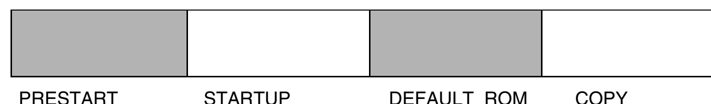
## DEFAULT_RAM

This is the default segment for all objects normally allocated to RAM. Use DEFAULT_RAM for variables not belonging to any segment or for variables belonging to a segment not assigned a section in the PLACEMENT block in the linker's parameter file. If you do not associate the SSTACK segment with a section, it is appended to the DEFAULT_RAM memory area.

## DEFAULT_ROM

This is the default segment for all functions. If a function is not assigned to a certain segment in the source code or if its segment is not associated with a section in the parameter file, it is automatically added to DEFAULT_ROM segment. If any of the _PRESTART, STARTUP, or COPY segments is not associated with a section, the linker includes these segments in the DEFAULT_ROM memory area in the following order:

**Figure 6.1 DEFAULT_ROM Segment Memory Order**




## STARTUP

The startup description data initialized by the linker and used by the startup routine is allocated to the STARTUP segment. This segment must be allocated to a READ_ONLY section.

## _PRESTART

The application entry point is stored in the segment _PRESTART. This segment must also be associated with a READ_ONLY section.

## _OVERLAP

This segment contains pseudo-static local variables, which are for non-reentrant functions.

The linker analyzes the call graph (that is, it keeps track of which function calls which other functions) and chooses distinct memory areas in the `_OVERLAP` segment if it detects a call dependency between two functions. If it doesn't detect such a dependency, it may overlap the memory areas used for local variables of two separate functions.

There are cases in which the linker cannot determine whether a function calls another function, especially in the presence of function pointers. If the linker detects a conflict between two functions, it issues an error message.

In the ELF object file format, the name `.overlap` is a synonym for `_OVERLAP`.

**NOTE** The `DEFAULT_RAM` and `DEFAULT_ROM` segments must always be associated with a section.

## VIRTUAL_TABLE_SEGMENT

The compiler generates virtual function tables if virtual functions are used. Because classes often are declared in header files, each implementation file including such header files with classes containing virtual member functions, may generate virtual function tables. These tables are constant by default and may be allocated in ROM.

To simplify this, the compiler places all virtual tables into a special segment named `VIRTUAL_TABLE_SEGMENT`. You can use this in the linker parameter file to allocate the virtual tables into ROM:

```
DEFAULT_ROM, ROM_VAR, VIRTUAL_TABLE_SEGMENT INTO MY_ROM
```

Additionally, the linker uses this segment name to avoid duplicate definitions of virtual function tables in your linked application.

7

# Program Startup

This section deals with advanced material. First-time users may skip this section; standard startup modules taking care of common cases are delivered with the programs and examples. It suffices to include the startup module in the files to link in the parameter file. For more information about the names of the startup modules and the different variants see the file `readme.txt` in the LIB directory subfolders.

**NOTE** The code shown in this chapter is example code. To understand what the startup modules for your environment do, be sure to look at the files in the installation.

Prior to calling the application's root function (`main`), one must:

- initialize the processor's registers,
- zero out memory, and
- copy initialization data from ROM to RAM.

Depending on the processor and the application's needs, different startup routines may be necessary.

There are standard startup routines for every processor and memory model. They are easy to adapt to your particular needs because all these startup routines are based on a startup descriptor containing all information needed. Different startup routines differ only in the way they make use of that information.

## Startup Descriptor (ELF)

The startup descriptor of the linker is declared in code similar to that shown below. Note that depending on architecture or memory model your startup descriptor may be different.

```
typedef struct{
  unsigned char *_FAR beg;int size;
} _Range;

typedef struct _Copy {
  int size; unsigned char * far dest;
} _Copy;

typedef void (*_PFunc)(void);
```

```
typedef struct_LibInit {
  _PFunc  *startup;   /* address of startup desc */
} _LibInit;

typedef struct _Cpp {
  _PFunc  initFunc;      /* address of init function */
} _Cpp;


extern struct _tagStartup {
   unsigned char   flags;
   _PFunc          main;
   unsigned short  stackOffset;
   unsigned short  nofZeroOuts;
   _Range          *pZeroOut;
   _Copy           *toCopyDownBeg;
   unsigned short  nofLibInits;
   _LibInit        *libInits;
   unsigned short  nofInitBodies;
   _Cpp            *initBodies;
   unsigned short  nofFiniBodies;
   _Cpp            *finiBodies;
} _startupData;
```

The linker expects, somewhere in your application, a declaration of the variable `_startupData`, that is:

```
struct _tagStartup _startupData;
```

The linker initializes the fields of this `struct` and allocates `_startupData` in ROM in `.startData` section. If there is no declaration of this variable, the linker does not create a startup descriptor. In this case, there is no `.copy` section, and the stack is not initialized. Furthermore, global C++ constructor and ROM libraries are not initialized.

Table 7.1 shows the semantics for these fields.

### Table 7.1 ELF Startup Descriptor Field Semantics

| Field Name | Description |
|---|---|
| `flags` | Contains some flags which can be used to detect special conditions at startup. Currently uses two bits. Linking the application as a ROM library sets bit 0 equal to 1. Bit 1 is set when no stack specification is made.<br>Startup code tests Bit 1 (with mask 2) to determine whether to initialize the stack pointer. |
| `main` | Function pointer set to application's root function. In a C program, this usually is function `main` unless a `MAIN` entry exists in the parameter file, specifying some other function as root. In a ROM library, `main` is zero. Standard startup code jumps to this address once initialization is over. |
| `stackOffset` | Valid only if `(flags & 2) == 0`. Contains the initial value of the stack pointer. |
| `nofZeroOuts` | Number of `READ_WRITE` segments to fill with zero bytes at startup. Not required if you do not have any RAM memory area, which requires initializing at startup. When not present in the startup structure, **`pZeroOut`** must not be present either. |
| `pZeroOut` | Pointer to a vector with elements of type `_Range`. It has exactly **`nofZeroOuts`** elements, each describing a memory area to be cleared. Not required if you do not have any RAM memory area, which requires initializing at startup. When not present in the startup structure, **`nofZeroOuts`** must not be present either. |
| `toCopyDownBeg` | Contains the address of the first item which must be copied from ROM to RAM at runtime. All data to be copied is stored in a contiguous piece of ROM memory and has the following format:<br>$\texttt{CopyData = \{Size}_{[t]}\ \texttt{TargetAddr \{Byte\}}^{\texttt{Size}}$<br>$\texttt{Alignment\} 0x0}_{[t]}$.<br>`Alignment= 0x0[0..7].`<br>Size is a binary number whose most significant byte is stored first. Not required if you do not have any RAM memory area, which requires initializing at startup. Alignment is used to align the next size and `TargetAddr` field. Number of alignment bytes depends on processor's capability to access unaligned data. For small processors, there is usually no alignment. Size t of $\texttt{Size}_{[t]}$ and $\texttt{0x0}_{[t]}$ depends on target processor and memory model. |

### Table 7.1 ELF Startup Descriptor Field Semantics (*continued*)

| Field Name | Description |
|---|---|
| `nofLibInits` | Number of ROM libraries linked with the application that must be initialized at startup. Not required if you do not link any ROM library with your application. When not present in startup structure, **`libInits`** must not be present. |
| `libInits` | Vector of pointers to the `_startupData` records of all ROM libraries in the application. Contains exactly **`nofLibInits`** elements. These addresses are needed to initialize the ROM libraries. Not required if you do not link any ROM library with your application. When not present in the startup structure, **`nofLibInits`** must not be present. |
| `nofInitBodies` | Number of C++ global constructors which must be executed prior to invoking application root function. Not required if application does not contain a C++ module. When not present in startup structure, **`initBodies`** must not be present. |
| `initBodies` | Pointer to a vector of function pointers containing addresses of the global C++ constructors in the application, sorted in calling order. Contains exactly **`nofInitBodies`** elements. If application does not contain any C++ modules, the vector is empty. Not required if application does not contain any C++ module. When not present in the startup structure, **`nofInitBodies`** must not be present either. |
| `nofFiniBodies` | Number of C++ global destructors which must be executed after the invocation of application root function. Not required if application does not contain a C++ module. When not present in startup structure, **`finiBodies`** must not be present either. If application root function does not return, **`nofFiniBodies`** and **`finiBodies`** can both be omitted. |
| finiBodies | Pointer to a vector of function pointers containing addresses of global C++ destructors in the application, sorted in calling order. Contains exactly **`nofFiniBodies`** elements. If an application does not contain any C++ modules, the vector is empty. Not required if application does not contain a C++ module. When not present in startup structure, **`nofFiniBodies`** must not be present either. If application root function does not return, **`nofFiniBodies`** and **`finiBodies`** can both be omitted. |

# User-Defined Startup Structure (ELF)

You can define your own startup structure. That means you can remove the fields, which are not required for your application, or move the fields inside of the structure. If you change the startup structure, it is your responsibility to adapt the startup function to match the modification.

## Example

If you have no RAM area to initialize at startup, no ROM libraries and no C++ modules in the application, you can define the startup structure as follows:

```
extern struct _tagStartup {
    unsigned short  flags;
    _PFunc          main;
    unsigned short  stackOffset;
} _startupData;
```

Adapt the startup code in the following way:

```
extern void near _Startup(void) {
/*  purpose:  1)  initialize the stack
              2)  call main;
    parameters: NONE */
  do { /* forever: initialize the program; call the root-procedure */
    INIT_SP_FROM_STARTUP_DESC();
   /* Here user defined code could be inserted,
       the stack can be used
    */
    /* call main() */
    (*_startupData.main)();
  } while(1); /* end loop forever */
}
```

**NOTE** Do not change the name of the fields in the startup structure. You are free to remove fields inside of the structure, but respect the names of the different fields or the SmartLinker may not initialize the structure correctly.

# User-Defined Startup Routines (ELF)

There are two ways to replace the standard startup routine with one of your own:

- You can provide a startup module containing a function named `_Startup` and link it with the application in place of the startup module delivered.
- You can implement a function with a name other than `_Startup` and define it as the entry point for your application using the command `INIT`:

```
INIT function_name
```

In this case, function `function_name` is the startup routine.

# Startup Descriptor (Freescale)

The Freescale startup descriptor of the linker is declared as below.

**NOTE** Descriptor declaration may vary depending on architecture or memory model.

```
typedef struct{
  unsigned char  *beg; int size;
} _Range;

typedef void (*_PFunc)(void);

extern struct _tagStartup{
  unsigned           flags;
  _PFunc             main;
  unsigned           dataPage;
  long               stackOffset;
  int                nofZeroOuts;
  _Range             *pZeroOut;
  long               toCopyDownBeg;
  _PFunc             *mInits;
  struct _tagStartup *libInits;
} _startupData;
```

The linker expects, somewhere in your application, a declaration of the variable `_startupData`, that is:

```
struct _tagStartup _startupData;
```

The linker initializes the fields of this `struct` and allocates the `struct` in ROM in `STARTUP` segment. If you do not declare this variable, the linker does not create a startup

descriptor. In this case, there is no COPY segment, and the stack is not initialized. Furthermore, global C++ constructor and ROM libraries are not initialized.

Table 7.2 shows the semantics for these fields.

**Table 7.2 Freescale Startup Descriptor Field Semantics**

| Field Name | Description |
|---|---|
| flags | Contains some flags, which may be used to detect special conditions at startup. Currently uses two bits. Linking the application as a ROM library sets bit 0 equal to 1. Bit 1 is set when no stack specification is made.<br>Startup code tests flags to determine whether to initialize the stack pointer. |
| main | Function pointer set to the application's root function. In a C program, usually function main unless a MAIN entry exists in the parameter file specifying some other function as being root. In a ROM library, main is zeroed out. Standard startup code jumps to this address once initialization completes. |
| dataPage | Used only for processors having paged memory and memory models supporting only one page. In this case, dataPage gives the page. |
| stackOffset | Valid only if flags == 0. Contains initial stack pointer value. |
| nofZeroOuts | Number of READ_WRITE segments to fill with zero bytes at startup. |
| pZeroOut | Pointer to a vector with elements of type _Range. It has exactly nofZeroOuts elements, each describing a memory area to be cleared. |
| toCopyDownBeg | Contains the address of the first item which must be copied from ROM to RAM at runtime. All data to be copied is stored in a contiguous piece of ROM memory and has the following format:<br>`CopyData = {Size[2] TargetAddr {Byte}Size} 0x0[2]`<br>Size is a binary number whose most significant byte is stored first. |
| libInits | Pointer to array of pointers to _startupData records of all ROM libraries in the application. These addresses are needed to initialize the ROM libraries. To specify end of the array, the last array element contains the value 0x0000ffff. |
| mInits | Pointer to array of function pointers containing addresses of the global C++ constructors in the application, sorted in calling order. Array is terminated by a single zero entry. |

# User-Defined Startup Routines (Freescale)

There are two ways to replace the standard startup routine with one of your own:

- You can provide a startup module containing a function named `_Startup` and link it with the application in place of the startup module delivered.
- You can implement a function with a name other than `_Startup` and define it as the entry point for your application using the command INIT:

```
INIT function_name
```

In this case, function `function_name` is the startup routine.

## Example of Startup Code in ANSI-C

Normally the startup code delivered with the compiler is provided in HLI for code efficiency reasons. But there is also an ANSI-C version available in the library directory (`startup.c` and `startup.h`). You can use this code for your own modifications or to get familiar with the startup concept.

The code shown here is an example and may be different depending on the actual implementation. See the files in your installation directory.

#### Listing 7.1 Header File startup.h:

```
/**************************************************
  FILE    : startup.h
  PURPOSE : data structures for startup
  LANGUAGE: ANSI-C
**************************************************/
#ifndef STARTUP_H
#define STARTUP_H
#ifdef __cplusplus
extern "C" {
#endif
#include <stdtypes.h>
#include <hidef.h>
/*
  the following data structures contain the data needed to
  initialize the processor and memory
*/

typedef struct{
  unsigned char *beg;
  int size;      /* [beg..beg+size] */
} _Range;
```

```
typedef struct _Copy{
  int size;
  unsigned char * dest;
} _Copy;

typedef struct _Cpp {
  _PFunc  initFunc;      /* address of init function */
} _Cpp;

typedef void (*_PFunc)(void);
typedef struct _LibInit{
  struct _tagStartup  *startup; /* address of startup desc */
} _LibInit;
#define STARTUP_FLAGS_NONE    0
#define STARTUP_FLAGS_ROM_LIB (1<<0) /* ROM library */
#define STARTUP_FLAGS_NOT_INIT_SP (1<<1) /* init stack */
#ifdef __ELF_OBJECT_FILE_FORMAT__
/* ELF/DWARF object file format */
/* attention: the linker scans for these structs */
/* to obtain the available fields and their sizes. */
/* So do not change the names in this file. */

extern struct _tagStartup {
  unsigned char flags;          /* STARTUP_FLAGS_xxx     */
  _PFunc         main;          /* first user fct        */
  unsigned short stackOffset;   /* initial stack pointer */
  unsigned short nofZeroOuts;   /* number of zero outs   */
  _Range         *pZeroOut;     /* vector of zero outs   */
  _Copy          *toCopyDownBeg; /* copy down start      */
  unsigned short nofLibInits;    /* number of ROM Libs   */
  _LibInit       *libInits;      /* vector of ROM Libs   */
  unsigned short  nofInitBodies; /* number of C++ inits */
  _Cpp           *initBodies;    /* C+ init funcs        */
  unsigned short  nofFiniBodies; /* number of C++ dtors */
  _Cpp           *finiBodies;    /* C+ dtors funcs       */
} _startupData;

#else /* HIWARE format */

extern struct _tagStartup {
  unsigned  flags;         /* STARTUP_FLAGS_xxx */
  _PFunc    main;          /* starting point of user code */
  unsigned  dataPage;      /* page where data begins */
  long      stackOffset;   /* initial stack pointer */
  int       nofZeroOuts;   /* number of zero out ranges */
  _Range    *pZeroOut;     /* ptr to zero out descriptor */
  long      toCopyDownBeg;/* address of copydown descr */
  _PFunc    *mInits;       /* ptr to C++ init fcts */
```

```
  _LibInit  *libInits;    /* ptr to ROM Lib descriptors */
} _startupData;

#endif

extern void _Startup(void);    /* execution begins here */
/*-------------------------------------------------*/
#ifdef __cplusplus
 }
#endif
#endif /* STARTUP_H */
```

**Listing 7.2 Implementation File startup.c:**

```
/*************************************************
  FILE        : startup.c
  PURPOSE     : standard startup code
  LANGUAGE    : ANSI-C / HLI
 *************************************************/
#include <hidef.h>
#include <startup.h>
/*************************************************/
struct _tagStartup _startupData; /* startup info   */
/*-------------------------------------------------*/
static void ZeroOut(struct _tagStartup *_startupData) {
/* purpose: zero out RAM-areas where data is allocated.*/
  int i, j;
  unsigned char *dst;
  _Range *r;
  r = _startupData->pZeroOut;
  for (i=0; i<_startupData->nofZeroOuts; i++) {
    dst = r->beg;
    j = r->size;
    do {
      *dst = '\0'; /* zero out */
      dst++;
      j--;
    } while(j>0);
    r++;
  }
}
/*----------------------------------------------------*/
static void CopyDown(struct _tagStartup *_startupData) {
/* purpose: zero out RAM-areas where data is allocated.
   this initializes global variables with their values,
    e.g. 'int i = 5;' then 'i' is here initialized with '5' */
  int i;
```

```
  unsigned char *dst;
  int *p;
  /* _startupData.toCopyDownBeg  ---> */
  /*  {nof(16) dstAddr(16) {bytes(8)}^nof} Zero(16) */
  p = (int*)_startupData->toCopyDownBeg;
  while (*p != 0) {
    i = *p; /* nof */
    p++;
    dst = (unsigned char*)*p; /* dstAddr */
    p++;
    do {
      /* p points now into 'bytes' */
      *dst = *((unsigned char*)p); /* copy byte-wise */
      dst++;
      ((char*)p)++;
      i--;
    } while (i>0);
  }
}
/*----------------------------------------------------*/
static void CallConstructors(struct _tagStartup *_startupData) {
/* purpose: C++ requires that the global constructors have
   to be called before main.
   This function is only called for C++ */
#ifdef __ELF_OBJECT_FILE_FORMAT__
  short i;
  _Cpp *fktPtr;

  fktPtr = _startupData->initBodies;
  for (i=_startupData->nofInitBodies; i>0; i--) {
    fktPtr->initFunc(); /* call constructors */
    fktPtr++;
  }
#else
  _PFunc *fktPtr;
  fktPtr = _startupData->mInits;
  if (fktPtr != NULL) {
    while(*fktPtr != NULL) {
      (**fktPtr)(); /* call constructors */
      fktPtr++;
    }
  }
#endif
}
/*----------------------------------------------------------*/
static void ProcessStartupDesc(struct _tagStartup *);
/*----------------------------------------------------*/
static void InitRomLibraries(struct _tagStartup *_sData) {
```

```
  /* purpose: ROM libraries have their own startup functions
     which have to be called. This is only necessary if ROM
     Libraries are used! */

#ifdef __ELF_OBJECT_FILE_FORMAT__
  short i;
  _LibInit *p;

  p = _sData->libInits;
  for (i=_sData->nofLibInits; i>0; i--) {
    ProcessStartupDesc(p->startup);
    p++;
  }
#else
  _LibInit *p;
  p = _sData->libInits;
  if (p != NULL) {
    do {
      ProcessStartupDesc(p->startup);
    } while ((long)p->startup != 0x0000FFFF);
  }
#endif
}
/*------------------------------------------------------*/
static void ProcessStartupDesc(struct _tagStartup *_sData) {
  ZeroOut(_sData);
  CopyDown(_sData);
#ifdef __cplusplus
  CallConstructors(_sData);
#endif
  if (_sData->flags&STARTUP_FLAGS_ROM_LIB) {
    InitRomLibraries(_sData);
  }
}
/*---------------------------------------------------------*/
#pragma NO_EXIT
#ifdef __cplusplus
  extern "C"
#endif
void _Startup (void) {
  for (;;) {
    asm {
      /* put your target specific initialization */
      /* (e.g. CHIP SELECTS) here */
    }
    if (!(_startupData.flags&STARTUP_FLAGS_NOT_INIT_SP)) {
      /* initialize the stack pointer */
      INIT_SP_FROM_STARTUP_DESC(); /* defined in hidef.h */
```

```
    }
    ProcessStartupDesc(&_startupData);
    (*_startupData.main)(); /* call main function */
  } /* end loop forever */
}
/*-----------------------------------------------------------*/
```

# 8

# The Map File

When linking completes successfully, the linker writes a protocol of the link process to a list file called a map file. The name of the map file is the same as that of the .ABS file, but with extension .map. The linker writes the map file to the directory given by the TEXTPATH environment variable (see TEXTPATH: Text Path).

## Map File Contents

Table 8.1 describes the sections contained in the map file.

**Table 8.1 Map File Contents**

| Section Name | Description |
|---|---|
| TARGET | Names the target processor and memory model. |
| FILE | Lists names of all files from which objects were used or referenced during link process. In most cases, these are the same names listed in linker parameter file between keywords NAMES and END. If a file refers to ROM library or program, lists all object files used by ROM library or program with indentation. |
| STARTUP | Lists prestart code and values used to initialize startup descriptor _startupData. Startup descriptor is listed member by member with the initialization data at the right side of the member name. |
| SEGMENT ALLOCATION | Lists segments in which at least one object was allocated. At right side of the segment name there is a pair of numbers, which give the address range in which the objects belonging to the segment were allocated. |
| OBJECT ALLOCATION | Contains names of all allocated objects and their addresses. Objects are grouped by module. ROM library addresses are followed by an @ sign. In this case the absolute file contains no code for the object (if it is a function), but the object's address was used for linking. A string object address followed by a dash "–" indicates that the string is a suffix of some other string. For example, if strings abc and bc are present in the same program, the string bc is not allocated and its address is the address of abc +1. |

**Table 8.1 Map File Contents (*continued*)**

| Section Name | Description |
|---|---|
| OBJECT DEPENDENCY | Lists every function and variable that uses other global objects and the names of these global objects. |
| DEPENDENCY TREE | Shows, in a tree format, all detected dependencies between functions. Also displays overlapping Locals displayed at their defining function. |
| UNUSED OBJECTS | Lists all objects found in object files that were not linked. |
| COPYDOWN | Lists all blocks that are copied from ROM to RAM at program startup. |
| STATISTICS | Delivers statistical information, like the number of bytes of code in the application. |

**NOTE** If linking fails because there are objects which were not found in any object file, no map file is written.

# 9

# ROM Libraries

The SmartLinker supports linking to objects to which addresses were assigned in previous link sessions. Packages of already linked objects are called ROM libraries. Creation of a ROM library only slightly differs from the linkage of a normal program. ROM libraries can then be used in subsequent link sessions by including them into the list of files between `NAMES` and `END`.

Examples for the use of ROM libraries are:

- If you use a set of related functions in different projects.

  It may be convenient to burn thoroughly tested library functions into ROM. We call such a set of objects (functions, variables and strings) at fixed addresses a ROM library.

- If you have a set of modules known to be error free and unchanging.

  To shorten the time needed for downloading, one can build a ROM library with modules known to be error free and that do not change. Such a ROM library must be downloaded only once, before beginning the tests of the other application modules.

- If the system allows you to download one program while another program is present in the target processor.

  The most prominent example is the monitor program. The linker facility described here enables an application program to use monitor functions.

## Creating a ROM Library

To create a ROM library, the keywords `AS ROM_LIB` must follow the `LINK` command in the linker parameter file. With the `ENTRIES` command, the linker includes only the given objects (functions and variables) in the ROM library. Without an `ENTRIES` command, the linker writes all exported objects to the ROM library. In both cases the ROM library also contains all global objects used by those functions and variables.

Since a program cannot consist of a ROM library alone, a ROM library must not contain a function `main` or a `MAIN` or `INIT` command, and the commands `STACKSIZE` and `STACKTOP` are ignored.

Besides all the application modules which form a ROM library, you must also define the variable `_startupData` in the ROM library. The library includes a module containing only a definition of this variable.

## ROM Libraries and Overlapping Locals

To allocate overlapping variables, all dependencies between functions must be known at link time. For ROM libraries, the linker is unaware of the dependencies between the objects in the ROM library. Therefore local variables of functions inside of the ROM library cannot overlap locals of the other modules. Instead, the ROM library must use a separate area for the `.overlap/_OVERLAP` segment which is not used in the main application.

# Using ROM Libraries

This section describes various activities involved when using ROM libraries.

## Suppressing Initialization

To link to a ROM library, add the name of the ROM library to the list of files in the `NAMES` section (see NAMES: List Files Building the Application) of the linker parameter file. Add a dash ( – ) immediately after the ROM library name (no blank between the last character of the file name and the dash) to prevent the startup routine from initializing the ROM library.

You can include an unlimited number of ROM libraries in the list of files to link, as long as no two ROM libraries use the same object file. If two ROM libraries contain identical objects (coming from the same object file) and both are linked in the same application, the linker reports an error, because allocating the same object more than once is not allowed.

## Example Application

In this example, we want to build and use a ROM library named `romlib.lib`. In this example the ROM library contains only one object file with one function and one global variable.

**Listing 9.1 Header File Example**

```
/* rl.h */
#ifndef __RL_H__
#define __RL_H__

char RL_Count(void);
  /* returns the actual counter and increments it */

#endif
```

Below is the implementation. Note that somewhere in the ROM library we must define an object named `_startupData` for the linker. We will use this startup descriptor to initialize the ROM library.

#### Listing 9.2  Startup Descriptor Example

```
/* rom library (RL_) rl.c */
#include "rl.h"
#include <startup.h>

struct _tagStartup _startupData; /* for linker */

static char RL_counter; /* initialized to zero by startup */

char RL_Count(void) {
  /* returns the actual counter and increments it */
  return RL_counter++;
}
```

After compiling `rl.c` we can now link it and build a ROM library using the following linker parameter file. The main difference between a normal application linker parameter file and a parameter file for ROM libraries is the `AS ROM_LIB` keyword in the `LINK` command.

#### Listing 9.3  Linker Parameter File Example

```
/* rl.prm */
LINK romLib.lib AS ROM_LIB

NAMES rl.o END

SECTIONS
    MY_RAM = READ_WRITE  0x4000 TO 0x43FF;
    MY_ROM = READ_ONLY   0x1000 TO 0x3FFF;

PLACEMENT
    DEFAULT_ROM, ROM_VAR, STRINGS  INTO  MY_ROM;
    DEFAULT_RAM                    INTO  MY_RAM;
END
```

In this example, RAM starts at 0x4000 and ROM starts at 0x1000. By default the linker generates startup descriptors for ROM libraries too. The startup descriptors are used to zero out global variables or to initialize global variables with initialization values. Additionally, C++ constructors and destructors may be called. This process is called *Module Initialization*.

To switch off Module Initialization for a single object file in the above linker parameter file, add a dash ( – ) at the end of each object file. For the above example this is:

```
NAMES rl.o- END
```

After building the ROM library, the linker generates a map file. Listing 9.4 shows an extract of this file. The linker also generates a startup descriptor at (in this case) address 0x1000 to initialize the ROM library.

**Listing 9.4 Map File Example**

```
*****************************************************
STARTUP SECTION
-----------------------------------------------------

Entry point: none
_startupData is allocated at 1000 and uses 44 Bytes


extern struct _tagStartup{
    unsigned flags                              3
    _PFunc   main                            103C ()
    unsigned dataPage                           0
    long     stackOffset                     4202
    int      nofZeroOuts                        1
    _Range   pZeroOut ->             4000       2
    long     toCopyDownBeg                   102C
    _PFunc   mInits   ->                     NONE
    void *   libInits ->                     NONE
} _startupData;


*****************************************************
SEGMENT-ALLOCATION SECTION
-----------------------------------------------------

Segmentname              Size Type    From       To   Name

FUNCS                      14   R     102E      1041  MY_ROM
COPY                        2   R     102C      102D  MY_ROM
STARTUP                    2C   R     1000      102B  MY_ROM
DEFAULT_RAM                 2 R/W     4000      4001  MY_RAM


*****************************************************
OBJECT-ALLOCATION SECTION
-----------------------------------------------------

Type:     Name:                         Address:  Size:
```

```
MODULE:              -- rl.o --
- PROCEDURES:
          RL_Count                         102E      14


- VARIABLES:
          _startupData                     1000      2C
          RL_counter                       4000       2
```

Now we want to use the ROM library from our application, as in Listing 9.5.

#### Listing 9.5 Simple Application Example

```
/* main application using ROM library: main.c */
#include "rl.h"

int cnt;

void main(void) {
  int i;

  for (i=0; i<100; i++) {
    cnt = RL_Count();
  }
}
```

After compiling `main.c` we can link it with our ROM library, as in Listing 9.6.

#### Listing 9.6 Linking Example

```
LINK main.abs

NAMES  main.o romlib.lib startup.o ansi.lib END

SECTIONS
    MY_RAM = READ_WRITE  0x5000 TO 0x53FF;
    MY_ROM = READ_ONLY   0x6000 TO 0x6FFF;

PLACEMENT
    DEFAULT_ROM, ROM_VAR, STRINGS  INTO  MY_ROM;
    DEFAULT_RAM                    INTO  MY_RAM;
END

STACKSIZE  0x200
```

Depending on your CPU configuration and memory model you may need to use a startup object file other than `startup.o` and a library other than `ansi.lib`. Additionally you must choose the right startup object file. For efficiency reasons most of the startup files implemented in HLI are optimized for a specific target. To save ROM usage, they do not support ROM libraries in the startup code. As long as no Module Initialization is needed, this is not a problem. To use the Module Initialization feature (as in our example), we use the ANSI-C implementation in the library directory (`startup.c`). Because this startup file may not be delivered in every target configuration, you must compile the `startup.c` startup file as well.

After linking to `main.abs`, you get a map file. Listing 9.7 shows an extract of this file.

#### Listing 9.7 Map File after Linking Example

```
*****************************************************
STARTUP SECTION
-----------------------------------------------------
Entry point: 0x6000
Linker generated code (at 0x6000) before calling __Startup:
MOVE #0x2700, SR
JMP 0x61A0
_startupData is allocated at 600A and uses 48 Bytes

extern struct _tagStartup{
    unsigned flags                               0
    _PFunc   main                             603C (_main)
    unsigned dataPage                            0
    long     stackOffset                      5202
    int      nofZeroOuts                         1
    _Range   pZeroOut ->            5000         2
    long     toCopyDownBeg                    603A
    _PFunc   mInits   ->                      NONE
    void *   libInits ->                      1000
} _startupData;

*****************************************************
SEGMENT-ALLOCATION SECTION
-----------------------------------------------------
Segmentname           Size Type    From        To  Name

FUNCS                  184  R      603C      61BF  MY_ROM
COPY                     2  R      603A      603B  MY_ROM
STARTUP                 30  R      600A      6039  MY_ROM
_PRESTART                A  R      6000      6009  MY_ROM
SSTACK                 200 R/W     5002      5201  MY_RAM
DEFAULT_RAM              2 R/W     5000      5001  MY_RAM
*****************************************************
OBJECT-ALLOCATION SECTION
```

```
------------------------------------------------------
Type:     Name:                        Address:  Size:
VECTOR
          value:        0                    0       4
          &_Startup                          4       4


MODULE:             -- main.o --
- PROCEDURES:
          main                            603C      26

- VARIABLES:
          cnt                             5000       2


MODULE:             -- X:\FREESCALE\DEMO\M68KC\rl.o --
- PROCEDURES:
          RL_Count                        102E      14 @

- VARIABLES:
          __startupData                   1000      2C @
          RL_counter                      4000       2 @


MODULE:             -- startup.o --
- PROCEDURES:
          ZeroOut                         6062      50
          CopyDown                        60B2      54
          ProcessStartupDesc              6142      3E
          HandleRomLibraries              6106      3C
          Start                           6180      20
          _Startup                        61A0      20

- VARIABLES:
          _startupData                    600A      30
```

The linker marks objects linked from the ROM library (`RL_Count`, `RL_counter`) with an @ in the `OBJECT-ALLOCATION-SECTION`. The linker in this case generates a startup descriptor at address `0x600A` which points, with field `libInits`, to the startup descriptor in our ROM library at address `0x1000`.

**NOTE** The `main.abs` file does NOT include the code/data of the ROM library, thus they are NOT downloaded during downloading of `main.abs`, and must be downloaded separately (e.g., with an EEPROM).

# 10

# Initializing the Vector Table

You can initialize the vector table in the assembly source file or in the linker parameter (prm) file. We recommend initializing it in the prm file.

## Using the SmartLinker prm File

Initializing the vector table from the prm file allows you to initialize single entries in the table. You can decide if you want to initialize all the entries in the vector table or not.

You must implement the labels or functions to insert into the vector table in the assembly source file. All these labels must be published, otherwise they cannot be addressed in the linker prm file.

### Example:

```
XDEF IRQFunc, XIRQFunc, SWIFunc, OpCodeFunc, ResetFunc

DataSec: SECTION
Data:  DS.W 5 ; Each interrupt increments another element of the table.

CodeSec: SECTION
; Implementation of the interrupt functions.

IRQFunc:
          LDAB #0
          BRA  int

XIRQFunc:
          LDAB #2
          BRA  int

SWIFunc:
          LDAB #4
          BRA  int

OpCodeFunc:
          LDAB #6
          BRA  int

ResetFunc:
```

```
          LDAB #8
          BRA  entry

int:
       LDX #Data ; Load address of symbol Data in X
        ABX      ; X <- address of the appropriate element in the table
       INC  0, X ; The table element is incremented
       RTI

entry:
        LDS #$AFE
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.

> **NOTE** As the HC12 processor automatically pushes all registers onto the stack on occurrence of an interrupt, the interrupt functions do not need to save and restore the registers being used.

> **NOTE** You must terminate all interrupt functions with an RTI instruction.

Initialize the vector table using the VECTOR ADDRESS linker command.

### Example:

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

SECTIONS
  MY_ROM  = READ_ONLY   0x0800 TO 0x08FF;
  MY_RAM  = READ_WRITE 0x0B00 TO 0x0CFF;

PLACEMENT
  DEFAULT_RAM        INTO MY_RAM;
  DEFAULT_ROM        INTO MY_ROM;
END

INIT ResetFunc
VECTOR ADDRESS 0xFFF2 IRQFunc
VECTOR ADDRESS 0xFFF4 XIRQFunc
```

```
VECTOR ADDRESS 0xFFF6 SWIFunc
VECTOR ADDRESS 0xFFF8 OpCodeFunc
VECTOR ADDRESS 0xFFFE 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.

**NOTE** The statement `VECTOR ADDRESS 0xFFF2 IRQFunc` tells the linker to write the address of function `IRQFunc` at address 0xFFF2.

# Using a Relocatable Section in the Assembly Source File

Initializing the vector table in the assembly source file requires initializing all the entries in the table. Unused interrupts must be associated with a standard handler.

You must implement the labels or functions to insert into the vector table in the assembly source file. You can define the vector table 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.
IRQFunc:
          LDAB #0
          BRA  int
XIRQFunc:
          LDAB #2
          BRA  int
SWIFunc:
          LDAB #4
          BRA  int
OpCodeFunc:
          LDAB #6
          BRA  int
ResetFunc:
          LDAB #8
          BRA  entry
```

```
DummyFunc:
          RTI
int:
          LDX  #Data
          ABX
          INC  0, X
          RTI
entry:
          LDS #$AFE
loop:     BRA loop

VectorTable:SECTION
; Definition of the vector table.
IRQInt:        DC.W IRQFunc
XIRQInt:       DC.W XIRQFunc
SWIInt:        DC.W SWIFunc
OpCodeInt:     DC.W OpCodeFunc
COPResetInt:   DC.W DummyFunc; No function attached to COP Reset.
ClMonResInt:   DC.W DummyFunc; No function attached to Clock
                             ; MonitorReset.
ResetInt      : DC.W ResetFunc
```

**NOTE** Each constant in the section `VectorTable` is defined as a word (2-byte constant), because the entries in the HC12 vector table are 16 bits wide.

**NOTE** The previous example initializes the constant `IRQInt` with the address of the label `IRQFunc`.

**NOTE** The previous example initializes the constant `XIRQInt` with the address of the label `XIRQFunc`.

**NOTE** All the labels specified as initialization values must be defined, published (using `XDEF`) or imported (using `XREF`) before the vector table section. No forward reference is allowed in `DC` directive.

Now place the section at the expected address, using the linker parameter file.

### Example:

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

SECTIONS
```

```
  MY_ROM   = READ_ONLY  0x0800 TO 0x08FF;
  MY_RAM   = READ_WRITE 0x0A00 TO 0x0BFF;
/* Define the memory range for the vector table */
  Vector   = READ_ONLY  0xFFF2 TO 0xFFFF;
PLACEMENT
  DEFAULT_RAM        INTO MY_RAM;
  DEFAULT_ROM        INTO MY_ROM;
/* Place the section 'VectorTable' at the appropriated address. */
  VectorTable  INTO Vector;
END

INIT ResetFunc
```

**NOTE** The statement `Vector = READ_ONLY 0xFFF2 TO 0xFFFF` defines the memory range for the vector table.

**NOTE** The statement `VectorTable INTO Vector` tells the linker to load the vector table into the read-only memory area `Vector`. This allocates the constant `IRQInt` at address 0xFFF2, the constant `XIRQInt` at address 0xFFF4, and so on, and allocates the constant `ResetInt` at address 0xFFFE.

**NOTE** The statement `NAMES test.o+ END` switches smart linking OFF in the module `test.o`. If this statement is missing in the prm file, the vector table never links with the application, because it is never referenced. The SmartLinker only links the referenced objects in the absolute file.

# Using an Absolute Section in the Assembly Source File

Initializing the vector table in the assembly source file requires initializing all the entries in the table. Unused interrupts must be associated with a standard handler.

You must implement the labels or functions to insert into the vector table in the assembly source file. You can define the vector table 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.
IRQFunc:
          LDAB #0
          BRA  int
XIRQFunc:
          LDAB #2
          BRA  int
SWIFunc:
          LDAB #4
          BRA  int
OpCodeFunc:
          LDAB #6
          BRA  int
ResetFunc:
          LDAB #8
          BRA  entry
DummyFunc:
          RTI
int:
          LDX  #Data
          ABX
          INC  0, X
          RTI
entry:
          LDS #$AFE
loop:     BRA loop

               ORG $FFF2
; Definition of the vector table in an absolute section
; starting at address
;  $FFF2.
IRQInt:        DC.W IRQFunc
XIRQInt:       DC.W XIRQFunc
SWIInt:        DC.W SWIFunc
OpCodeInt:     DC.W OpCodeFunc
COPResetInt:   DC.W DummyFunc; No function attached to COP Reset.
ClMonResInt:   DC.W DummyFunc; No function attached to Clock
                             ; MonitorReset.
ResetInt     : DC.W ResetFunc
```

**NOTE** Each constant in the section `VectorTable` is defined as a word (2-byte constant), because the entries in the HC12 vector table are 16 bits wide.

**NOTE** In the previous example initializes the constant `IRQInt` with the address of the label `IRQFunc`.

**NOTE** In the previous example initializes the constant `XIRQInt` with the address of the label `XIRQFunc`.

**NOTE** All the labels specified as initialization value must be defined, published (using `XDEF`) or imported (using `XREF`) before the vector table section. No forward reference is allowed in `DC` directive.

**NOTE** The statement `ORG $FFF2` specifies that the next section must start at address $FFF2.

### Example:

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

SEGMENTS
  MY_ROM   = READ_ONLY  0x0800 TO 0x08FF;
  MY_RAM   = READ_WRITE 0x0A00 TO 0x0BFF;
PLACEMENT
  DEFAULT_RAM        INTO MY_RAM;
  DEFAULT_ROM        INTO MY_ROM;
END

INIT ResetFunc
```

**NOTE** The statement `NAMES test.o+ END` switches smart linking OFF in the module `test.o`. If this statement is missing in the prm file, the vector table never links with the application, because it is never referenced. The SmartLinker links only the referenced objects in the absolute file.

# Burner Utility

## Introduction

The CodeWarrior IDE burner utility converts an `.ABS` file into a file that can be handled by an EPROM burner. The Burner is available as either:

- An interactive burner with a graphical user interface (GUI).
- A batch burner that accepts commands either from a command line or in a command file. It can then be invoked by the Make Utility.

This section consists of the following chapters:

- Interactive Burner GUI: Description of GUI
- Batch Burner Language: Description of Batch Burner Language (BBL)

## Product Highlights

The burner utility:

- Has a powerful user interface
- Has available on-line help
- Offers flexible message management
- Has 32-bit application
- Can generate S-Record, Binary, or Intel Hex files
- Can split the application into different EEPROMS (1-, 2- or 4-byte bus width)
- Has an interactive (GUI) and batch language interface (Batch Burner)
- Uses a powerful Batch Burner Language with various commands, including:
  - baudRate, busWidth, CLOSE, dataBit, destination, DO, ECHO, ELSE, END, fillByte, FOR, format, header, IF, len, OPENCOM, OPENFILE, origin, parity,

PAUSE, range, SENDBYTE, SENDWORD, SLINELEN, SRECORD, swapByte, THEN, TO, and undefByte.

- Supports Freescale and ELF/DWARF Object File Format, S-Records and Intel Hex Files as input
- Supports a serial programmer attached to a serial port with various configuration settings

# Starting the Burner Utility

You can start all of the utilities described in this book from executable files located in the `Prog` folder of your IDE installation. The executable files are:

- `linker.exe` The SmartLinker
- `maker.exe` Maker: The Make Tool
- `burner.exe` The Burner Utility
- `decoder.exe` The Decoder
- `libmaker.exe` Libmaker

With a standard full installation of the HC(S)08/RS08 CodeWarrior IDE, you can find the executable files in:

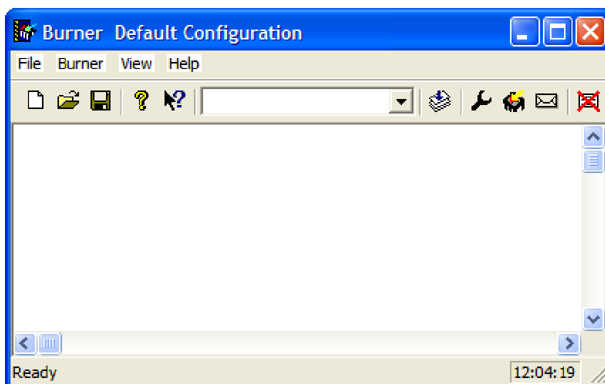
```
C:\Program Files\Freescale\CodeWarrior for Microcontrollers V6.2\Prog
```

With a standard full installation of the S12 CodeWarrior IDE, you can find the executable files in:

```
C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\Prog
```

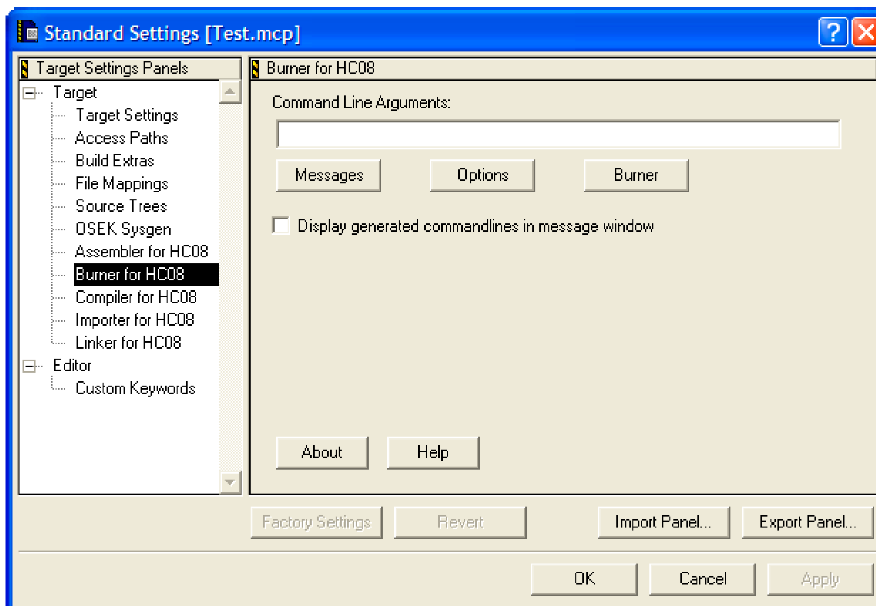
To start the Burner Utility, click on `burner.exe`. The Burner Default Configuration window appears (Figure 10.1).

**Figure 10.1 Burner Default Configuration Window**




Alternatively, from within the IDE Project Target Settings window, select the Burner for HC08 option from among the listed settings panels. Click on the Burner command button in the Burner for HC08 panel. The Burner window of the Interactive Burner GUI appears (Figure 10.2).

**Figure 10.2 IDE Project Target Settings Panel Burner for HC08 Window**



# 11

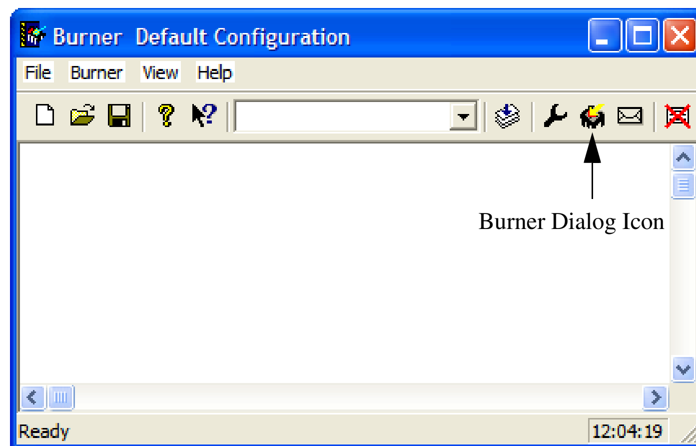
# Interactive Burner GUI

You can use the interactive burner graphic user interface (GUI) to burn your EEPROM instead of writing a batch burner language file. Within the GUI you can set all parameters and receive the output needed for a batch burner language file. You can then use the commands displayed on the Burner Dialog Box Command File tab in a make file.

## Burner Default Configuration Window

When you start the Burner, the Burner Default Configuration window opens.

**Figure 11.1 Burner Default Configuration Window**




To open the burner dialog box, click the **Burner Dialog** icon in the toolbar or select the Burner Dialog option from the Burner list menu.

You can also access the burner dialog box with the following command line option:

```
burner.exe -D
```

# Burner Dialog Box

The Burner dialog box consists of three tabs:

- Input/Output Tab
- Content Tab
- Command File Tab

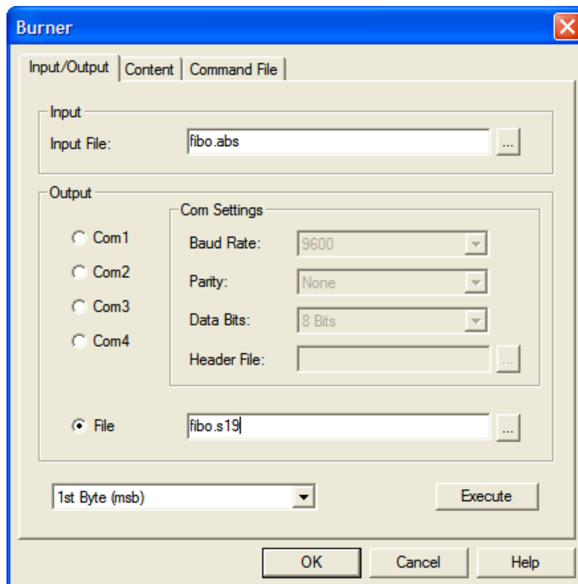
The Burner uses the last burn session values as initial values for the Burner dialog box tabs. The Burner writes the values to the `project.ini` file in the `[BURNER]` section.

## Input/Output Tab

In the Input/Output tab, specify which file you want the burner to use for input and where to write the output. Click the Execute button to start the operation.

Output from the burn process usually goes to a PROM burner connected to the serial port. You can also redirect output to a file written in either Intel Hex format, as Freescale S-Records or as plain binary.

**Figure 11.2 Burner Dialog Box Input/Output Tab**



# Input Group

Specify the input file in the *Input File* text field. The browse button on the right side is used to browse for a file. The following file types are supported:

- Absolute files produced by linker. The absolute file format may be either Freescale or ELF/DWARF
- S-Record File
- Intel Hex File

The corresponding Batch Burner command is SENDBYTE: Transfer Bytes or SENDWORD: Transfer Words.

To specify the input file, you can use the `%ABS_FILE%` macro to pass `ABS_FILE` using an environment variable. See Environment Variable Details.

For example:

```
-ENV" ABS_FILE=file_name"
```

# Output Group

The burner writes output to a serial port (Com1, Com2, Com3 or Com4) or a file.

## File

Select the *File* option button to write output to a file. In the corresponding text box, enter the output file name or browse for an existing file.

The corresponding Batch Burner command is OPENFILE: Open Output File.

If you use the macro `%ABS_FILE%` for the input file, you can add an extension to automatically generate the output file.

Example:

```
%ABS_FILE%.s19
```

## Com1, Com2, Com3, Com4

To write the output to a serial port, select an available port and define the communication settings.

The corresponding Batch Burner command is OPENCOM: Open Output Communication Port.

# Com Settings Group

Writing output to a serial port (Com1, Com2, Com3 or Com4) specifies Baud Rate, Parity, Data bits and Header File in the list boxes and text box of the Com Settings group.

**Table 11.1 Serial Port Specifications**

| Name | Available Options | Corresponding Batch Burner Command |
|---|---|---|
| Baud Rate | Supported Baud Rates: 300, 600, 1200, 2400, 4800, 9600, 19200 and 38400 | baudRate: Baudrate for Serial Communication |
| Parity | Set communication parity to none, even or odd. | parity: Set Communication Parity |
| Data Bits | Set number of data bits transferred to 7 or 8 bits. | dataBit: Number of Data Bits |
| Header File | Use to specify an initialization file for the PROM burner. File is sent to PROM burner byte by byte (binary), without modification, before anything else. | header: Header File for PROM Burner |

# Execute Group

The Execute group selects a data width and writes data.

1. From the list menu select the byte or word to write:
   - 1st Byte (msb)
   - 2nd Byte
   - 3rd Byte
   - 4th Byte
   - 1st Word
   - 2nd Word
2. Click the **Execute** command button to write the data.

   Depending on the data width chosen, you may have to send the result to more than one output file.

   Example: Format is **S Record** and data bus is **2 Bytes**

   This generates two output files. Data for the first Byte (msb) is sent to a file named `fibo_1.s19` and data for the second byte is sent to `fibo_2.s19`.
3. Select **1st Byte** *(msb)*

   If your data bus is 2 bytes wide, the code is split into two parts:
   - Selecting **1st Byte** (*msb*) and clicking *Execute* transfers the even part of the data (corresponding to D8 to D15).

- Selecting **2nd Byte** transfers the odd part, which corresponds to LSB or D0 to D7.

If the data bus is 4 bytes wide:

- **1st Byte** *(msb)* transfers D24 to D31
- **4th Byte** sends the LSB (D0 to D7).

If using 16-bit EPROMs, select one of the Word formats. If necessary, you can exchange the high and low byte. Check *Swap Bytes* in the *Content* tab of the Burner dialog box.

4. Click *Execute* to transfer the code bytes, if you select a data bus width of 1 byte.

The corresponding Batch Burner commands are SENDBYTE: Transfer Bytes and SENDWORD: Transfer Words.

# Content Tab

Use the Content tab in the Burner dialog box to specify the data format and range to be written.

**Figure 11.3 Burner Dialog Box Content Tab**

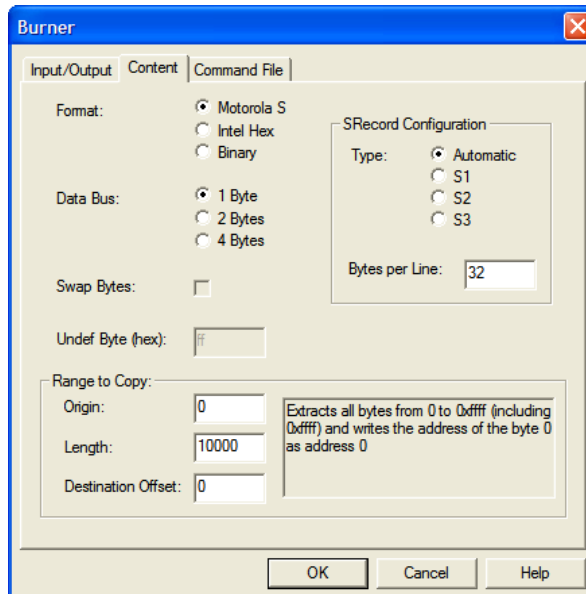


**Table 11.2 Content Tab Group Details**

| Group Name | Use | Available Options | Corresponding Batch Burner Command |
|---|---|---|---|
| Format | Use to select an output format | S Records<br>Intel Hex Files<br>Binary Files | format: Output Format |
| SRecord Configuration | Use to select type of SRecord and bytes per line to be written<br>OR<br>Use to configure the number of bytes per SRecord line. Useful when using tools with restricted capacity. | automatic,<br>S1<br>S2<br>S3 | SRECORD: S-Record Type<br><br>SLINELEN: SRecord Line Length |
| Data Bus | Use to select a Data Bus width | 1, 2 or 4 bytes | busWidth: Data Bus Width |
| Swap Bytes Checkbox | Use to enable swapping bytes. Available if data bus is 2 or 4 bytes | | swapByte: Swap Bytes |
| Undef Byte Textbox | For a binary output file, normally all undefined bytes in output are written as 0xFF. If desired, another pattern can be specified. | | undefByte: Fill Byte for Binary Files |
| Range to Copy | Use to specify the range to copy. Text box explains result. | origin (start), length, offset | See Range to Copy Group for more information. |

## Range to Copy Group

Example: If your application is linked at address $3000 to $4000 and the EPROM is at address $2000 (Origin) and Length is $2000, the code will start at address $1000 relative to the EPROM. If the EPROM is at address $3000 (Origin) and Length is $1000, it is filled from the start.

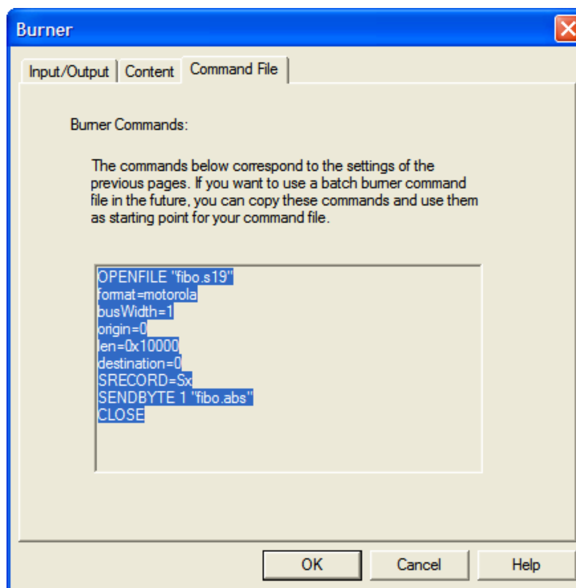
**Table 11.3 Range to Copy Group Details**

| Textbox | Use | Corresponding Batch Burner Command |
|---|---|---|
| Origin Textbox | Set to EEPROM start address in system. | origin: EEPROM Start Address |
| Length | Enter range of program code to be copied. | len: Length to be Copied |
| Destination Offset | Enter additional offset to add to resulting S Record or Intel Hex File. Example: if you set *Origin* to 0x3000 and *Destination Offset* to 0x1000, then written address is 0x4000. | destination: Destination Offset |

# Command File Tab

The *Command File* tab of the Burner dialog box displays a summary of your settings as Batch Burner commands. You can select and copy the commands for use in make files or Batch Burner Language (`.bbl`) files.

**Figure 11.4 Burner Dialog Box Command File Tab**



If you use the selection displayed on the *Command File* tab in a make file, you must either place everything on a single line or use the line continuation character (\) as shown.

```
burn:
  $(BURN) \
    OPENFILE "fibo.s19" \
    format = freescale \
    origin = 0xE000 \
    len = 0x2000 \
    busWidth = 1
```

# 12

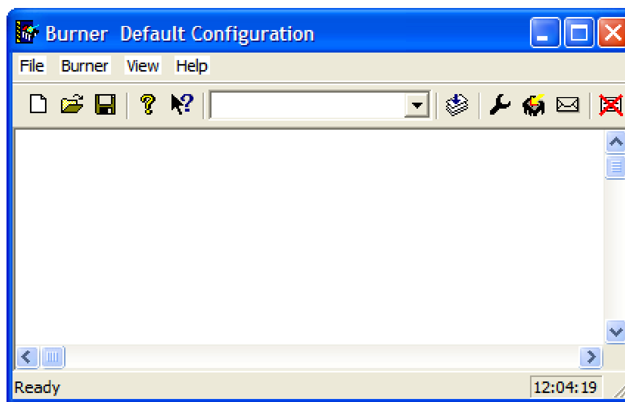
# Batch Burner Language

This chapter describes the Batch Burner Language (BBL).

## Batch Burner User Interface

Starting the Burner utility displays the window shown in Figure 12.1.

**Figure 12.1 Burner Default Configuration Window**




To use the Batch Burner, type in your batch burner commands on the command line, specify a file using the `-F` option on the command line, or use a startup option:

```
-Ffibo.bbl
```

or

```
OPENFILE "fibo.s19" origin=0xE000 len=0x2000 SENDBYTE 1
"fibo.abs"
```

You can also specify options and burner commands with the burner program:

```
burner.exe -Ffibo.bbl
```

You can use the Burner directly from a make file:

```
burn:
  $(BURN) \
    OPENFILE "fibo.s19" \
    format = freescale \
    origin = 0xE000 \
    len = 0x2000 \
    busWidth = 1
    SENDBYTE 1 "fibo.abs"
```

# Syntax of Burner Command Files

The following example shows the syntax of burner commands.

**Listing 12.1 Example of Burner Command File Syntax**

```
StatementList = Statement {Separator Statement}.
Statement = [IfSat | ForStat | Open | Send | Close | Pause
             | Echo | Format | SFormat | Origin | Len
             | BusWidth | Parity | SwapByte | Header
             | BaudRate | DataBit | UndefByte
             | Destination | AssignExpr | SLineLen].
IfStat = "IF" RelExpr "THEN" StatementList
             ["ELSE" StatementList] "END".
Assign = ("=" | ":=").
ForStat = "FOR" Ident Assign SimpleExpr "TO" SimpleExpr
              "DO" StatementList "END".
Open = ("OPENFILE" String) | ("OPENCOM" SimpleExpr).
Send = ("SENDBYTE" | "SENDWORD") SimpleExpr String.
Close = "CLOSE".
Pause = "PAUSE" [String].
Echo = "ECHO" [String].
Format = "format" Assign ("freescale" | "intel" | "binary").
SFormat = "SRECORD" Assign ("Sx" | "S1" | "S2" | "S3").
Origin = "origin" Assign SimpleExpr.
Len = "len" Assign SimpleExpr.
BusWidth = "busWidth" Assign ("1" | "2" | "4").
Parity = "parity" Assign ("none" | "even" | "odd").
SwapByte = "swapByte" Assign ("yes" | "no").
Header = "header" Assign string.
BaudRate = "baudRate" Assign ( "300" | "600" | "1200"
                             | "2400" | "4800" | "9600"
```

```
                             | "19200" | "38400").
DataBit = "dataBit" Assign ("7" | "8").
UndefByte = "undefByte" Assign SimpleExpr.
Destination = "destination" Assign SimpleExpr.
SLineLen = "SLINELEN" Assign SimpleExpr.
AssignExpr = Ident Assign SimpleExpr.
RelExpr = SimpleExpr {RelOp SimpleExpr}.
RelOp = "=" | "==" | "#" | "<>" | "!=" | "<"
            | "<=" | ">" | ">=".
SimpleExpr = ["+" | "-"] Term {AddOp Term}.
AddOp = "+" | "-".
Term = Number | String | Ident.
Number = 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | {Number}
Ident = "i".
String = '"' {char} '"'.
```

**NOTE** The identifier used in a `FOR` statement must be called `i`.

## Command File Comments

Command files accept both ANSI-C style or Modula-2 style comments.

```
/* This is a C like comment */
(* This is a Modula-2 like comment *)
```

Specify assignments using ANSI-C or Modula-2 syntax:

```
dataBit := 2 (* Modula-2 like *)
dataBit = 2 /* C like */
```

Specify constant format using either ANSI-C or Modula-2 syntax:

```
origin = 0x1000 /* C like */
origin := 1000H (* Modula-2 like *)
```

# Batch Burner with Makefile

In a makefile, you can use the burner in two different ways. The first way is to specify a command file:

```
BURNER.EXE -f "<CmdFile>"
```

The second way is to directly specify commands on the command line:

```
BURNER.EXE SENDBYTE 1 "InFile.abs"
```

If the commands are long, you can use line continuation characters in your make file as below:

```
burn:
  $(BURN) \
    OPENFILE "fibo.s19" \
    format = freescale \
    origin = 0xE000 \
    len = 0x2000 \
    busWidth = 1
```

If you use the second method, you can include parameter initialization in the `DEFAULT.ENV` file located in the working directory. This reduces the length of the command line parameters, which are limited to 65535 bytes. Variables that can be specified using environment variables are listed below:

```
header=
format=freescale
busWidth=1
origin=0
len=0x10000
parity=none
undefByte=0xff
baudRate=9600
dataBit=8
swapByte=no
```

The example above shows the default values but any legal value can be assigned (see Batch Burner Commands). For further details, see the example in the following section.

# Command File Examples

The following examples show how to write a command file. Listing 12.2 shows a command file for conditional and repetitive statements.

If the symbol # appears in a string it is replaced by the value of `i`.

#### Listing 12.2 Sample Command File for Conditional and Repetitive Statements

```
ECHO
ECHO " I can count... and I can take decisions"
FOR i = 0 TO 8 DO
    IF i == 7 THEN
       ECHO "This is the number seven"
    ELSE
       ECHO "#"
    END
    IF i == 3 THEN
       ECHO "This was the number three"
    END
END
```

Listing 12.3 shows a command file for redirecting the output to a file. To redirect output, use the command `OPENFILE`.

#### Listing 12.3 Command File for Redirecting Output

```
ECHO
ECHO "Programming 2 EPROMs with 3 files"
ECHO "the first byte of the word goes into the first EPROM"
ECHO "the second byte of the word goes into the second EPROM"
PAUSE "Hit any key to continue"
  format = freescale
  busWidth = 2
  origin = 0
  len = 0x3000
FOR i = 1 TO 2 DO
    PAUSE "Insert EPROM n# and press <return>"
    OPENFILE "prom#.bin"
       origin = 0X
       SENDBYTE i "demo1.abs"
       origin = origin + 0x500
       SENDBYTE i "demo2.abs"
       origin = origin + 0x500
       SENDBYTE i "demo3.abs"
    CLOSE
END
```

Listing 12.4 shows a command file for redirecting the output to a serial port. Use the `OPENCOM` command to redirect the output to a serial port.

### Listing 12.4 Command File for Redirecting Output to Serial Port

```
ECHO
ECHO "I can also program 16-bit EPROMs with header"
PAUSE "Hit any key to continue"
header = "init.prm"
format = intel
busWidth = 2
origin = 0x0
len = 0x1000
OPENCOM 1 /* here com1, com2, com3 or com4 could be used*/
SENDWORD 1 "fbin1.map"
CLOSE
```

Listing 12.5 shows a command file for calling the burner from a makefile. After compiling and linking the application, the burner prepares the generated code to be burned into two EPROMs, one containing the odd bytes (`fibo_odd.s1`) and the other the even bytes (`fibo_eve.s1`).

### Listing 12.5 Command File for Calling Burner from makefile

```
makeall:
  $(COMP) $(FLAGS)     fibo.c
  $(LINK)              fibo.prm
  burner.exe OPENFILE "fibo_odd.s1" \
    busWidth=2 SENDBYTE 1 "fibo.abs"
  burner.exe OPENFILE "fibo_eve.s1" \
    busWidth=2 SENDBYTE 2 "fibo.abs"
```

**NOTE** For all parameters not specified in the parameter list, the burner uses default values or the values specified by environment variables.

# Libmaker Utility

## Introduction

This section describes the Libmaker, a utility program for creating and maintaining object file libraries. Using libraries can speed up linking since fewer files are involved, and also helps in structuring large applications.

Libraries may be given in the linker parameter file instead of object files.

This section consists of the following chapters:

- Libmaker Interface: Description of the GUI.

## User Interface

Libmaker provides:

- Graphical User Interface (GUI)
- Command-Line User Interface
- Online Help
- Flexible Message Management
- 32-bit Application
- Builds libraries with Freescale or ELF/DWARF object files
- Error Feedback
- Easy integration with other tools (e.g. CodeWarrior IDE, CodeWright, MS Visual Studio, WinEdit)

# Starting the Libmaker Utility

You can start tools (compiler/linker/assembler/decoder/) using:

- Windows Explorer
- Icon on the desktop
- Icon in a program group
- Batch/command files
- Other tools (Editor, Visual Studio)

You can start all of the utilities described in this book from executable files located in the `Prog` folder of your IDE installation. The executable files are:

- `linker.exe` The SmartLinker
- `maker.exe` Maker: The Make Tool
- `burner.exe` The Burner Utility
- `decoder.exe` The Decoder
- `libmaker.exe` Libmaker

With a standard full installation of the HC(S)08/RS08 CodeWarrior IDE you can find the executable files at this location:

```
C:\Program Files\Freescale\CodeWarrior for Microcontrollers V6.2\Prog
```

With a standard full installation of the HC(S)12 CodeWarrior IDE you can find the executable files at this location:

```
C:\Program Files\Freescale\CodeWarrior for HC(S)12 V4.7\Prog
```

To start the Libmaker Utility, click on `libmaker.exe`. The Libmaker Default Configuration window appears.

## Interactive Mode

If you start the libmaker with no input (no options or input files), then the graphical user interface is active (interactive mode). This is usually the case if you start the tool using Explorer or an icon.

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# Libmaker Interface

## Startup Command Line Options

There are special options for tools which can only be specified at tool startup (while launching the tool), e.g. they cannot be specified interactively:

Use `-Prod` (see -Prod: Specify Project File at Startup (PC) (No d, no m)) to specify the current project directory or file, for example:

```
libmaker.exe -Prod=C:\Program Files\Freescale\CodeWarrior
for S12(X) V5.x\demo\myproject.pjt
```

There are other options used to launch the tool and open its dialog boxes. Those dialogs are available in the compiler/assembler/burner/maker/linker/decoder/libmaker:

- `-ShowOptionDialog`: This startup option opens the tool option dialog.
- `-ShowMessageDialog`: This startup option opens the tool message dialog.
- `-ShowConfigurationDialog`: This opens the *File* > *Configuration* dialog.
- `-ShowBurnerDialog`: Opens burner dialog (burner only)
- `-ShowSmartSliderDialog`: Opens smart slider dialog (compiler only)
- `-ShowAboutDialog`: Opens the tool about box.

These options open dialogs in which you can specify tool settings. When you click the *OK* button in the dialog, Libmaker stores the settings in the current project settings file. Example:

```
C:\Program Files\Freescale\CodeWarrior for S12(X)
V5.x\prog\libmaker.exe -ShowOptionDialog
-Prod=c:\demos\myproject.pjt
```

## Command Line Interface

Libmaker provides both a command line interface and an interactive interface. If you do not specify any arguments on the command line, a window appears.

# Libmaker Commands

When you start Libmaker, it opens a window and prompts for arguments. The arguments may be given on a command line in the format shown in Listing 13.1.

**Listing 13.1  Libmaker Argument Format**

```
LibCommand      =  Creation
                   | AppendFiles
                   | RemoveFiles
                   | List
                   | "@" FileName.
Creation         =  FileName AddList "=" LibName.
AddList          =  {"+" FileName}.
AppendFile       =  LibName AddList "=" LibName.
RemoveFiles      =  LibName SubList ["=" LibName].
SubList          =  "-" FileName {"-" FileName}.
List               =  LibName "?" FileName.
```

Libmaker uses the environment variable `OBJPATH` when looking for object or library files, or writing the library file. It uses the environment variable `TEXTPATH` when looking for a command file or writing the listing file.

# Managing Libraries

All the commands below are supposed to be in a libmaker command file (text file with the commands in it, line by line). Alternatively you can pack the commands into the `-Cmd` option (see -Cmd: Libmaker Commands) and pass it to the libmaker directly (e.g. from a make file). For example:

```
a.o + b.o = c.lib
```

This can be written as an option to the libmaker as:

```
libmaker.exe -Cmd(a.o + b.o = c.lib)
```

As it is difficult to create a command line with the '+' operator in a make utility, the libmaker supports the alternative syntax without the '+' operator:

```
 -Cmd(a.o + b.o = c.lib)
```

This can also be written as:

```
 -Cmd(a.o b.o = c.lib)
```

# Building a Library

Building a library collects all the given object files and/or libraries into one new library, given after the equal sign:

```
file1.o + file2.o + mylib.LIB = ourlib
```

**NOTE** To create a library, there must be at least two files to the left of the equal sign.

## Adding Files to a Library

Adding files to an existing library works the same as building a library:

```
ourlib.LIB + file3.o = ourlib
```

## Removing a File from a Library

You can also remove one or more files from a library:

```
ourlib.LIB - file1.o = ourlib
```

This removes the object file `file1.o` from the library.

## Creating a New Library

You can create a new library:

```
ourlib - file1.o = hislib
```

In this case, the original library `ourlib` is *not* overwritten.

## Extracting a File from a Library

Use the following code line to extract a file from a library.

```
LibName * ObjName
```

The code line above extracts the object file named `ObjName` from the library. No path is given with the argument `ObjName`. The libmaker writes the object file to the same directory as the library, and does not remove the file from the library. An existing object file with the same name as an extracted object file is overwritten without warning.

Example:

```
mylib.lib * myobj.obj
```

This writes the object file `myobj.obj` into the same directory as `mylib.lib`.

## Listing the Contents of a Library

Libmaker also generates an alphabetically sorted list of all exported objects in the library. Enter the name of the library:

```
ourlib.LIB
```

The list file has the same name as the library, but with extension .LST. To specify a different name, enter:

```
ourlib.LIB ? mylist.TXT
```

# Command Files

Libmaker also supports command files. A command file is a text file containing commands for the libmaker. To use a command file, enter:

```
@mycmds.CMD
```

The libmaker reads the file and interprets the commands line by line.

# Batch Mode

If you start the tool with arguments (options and/or input files), then the tool starts in batch mode. For example, you can specify the following line:

```
C:\Program Files\Freescale\CodeWarrior for S12(X)
V5.x\PROG\libmaker.exe @mycommands.txt
```

In batch mode, the tool does not open a window. It is displayed in the taskbar while the input is processed and terminates afterwards.

Because it is possible to start 32-bit applications from the command line, you can simply type the commands you want to execute:

```
C:\>C:\Program Files\Freescale\CodeWarrior for S12(X)
V5.x\PROG\libmaker.exe -cmd(a.o b.o = c.lib)
```

You can redirect the message output (stdout) of a tool using the normal redirection operators, (e.g. '>' to write the message output to a file):

```
C:\> C:\Program Files\Freescale\CodeWarrior for S12(X)
V5.x\PROG\libmaker.exe -h > myoutput.txt
```

Notice that the command line process immediately returns after starting the tool process. It does not wait until the process finishes. To start a process and wait for termination (e.g. for synchronization) use the start command under Windows or the /wait option (see Windows help: 'help start' for more information):

```
C:\> start /wait C:\Program Files\Freescale\CodeWarrior for
S12(X) V5.x\PROG\libmaker.exe -cmd(a.o b.o = c.lib)
```

Using start /wait you can write batch files to process your files.

To redirect the libmaker output to stderr/stdout on your DOS shell, use the piper utility:

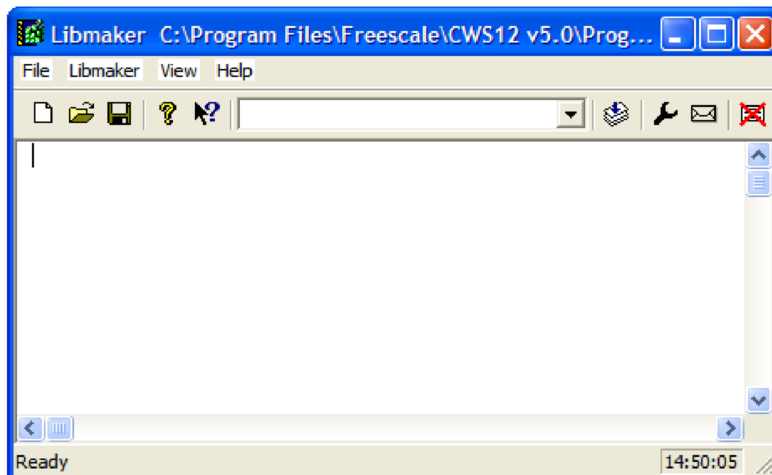
```
C:\> C:\Program Files\Freescale\CodeWarrior for S12(X)
V5.x\PROG\piper.exe C:\Program Files\Freescale\CodeWarrior
for S12(X) V5.x\PROG\libmaker.exe -h
```

This directs all the messages to the DOS shell.

# Libmaker Graphic User Interface

The Libmaker Default Configuration window appears when you do not specify a file name while starting the application. This window contains a menu bar, toolbar, content area, and status bar.

**Figure 13.1 Libmaker Default Configuration WIndow**




## Libmaker Default Configuration Window

The Libmaker Default Configuration window title displays the application name and project name. If no project is loaded, *Default Configuration* appears. An asterisk ( * ) after the configuration name indicates that some values have changed.

**NOTE** Not only option changes, but editor configuration and appearance changes cause the “*” to appear.

## Window Content Area

The content area is a text container that displays logging information about the process session. This information consists of:

- The name of file being processed
- The name (including full path) of files processed (main C file and all files included)
- A list of error, warning and information messages generated
- The size of code generated during the process session

When you drop a file into the application window content area, the corresponding file loads as a configuration file if the file has the extension `.ini`. If not, the file is processed with the current option settings.

Text in the application window content area displays the following information:

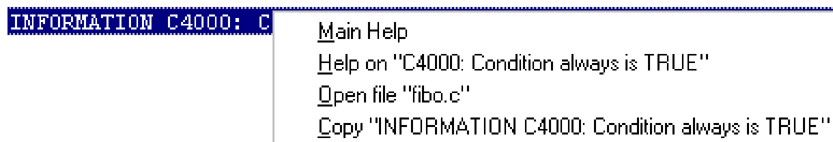
- The file name, including a position inside of file
- A message number

File information is available for text file output. Information is available for all source and include files and messages. If file information is available, double-clicking on the text or message opens the file in an editor; as specified in the editor configuration. Also, you can open a context menu with the right mouse button. The menu contains an *Open* entry if file information is available. If a file cannot be opened although a context menu entry is present, see the Configuration Window Editor Settings Tab section.

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. If the selected line does not have a message number, F1 displays the main help.
- Press Shift-F1 and then click on the message text. If the text clicked does not have a message number, this displays the main help.
- Right-click on the message and select “Help on”. This entry is only available if a message number is available.

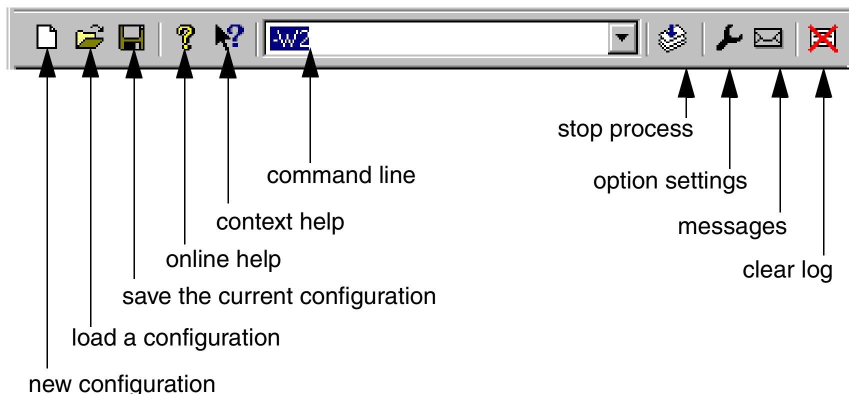
**Figure 13.2 Libmaker Help Menu**



## Window Toolbar

Figure 13.3 shows the Libmaker Default Configuration window toolbar.

**Figure 13.3 Default Configuration Window Toolbar**




The three icons on the left correspond with *File* menu entries. The next button opens the *Online Help* dialog. After pressing the Context Help icon (or the shortcut Shift F1), the mouse cursor changes its form and has a question mark beside the arrow. Help is called for the next item clicked. You can click on menus, toolbar buttons and on the window area to get specific help.

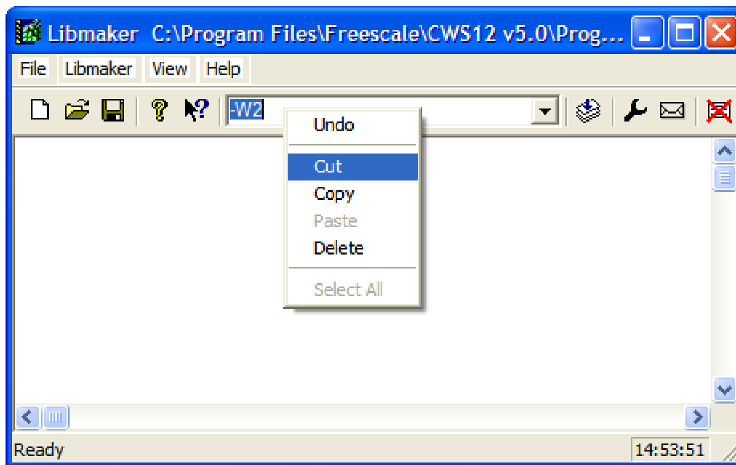
The command line history contains a list of commands executed. Once you have selected or entered a command in history, clicking *Process* executes the command. You may use the keyboard shortcut key **F2** to jump to the command line. Additionally, there is a context menu associated with the command line (see Figure 13.4).

The **Stop** icon allows you to stop the current process session.

The next four icons open option settings, the smart slider, the type setting, and message setting dialog box.

The last icon clears the content area.

**Figure 13.4  Command Line Context Menu**

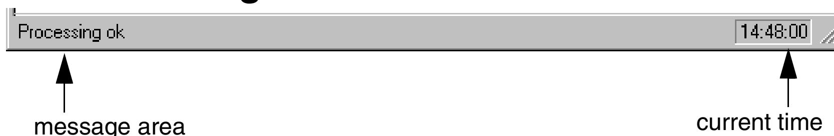



# Default Configuration Window Status Bar

Point to a menu entry or icon in the toolbar to display a brief explanation of the button or menu entry in the message area.

**Figure 13.5  Window Status Bar**

# Default Configuration Window Menu Bar




File, Libmaker, View and Help options are available from the menu bar.

**Figure 13.6  Window Menu Bar**

Table 13.1 describes the functions available in the menu bar:

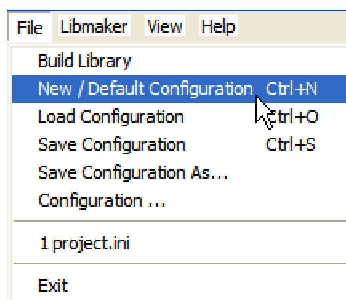
**Table 13.1 Menu Bar Functions**

| Menu entry | Description |
|---|---|
| File | Contains entries to manage application configuration files. |
| Libmaker | Contains entries to set application options. |
| View | Contains entries to customize the application window output. |
| Help | A standard Windows Help menu. |

# Default Configuration Window File Menu

Use the File menu to save or load configuration files.

**Figure 13.7 File Menu**




A configuration file contains the following information:

- Application option settings specified in the application dialog boxes
- Message settings that specify which messages to display and treat as errors
- List of last command line executed and current command line
- Window position
- Tip of the Day settings

Configuration files are text files with an extension of `.ini`. The user can define as many configuration files as required for the project, and can switch between the different configuration files using the **File > Load Configuration** and **File > Save Configuration** menu entry, or the corresponding toolbar buttons.

**Table 13.2 File Menu Options**

| Menu Entry | Description |
|---|---|
| Build Library | Opens a standard Open File dialog box. Processes selected file as soon as Open File box is closed with *OK*. |
| New/Default Configuration | Resets application option settings to default value. See Startup Command Line Options. |
| Load Configuration | Opens a standard Open File dialog box. Loads configuration data stored in selected file and uses it in subsequent sessions. |
| Save Configuration | Saves the current settings. |
| Save Configuration as | Opens a standard Save As dialog box. Saves current settings in a configuration file with the specified name. |
| Configuration | Opens *Configuration* dialog box to specify editor used for error feedback and which parts to save with a configuration. |
| 1..... project.ini<br>2..... | Recent project list. This list can be accessed to open a recently opened project. |
| Exit | Closes the application. |

# Default Configuration Libmaker Menu

The Libmaker menu allows you to customize the application. You can set or reset application options or define the optimization level you want to reach.

**Figure 13.8 Libmaker Default Configuration Libmaker Menu**

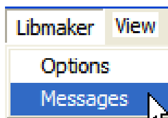


**Table 13.3 Libmaker Menu Functions**

| Menu Entry | Description |
|---|---|
| Options | Allows you to customize the application. You can set/reset options. |
| Messages | Opens a dialog box in which you can map error, warning or information messages to different message classes (see Libmaker Message Settings Window). |
| Stop | Stops the current processing session. |

# Default Configuration Window View Menu

The View menu allows you to customize the application window. You can specify whether to display or hide the status or toolbar. You can also define the font used in the window or clear the window.

**Figure 13.9 Libmaker Default Configuration View Menu**

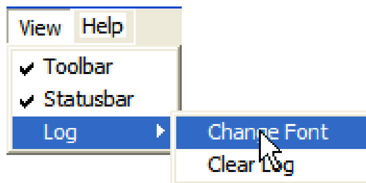



**Table 13.4 View Menu Functions**

| Menu entry | Description |
|---|---|
| Tool Bar | Hide or show toolbar in application window |
| Status Bar | Hide or show status bar in application window |
| Log | Allows you to customize output in application window content area |
| Change Font | Opens a standard font selection box; options selected in font dialog box are applied to application window content area |
| Clear Log | Clears application window content area |

## Default Configuration Window Help Menu

The Help menu allows you to enable or disable the Tip of the Day dialog, display the help file, and an About box.

**Figure 13.10  Libmaker Default Configuration Help Menu**

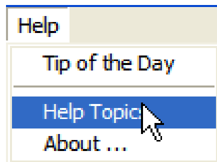



**Table 13.5  Help Menu Functions**

| Menu entry | Description |
|---|---|
| Tip of the Day | Enable or disable Tip of the Day during startup. |
| Help Topics | Standard Help topics. |
| About | Displays an About box with version and license information. |

# Configuration Window

The three tabs of the Configuration Window let you specify the Editor Settings, Save the Configuration, and specify the Environment.

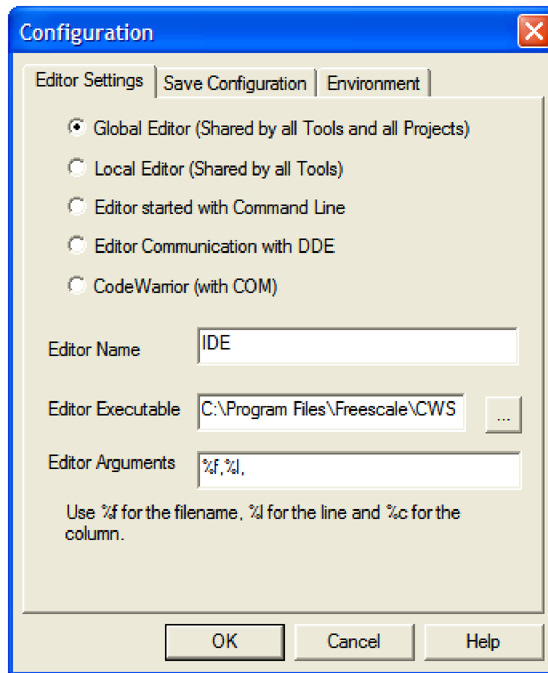
## Configuration Window Editor Settings Tab

In the Editor Settings tab, select the type of editor to use. Depending on the editor type selected, the tab content changes.

### Editor Settings Tab - Global Editor Option

Figure 13.11 shows the Editor Settings tab contents when you choose the Global Editor option.

**Figure 13.11 Editor Settings Tab - Global Editor Option**

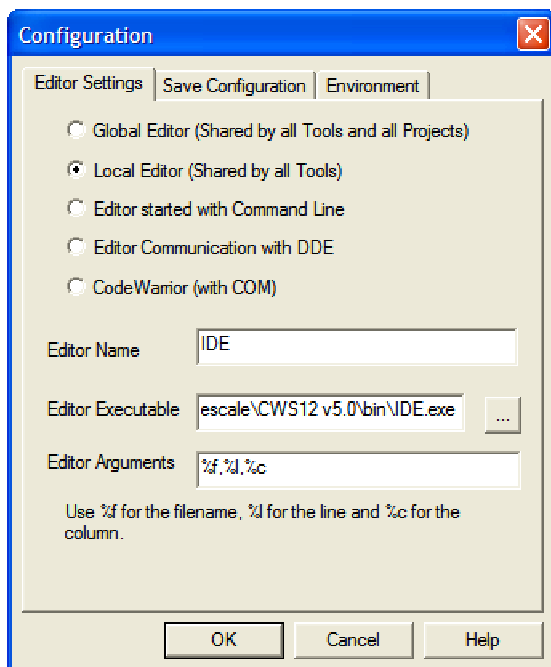



All tools and projects on one computer share the global editor. Editor information is stored in the global initialization file `MCUTOOLS.INI` in the `[Editor]` section. You can specify some Modifiers on the editor command line.

## Editor Settings Tab - Local Editor Option

Figure 13.12 shows the Editor Settings Tab contents when the Local Editor option is chosen:

**Figure 13.12 Editor Settings Tab - Local Editor Option**



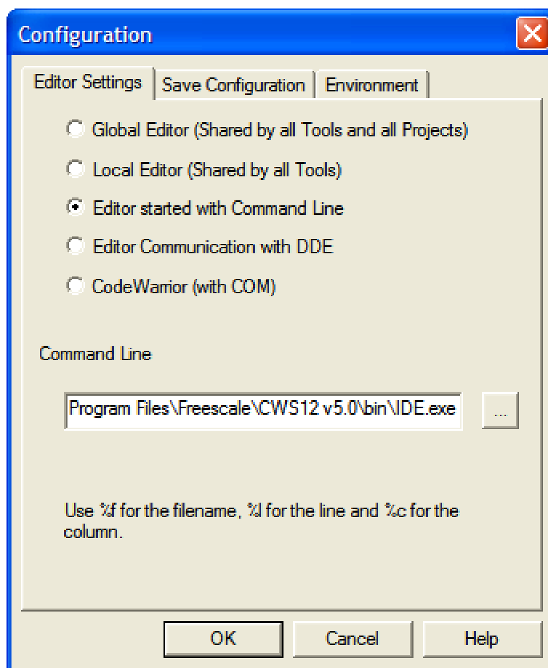

All tools using the same project file share the local editor. You can specify some Modifiers on the editor command line.

You can edit the Global and Local Editor configuration. However, when these entries are stored, the behavior of other tools using the same entries also changes when you start the tools again.

## Editor Settings Tab - Editor Started with Command Line Option

Figure 13.13 shows the Editor Settings Tab contents when the Editor started with Command Line option is chosen:

**Figure 13.13 Editor Settings Tab - Editor started with Command Line**




Selecting this editor type associates a separate editor with the application to obtain error feedback.

Enter the command to use to start the editor.

You can start the editor with modifiers. Some Modifiers can be specified on the editor command line that refer to a file name and a line number (see Modifiers).

Examples: (also refer to notes below)

- For IDF use (with path to `idf.exe` file)

  `C:\prog\idf.exe %f -g%l,%c`

- For Premia CodeWright V6.0 (with path to `cw32.exe` file)

  `C:\Premia\cw32.exe %f -g%l`

- For Winedit 32-bit version use (with path to `winedit.exe` file)

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

## Editor Settings Tab - Editor Communication with DDE Option

Figure 13.14 shows the Editor Settings Tab contents when the Editor Communication with DDE option is chosen:

**Figure 13.14 Editor Settings Tab - Editor Communication with DDE**

Enter the service, topic and client name to be used for a DDE connection to the editor. Entries for Topic and Client Command can have modifiers for file name, line number and column number as explained below.

Examples:

- For Microsoft Developer Studio use the following setting:

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

- UltraEdit is a powerful shareware editor. It is available from `www.idmcomp.com` or `www.ultraedit.com`, email `idm@idmcomp.com`. The latest version of UltraEdit can also be found on the CD-ROM in the `addons` directory.

  For UltraEdit use the following setting:

```
Service Name   : UEDIT32
Topic Name     : system
ClientCommand  : [open("%f/%l/%c")]
```

**NOTE** The DDE application (Microsoft Developer Studio, UltraEdit) must be started or else the DDE communication will fail.

## Modifiers

The configurations can contain modifiers that tell the editor which file to open and at which line.

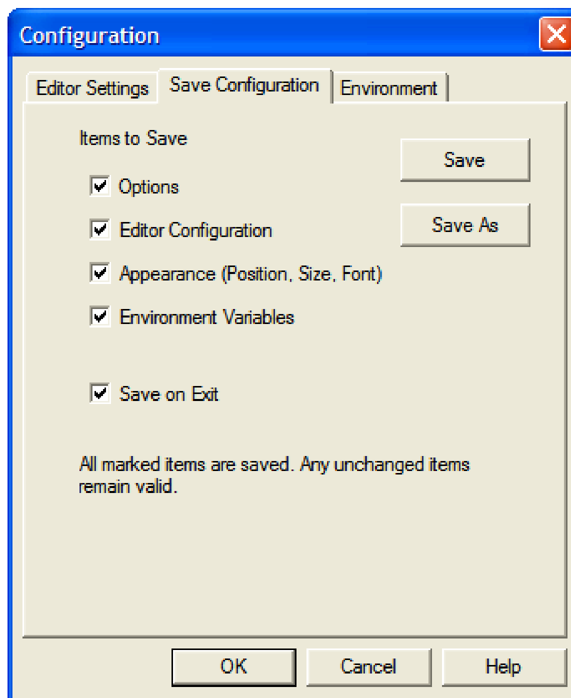
- The `%f` modifier refers to the name of the file (including path) where the message has been detected.
- The `%l` modifier refers to the line number where the message has been detected.
- The `%c` modifier refers to the column number where the message has been detected.

**NOTE** The `%l` modifier can only be used with an editor that can be started with a line number as a parameter. This is not the case for WinEdit version 3.1 or lower, or Notepad. With these editors, you can start with the file name as a parameter and then select the menu entry *Go to* to jump to the line where the message has been detected. In this case, the editor command looks like:
`C:\WINAPPS\WINEDIT\Winedit.EXE %f`
Check your editor manual to define the command line used to start the editor.

## Configuration Window - Save Configuration Tab

The Save Configuration tab of the configuration dialog contains options for the save operation.

**Figure 13.15 Configuration Window - Save Configuration Tab**




Use the Save Configuration tab to store selected items in a project file. This tab has the following items:

- Options: If checked, saves the current option and message settings. Clearing this option retains the last saved contents.
- Editor Configuration: If checked, saves the current editor settings. Clearing this option retains the last saved contents.
- Appearance: If checked, saves the window position, size, and font used. Also saves the command line content and history in the project file.

**NOTE** After you have saved the options you want, disable the options that you do not want saved to the Local Configuration File (usually project.ini) in subsequent configuration settings. Clear the *Save on Exit* option to retain settings saved during a previous configuration.

- Environment Variables: If checked, saves environment variables in the project file.
- Save on Exit: If checked, the application writes the configuration settings on exit without confirmation. If not checked, the application does not save configuration changes.

**NOTE** Almost all settings are stored in the Local Configuration File (usually project.ini). The only exceptions are:
- The recently used configuration list.
- All settings in this tab.

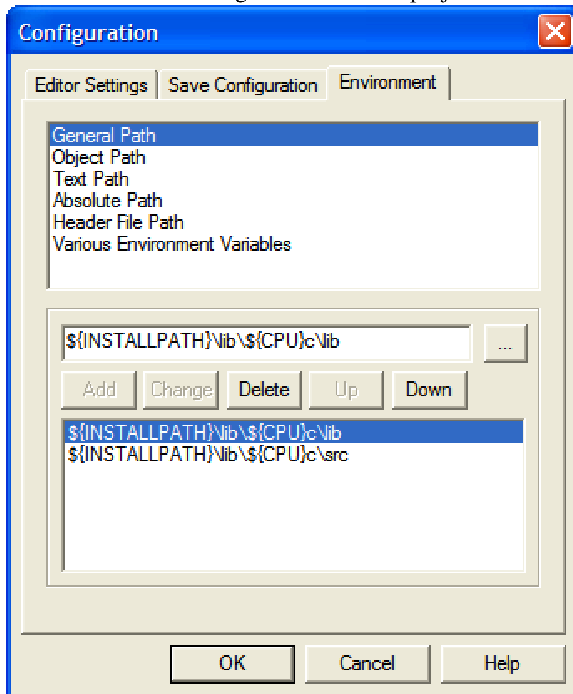
**NOTE** Application configuration information can coexist in the same file as the project configuration for the IDE. When you configure an editor with the shell, the application can read this information from the project file, if present. The project configuration file is named `project.ini`.

## Configuration Window - Environment Tab

Use the Environment tab of the Configuration window to configure the environment.

**Figure 13.16 Configuration Window - Environment Tab**

The content of the dialog is read from the project file in the section `[Environment`




`Variables]`. The following variables are available:

- General Path: GENPATH
- Object Path: OBJPATH
- Text Path: TEXTPATH
- Absolute Path: ABSPATH
- Header File Path: LIBPATH
- Various Environment Variables: other variables not covered by the above list.

The following command buttons are available:

- Add: Adds a new line/entry
- Change: changes a line/entry
- Delete: deletes a line/entry
- Up: Moves a line/entry up

- Down: Moves a line/entry down

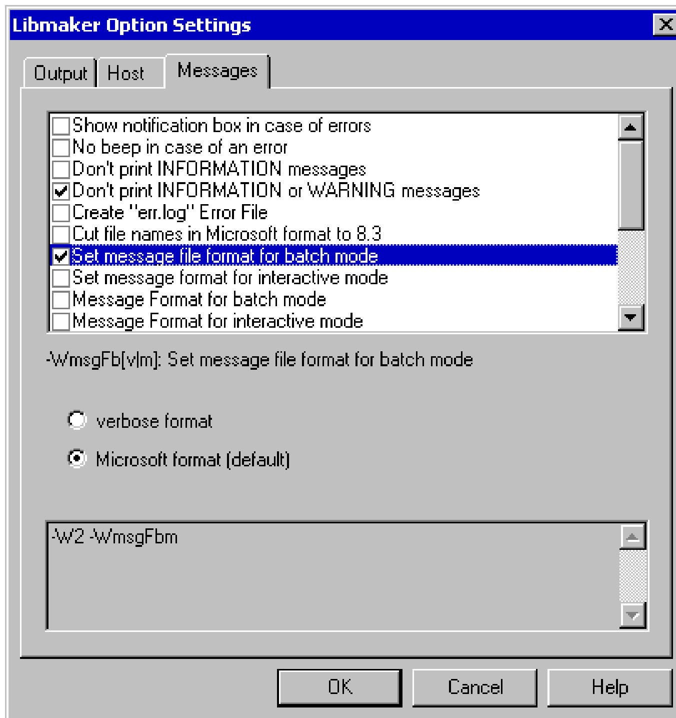
**NOTE** Variables are written to the project file only if you press the *Save* button, select *File > Save Configuration*, or select CTRL-S.

# Libmaker Option Settings Window

The Libmaker Option Settings window allows you to set/reset application options.

**Figure 13.17 Libmaker Options Settings Window - Messages Tab**

The lower display area shows available command line options. Available options are




arranged in different groups. The content of the list box depends on the selected tab, such as Messages (not all groups may be available).

**Table 13.6 Option Settings Functions**

| Group | Description |
|---|---|
| Optimization | Lists optimization options |
| Output | Lists output file options |
| Input | Lists input file options |
| Language | Lists programming language options (ANSI C, C++) |
| Target | Lists target processor options |
| Host | Lists host options |
| Code Generation | Lists code generation options (memory models, float format) |
| Messages | Lists options that control generation of error messages |
| Various | Lists options not related to the above |

Checking the checkbox sets an option. To obtain more detailed information for a specific option, select the option and press the F1 key or help button. To select an option, click the option text. If no option is selected, press F1 or help button to display help for the dialog box.

**NOTE** For options that require additional parameters, an edit box or additional window appears. For example, the option 'Write statistic output to file', in the Output tab.

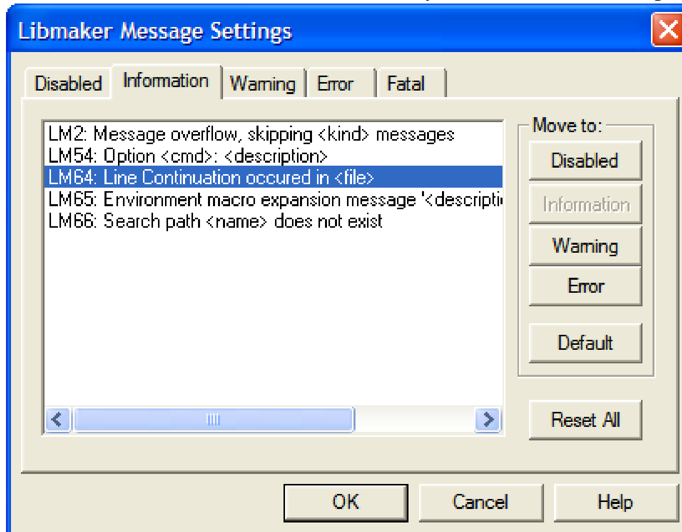
# Libmaker Message Settings Window

This window allows you to map messages to different message classes. A tab is available for each message group: Disabled, Information, Warning, Error and Fatal.

Each message has a one character identifier (e.g. C for Compiler messages, A for Assembler messages, L for Linker messages, M for Maker messages, LM for Libmaker messages) followed by a 4- or 5-digit number. See Libmaker Message List for detailed information about specific messages.

**Figure 13.18 Libmaker Message Settings Window**

In this window, some command buttons may be disabled. For example, if a message




cannot be mapped as an Information message, the “Move to” group ‘Information’ command button is disabled when this message is highlighted.

**Table 13.7 Message Classes**

| Message group | Description |
|---|---|
| Disabled | Lists all disabled messages that will not be displayed by the application. |
| Information | Lists all information messages. |
| Warning | Lists all warning messages. Input file processing continues if a warning occurs. |
| Error | Lists all error messages. Input file processing continues if an error occurs. |
| Fatal | Lists all fatal error messages. If a fatal message occurs, processing stops immediately. Fatal messages cannot be changed. |

**Table 13.8 Command Button Functions**

| Command Button | Description |
|---|---|
| Move to: Disabled | Disables selected messages |
| Move to: Information | Selected messages become information messages. |
| Move to: Warning | Selected messages become warning messages. |
| Move to: Error | Selected messages become error messages. |
| Move to: Default | Selected messages revert back to their default mapping. |
| Reset All | Resets all messages to their default. |
| Ok | Exits and accepts changes. |
| Cancel | Exits without accepting changes. |
| Help | Displays online help. |

# Changing the Class Associated with a Message

Configure your own message mapping by using the buttons located on the right side of the dialog box. Each button refers to a message class. To change the class associated with a message, select the message in the list box and then click the button associated with another class.

**NOTE** The **Move to** buttons are only active for messages that can be moved.

For example, to change a warning message to an error message:

1. Click the **Warning** tab to display the list of all warning messages.
2. Click on the message you want to change.
3. Click **Error** to define this message as an error message.

**NOTE** Messages cannot be moved to or from the fatal error class.

To validate the new error message mapping, click OK to close the **Message Settings** dialog box. If you click **Cancel**, changes are ignored and the previous message mappings remain valid.

## Retrieving Information About an Error Message

You can access information about each message displayed in the list box. Select the message in the list box and click *Help* or the F1 key. An information box appears, which contains a detailed description of the error message and an example of code that produces the message. If several messages are selected, help for the first message is shown. If no message is selected, pressing the F1 key or help button displays help for this dialog box.

# About Libmaker Dialog Box

Select **Help > About** to display the About box. The about box contains the current directory and version information for application modules. The main version is displayed at the top of the dialog.

The **Extended Information** button displays license information about all software components in the same directory as the executable. Click *OK* to close this dialog.

**NOTE** During processing, you cannot request other versions of the application modules. They are only displayed when the application is not processing information.

IV

# Decoder Utility

## Introduction

This section describes the CodeWarrior IDE ELF/Freescale Decoder utility, which disassembles object files, absolute files and libraries in the Freescale object file format or ELF/DWARF format and S-Record files. Various output formats are available.

The chapters in this section are:

- Input and Output Files: Describes Decoder input and output files
- Decoder Controls: List menus and the Graphical User Interface (GUI)

## Product Highlights

The decoder utility has:

- Graphical User Interface (GUI)
- On-line Help
- Message Management
- 32-bit Functionality
- Decodes Freescale object file format
- Decodes ELF/DWARF 1.1 and 2.0 object file format
- Decodes S-Record files

# User Interface

The decoder provides a command line interface and an interactive interface (GUI). If no arguments are given on the command line, a window opens that prompts for arguments.

The Decoder accepts object or absolute files, libraries, and S-Record files as input to generate the listing file. The name of the source files are encoded in the object or absolute file or library. For S-Record files, the processor must be specified with the `-Env` option (see -Env: Set Environment Variable).

The generated listing file has the same name as the input file but with extension `.LST`. It contains source and assembly statements. The corresponding C/C++ source statements can be displayed within the generated assembly instructions.

# 14

# Input and Output Files

This chapter describes Decoder input and output files.

- Input Files
- Output Files

## Input Files

Input files include the following file types:

- Absolute files
- Object files
- S-Record files
- Intel Hex files

### Absolute Files

The decoder takes any file as input, and does not require the file name to have a special extension. However, we suggest that all your absolute file names have extension `.ABS`. The decoder searches for absolute files first in the project directory and then in the directories listed in `GENPATH`. The absolute file must be a valid ELF/DWARF V1.1, ELF/DWARF V2.0 or Freescale absolute file.

**NOTE** Freescale absolute files do not contain source information, so no source information is decoded.

### Object File

The decoder takes any file as input, and does not require the file name to have a special extension. However, we suggest that all your relocatable file names have extension `.o`. The decoder searches for object files first in the project directory and then in the directories listed in `GENPATH`. The object file must be a valid ELF/DWARF V1.1, ELF/DWARF V2.0, or Freescale relocatable file.

## S-Record Files

For S-Record files, you must specify the processor with the `-Proc` option (see -Proc: Set Processor (Decoder)). Otherwise the structure of the S-Record file prints, but the code is not disassembled.

## Intel Hex Files

For Intel Hex files you must specify the processor with the `-Proc` option (see -Proc: Set Processor (Decoder)). Otherwise the structure of the Hex file prints, but the code is not disassembled.

# Output Files

After a successful decoding session, the Decoder generates a listing file containing the disassembled instructions generated by each source statement. The Decoder writes this file to the directory given in the environment variable `TEXTPATH`. If that variable contains more than one path, the Decoder writes the listing file in the first directory given. If this variable is not set, the Decoder writes the listing file in the directory containing the binary input file. Listing files always get the extension `.LST`.

In a standard listing file, the code depends on the target. A sample listing is as follows:

```
DISASSEMBLY OF: '.text' FROM 331 TO 416 SIZE
85 (0X55)
Source file: 'Y:\DEMO\WAVE12C\fibo.c'
    8: unsigned int Fibonacci(unsigned int n)
Fibonacci:
00000867 1B98          LEAS  -8,SP
00000869 3B            PSHD
   13:   fib1 = 0;
0000086A C7            CLRB
0000086B 87            CLRA
0000086C 6C88          STD   8,SP
   14:   fib2 = 1;
0000086E 52            INCB
0000086F 6C84          STD   4,SP
   15:   fibo = n;
00000871 EE80          LDX   0,SP
00000873 6E86          STX   6,SP
   16:   i = 2;
00000875 58            ASLB
00000876 6C82          STD   2,SP
   17:   while (i <= n) {
00000878 2011          BRA   *+19    ;abs = 088B
```

```
   18:     fibo = fib1 + fib2;
0000087A EC88          LDD   8,SP
0000087C E384          ADDD  4,SP
0000087E 6C86          STD   6,SP
   19:     fib1 = fib2;
00000880 EE84          LDX   4,SP
00000882 6E88          STX   8,SP
   20:     fib2 = fibo;
00000884 6C84          STD   4,SP
   21:     i++;
00000886 EE82          LDX   2,SP
00000888 08            INX
00000889 6E82          STX   2,SP
   17:   while (i <= n) {
0000088B EC82          LDD   2,SP
0000088D AC80          CPD   0,SP
0000088F 23E9          BLS   *-21    ;abs = 087A
   23:   return(fibo);
00000891 EC86          LDD   6,SP
   24: }
00000893 1B8A          LEAS  10,SP
00000895 3D            RTS
```

15

# Decoder Controls

This chapter describes Decoder controls; list menus and the Graphical User Interface (GUI).

This chapter is comprised of the following sections:

- List Menus
- Graphical User Interface
- Specifying the Input File
- Message and Error Feedback

## List Menus

The Decoder list menus are on the menu bar of the Decoder main window. The following table lists and describes the main window's top-level list menus.

**Table 15.1 Decoder Main Window List Menus**

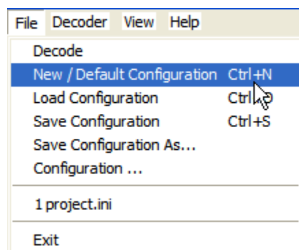
| Menu Name | Contains |
|---|---|
| File | Options for managing configuration files |
| Decoder | Commands for setting options |
| View | Options for customizing window output |
| Help | Standard Windows Help menu |

# File Menu

With the File list menu (Figure 15.1), you can save or load configuration files. Configuration files contain:

- Configuration dialog option settings.
- Message settings that specify which messages to display and which to treat as errors.
- List of last commands executed and current command line
- Window position
- Tip of the Day settings, including whether the Tip of the Day is enabled at startup and current entry

**Figure 15.1 File Menu**




The following table lists and describes the File menu selections:

**Table 15.2 File Menu Selections**

| Menu Selection | Description |
|---|---|
| Decode | Opens a standard **Open File** dialog. Processes selected file as soon as the Open File box is closed using *OK*. |
| New/Default Configuration | Resets option settings to default value. Default options are specified in Tool Options. |
| Load Configuration | Opens the standard **Open File** dialog. Loads configuration data stored in selected file and uses it in session. |
| Save Configuration | Saves current settings. |
| Save Configuration as | Opens a standard **Save As** dialog. Saves current settings in a configuration file with the specified name. |
| Configuration | Opens **Configuration** dialog to specify the editor to use for error feedback and which parts to save with a configuration. |

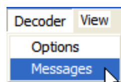
**Table 15.2 File Menu Selections (*continued*)**

| Menu Selection | Description |
|---|---|
| 1..... project.ini<br>2..... | Recent project list. Access to reopen a recently opened project. |
| Exit | Closes the Decoder. |

# Decoder Menu

With the Decoder list menu (Figure 15.2), you can customize the Decoder, graphically set or reset options, and access message settings.

**Figure 15.2 Decoder Menu**




The following table lists and describes the Decoder menu selections.

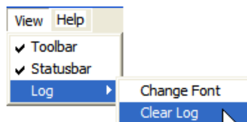
**Table 15.3 Decoder Menu Selections**

| Menu entry | Description |
|---|---|
| Options | Displays the Option Settings dialog box, where you can define options for processing an input file. |
| Messages | Opens the Message Settings dialog box, where you can map error, warning or information messages to another message class. |

# View Menu

With the *View* Menu (Figure 15.3), you can customize the main window. You can choose whether to display or hide the status bar and the toolbar, choose the font used in the window, and clear the window.

**Figure 15.3 View Menu**




The following table lists and describes the *View* menu selections.

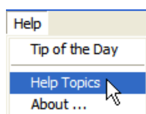
**Table 15.4 View Menu Selections**

| Menu Entry | Description |
|---|---|
| Tool Bar | Displays toolbar in the main window. |
| Status Bar | Displays status bar in the main window. |
| Log | Lets you customize the output in the main window content area. |
| Change Font | Opens a standard font-selection dialog. Your selections appear in the main window content area. |
| Clear Log | Lets you clear the main window content area. |

## Help Menu

From the Help menu (Figure 15.4), you can customize the **Tip of the Day** dialog and display help, Decoder version information, and license information.

**Figure 15.4 Help Menu**




The following table lists and describes the Help menu selections.

**Table 15.5 Help Menu Selections**

| Menu entry | Description |
|---|---|
| Tip of the Day | Switches on or off the Tip of the Day display during startup. |
| Help Topics | Displays standard Help. |
| About | Displays an About box with version and license information. |

# Graphical User Interface

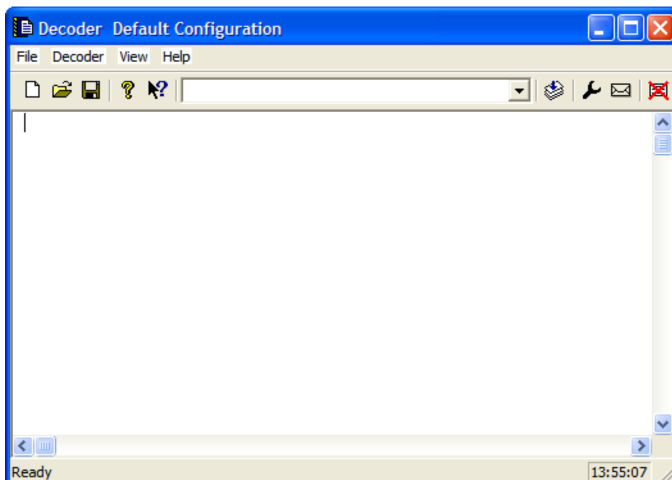
This section describes important aspects of the Decoder graphical user interface (GUI). Windows and dialogs covered here are:

- Decoder Main Window
- Configuration Dialog

# Decoder Main Window

The Decoder main window appears if you do not specify a file name on the command line. If you start a tool using the Decoder, the Decoder main window does not appear.

**Figure 15.5 Decoder Main Window**




## Main Window Components

The following sections describe the Decoder main window components.

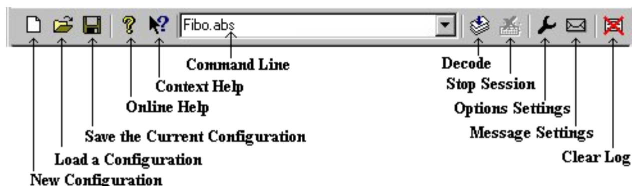
### Window Title

The window title displays the tool name and project name. If no project is loaded, *Default Configuration* displays in the title area. An asterisk after the configuration name indicates you have an unsaved change.

### Toolbar

Figure 15.6 indicates main window toolbar buttons.

**Figure 15.6 Decoder Main Window Toolbar Buttons**




The following table lists the Decoder main window toolbar buttons and describes their functions:

**Table 15.6 Main Window Toolbar Buttons**

| Button Name | Function |
|---|---|
| New Configuration | Same as the *File > New Configuration* menu selection |
| Load a Configuration | Same as the *File > Load Configuration* menu selection |
| Save the Current Configuration | Same as the *File > Save Configuration* menu selection |
| Online Help | Displays Decoder online help |
| Context Help | Changes cursor to question mark. When you hover the cursor over a Decoder screen area and click the left mouse button, context-sensitive help appears for the area you selected. |
| Command Line | Displays a context menu associated with the command line. |
| Decode | Starts execution of a desired command. |
| Stop Session | Stops the current session |
| Option settings | Displays the *Option Settings* dialog |
| Message settings | Displays the *Message Settings* dialog |
| Clear log | Clears main window content |

### Status Bar

The status bar (Figure 15.7) has two dynamic areas:

- Messages
- Time

When you point to a button in the toolbar or a menu entry, the message area displays the function of the button or menu entry.

The time field shows the start time of the current session (if one is active) or current system time.

**Figure 15.7 Main Window Status Bar**

# Decoder Configuration Window

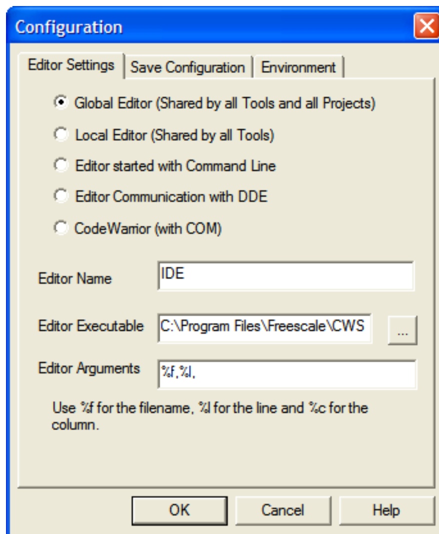
When you choose **File > Configuration** from the Decoder list menus, the Configuration Window appears. The Configuration Window has three tabs:

- Editor Settings
- Save Configuration
- Environment

## Editor Settings Tab

Figure 15.8 shows the Configuration Window with the Editor Settings tab selected.

**Figure 15.8 Decoder Configuration Window - Editor Settings Tab**




The following table lists and describes the Editor Settings tab controls.

**Table 15.7 Editor Settings Tab Controls**

| Control | Function |
|---|---|
| Global Editor | Shared among all tools and projects on one computer and stored in the `MCUTOOLS.INI` global initialization file. |
| Local Editor | Shared among all tools using the same project file |
| Editor started with Command Line | Enable command-line editor. For Winedit 32-bit version use the `winedit.exe` file `C:\WinEdit32\WinEdit.exe%f /#:%l` |
| Editor started with DDE | Enter service, topic and client name to be used for a DDE connection to editor. All entries can have modifiers for file name and line number. |
| CodeWarrior (with COM) | If selected, the CodeWarrior software registered in the Windows Registry launches. |
| Editor Name | Type a name for the desired editor in the text-entry field |

**Table 15.7 Editor Settings Tab Controls (*continued*)**

| Control | Function |
|---|---|
| Editor Executable | Specify editor's path and executable name. Use browse button (...) to locate the executable. |
| Editor Arguments | Type in command-line arguments for the editor in text-entry field. Use `%f` for filename, `%l` for line number, and `%c` for column number. |

## Save Configuration Tab

Figure 15.9 shows the *Configuration Window* with the Save Configuration tab selected.

**Figure 15.9 Decoder Configuration Window - Save Configuration Tab**

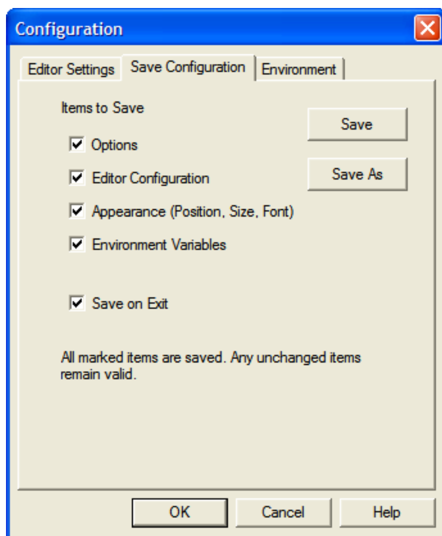


Table 15.8 lists and describes the Save Configuration tab controls.

**Table 15.8 Save Configuration Tab Controls**

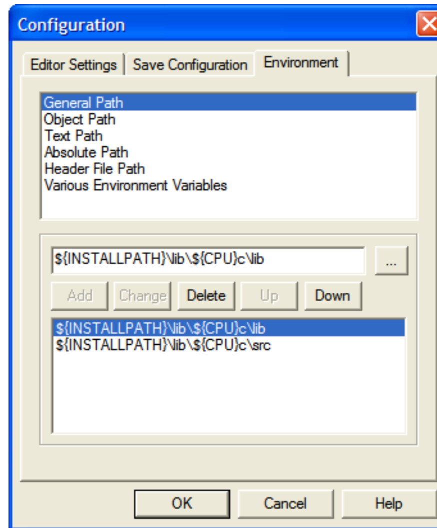
| Control | Function |
| --- | --- |
| Options | When checked, saves current option and message settings when a configuration is written. When cleared, last saved content remains valid. |
| Editor Configuration | When checked, saves current editor settings when a configuration is written. When cleared, the last saved content remains valid. |
| Appearance | When checked, window position, command line content, and history settings are retained when a configuration is written. |
| Environment Variables | When checked, writes the environment variable settings in the Environment Tab to the configuration. |
| Save on Exit | When checked, Decoder writes configuration on exit. No confirmation message appears. When cleared, Decoder does not save configuration on exit, even if options or another part of configuration has changed. No confirmation message appears when closing Decoder. |

**NOTE** Settings are stored in the configuration file. Exceptions are recently used configuration list and settings in this dialog. Configurations can coexist in the same file as the shell project configuration. When the shell configures an editor, the Decoder can read the content from the project file. The shell project configuration filename is `project.ini`.

# Environment Tab

Figure 15.10 shows the Configuration Window with the Environment tab selected.

**Figure 15.10 Decoder Configuration Window - Environment Tab**




Use the Environment tab to configure the environment. The content of the tab is read from the project file in the `[Environment Variables]` section. You can choose from the following environment variables:

- General Path: GENPATH
- Object Path: OBJPATH
- Text Path: TEXTPATH
- Absolute Path: ABSPATH
- Header File Path: LIBPATH
- Various Environment Variables: other variables not covered in this list

Table 15.9 lists and describes the Environment tab controls.

**Table 15.9 Environment Tab Buttons**

| Button | Function |
| --- | --- |
| Add | Adds a new line/entry |
| Change | Changes a new line/entry |
| Delete | Deletes a new line/entry |
| Up | Moves a line/entry up |
| Down | Moves a line/entry down |

# Decoder Option Settings

The Options Settings window appears when you select **Decoder > Options** from the menus. Click on the text in the list box to select an option. For help, select an option and press **F1**. The command-line option in the lower part of the dialog corresponds with your selection in the list box.

**NOTE** When options requiring additional parameters are selected, a dialog box or window may appear.

**Figure 15.11 Decoder Options Settings Window**

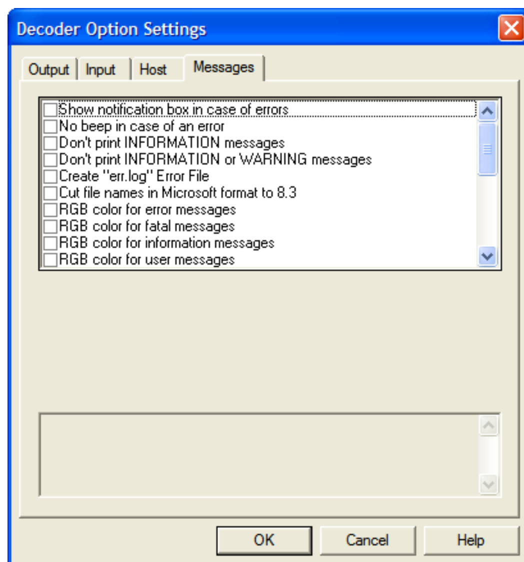



Table 15.10 describes the tabs in the Decoder Option Settings Window.

**Table 15.10 Option Settings Window Tabs**

| Tab | Description |
|---|---|
| Output | Command-line execution and print output settings |
| Input | Macro settings |
| Host | Lists options related to the host operating system |
| Messages | Message-handler settings - format, kind, and number of printed messages |

## Message Settings Window

The Message Settings window (Figure 15.12) appears when you select *Decoder > Messages* from the list menus. This window lets you map messages to different message classes.

Each message has its own ID (a character followed by a 4- or 5-digit number). This number allows you to search for the message in the manual and online help. For more information about specific messages, see Decoder Message List.

**Figure 15.12 Message Settings Window**

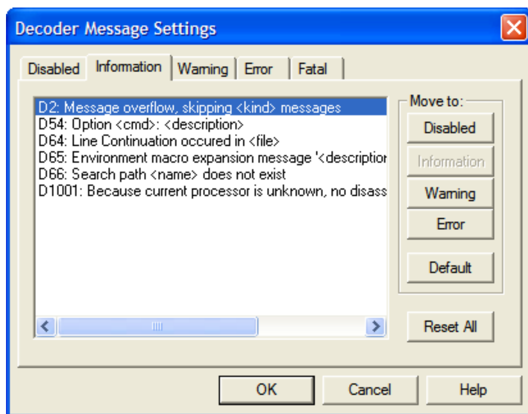



Table 15.11 describes the tabs in the *Message Settings* window.

**Table 15.11 Message Settings Window Tabs**

| Message Group | Description |
|---|---|
| Disabled | Lists disabled messages. Messages displayed in the list box are not written to the output stream. |
| Information | Lists information messages. Information messages inform you of actions taken. |
| Warning | Lists warning messages. When a warning message is generated, processing of the input file continues. |

**Table 15.11 Message Settings Window Tabs (*continued*)**

| Message Group | Description |
|---|---|
| Error | Lists error messages. When an error message is generated, processing of the input file stops. |
| Fatal | Lists fatal error messages. These messages report system consistency errors. Fatal error messages cannot be ignored or moved. |

# Changing a Message Class

You can map messages to different classes using one of the buttons on the right side of the dialog. Each button refers to a message class. To change the class associated with a message, select the message in the list box and then click the button corresponding with the desired message class.

## Example:

To define message `D51 could not open statistic log file` (warning message) as an error message:

1. Click the **Warning** tab

   A list of warning messages displays in the list box.

2. Click the string `D51 could not open statistic log file` in the list box.
3. Click the **Error** button to define the message as an error message.

**NOTE** You cannot move messages to or from the **fatal** error class.

**NOTE** The **move to** buttons are active only when you select messages that can be moved. When you select a message only valid *Move to* buttons remain active.

To validate the changes made in the error message mapping, click **OK** to close the **Message Settings** window. If you click the **Cancel** button, the previous message mapping remains valid.

# Retrieving Information about an Error Message

You can access information about each message in the list box. Select the message in the list box, then click **Help**. An information box opens which contains a more detailed description of the error message as well as a small example of code that could produce the

error. If you select several messages, help for the first message displays. If you select no message, pressing **F1** shows help for the dialog.

## About Decoder Dialog Box

The **About Decoder** dialog box appears when you select **Help > About** from the menus. This dialog box shows the current directory and the versions of Decoder components, with the version displayed at the top of the dialog box. Click **OK** to close the dialog box.

# Specifying the Input File

The following list explains the different ways to specify the decode file to be processed. During processing, the software sets options according to configurations specified in Decoder windows.

**NOTE** Before starting the decoding process of a file, use your editor to specify a working directory.

- Use the Command Line in the Toolbar to Decode

  You can use the command line to process files. The command line lets you enter a new file name and additional Decoder options.

- Processing a File Already Run

  You can display the previously executed command using the arrow at the right of the command line. Select a command by clicking it, which puts it on the command line. The software processes the file you choose after you click the **Decode** button in the toolbar or press the **Enter** key.

- **File > Decode**

  When you select **File > Decode**, a standard open file dialog box displays. Browse to the file you want to process. The software processes the file you choose after you click the *Decode* button in the toolbar or press the **Enter** key.

- Drag and Drop

  You can drag a file from other programs (such as the File Manager or Explorer) and drop it into the Decoder main window. The software processes the dropped file after you release the mouse button.

  If the dragged file has a `.ini` extension, it is loaded and treated as a configuration file, not as a file to be decoded.

# Message and Error Feedback

After making, there are several ways to check for different errors or warnings. The format of an error message looks like this:

```
<msgType> <msgCode>: <Message>
```

### Examples:

```
Could not open the file 'Fibo.abs'
FATAL D50: Input file 'Fibo.abs' not found
*** command line: 'Fibo.abs' ***
Decoder: *** Error occurred while processing! ***
```

The second example shows that messages from called applications are also displayed, but only if an error occurs. They are extracted from the error file if the called application reports an error.

## Using Information from the Main Window

Once a file has been processed, the Decoder window content area displays the list of detected errors or warnings. Use the editor of your choice to open the source file and correct the errors.

## Using a User-Defined Editor

You must first configure the editor you want to use for message or error feedback in the *Configuration* dialog. Once a file has been processed, you can double-click on an error message. Your selected editor opens automatically and points to the line containing the error.

V

# Maker Utility

This section describes the IDE Maker Utility. Maker implements the UNIX make command with a Graphical User Interface (GUI). In addition, you can use Maker to build Modula-2 applications as well as maintain C/C++ projects. Maker has:

- Online Help
- Flexible Message Management
- 32-bit functionality

This section consists of the following chapters:

- Maker Controls: Describes Maker controls, menus and the Graphical User Interface.
- Using Maker: Describes using Maker to build Modula-2 applications and to maintain C/C++ projects.
- Building Libraries: Describes how to use the Maker utility to adapt or build your own libraries.

**Starting the Maker Utility**

All of the utilities described in this book may be started from executable files located in the Prog folder of your IDE installation. The executable files are:

- `maker.exe` Maker: The Make Tool
- `burner.exe` The Burner Utility
- `decoder.exe` The Decoder
- `libmaker.exe` Libmaker
- `linker.exe` The SmartLinker Utility

With a standard full installation of the HC(S)08/RS08 CodeWarrior IDE, the executable files are located here:

```
C:\Program Files\Freescale\CodeWarrior for Microcontrollers V6.2\Prog
```

With a standard full installation of the HC(S)12 CodeWarrior IDE, the executable files are located at:

```
C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\Prog
```

To start the Maker Utility, you can click on `maker.exe`.

# 16

# Maker Controls

This chapter describes Maker controls, such as menus and the Graphical User Interface (GUI), and contains the following sections:

- Graphical User Interface
- Specifying the Input File
- Message and Error Feedback

## Graphical User Interface

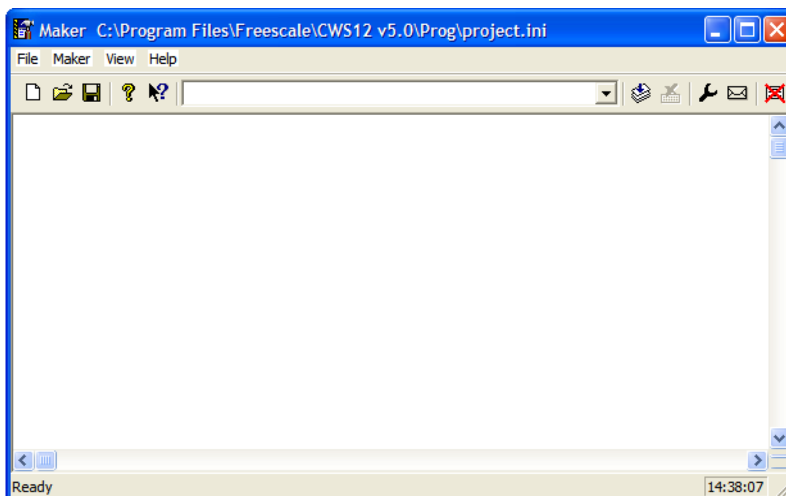
This section describes important aspects of Maker's Graphical User Interface (GUI). This section covers these windows and dialogs:

- Maker Main Window
- Configuration Dialog

### Maker Main Window

The Maker main window appears if you do not specify a file name on the command line. If you start a tool using Maker, the Maker main window does not appear.

**Figure 16.1 Maker Main Window**




# Main Window Components

The Maker main window has these components:

- Window title
- Menu bar
- Toolbar
- Content area
- Status bar

## Window Title

The window title displays the tool name and the project name. If Maker has no loaded project, *Default Configuration* appears in the title area. An asterisk after the configuration name indicates that you have unsaved changes.

# Maker Main Window Menu Bar

Maker menus are on the menu bar of the main window. Table 16.1 describes Maker's top-level menus.

**Table 16.1 Maker List Menus**

| Menu Name | Contains |
|---|---|
| File | Selections for managing configuration files |
| Maker | Selections for setting options |
| View | Selections for customizing window output |
| Help | Standard Windows Help menu |

# File Menu

Use the File Menu to save or load configuration files. Configuration files contain:

- Configuration dialog option settings.
- Message settings that specify which messages to display and which to treat as errors.
- A list of the last command line executed and the current command line.
- The window position.
- Tips of the Day settings, including the startup settings and the current entry.

**Figure 16.2 File Menu**

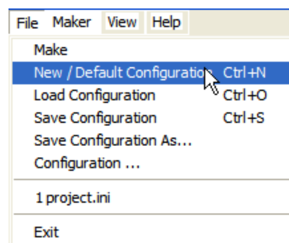



Table 16.2 describes *File* menu selections.

**Table 16.2 File Menu Selections**

| Menu Selection | Description |
|---|---|
| Make | Opens a standard *Open File* dialog. Maker processes selected file after you click *OK* to close the Open File dialog. |
| New/Default Configuration | Resets the option settings to default values. Tool Options specifies the default activated options. |

**Table 16.2 File Menu Selections (*continued*)**

| Menu Selection | Description |
| --- | --- |
| Load Configuration | Opens the standard *Open File* dialog. Future sessions load and use the configuration data stored in the selected file. |
| Save Configuration | Saves the current settings. |
| Save Configuration as | Opens a standard *Save As* dialog. Maker saves the current settings in a configuration file with the specified name. |
| Configuration | Opens *Configuration* dialog to specify the editor to use for error feedback and the parts to save with a configuration. |
| 1..... project.ini<br>2..... | Recent project list. Access this list to open a recently used project again. |
| Exit | Closes the Maker. |

# Maker Menu

With the Maker menu you can customize Maker, graphically set or reset options, and access message settings.

**Figure 16.3 Maker Menu**

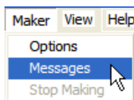



Table 16.3 describes *Maker* menu selections.

**Table 16.3 Maker Menu Selections**

| Menu entry | Description |
| --- | --- |
| Options | Displays the *Options Settings* dialog in which you can define options for processing an input file. |
| Messages | Opens the *Message Settings* dialog in which you can map error, warning, or information messages to different message classes. |
| Stop Making | Stops the current Make process. Maker grays out this selection when no active Make process exists. |

# View Menu

With the View menu you can customize the main window. You can choose the font used in the window, specify whether Maker displays or hides the status bar and the toolbar, and clear the window.

### Figure 16.4 View Menu

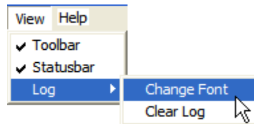



Table 16.4 describes *View* menu selections.

### Table 16.4 View Menu Selections

| Menu entry | Description |
|---|---|
| Tool Bar | Toggles display of the toolbar in the main window. |
| Status Bar | Toggles display of the status bar in the main window. |
| Log | Lets you customize the output in the main window content area. |
| Change Font | Opens a standard font-selection dialog. Your selections appear in the main window content area. |
| Clear Log | Clears the main window content area. |

# Help Menu

From the Help menu you can customize the Tip of the Day dialog. Use this menu to display Windows help as well as Maker version and license information.

### Figure 16.5 Help Menu

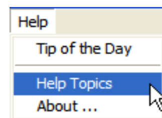



Table 16.5 describes *Help* menu selections.

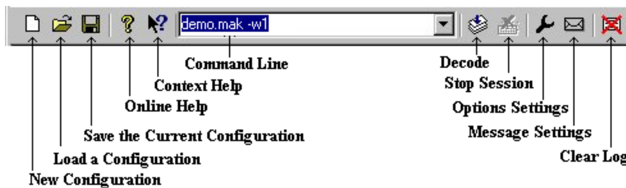
**Table 16.5 Help Menu Selections**

| Menu entry | Description |
|---|---|
| Tip of the Day | Toggles display of a Tip of the Day during startup. |
| Help Topics | Displays standard Help. |
| About | Displays an About box with version and license information. |

# Maker Main Window Toolbar

The Maker Main window toolbar icons are shown in Figure 16.6.

**Figure 16.6 Maker Main Window Toolbar Icons**




The following table lists the Maker main window toolbar buttons and describes their functions.

**Table 16.6 Main Window Toolbar Icon**

| Icon Name | Function |
|---|---|
| New Configuration | Mimics the *File > New Configuration* menu selection. |
| Load a Configuration | Mimics the *File > Load Configuration* menu selection. |
| Save the Current Configuration | Mimics the *File > Save Configuration* menu selection. |
| Online Help | Displays Maker online help. |
| Context Help | Changes the cursor to a question mark. When you hover your cursor over a Maker screen area and click the left mouse button, context-sensitive help appears for the area you selected. |
| Command Line | Displays a context menu associated with the command line. |
| Make | Starts the execution of a desired command. |

**Table 16.6 Main Window Toolbar Icon (*continued*)**

| Icon Name | Function |
|---|---|
| Stop Session | Stops the current session. |
| Option settings | Displays the *Option Settings* dialog. |
| Message settings | Displays the *Message Settings* dialog. |
| Clear log | Clears the main window content. |

## Maker Main Window Status Bar

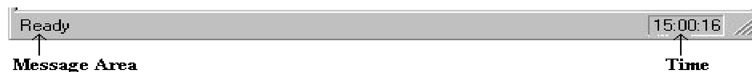
The Maker Main window status bar has two dynamic areas:

- Messages
- Time

When you point to an icon on the toolbar or to a menu entry, the message area displays the function of the button or menu entry.

The time field shows the start time of the current session (if an active session exists) or the current system time.

**Figure 16.7 Main Window Status Bar**




# Maker Configuration Window

When you choose *File* > *Configuration* from the Maker Main window list menus, the *Configuration* window appears. The *Configuration* window has three tabs:

- Editor Settings
- Save Configuration
- Environment

## Configuration Window Editor Settings Tab

Figure 16.8 shows the *Configuration* window with the *Editor Settings* tab selected.

**Figure 16.8 Configuration Window - Editor Settings Tab**

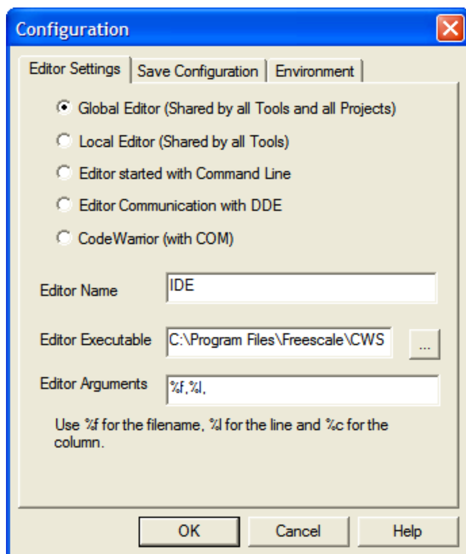



Table 16.7 describes *Editor Settings* tab controls.

**Table 16.7 Editor Settings Tab Controls**

| Control | Function |
|---|---|
| Global Editor | Shared among all tools and projects on one computer. The `MCUTOOLS.INI` global initialization file stores the global editor. |
| Local Editor | Shared among all tools using the same project file. |
| Editor started with Command Line | Enable command-line editor starting. For Winedit 32-bit version use the `winedit.exe` file `C:\WinEdit32\WinEdit.exe%f /#:%l` |
| Editor started with DDE | Enter service, topic, and client name to use for DDE connection to editor. All entries can have modifiers for file name and line number. |
| CodeWarrior (with COM) | If selected, the CodeWarrior IDE version registered in the Windows Registry launches. |
| Editor Name | Enter name of desired editor in this text-entry field. |

**Table 16.7 Editor Settings Tab Controls (*continued*)**

| Control | Function |
|---|---|
| Editor Executable | Specify editor's path and executable name. Use browse button (...) to locate executable file. |
| Editor Arguments | Enter command-line arguments for editor in this text-entry field. Use `%f` for filename, `%l` for line number, and `%c` for column number. |

**NOTE** Changing the Editor Selection option button settings in this window changes the entries in the text entry fields at the bottom of the window.

# Configuration Window Save Configuration Tab

Figure 16.9 shows the *Configuration* dialog with the *Save Configuration* tab selected.

**Figure 16.9 Configuration Dialog - Save Configuration Tab**

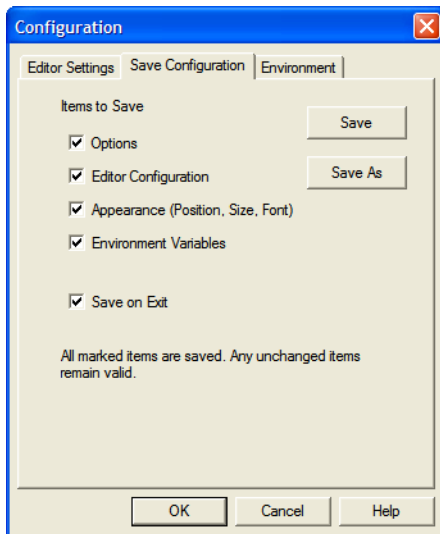


Table 16.8 describes the *Save Configuration* tab controls.

**Table 16.8 Save Configuration Tab Controls**

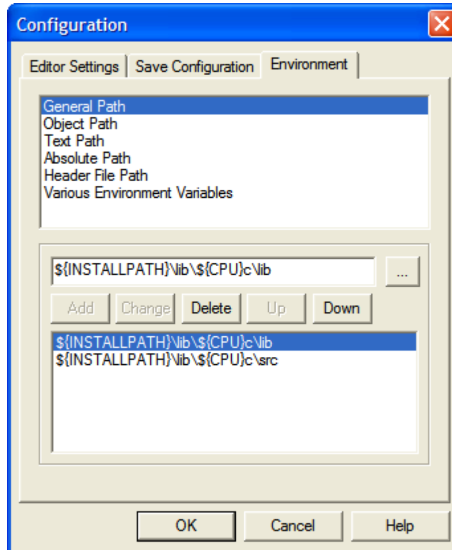
| Control | Function |
|---|---|
| Options | When checked, Maker saves current option and message settings to configuration file. When cleared, last saved content remains valid. |
| Editor Configuration | When checked, Maker saves current editor setting to configuration file. When cleared, last saved content remains valid. |
| Appearance | When checked, Maker saves window position, command-line content, and history settings to configuration file. When cleared, last saved content remains valid. |
| Environment Variables | When checked, Maker saves environment variable settings in Environment Tab to the configuration file. When cleared, last saved content remains valid. |
| Save on Exit | When checked, Maker saves the configuration file on exit. No confirmation message appears. When cleared, Maker does not save configuration file on exit, even if you change options or another part of the configuration file. No confirmation message appears when closing Maker. |

**NOTE** Maker stores settings in the configuration file, with the exception of the recently used configuration list and the settings in this dialog. Configurations can coexist in the same file as the shell project configuration. When the shell configures an editor, Maker can read the content from the project file. The shell project configuration filename is `project.ini`.

## Configuration Window Environment Tab

Use the **Configuration** window with the **Environment** tab selected to configure the environment.

**Figure 16.10 Configuration Dialog - Environment Tab**




Maker reads the content of the dialog from the `[Environment Variables]` section of the actual project file. You can choose from these environment variables:

- General Path: GENPATH
- Object Path: OBJPATH
- Text Path: TEXTPATH
- Absolute Path: ABSPATH
- Header File Path: LIBPATH
- Various Environment Variables: other variables not covered in this list

Table 16.9 describes the *Configuration* window *Environment* tab controls.

**Table 16.9 Environment Tab Buttons**

| Button | Function |
|---|---|
| Add | Adds a new line/entry |
| Change | Changes a new line/entry |
| Delete | Deletes a new line/entry |

**Table 16.9 Environment Tab Buttons (*continued*)**

| Button | Function |
|---|---|
| Up | Moves a line/entry up |
| Down | Moves a line/entry down |

## Tip of the Day Window

When you start the tool, a **Tip of the Day** window displays a randomly chosen user tip.

The **Next Tip** button lets you read the next hint. If you don't want the Tip of the Day window to open after the program starts, uncheck the **Show Tips on StartUp** box. Click *Close* to close the **Tip of the Day** window.

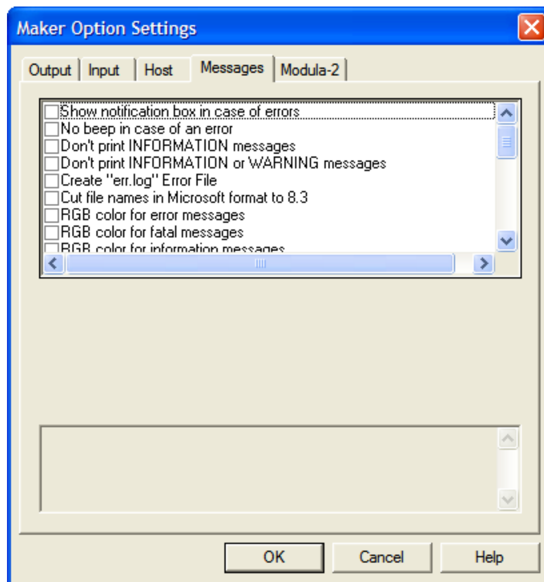
**NOTE** The local project file stores user configurations.

# Maker Option Settings Window

The Option Settings window appears when you select **Maker > Options** from the menus. Click once on the text in the list box to select an option. For help, select an option and press **F1**. The command-line option in the lower part of the dialog corresponds to your selection in the list box. For more information on Maker options, see Tool Options.

**NOTE** When you select options requiring additional parameters, a dialog box or subwindow may appear.

**Figure 16.11 Option Settings Window**




[Table 16.10](#) describes the tabs in the *Option Settings* dialog.

**Table 16.10 Option Settings Dialog Tabs**

| Tab | Description |
|---|---|
| Output | Command-line execution and print-output settings. |
| Input | Macro settings. |
| Host | Lists options related to the host operating system. |
| Messages | Message-handler settings, such as format, kind, and number of printed messages. |
| Modula-2 | Modula-2 make-specific options (not relevant for C users). |

# Maker Message Settings Window

The **Message Settings** window appears when you select **Maker > Messages** from the list menus. This window lets you map messages to different message classes.

Each message has its own ID (a character followed by a 4- or 5-digit number). This number allows for message look-up both in the manual and in the online help. For information about specific messages, see Makefile Messages.

#### Figure 16.12 Message Settings Window

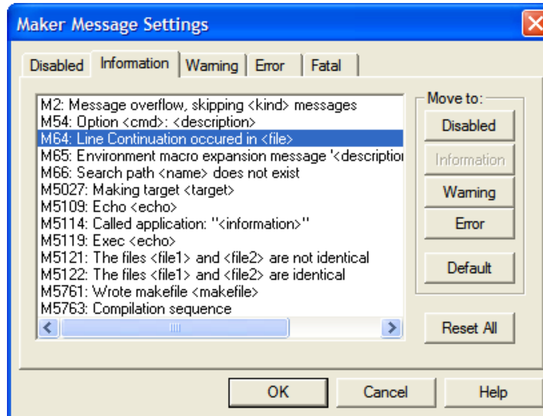



Table 16.11 describes the tabs in the **Message Settings** window.

#### Table 16.11 Message Settings Window Tabs

| Message Group | Description |
|---|---|
| Disabled | Lists disabled messages. Maker does not write the messages displayed in the list box to the output stream. |
| Information | Lists information messages. Information messages inform you of actions taken. |
| Warning | Lists warning messages. When Maker generates a warning message, it continues processing the input file. |
| Error | Lists error messages. When Maker generates an error message, it stops processing the input file. |
| Fatal | Lists fatal error messages. These messages report system consistency errors. You cannot ignore or move fatal error messages. |

## Changing a Message Class

You can map messages to different classes using one of the buttons at the right of the dialog. Each button refers to a message class. To change the class associated with a message, select the message in the list box and then click the button corresponding with the desired message class.

### Example:

To define message `M5116 could not delete file` (a warning message) as an error message, follow these steps:

1. Click the **Warning** tab

   A list of warning messages appears in the list box.

2. Click the string `M5116 could not delete file` in the list box.
3. Click the **Error** button to define the message as an error message.

**NOTE** You cannot move messages from or to the **fatal** error class. Maker only enables the **move to** buttons when you select movable messages. If you try to move a message to an impermissible group, Maker grays out the impermissible move to button.

To save the modification you performed in the error message mapping, click **OK** to close the **Message Settings** dialog. If you click **Cancel** to close the dialog, the previous message mapping remains valid.

## Retrieving Information about an Error Message

You can access information about each message in the list box. Select the message in the list box, then click **Help**. An information box opens, which contains a detailed description of the error message as well as a small example of code producing it. If you select several messages, help for the first message appears. If you select no message, pressing **F1** shows the help for the dialog.

# About Dialog Box

The **About** dialog box appears when you select **Help > About** from the list menus. This dialog shows the current directory and the Maker component versions. The Maker version appears separately at the top of the dialog. Click *OK* to close the dialog.

**NOTE** During a Maker process, Maker component versions do not appear. Maker must be idle in order for versions to appear.

# Specifying the Input File

You can use several different ways to tell the make file to process. During processing, the software sets options according to the configurations that you specified in Maker dialogs.

Before starting to process a make file, specify a working directory using your editor.

- Use the Toolbar Command Line to Make

  Use the command line to process files. The command line lets you enter a new file name and additional Maker options.

- Processing a File Already Run

  You can display the previously executed command using the arrow at the right of the command line. Select a command by clicking it, which puts it on the command line. The software processes the file you choose after you click the **Make** button in the toolbar or after you press the **Enter** key.

- File > Make

  When you select **File > Make** from the list menus, a standard **Open File** dialog appears. Navigate and select the file you want to process. The software processes the file you choose after you click the **Make** button in the toolbar or press the *Enter* key.

- Drag and Drop

  You can drag a file from other software (such as the File Manager or Explorer) and drop it into the Maker main window. The software processes the dropped file after you release the mouse button.

  If the dragged file has the `.ini` extension, Maker loads and treats it as a configuration file, not as a makefile. To process a makefile with an `.ini` extension, use another method to run it.

# Message and Error Feedback

After making, there are several ways to check where Maker detected different errors or warnings. The format of an error message looks like this:

```
<msgType> <msgCode>: <Message>
```

## Examples:

```
ERROR M5102: input file not found
```

```
ERROR M5112: called application: "ERROR C1011: Undeclared
enumeration tag"
```

The second example shows that Maker also displays messages from called applications, but only if an error occurs. Maker extracts the messages from the error file if the called application reports an error.

## Using Information from the Main Window

After Maker processes a file, the Maker window content area displays a list of detected errors or warnings. Use the editor of your choice to open the source file and correct the errors.

## Using a User-Defined Editor

You must first configure the editor you want to use for message or error feedback in the **Configuration** dialog. After Maker processes a file, you need only double-click an error message to open your selected editor automatically and point to the line containing the error.

# 17

# Using Maker

With Maker you can build Modula-2 applications as well as maintain C/C++ projects. Maker syntax is a subset of the UNIX **Make** command.

This chapter covers the following subjects:


- Making Modula–2 Applications
- Making C Applications
- User-Defined Macros (Static Macros)
- Directives and Special Targets


## Making Modula–2 Applications

To make a Modula-2 application, enter the name of the main module at the input prompt (or the command line). First, Maker collects dependencies given by the IMPORT clauses in the source files of both implementation and definition modules. Second, Maker recompiles files modified since the last compilation. Third, Maker tries to link the application.

The **Make** utility needs three environment variables:

LINK: Linker for Modula-2 — Defines the linker program

COMP: Modula-2 Compiler — Defines the compiler

FLAGS: Options for Modula-2 Compiler — Defines the compiler options for the compiler given in COMP

These variables are necessary only when you use the Maker to build a Modula-2 application, not for makefile processing (although you can use them as macros, as described later in this chapter).

## Making C Applications

Since in C you cannot always deduce dependencies between files by looking at the source files, automatic make (as with Modula-2 applications) is not possible. However, if you describe these dependencies in a file, Make can process this makefile and build, or rebuild, a C application.

# Using Makefiles

This section gives a short introduction to writing and using makefiles. If you already know UNIX–style make utilities, you probably already know most of what follows. If you have been working until now with Microsoft Make, we strongly recommend that you read this section.

## Syntax of Makefiles

Makefile syntax is as follows:

```
MakeFile    =  {Entry | Directive}.
Entry       =  {Macro | Update | Rule}.
Macro       =  Name {"="|"+="|"=+"} Line NL.
Update      =  Name ":" [Name {[","] Name}] NL {Command}.
Command     =  WhiteSpace {WhiteSpace} Line NL.
Rule        =  "." Suffix ["." Suffix] ":" NL {Command}.
Directive   =  INCLUDE Name NL.
WhiteSpace  =  " "|"\t".
NL          =  "\n".
Line        =  {<any char except un-escaped linebreaks>}.
Name        =  <any valid file name>.
Suffix      =  Letter [Letter] [Letter].
Letter      =  any letter from "A" to "Z" or from "a" to "z">.
```

## Case Sensitivity

By default, Maker is case-sensitive. However, if you set the -C option, Maker treats uppercase and lowercase letters the same.

## Line Breaks

Processing a makefile is a line-oriented job because you use a linebreak to terminate most constructs, such as macro definitions or dependency lists. If you want Make to ignore a linebreak, place a backslash (“\”) immediately before the linebreak. Make then reads the combination of backslash and linebreak as one single blank. You cannot use a line continuation to enlarge comment lines.

## Comments

Comments in a makefile start with the number sign (#) and end with the next linebreak.

## Dependencies

Makefile update entries determine dependencies between files. Such an update entry has the form:

```
target file: {dependency file} {command line}
```

This entry tells HI-CROSS Make that the target file depends on all the dependency files. If any of the dependency files changed since the last target-file make, or if the target file does not exist, Make executes the command lines in order of appearance. If dependencies do not exist, Make always executes the command lines. If command lines do not exist, the target needs re-making, and rules are inapplicable, Make issues an error message. See the following sections for more information on rules.

## Commands

You must begin each command on a new line and prefix that command by at least one blank or tab. Maker does not claim the tab as in UNIX make. The following list describes additional characteristics:

- Maker strips leading and trailing blanks and tabs from the command line.
- If the command line terminates with an exit code not equal to zero, Maker displays an error message and stops makefile processing, unless the line starts with a dash (–). Maker removes the `dash` before executing the command.
- An asterisk (*) at the start of the command line prevents Maker from capturing the output of the called tool. Sixteen-bit applications such as `command.com` need the asterisk to function properly.

## Processing

Make processes updated entries recursively, which means that if a dependency file appears as a target in some other update entry, Make processes that other update entry first. If a dependency file does not exist and rules are inapplicable, Make issues an error message. See the following sections for more information on rules.

Normally, makefile processing starts with the update entry for the target given on the command line or at the input prompt. If you do not specify a target, processing starts at the first update entry in the makefile.

If there are two update entries for the same target file, Make appends the dependencies and commands of the second update entry to those of the first update entry.

Make issues an error message if it finds circular dependencies.

## Macros

Macros associate a name with some arbitrary text. You can substitute this name for each occurrence of the arbitrary text in the makefile. There are two different forms of macros: user-defined static macros and predefined dynamic macros.

# User-Defined Macros (Static Macros)

This section describes the macro definition form.

## Definition

A macro definition has the form:

```
macro_name = text up to the next un-escaped linebreak
```

After you define a macro, you can use a macro reference to include the text at any place in a makefile.

## Reference

A macro reference has the form:

```
$(macro_name)
```

Make replaces the reference with the text, including the "`$(`" and the "`)`". If the text itself contains more macro references, Make expands those, as well.

## Redefinition

You can redefine macros, in which case the text in the new definition overwrites the text in the old definition. Maker issues an error message if it detects a circular macro definition like this:

```
ThisMacro = $(ThatMacro)
ThatMacro = Not $(ThisMacro)
```

## Macro Substitution

During macro expansion, use the following syntax to have Maker replace strings:

```
$(macroname:find=replace)
```

In this example, Maker replaces every occurrence of `find` with `replace`.

Use this kind of macro expansion to derive filenames, as in the following example:

```
SRCNAMES= a.c b.c
OBJNAMES = $(SRCNAMES:.c=.o)
```

As a result of this example, `OBJNAMES` contains `a.o b.o`.

> **NOTE** Maker does not allow spaces in the search string, the replace string, the whole macro definition, or before or after the ":" or the "="

# Macros and Comments

If a comment follows a macro on the same line, as in the following example, the text that replaces any reference of these macros ends just before the # character:

```
MyMacro    = another #And that's a comment
OurMacro   = This is \
$(MyMacro)  example #That's a comment, too!
MyMacro    = a third #Redefinition of a macro
HisMacro   = This is \
         $(MyMacro) example
```

Maker replaces the macro references as follows (without double quotes):

```
$(MyMacro)  = "a third"
$(OurMacro) = "This is a third example"
$(HisMacro) = "This is a third example"
```

You can use macro references in update entries, inference rules, macro definitions, and macro references. See the following sections for more information on rules. The macro-reference possibility allows constructs such as:

```
This = Macro
MyMacro = This is a circular macro reference!
$(My$(This))
```

This example first evaluates to "`$(MyMacro)`" and then to "This is a circular macro reference!".

# Concatenation

Besides the macro definition operator "=", **Make** knows two additional operators: "+=" and "=+". The first operator appends the text on the right to the macro on the left. The second operator assigns to the macro the value given by appending the macro's previous value to the text given on the right:

```
MyMacro = File
MyMacro += .TXT
     #Now the macro has the value "File.TXT"
MyMacro =+ D:\
     #Now it has the value "D:\File.TXT"
```

The following macro is a case handled differently by different make utilities:

`MyMacro = D:\SomeDir\`

In `HI-CROSS` **Make** it has the value `D:\SomeDir\`. Other make implementations expand it as `D:\SomeDir` and take the last backslash as part of an escaped linebreak.

# Command-Line Macros

There are two kinds of user-defined macros: Command-line macros and makefile macros. Makefile macros are the macro definitions that appear in the make file. Command-line macros are macros on the command line with option `-d`. Command-line macros have a higher priority than macros defined in the makefile or in an included file. Therefore, if you define a macro on command line, Maker ignores further definition of a macro with the same name in the makefile.

A special command-line macro is `TARGET`, which defines the name of the top target to make. The `TARGET` macro provides compatibility with previous Maker versions. Specify a top target by adding its name after the makefile name. Defining an explicit top target with the `TARGET` macro works only on the command line. The `TARGET` macro in the makefile does not define a new top target. Do this explicitly by specifying a new target at the top, which has the top target to make as dependency.

# Dynamic Macros

In addition to user-defined macros, which are always static, `HI-CROSS` **Make** recognizes the following dynamic macros, which evaluate differently in different contexts:

```
$*  base name (without suffix and period) of the target file.
$@  complete target file name.
$<  complete list of dependency files.
$?  list of dependency files that are younger than the target
$$  evaluates to a single dollar sign.
```

Except for the first and last macro, these dynamic macros may only appear within command lines. Maker replaces them at the very end of macro substitution, just as it executes the command:

```
MyMacro = $<
OurMacro = file.c $(MyMacro)
THAT.EXE : $*.C $(OurMacro)
  $(COMP) $(MyMacro)
  $(LINK) $*.PRM
```

The first line evaluates to:

```
THAT.EXE : THAT.C file.c $<
```

This line is circular, since Maker now replaces `$<` with `THAT.C file.c $<` and so on. For this reason, the dynamic macros `$<` and `$?` may only appear on a command line (after Maker completes all macro substitution). If we define `OurMacro` as:

```
OurMacro = file.c io.c
```

Once Maker completes all macro substitution, we get:

```
THAT.EXE : THAT.C file.c io.c
```

Example of `$<`:

```
target.o: target.c a.c b.c
  $(COMP) $<
```

replaced with:

```
target.o: target.c a.c b.c
  $(COMP) target.c a.c b.c
```

Example of `$?`:

```
target.o: target.c a.c b.c
  $(COMP) $?
```

If a.c and b.c are newer than target.o, then the result is:

```
target.o: target.c a.c b.c
  $(COMP) a.c b.c
```

**NOTE** HI-CROSS Make also defines macros for all currently set environment variables. You can redefine these macros like any other macro.

# Inference Rules

Inference rules specify default rules for certain common cases. Inference rules have the form:

```
.depSuffix.targetSuffix:
  {Commands}
```

or:

```
.depSuffix:
  {Commands}
```

These rules tell HI-CROSS Make how to make a file with suffix targetSuffix if it cannot find an update entry for the file: look for a file with the same name as the target but with suffix depSuffix. Assume the target depends on that file, make the usual checks, and if Maker must remake the target, execute the commands. If commands do not exist and the target needs remaking, Maker issues an error.

The second form of an inference rule with only one suffix works exactly as the first one. Maker assumes an empty target suffix.

For example, object files usually depend on a source file of the same name, but with a different suffix, and Make calls a compiler to create those object files. Assume that object files have the extension .o and source files have the extension .c. For example:

```
.c.o:
  $(COMP) $*.c
```

If Make now finds a dependency file with extension .o (for example, THIS.o) but no update entry having this file as target, it applies the above rule. The result is exactly the same as if your makefile contained the dependency:

```
THIS.o: THIS.c
  $(COMP) $*.c
```

Rules also play a different role: if there is an update entry without command lines, HI-CROSS Make searches for a rule that might apply and executes the commands specified in that rule. For example, with your makefile containing the above rule, the update entry:

```
THAT.o: FILE.h DATA.h
```

This is equivalent to:

```
THAT.o: FILE.h DATA.h THAT.c
  $(COMP) $*.c
```

If you define two different inference rules for the same target suffix, only the last one is active.

If `HI-CROSS Make` finds a dependency file that does not appear as a target in some other update entry, it tries to find an inference rule to apply. If Make cannot find an inference rule, and the file exists, Make assumes that the file is up to date. If the file does not exist, Maker needs to remake it. Since Maker lacks a rule or an update entry for the file, it issues an error message.

Here is a more complex example:

```
# demo make file for assembly project

OBJECTS = a_1.o a_2.o a_3.o
ASM = c:\freescale\prog\assembler.exe
LINK = c:\freescale\prog\linker.exe
all: myasm.abs
  echo "all done"
myasm.abs: $(OBJECTS) myasm.prm
a_1.o: a_1.inc
a_2.o: a_1.inc a_2.inc
  .prm.abs:
  $(LINK) $*.prm
  .asm.o :
  $(ASM) $*.asm
```

# Multiple Inference Rules

You can specify more than one inference rule for each dependency suffix. Use this technique when you have source files written in different programming languages with different file suffixes. For example, assume you have sources written in assembly language, in ANSI-C and C++. The object files produced by the assembler and compiler have all the same suffixes. They are linked together to one program or library. You can represent this relationship by one target having all the object files as a dependency list:

```
makeAll: asm_obj1.o asm_obj2.o asm_obj3.o c_obj1.o cobj2.o
cpp_obj1.o
```

These rules build the object files:

```
.asm.o:
    $(ASSEMBLE) $*.asm $(ASMOPTIONS)
.c.o:
    $(COMPILE) $*.c $(COPTIONS)
.cpp.o:
    $(COMPILE) $*.cpp $(CPPOPTIONS)
```

Maker selects the first applicable rule.

**NOTE** The Maker resolution algorithm is logically incomplete. You can chain rules together in some cases, but doing so may lead to conflicts with the handling of multiple inference rules. For example, if you use template frames with the suffix `.tpl` compiled by a program that produces C files from TPL files, Maker may have problems resolving multiple rules in the further compilation steps. To work around these problems, construct and use a test makefile that contains the main resolution features in order to investigate Maker's build behavior. If the test makefile works, the full makefile also works.

# Directives and Special Targets

HI-CROSS **Make** lets you include one makefile into another by using an include directive of the form:

```
INCLUDE filename
```

This directive textually replaces the include directive with the given file's contents (from another makefile). If Make cannot locate, open, or read the file, it issues an error message.

Make always includes the default makefile DEFAULT.MAK at the very beginning. The environment variable GENPATH specifies the directory that contains the makefile.

**NOTE** Because the DEFAULT.MAK is included automatically, you have to be careful when using this name. An incorrectly used DEFAULT.MAK causes failures in all other makefiles for which it is in the search path. We recommend sharing common definitions by explicit makefile includes instead of using the implicitly included DEFAULT.MAK.

Make issues an error message for circular includes.

HI-CROSS **Make** also allows definition of two special targets without dependencies:

```
BEFORE:
  {Commands}
```

and

```
AFTER:
  {Commands}
```

Make executes these commands just before and just after processing the top target given on the command line.

# Built-In Commands

You can start DOS programs from the `HI-CROSS` **Make** Utility on the command line. You can directly execute external DOS commands; to execute built-in commands call `COMMAND.COM` with option `/c`, like this:

```
*COMMAND.COM /c dir C:\freescale > C:\DIR.TXT
```

**NOTE** The asterisk ( * ) prevents Maker from capturing the output of `command.com`. The output capture facility is inconsistent when handling 16-bit executables like `command.com`. In WinNT environments, use the native 32-bit shell `cmd.exe` instead of `command.com`.

The HI-CROSS **Make** Utility also has a few simple built-in commands. These commands include:

```
copy file1 file2
```

This command creates a copy of `file1` with the name `file2`. No wildcards are allowed. If you need wildcards, use the DOS built-in `copy` command.

```
del file1 file2... fileN
```

This command deletes the files passed as arguments. Again, no wildcards are allowed. Maker follows the file path from the current directory, if you do not specify an absolute path. Maker does not consult the environment settings to find the files to delete.

```
cd directory
```

This command changes the current directory. The scope of the `cd` command is the command list of a target from which Maker called it.

**NOTE** Avoid using this command unless absolutely necessary. The command may lead to inconsistency with relative-path definitions in the environment.

```
echo text
```

This command is actually a no-op. If Maker displays the commands, it displays the text, too. You can view the echo text command as a way of defining a comment that Maker shows, while hiding normal comments starting with `#`.

```
puts outputfile text
```

This command writes text, the rest of the command line, to the file specified with `outputfile` (the first identifier of the command line). The write mode is appending. If the file does not exist, Maker creates it (mode `a+`).

## Example:

```
puts myOutput.txt This is a text\n
```

This example writes the text `This is a text` with a line break at the end to the file `myOutput.txt`.

## Example:

```
GENMAKE= bb.mak
TARGET = b
MAKE= c:\freescale\prog\maker.exe
COMP= c:\freescale\prog\compiler.exe
STAR=*
DEPENDENDS = $(TARGET).c $(TARGET).h
 create$(GENMAKE):
   -del $(GENMAKE)
  puts $(GENMAKE) \nCOMP=$(COMP)
  puts $(GENMAKE) \nMAKE=$(MAKE)
  puts $(GENMAKE) \n$(TARGET).o :  $(DEPENDENDS)
  puts $(GENMAKE) \n $$(COMP) $(TARGET).c
  $(MAKE) $(GENMAKE) $(TARGET).o
```

This example generates and runs `bb.mak`:

```
COMP=c:\freescale\prog\compiler.exe
MAKE=c:\freescale\prog\maker.exe
b.o : b.c b.h
 c:\freescale\prog\compiler.exe b.c

fc file1 file2
```

This example compares two files, specified by name as `file1` and `file2`, byte by byte and remembers the result for the next `?` command. The result is TRUE if the files are identical and FALSE if they are not identical.

`fctext file1 file2`

This example compares two text files byte by byte, ignoring blanks for compare, and remembers the result for the next `?` command. The result is TRUE if the files are identical and FALSE if they are not identical.

`?`

`Syntax:   ? <commandIfYes> ':' <commandIfNo>`

The result of the last compare operation executes either `<commandIfYes>`, if the compared files were identical, or `<commandIfNo>` if the compared files were not identical.

### Example:

```
fctext  upxcall.c upxcall.old
? puts log.txt files are equal : puts log.txt files are not equal
```

or:

```
fctext upxcall.c upxcall.old
? puts log.txt files are equal \
: puts log.txt files are not equal
rehash
```

This example reloads the HI-CROSS environment from the `default.env` file. Thereafter all commands, all macro expansions, and all file searches execute in the new environment.

```
ren file1 file2
```

This example renames `file1` to `file2`. No wildcards are allowed.

# Command Line

The Maker command line consists of three parts:

- Maker Options

  Maker treats all entries starting with a dash ( - ) as options. To specify the top target, use the target name on the command line after the makefile name.

- Makefile name

  Maker treats the first command line argument, which does not start with a dash, as a makefile name.

- Targets

  Maker treats all remaining arguments without a leading dash as targets to build. If you do not specify targets, the first rule is build.

When you start Maker without command-line arguments, a window opens in which you can manually enter commands.

# Implementation Restrictions

**Make** has only one implementation restriction: the string resulting from a macro substitution cannot contain more than 4095 characters.

18

# Building Libraries

This chapter explains using the Maker utility to adapt or build your own libraries. Listings in this chapter have the `<target>` identifier instead of a specific CPU name. `<target>` stands for your own target name.

The following targets are covered in this chapter:

- Maker Directory Structure
- Configuring WinEdit for the Maker
- Configuring default.env for the Maker
- Building Libraries with Defined Memory Model Options
- Building Libraries with Objects Added
- Structured Makefiles for Libraries

## Maker Directory Structure

The make files distributed for building the libraries expect the directory structure recommended in the Tools installation. The following items are installed in the `C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x` directory.

- `FREESCALE` program folder. Normal installation places the `.EXE` files for each tool in this folder:

  ```
  C:\Program Files\Freescale\CodeWarrior for S12(X)
  V5.x\prog
  ```

- Your working directory for building libraries, makefiles, project files, and configuration files installed here:

  ```
  C:\Program Files\Freescale\CodeWarrior for S12(X)
  V5.x\lib\<target>
  ```

- Binary tool path, defined as a relative path from your working directory in the environment variable `OBJPATH`. Object files and libraries build here:

  ```
  C:\Program Files\Freescale\CodeWarrior for S12(X)
  V5.x\lib\<target>\lib
  ```

- The `lib` directory contains the library in the preferred object-file format. For targets supporting different object-file formats, other formats reside in these directories (which exist only if the format supports libraries and is not the default):

  `FREESCALE: C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\lib\<target>\lib.hix`

  `ELF/DWARF 1.1: C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\lib\<target>\lib.e11`

  `ELF/DWARF 2.0: C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\lib\<target>\lib.e20`

- Source paths of the Compiler or Assembler used, defined as a relative path from your working directory in the environment variable `GENPATH`:

  `C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\lib\<target>\src`

- Include path of the Compiler or Assembler used, defined as a relative path from your working directory in the environment variable `LIBPATH`:

  `C:\Program Files\Freescale\CodeWarrior for S12(X) V5.x\lib\<target>\include`

# Configuring WinEdit for the Maker

Configure WinEdit as follows:

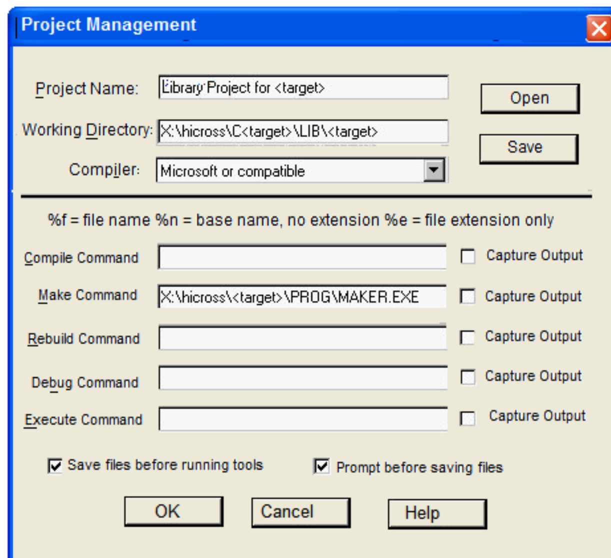
1. Open the Dialog **Project > Configure** in WinEdit.

   This dialog appears only when you open a source file.

2. Load a prepared configuration file with **Open** or edit the tool definition and save the configuration file.
3. For the Maker configuration (and also the other tools used directly from WinEdit) you must enter the full path to the application in the corresponding text box.
4. Enter the path to your make files in the working directory field.

Figure 18.1 shows a sample configuration in the Project Management dialog box.

**Figure 18.1 Project Management Dialog Box**




# Configuring default.env for the Maker

This section contains a sample `default.env` (see ENVIRONMENT: Environment File Specification) with Maker settings. For building libraries, you need `COMP` for the compiler, `MAKE` for the make tool, and `LIBM` for the library. Additionally, you must specify path environment variables such as `OBJPATH` and `GENPATH`. The makefiles introduced in this section also reference these paths.

```
OBJPATH=.\lib
GENPATH=.\src
LIBPATH=.\include
MAKE=..\..\prog\maker.exe
COMP=..\..\prog\c<target>.exe
LIBM=..\..\prog\libmaker.exe
```

# Building Libraries with Defined Memory Model Options

Modify memory-model options of a library to build or to extend the built libraries with a new one as follows:

1. Open the file `mkall.mak`.

   This file is the main makefile for building libraries. For every library, you specify a command line under the top target `makeall`. An example is:

   ```
   $(MAKE) mklib.mak -D(MM=$(FLAGS) -Ms) \
                       -D(LIBDIR=$(LIBDIR))\
                       -D(LIBNAME=testlib)\
                       -D(INCLIBS=ansilib.lib cpplib.lib)
   ```

2. With the command line macro `MM`, specify the options for your library (memory model option and others).

   To change the memory model from small to banked, replace `-Ms` in the macro definition with `-Mb`.

**NOTE** The macro definition introduced here is in -D: Define a Macro (Maker). You can specify more than one option switch inside the braces, as in this example: `-D(MM=$(FLAGS) -Ms -Cf)`

3. Specify the library directory in `LIBDIR`.

   This step is necessary only when you use the default directory `\lib`, as with processors supporting ELF and Freescale object-file format.

4. In `LIBNAME`, name the library to build without an extension. For example, use `testlib` if the name of the library to build is `testlib.lib`.

5. Call Maker with `mkall.mak`.

   The library built with this example includes the ANSI library and the C++ library.

# Building Libraries with Objects Added

Add your own objects to a library or build a new one as follows:

1. Copy the `ansilib.mak` makefile to a makefile with the name of the library you want to build. For example, use `mylib.mak` if the name of the library you want to build is `mylib.lib`.

2. Put this makefile in the same directory as the other makefiles.

**NOTE** The name of the sublibrary of a built library must be the same as the underlying makefile, with the `.lib` extension instead of `.mak`.

3. Remove all object files listed in the macro `OBJECTS` in `mylib.mak`.

   If you now list the new makefile `mylib.mak`, you get:

```
OBJECTS =
makeLib: createLib $(OBJECTS)
  echo --- Sublibrary ansilib created
createLib:
  $(CC) string.c assert.c
  $(LIBM) string.o + assert.o = $(OBJPATH)\$(LIBNAME).lib
  del $(OBJPATH)\string.o
  del $(OBJPATH)\assert.o
.c.o:
  $(CC) $*.c
  $(LIBM) $(OBJPATH)\$(LIBNAME).lib+$*.o =
$(OBJPATH)\$(LIBNAME).lib
  del $(OBJPATH)\$*.o
```

4. List your object files with the `.o` extension in the `OBJECTS` macro.

   Place your library source files in the folder specified in GENPATH (see GENPATH: Define Paths to Search for Input Files).

5. Open the `mkall.mak` file.

   `mkall.mak` is the main makefile for building libraries. For every library, you specify a command line under the top target `makeall:`.

   An example is:

```
$(MAKE) mklib.mak -D(MM=$(FLAGS) -Ms) \
                  -D(LIBNAME=testlib)\
                  -D(STARTANSIOBJ=start<target>s)\
                  -D(STARTCPPOBJ=strt<target>sp)\
                  -D(INCLIBS=mylib.lib)
```

6. In the passed `INCLIBS` command-line macro, specify the sublibrary names.

   In the example above, Maker builds only the sublibrary `mylib.lib` with `mylib.mak`. In this example, we list only one sublibrary. You can add additional sublibraries to the list, separated by spaces.

7. In `LIBNAME`, specify the name of the built library without the extension.

   The other macros passed specify the startup files to build. Maker does not insert the startup files into the library but instead builds them separately.

**NOTE** The name of the library to build, specified in `LIBNAME`, must be different from the name of the sublibrary included, such as `mylib` in the example. If not, Maker deletes the built library just after building it. (Maker deletes the sublibrary after adding it to the built library.)

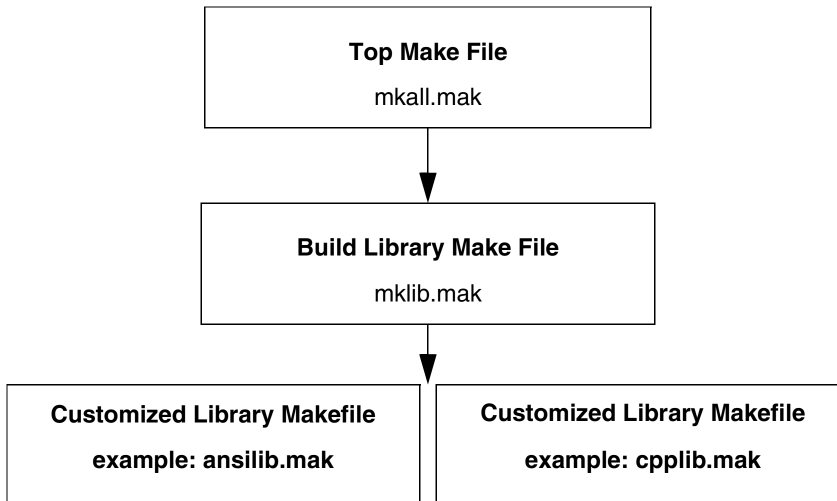
8. Call Maker with `mkall.mak`

   Your library builds among the others.

# Structured Makefiles for Libraries

Building a library works on three makefile levels, as shown in Figure 18.2.

**Figure 18.2 Building a Library**




This layering compares to the modular concept of procedural programming languages. An upper makefile calls Maker with the makefile and the arguments passed over command-line macros. The top layer makefile `mkall.mak`, for example, calls the makefile `mklib.mak` to build one library and passes the memory model, the name of the library to build, the name of the participant sublibraries, and the startup files build.

A sample makefile, `mkall.mak`, looks like this:

```
FLAGS    =  ## insert here the global options for all libraries
makeall:
  -dosprmpt.pif /c del lib\*.*
  echo --- Making all libraries:
  $(MAKE) mklib.mak -D(MM=$(FLAGS) -Ms) -D(LIBNAME=ansis) \
                    -D(STARTANSIOBJ=start<target>s) \
                    -D(STARTCPPOBJ=strt<target>sp) \
                    -D(INCLIBS=ansilib.lib cpplib.lib)
  $(MAKE) mklib.mak -D(MM=$(FLAGS) -Ms -Cf) \
                    -D(LIBNAME=ansisf) \
                    -D(STARTANSIOBJ=start<target>s) \
                    -D(STARTCPPOBJ=strt<target>sp) \
                    -D(INCLIBS=ansilib.lib cpplib.lib)
  $(MAKE) mklib.mak -D(MM=$(FLAGS) -Mb) -D(LIBNAME=ansib)  \
                    -D(STARTANSIOBJ=start<target>b) \
                    -D(STARTCPPOBJ=strt<target>bp)  \
                    -D(INCLIBS=ansilib.lib cpplib.lib)
  $(MAKE) mklib.mak -D(MM=$(FLAGS) -Mb -Cf)
                    -D(LIBNAME=ansibf) \
                    -D(STARTANSIOBJ=start<target>b) \
                    -D(STARTCPPOBJ=strt<target>bp) \
                    -D(INCLIBS=ansilib.lib cpplib.lib)
  echo "--- libraries done
```

The first command for the top target `makeall` deletes all libraries and object files previously built.

One Maker call with `$(MAKE)` evaluates Maker over the environment variable `MAKE` in `default.env`, which corresponds to building one library.

- The first Maker call of `mklib.mak`, for example, builds an ANSI library for the small memory model (with option `-Ms` passed over the command-line macro `MM`).
- `mklib.mak` expects these command-line macros:
  - `MM` = options for the memory model,
  - `LIBNAME` = name of the produced library
  - `STARTUP` = name of the ANSI-C Startup file
  - `STARTCPP` = name of the C++ Startup file
  - `INCLIBS` = in library of included sub libraries

In the example, we pass the library names `cpplib.lib` and `ansilib.lib` in the `INCLIBS` command-line macro. The `mklib.mak` makefile appears below:

**NOTE** Do not modify `mklib.mak`. Instead, use `mkall.mak` to specify the compiler options, the sublibrary list, and your own sublibraries, such as `ansilib.mak`, `cpplib.mak`, and the example, `mylib.mak`.

```
CC =  $(COMP) $(MM)
makeall: startup createLib $(INCLIBS)
  echo "--- all done! ---"
startup: start<target>.c
  echo "--- making startup
  $(CC) $(GENPATH)\start<target>.c
  copy $(OBJPATH)\start<target>.o
$(OBJPATH)\$(STARTANSIOBJ).o
  $(CC) -C++ $(GENPATH)\start<target>.c
  copy $(OBJPATH)\start<target>.o
$(OBJPATH)\$(STARTCPPOBJ).o
  del  $(OBJPATH)\start<target>.o
  echo "--- startup done
createLib:
  echo "--- creating library
  $(LIBM) $(OBJPATH)\$(STARTANSIOBJ).o =
$(OBJPATH)\$(LIBNAME).lib
  $(LIBM) $(OBJPATH)\$(LIBNAME).lib -
$(OBJPATH)\$(STARTANSIOBJ).o =\
    $(OBJPATH)\$(LIBNAME).lib
  $(LIBM) $(OBJPATH)\$(LIBNAME).lib ?
$(OBJPATH)\$(LIBNAME).lst
  echo "--- library done
  .mak.lib:
  echo "--- making and add $* library
  $(MAKE) $*.mak -D(CC=$(CC)) -D(LIBNAME=$*)
  $(LIBM) $(OBJPATH)\$(LIBNAME).lib + $(OBJPATH)\$*.lib =\
    $(OBJPATH)\$(LIBNAME).lib
  del $(OBJPATH)\$*.lib
  del $(OBJPATH)\$*.lst
```

The makefile uses build rules. For each library built, the makefile `mylib.mak` must reside in the working directory. The makefile collects a group of object files. Maker calls the makefile, passing these command-line arguments as parameters:

- `CC` = compiler with option list
- `LIBNAME` = name of the produced library

These settings depend on settings already passed from `mkall.mak`. The sublibraries built with the delivered makefiles are `ansilib.mak` and `cpplib.mak`.

# VI

# Appendices

This section contains topics common to all of the build tools, and contains the following chapters:

- Environment Variables
- Tool Options
- Messages
- Tool Commands
- EBNF Notation

Items and topics specific to individual tools are marked within the text.

# A

# Environment Variables

This chapter describes the environment variables used by the tools described in this manual. Differences between tools are noted in the text. Other tools, such as the Assembler and the Compiler, use some of the same environment variables. Refer to the respective tool manuals for more information.

You can set parameters in the environment using environment variables. The syntax is always the same:

```
VARIABLENAME=Definition
```

**NOTE** **No** blanks are allowed in the definition of an environment variable.

Example:

```
GENPATH=C:\INSTALL\LIB;D:\PROJECTS\TESTS;/usr/local/lib;/
home/me/my_project
```

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 project directory.

**NOTE** The maximum length of environment variable entries in the `DEFAULT.ENV` or `.hidefaults` is 65535 characters (1024 characters for the Decoder and Maker).

- Putting the definitions in a file given by the value of the system environment variable ENVIRONMENT: Environment File Specification.

**NOTE** The project directory shown above can be set using the `DEFAULT` system environment variable DEFAULTDIR: Default Current Directory.

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: Environment File Specification. If no definition can be found, the tool assumes a default value.

**NOTE** You can also change the environment using the `-Env` option. Do not leave spaces at the end of environment variables.

# Current Directory

The most important environment variable for all tools is the current directory. The current directory is the base search directory where the tool starts to search for files (for example, for the `DEFAULT.ENV /.hidefaults`).

Normally, the operating system or a program that launches another program (for example, WinEdit) determines the current directory of a tool. For the UNIX operating system, the directory in which an executable is started is also the current directory from which the binary file starts. For Microsoft® Windows®-based operating systems, the current directory definition is more complicated:

- If you launch the tool using a File Manager/Explorer, the current directory is the location of the executable launched.
- If you launch the tool using a desktop icon, the current directory is the working directory specified and associated with the icon.
- If you launch the tool by dragging a file onto the desktop icon, the desktop is the current directory.
- If you launch the tool from another tool with its own working directory specification (e.g., an editor as WinEdit), the current directory is the one specified by the launching tool (e.g., working directory definition in WinEdit).
- Changing the current project file also changes the current directory if the new project file is in a different directory. Browsing for a prm file does not change the current directory.

To overwrite this behavior, you can use the environment variable DEFAULTDIR: Default Current Directory.

To view the current directory, as well as other information, use the `-v` option or the **About** box.

# Tool-Specific Search Information

This section details environment information unique to each tool. For further information about the Compiler, Assembler, and Debugger refer to the appropriate manual.

## Compiler

- Symbol Files
  - The compiler looks for symbol files in the current directory, then in the directories given by the environment variable `SYMPATH` and finally in directories given in `GENPATH`.
  - New symbol files are written in the directory containing the source, unless the environment variable `SYMPATH` is set. If set, the compiler puts the symbol file in the first directory in the path list.
- Object Files
  - The compiler normally puts object files in the first directory specified in the environment variable `OBJPATH`. If that variable is not set, the compiler writes the object file into the directory containing the source file.
- Compiler Variables: `COMPOPTIONS`
  - If you set this variable, the compiler appends its contents to the command line each time a file is compiled. You can use this variable to globally specify certain options, so you don't have to specify them at each compilation.

## Debugger

- Object Files
  - The debugger looks for object files in the current directory, then in directories specified in the environment variable `OBJPATH` and finally in `GENPATH`.
- Absolute Files
  - The debugger looks for absolute files in the current directory, then in directories specified in `ABSPATH` and finally in `GENPATH`.

## Libmaker

- Source Files, Linker Parameter File
  - The Libmaker searches for Source Files and the Linker Parameter File first in the current directory, then in the other directories defined by the environment variable `GENPATH`.

- Header Files
  - If you include a header file in double quotes, the Libmaker searches the current directory first, then the directories given in GENPATH and finally those given in LIBPATH.
  - If you include a header file using angle brackets, Libmaker does not search the directories in GENPATH, but searches only the current directory and those specified in LIBPATH.

# Maker

- Maker Utility Variables
  - The maker utility can access any environment variable with the following syntax: `$(Name)` (e.g. $(COMP)). For makefiles given in your installation, the following environment variables are used.

    `COMP:` contains name of Compiler

    `LINK:` contains name of Linker

    `FLAGS:` contains command line options for the compiler specified by COMP.
- Makefiles and Include files
  - Maker searches for makefiles and include files first in the current directory and then in the GENPATH: Define Paths to Search for Input Files directory.
  - Maker calls the tools that produce the output files of a make run (except error reports). Refer to the corresponding manuals for the tools you use.

# SmartLinker

- Object Files
  - The linker looks for object files in the current directory, then in directories specified in the environment variable OBJPATH and finally in GENPATH.
- Map Files
  - If linking succeeds, the linker writes a protocol of the link process to a list file called map file. The name of the map file is the same as that of the ABS file, but with extension MAP. The linker writes the map file to the directory specified by the environment variable TEXTPATH.
- Absolute Files
  - The linker creates absolute files in the first directory specified in ABSPATH. If that variable is not set, the linker generates the absolute file in the directory containing the parameter file.

# Global Initialization File (MCUTOOLS.INI - PC Only)

All tools may store some global data into the `MCUTOOLS.INI` file. The tool first searches for this file in the directory of the tool itself (path of the executable). If there is no `MCUTOOLS.INI` file in this directory, the tool looks for an `MCUTOOLS.INI` file located in the Microsoft Windows installation directory (for example, `C:\WINDOWS`).

Example:

```
C:\WINDOWS\MCUTOOLS.INI
```

```
D:\INSTALL\PROG\MCUTOOLS.INI
```

If you start the tool in the `D:\INSTALL\PROG` directory, the tool uses the current file located in the same directory as the tool (`D:\INSTALL\PROG\MCUTOOLS.INI`).

However, if you start the tool outside the `D:\INSTALL\PROG` directory, the tool uses the current file in the Windows directory `(C:\WINDOWS\MCUTOOLS.INI)`.

## [Installation] Section

### Path

#### Arguments

Last installation path

#### Description

When you install a tool, the installation script stores the installation destination directory in this variable.

#### Example

```
Path=c:\install
```

## Group

### Arguments

Last installation program group.

### Description

When you install a tool, the installation script stores the created program group in this variable.

### Example

```
Group=ANSI-C Compiler
```

# [Options] Section

## DefaultDir

### Arguments

Default Directory to use.

### Description

Specifies the current directory for all tools on a global level (see also environment variable DEFAULTDIR: Default Current Directory).

### Example

```
DefaultDir=c:\install\project
```

# [Tool] Section

Variables listed in this section in the global configuration file appear in separate sections by tool name, i.e., `[LINKER] Section`, `[BURNER] Section`.

## SaveOnExit

### Arguments

`1/0`

### Description

1: Stores the configuration when the tool closes

0: Discards the configuration

The tool does not ask to store a configuration in either case.

## SaveAppearance

### Arguments

`1/0`

### Description

1: Stores the visible topics when writing a project file

0: Discards visible topics

The command line, its history, the windows position and other topics belong to this entry.

## SaveEditor

### Arguments

`1/0`

### Description

1: Stores the visible topics when writing a project file

0: Discards the visible topics

The editor settings contain all information of the editor configuration dialog.

## SaveOptions

### Arguments

`1/0`

### Description

1: Saves the options when writing a project file

0: Discards the options

The options also contain the message settings.

## RecentProject0, RecentProject1, etc.

### Arguments:

Names of the last and prior project files

### Description

Loading or saving a project updates this list. The file menu shows its current content.

### Example

```
SaveOnExit=1
SaveAppearance=1
SaveEditor=1
SaveOptions=1
RecentProject0=C:\myprj\project.ini
RecentProject1=C:\otherprj\project.ini
```

## TipFilePos

### Arguments

Any integer

### Description

Index number of the tip of the day shown; used to display different tip every time.

## ShowTipOfDay

### Arguments

`0/1`

### Description

Specifies whether to show the Tip of the Day dialog at startup.

1: Shows Tip of the Day at startup

0: Shows Tip of the Day only when opened from the help menu.

## TipTimeStamp

### Arguments

`Date`

### Description

Used to record the time that new tips became available. When the date specified here does not match the date of the tips, the first tip is displayed.

### Example

```
[LINKER]
TipFilePos=357
TipTimeStamp=Jan 25 2000 12:37:41
ShowTipOfDay=0
SaveOnExit=1
SaveAppearance=1
SaveEditor=1
SaveOptions=0
RecentProject0=C:\myprj\project.ini
RecentProject1=C:\otherprj\project.ini
```

# [Editor] Section

## Editor_Name

### Arguments

The name of the global editor

### Description

Specifies the name displayed in the global editor. This entry has a descriptive effect only. Its content does not apply to starting the editor.

**NOTE** Maker cannot modify this entry.

## Editor_Exe

### Arguments

The name of the executable file of the global editor

### Description

Specifies the file name (including its path) which is called for showing a text file when the global editor setting is active. In the editor configuration dialog, the global editor selection is active only when this entry is present and not empty.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** tab.

**NOTE** Maker cannot modify this entry.

## Editor_Opts

### Arguments

The options to use the global editor

### Description

Specifies options for the global editor. If this entry is missing or empty, `%f` is used. The command line to launch the editor is built by taking the `Editor_Exe` content, appending a space, then appending this entry.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** tab.

### Example

```
[Editor]
editor_name=WinEdit
editor_exe=C:\Winedit\WinEdit.exe
editor_opts=%f
```

**NOTE** Maker cannot modify this entry.

### MCUTOOLS.INI Example

Listing A.1 shows a typical layout of the `MCUTOOLS.INI` file.

**Listing A.1 Sample MCUTOOLS.INI file**

```
[Installation]
Path=c:\Freescale
Group=ANSI-C Compiler

[Editor]
editor_name=WinEdit
editor_exe=C:\Winedit\WinEdit.exe
editor_opts=%f

[Options]
DefaultDir=c:\myprj

[Linker]
SaveOnExit=1
SaveAppearance=1
SaveEditor=1
SaveOptions=1
RecentProject0=c:\myprj\project.ini
RecentProject1=c:\otherprj\project.ini
```

# Local Configuration File (usually project.ini)

The tools read `DEFAULT.ENV` and do not change its content in any way. The configuration file stores all the configuration properties. Different applications use the same configuration file. The configuration file format is the same format as Windows® `*.ini` files.

The tools can use any file name for the project configuration file, and store their own entries with the same section name as in the global `mcutools.ini` file. The application

backend is encoded into the section name so that different application backends can use the same file without overlapping. Different versions of the same tools use the same entries. This is important mainly when options available in only one version are stored in the configuration file. In such situations, you must maintain two files for the different tool versions. If no incompatible options are enabled when the file is last saved, you can use the same file for both versions.

The current directory is always the directory where the configuration file is located. If you load a configuration file in a different directory, then the current directory also changes. Changing the current directory reloads the `DEFAULT.ENV` file.

The shell uses the configuration file with the name `project.ini` in the current directory only, therefore it is recommended that you use this name with the tools as well. The tools can use the editor configuration written and maintained by the shell only when the shell uses the same file. Apart from this distinction, the tools can use any file name for the project file.

Loading or storing a configuration file reloads the options in the environment variables LINKOPTIONS (see LINKOPTIONS: Default SmartLinker Options) and COMPOPTIONS, and adds the options to the project options. This behavior is important to note when different `DEFAULT.ENV` files exist in different directories and contain incompatible LINKOPTIONS options. When you load a project using the first `DEFAULT.ENV`, you add its LINKOPTIONS and COMPOPTIONS to the configuration file. If you store this configuration in a different directory which contains a `DEFAULT.ENV` file with incompatible options, the tools add the options and reports the inconsistency. A message appears to report that the `DEFAULT.ENV` options were not added. If this occurs, you can either remove the option from the configuration file using the advanced option dialog, or you can remove the option from the `DEFAULT.ENV` with the shell or a text editor, depending upon which options you want to use in the future.

At startup there are two ways to load a configuration:

- Use the `-Prod` command line option
- Use the `project.ini` file in the current directory

If you use the `-Prod` option, then the directory containing the project file is the current directory. If you specify a directory using the `-Prod` option, you load the `project.ini` file from the specified directory.

# [Editor] Section

## Editor_Name

### Arguments

The name of the local editor

### Description

Specifies the name displayed in the local editor. This entry has a descriptive effect only. Its content does not apply to starting the editor.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab. This entry has the same format as the global editor configuration in the `mcutools.ini` file.

**NOTE** Maker cannot modify this entry.

## Editor_Exe

### Arguments

The name of the executable file of the local editor

### Description

Specifies the file name which is called for showing a text file when the local editor setting is active. In the editor configuration dialog, the local editor selection is active only when this entry is present and not empty.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab. This entry has the same format as the global editor configuration in the `mcutools.ini` file.

**NOTE** Maker cannot modify this entry.

## Editor_Opts

### Arguments

The options to use the local editor

### Description

Specifies the options to use for the local editor. If this entry is absent or empty, the tools use `%f`. The tools construct the command line to launch the editor by taking the `Editor_Exe` content, appending a space, then adding the `Editor_Opts` entry.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab. This entry has the same format as the global editor configuration in the `mcutools.ini` file.

**NOTE** Maker cannot modify this entry.

### Example

```
[Editor]
editor_name=WinEdit
editor_exe=C:\Winedit\WinEdit.exe
editor_opts=%f
```

# [Tool] Section

The local configuration file stores the following variables in separate sections for each tool and labeled accordingly, i.e., `[LINKER]`, `[BURNER]`.

## RecentCommandLineX, X=Integer

### Arguments

String with a command line history entry. For example: `fibo.prm`, `fibo.bbl`

### Description

This list of entries contains the content of command line history.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** Tab.

## CurrentCommandLine

### Arguments

String with the command line. For example: `fibo.prm -w1`, `fibo.bbl -w1`

### Description

The currently visible command line content.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** Tab.

## StatusbarEnabled

### Arguments

`1/0`

### Description

This entry is considered only at startup. Later load operations do not use it.

1: Enables the status bar

0: Hides the status bar

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** Tab.

## ToolbarEnabled

### Arguments

`1/0`

### Description

The tool considers this entry only at startup. Later load operations do not use it.

1: Enables the toolbar

0: Hides the toolbar

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** Tab.

## WindowPos

### Arguments

10 integers, e.g., `0,1,-1,-1,-1,-1,390,107,1103,643`

### Description

The tool considers this entry only at startup. Later load operations do not use it.

**NOTE** Changes of this entry do not show the * in the title.

These numbers contain the position and the state of the window (maximized, minimized) and other flags.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** Tab.

## WindowFont

### Arguments

`Size:` == 0 -> generic size, < 0 -> font character height, > 0 font cell height,

`Weight`: 400 = normal, 700 = bold (valid values are 0–1000),

`Italic`: 0 == no, 1 == yes,

`Font name`: max 32 characters.

### Description

Font attributes.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** Tab.

### Example

```
WindowFont=-16,500,0,Courier
```

## TipFilePos

### Arguments

Any integer, e.g. 236

### Description

Actual position of tip of the day file.

### Saved

Always when saving a configuration file.

## ShowTipOfDay

### Arguments

0/1

### Description

Display Tip of the Day dialog at startup.

1: Shows the Tip of the Day dialog

0: Hides the Tip of the Day dialog (can be displayed from the help menu)

### Saved

Always when saving a configuration file.

## Options

### Arguments

`W2`

### Description

The currently active option string. Because this entry contains the messages, the entry can be very long.

### Saved

Only with Options set in the **File > Configuration > Save Configuration** Tab.

## EditorType

### Arguments

`0/1/2/3`

### Description

This entry specifies the active editor configuration.

0: Global editor configuration (in the file `mcutools.ini`)

1: Local editor configuration (the one in this file)

2: Command line editor configuration: entry `EditorCommandLine`

3: DDE editor configuration: entries beginning with `EditorDDE`.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab.

## EditorCommandLine

### Arguments

Command line. For WinEdit: `C:\Winapps\WinEdit.exe %f /#:%l`

### Description

Command line content to open a file.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab.

## EditorDDEClientName

### Arguments

Client command. For example, `[open(%f)]`

### Description

Name of the client for DDE editor configuration.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab.

## EditorDDETopicName

### Arguments

Topic name. For example, `system`

### Description

Name of the topic for DDE editor configuration.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab.

## EditorDDEServiceName

### Arguments

Service name. For example, `system`

### Description

Name of the service for DDE editor configuration.

### Saved

Only with Editor Configuration set in the **File > Configuration > Save Configuration** Tab.

# Burner Dialog Entries in [BURNER]

The following entries are specific to the Burner, and appear only in the [BURNER] section of the `project.ini` file.

## BurnerUndefByte

### Arguments

Integral value of undefined bytes. Default is 0xff.

### Description

Value of the Undef Byte entry on the Content page in the Burner dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerSwapByte

### Arguments

0: Do not swap

1: Swap

### Description

Value of the Swap Bytes check box on the Content page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerOrigin

### Arguments

Integral value (0,1,2)

### Description

Value of the Origin field on the Content page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerDestination

### Arguments

Integral value (0,1,2)

### Description

Value of the Destination Offset field on the Content page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerLength

### Arguments

Integral value (0,1,2)

### Description

Value of the Length field on the Content page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerFormat

### Arguments

0: Freescale S record format

1: Intel Hex file format

2: Binary file format

### Description

Format type specified on the Content page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerDataBus

### Arguments

0: “1 Byte”

1: “2 Bytes”

2: “4 Bytes”

Not the size in bytes.

### Description

Setting in the Data Bus field on the Content page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerOutputType

### Arguments

0: Com1

1: Com2

2: Com3

3: Com4

4: File

### Description

Setting in the Output field on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerDataBits

### Arguments

0: 7 Bits

1: 8 Bits

### Description

Setting in the Data Bits field on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerParity

### Arguments

0: None

1: Odd

2: Even

### Description

Setting in the Parity field on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerByteCommands

### Arguments

0: 1st Byte (msb)

1: 2nd Byte

2: 3rd Byte

3: 4th Byte

4: 1st Word

5: 2nd Word

### Description

Setting in the command box on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerBaudRate

### Arguments

300, 600, 1200, 2400, 4800, 9600, 19200, 38400

### Description

Setting in the Baud Rate box on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerOutputFile

### Arguments

File Name, e.g., `file.s19`

### Description

Content of the Name box on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerHeaderFile

### Arguments

File Name, e.g., `headerfile`

### Description

Content of the Header File box on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## BurnerInputFile

### Arguments

File Name, e.g., `file.abs`

### Description

Content of the Input File box on the Input/Output page in the **Burner** dialog.

### Saved

Only with Appearance set in the **File > Configuration > Save Configuration** dialog.

## Configuration File Example

Listing A.2 shows a typical layout of the configuration file (usually `project.ini`).

**Listing A.2 Example Configuration File**

```
[Editor]
Editor_Name=WinEdit
Editor_Exe=C:\WinEdit\WinEdit.exe %f /#:%l
Editor_Opts=%f

[Linker]
StatusbarEnabled=1
ToolbarEnabled=1
WindowPos=0,1,-1,-1,-1,-1,390,107,1103,643
WindowFont=-16,500,0,Courier
Options=-w1
EditorType=3
RecentCommandLine0=fibo.prm -w2
RecentCommandLine1=fibo.prm
CurrentCommandLine=calc.prm -w2
EditorDDEClientName=[open(%f)]
EditorDDETopicName=system
EditorDDEServiceName=msdev
EditorCommandLine=C:\WinEdit\WinEdit.exe %f /#:%l

[Burner]
StatusbarEnabled=1
ToolbarEnabled=1
WindowPos=0,1,-1,-1,-1,-1,390,107,1103,643
WindowFont=-16,500,0,Courier
TipFilePos=0
ShowTipOfDay=1
Options=-w1
EditorType=3
RecentCommandLine0=-ffibo.bbl -w1
CurrentCommandLine=-ffibo.bbl -w2
EditorDDEClientName=[open(%f)]
EditorDDETopicName=system
EditorDDEServiceName=msdev
EditorCommandLine=C:\WinEdit\WinEdit.exe %f /#:%l
BurnerUndefByte=255
BurnerSwapByte=0
BurnerOrigin=0
BurnerDestination=0
BurnerLength=65536
BurnerFormat=0
BurnerDataBus=0
```

```
BurnerOutputType=4
BurnerDataBits=1
BurnerParity=0
BurnerByteCommands=0
BurnerBaudRate=9600
BurnerOutputFile=outputfile.s19
BurnerHeaderFile=headerfile
BurnerInputFile=InputFile.abs

[Maker]
StatusbarEnabled=1
ToolbarEnabled=1
WindowPos=0,1,-1,-1,-1,-1,390,107,1103,643
WindowFont=-16,500,0,Courier
TipFilePos=0
ShowTipOfDay=1
EditorType=3
RecentCommandLine0=mkall.mak
RecentCommandLine1=cpplib.mak -D(LIBNAME=cpplib)
CurrentCommandLine=mkall.mak
EditorDDEClientName=[open(%f)]
EditorDDETopicName=system
EditorDDEServiceName=msdev
EditorCommandLine=C:\WinEdit\WinEdit.exe %f /#:%l
```

# 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:\PROJECT\TESTS;\usr\local\freescale
\lib;/home/me/my_project
```

If a directory name is preceded by an asterisk ( `*` ), the programs recursively search that whole 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
```

**NOTE** Some DOS/UNIX environment variables (like `GENPATH`, `LIBPATH`, etc.) are used. For further details refer to Environment Variable Details.

We recommend working with WinEdit and setting the environment by means of a `DEFAULT.ENV` (`.hidefaults` for UNIX) file in your project directory. You can set this project directory in WinEdit's **Project Configure** menu command. This way, you can have different projects in different directories, each with its own environment.

**NOTE** When using WinEdit, do *not* set the system environment variable DEFAULTDIR: Default Current Directory. If you use this variable and it does not contain the project directory given in WinEdit's project configuration, files might not be put where you expect them.

# Line Continuation

It is possible to specify an environment variable in an environment file (`default.env`/ `.hidefaults`) over different lines, using the line continuation character '\':

Example:

```
COMPOPTIONS=\
-W2 \
-Wpd
```

This is the same as:

```
COMPOPTIONS=-W2 -Wpd
```

Use caution when pairing this continuation character with paths. The following code:

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

Results in:

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

To avoid such problems, use a semicolon ( ; ) at the end of a path if the path contains a '\' at the end:

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

# Environment Variable Details

The remainder of this section describes each of the environment variables available for the tools. Table A.1 shows the types of information provided in the variable descriptions.

**Table A.1 Environment Variable Description**

| Topic | Description |
|---|---|
| Tools | Lists tools which use this variable. |
| Synonym | Synonyms exist for some environment variables. Those synonyms may be used for older releases of the SmartLinker and will be removed in the future. A synonym has lower precedence than the environment variable. |
| Syntax | Specifies the syntax of the option in EBNF format. |
| Arguments | Describes and lists optional and required arguments for the variable. |
| Default | Shows the default setting for the variable, or none. |
| Description | Provides a detailed description of the option and how to use it. |
| Example | Gives a usage example, and illustrates the effects of the variable when possible. Shows an entry in the `default.env` for PC or in the `.hidefaults` for UNIX. |
| See also | Names related sections. |

## ABSPATH: Absolute Path

### Tools

SmartLinker, Debugger

### Synonym

None

### Syntax

```
ABSPATH= {<path>}
```

### Arguments

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

### Description

When you define this environment variable, the SmartLinker stores the absolute files it produces in the first directory specified there. If `ABSPATH` is not set, the SmartLinker stores the generated absolute files in the directory in which the parameter file was found.

### Example

```
ABSPATH=\sources\bin;..\..\headers;\usr\local\bin
```

### See also

None

## COMP: Modula-2 Compiler

### Tools

Maker

### Synonym

None

### Syntax

```
COMP = <compiler>.
```

### Arguments

```
<compiler>: Used Modula-2 compiler.
```

### Default

None.

### Description

Use this environment variable to specify the Modula-2 compiler.

### Example

```
COMP=C:\INSTALL\PROG\TPM.EXE
```

## COPYRIGHT: Copyright Entry in Absolute File

### Tools

Compiler, Assembler, SmartLinker, Libmaker

### Synonym

None

### Syntax

```
COPYRIGHT= <copyright>
```

### Arguments

`<copyright>`: copyright entry.

### Default

None

### Description

Each absolute file contains an entry for a copyright string. Use the decoder to retrieve this information from the absolute files.

### Example

```
COPYRIGHT=Copyright by PowerUser
```

### See also

Environment variables USERNAME: User Name in Object File and INCLUDETIME: Creation Time in Object File.

## DEFAULTDIR: Default Current Directory

### Tools

Compiler, Assembler, SmartLinker, Decoder, Debugger, Libmaker, Maker, Burner

### Synonym

None

### Syntax

`DEFAULTDIR= <directory>.`

### Arguments

`<directory>`: Directory to be the default current directory.

### Default

None

### Description

Use this environment variable to specify the default directory for all tools. When you use this environment variable, all the tools indicated above take the specified directory as their current directory instead of the one defined by the operating system or launching tool.

### Example

`DEFAULTDIR=C:\INSTALL\PROJECT`

### See also

Current Directory and Global Initialization File (MCUTOOLS.INI - PC Only).

**NOTE** This is a the system level (global) environment variable. It cannot be specified in a default environment file (`DEFAULT.ENV/.hidefaults`).

## ENVIRONMENT: Environment File Specification

### Tools

Compiler, SmartLinker, Decoder, Debugger, Libmaker, Maker, Burner

### Synonym

`HIENVIRONMENT`

### Syntax

`ENVIRONMENT= <file>`

### Arguments

`<file>`: file name with path specification, without spaces

### Default

None

### Description

You must specify this variable at the system level. Normally the application looks in the current directory for the `default.env/.hidefaults` environment file. Using ENVIRONMENT (e.g. set in the `autoexec.bat` (DOS) or `.cshrc` (UNIX) file), a different file name may be specified.

### Example

```
ENVIRONMENT=\Freescale\prog\global.env
```

### See also

None

**NOTE** This is a system level (global) environment variable. It cannot be specified in a default environment file (`DEFAULT.ENV/.hidefaults`).

## ERRORFILE: Error File Name Specification

### Tools

Compiler, SmartLinker, Assembler, Burner, Libmaker, Maker (restricted)

### 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. 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 full file name, i.e. with path and name (the same as `%p%n`).

Using an invalid error file name causes a notification box to appear.

**NOTE** Maker does not recognize error files of other tools containing `%` substitutions. Maker reads the string assigned to the environment variable `ERRORFILE` as filename string without substitutions, so tools that use `%` substitutions for their error output report their error to Maker as the unspecified error message `M5108 called application detected an error`.

**NOTE** Maker cannot report error-position information with the same precision as a compiler because most of the errors have a long history. Maker can only report the general position, not the position where the error occurred. Most of Maker's messages lack position information (pos = 0).

### Example

`ERRORFILE=MyErrors.err` lists all errors into the file `MyErrors.err` in the project directory.

`ERRORFILE=\tmp\errors` lists all errors into the file called `errors` in the `\tmp` directory.

`ERRORFILE=%f.err` lists all errors into a file with the same name as the source file, but with extension `.err`, into the same directory as the source file. For example, linking a file called `\sources\test.prm` generates an error list file called `\sources\test.err`.

Specifying `ERRORFILE=\dir1\%n.err` and linking a source file called `test.prm` generates an error list file called `\dir1\test.err`.

Specifying `ERRORFILE=%p\errors.txt` and linking a source file called `\dir1\dir2\test.prm` generates an error list file called `\dir1\dir2\errors.txt`.

If the environment variable `ERRORFILE` is not set, the errors are written to the file `EDOUT` in the project directory, or to the default error file. The default error file name depends on the way the application is started:

- If a file name is provided on the application command line, the errors are written to the file `EDOUT` in the project directory.
- If no file name is provided on the application command line, the errors are written to the file `ERR.TXT` in the project directory.

### Example

This example shows 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
```

**NOTE** Be sure to set this variable if the WinEdit Editor is use, otherwise the editor cannot find the `EDOUT` file.

### Maker-Specific Error Listing Information

If Maker detects any errors, it creates an error listing file `ERR.TXT`. Maker generates this file in the working directory.

If you start Maker from WinEdit (with `%f` on the command line) or Codewright (with `%b%e` on the command line), it does not produce this error file. Instead, Maker writes the error messages in a special format in a file called `EDOUT` using the default Microsoft format. Use WinEdit's `Next Error` or Codewright's `Find Next Error` command to see both the error positions and the error messages.

### Interactive Mode (Main Window Opened)

If you set ERRORFILE: Error File Name Specification, Maker creates a message file with the name specified in this environment variable.

If you do not set ERRORFILE, Maker generates a default file named `ERR.TXT` in the current directory.

### Batch Mode (Main Window Closed)

If you set ERRORFILE: Error File Name Specification, Maker creates a message file with the name specified in this environment variable.

If you do not set ERRORFILE, Maker generates a default file named `EDOUT` in the current directory.

## FLAGS: Options for Modula-2 Compiler

### Tools

Maker for Modula-2

### Syntax

`FLAGS = {<optionlist>}.`

### Arguments

`<optionlist>: List of options.`

### Default

None

### Description

Maker, fed with a Modula-2 main module, starts the compiler with the options specified with `FLAGS`. The environment variable `COMP` specifies the Modula-2 compiler.

## GENPATH: Define Paths to Search for Input Files

### Tools

Compiler, Assembler, SmartLinker, Decoder, Debugger, Libmaker, Burner, Maker

### Synonym

`HIPATH`

### Syntax

`GENPATH= {<path>}`

### Arguments

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

### Description

The application looks for the `prm` first in the project directory, then in the directories listed in the environment variable `GENPATH`. The object and library files specified in the

linker `prm` file are searched in the project directory, then in the directories listed in the environment variable `OBJPATH` and finally in those specified in `GENPATH`.

### Example

```
GENPATH=\obj;..\..\lib;
GENPATH=\sources\include;..\..\headers;\usr\local\lib
```

**NOTE** If a directory specification in this environment variables starts with an asterisk ( * ), the application searches the whole directory tree recursively, depth first, i.e., all subdirectories and *their* subdirectories and so on are searched, too. Within one level in the tree, search order of the subdirectories is indeterminate.

## INCLUDETIME: Creation Time in Object File

### Tools

Compiler, Assembler, SmartLinker, Libmaker

### 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 absolute file created contains a time stamp indicating the creation time and data as strings. When one of the tools creates a new file, the new file gets a new time stamp entry.

This behavior may be undesirable if a binary file compare must be performed. Even if the information in two absolute files is the same, the files do not match exactly because the

time stamps are different. To avoid such problems this variable may be set to OFF. In this case the time stamp strings in the absolute file for date and time are **none** in the object file.

Use the decoder to retrieve the time stamp from the object files.

### Example

```
INCLUDETIME=OFF
```

## LINK: Linker for Modula-2

### Tools

Maker for Modula-2

### Syntax

```
LINK = {<linker>}.
```

### Arguments

`<linker>`: Linker for Modula-2.

### Default

none

### Description

Maker, fed with a Modula-2 main module, starts the linker specified in this environment variable.

## LINKOPTIONS: Default SmartLinker Options

### Tools

SmartLinker

### Synonym

None

### Syntax

```
LINKOPTIONS= {<option>}
```

### Arguments

`<option>`: SmartLinker command line option.

### Description

Setting this environment variable appends the option contents to the SmartLinker command line each time a file is linked. Use this option to specify certain required options, so that you do not have to specify them each time a file is linked.

### Example

```
LINKOPTIONS=-W2
```

### See also

Option Details

## OBJPATH: Object File Path

### Tools

Compiler, Assembler, SmartLinker, Decoder, Debugger

### Synonym

None

### Syntax

```
OBJPATH= {<path>}
```

### Arguments

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

### Description

Defining this environment variable causes the linker to search for the object and library files specified in the linker `prm` file in the project directory, then in the directories listed in the environment variable `OBJPATH`, and finally in those specified in `GENPATH`.

### Example

```
OBJPATH=\sources\bin;..\..\headers;\usr\local\bin
```

## RESETVECTOR: Reset Vector Location

### Tools

Compiler, Assembler, SmartLinker

### Synonym

None

### Syntax

```
RESETVECTOR= <Address>
```

### Arguments

`<Address>`: Address of reset vector

### Default

`0xFFFE`

### Description

For the VECTOR directive, the linker must know where to place VECTOR 0.

### Example

```
RESETVECTOR=0xFFFE
```

## SRECORD: S Record File Format

### Tools

Assembler, SmartLinker, Burner

### Synonym

None

### Syntax

```
SRECORD= <RecordType>
```

### Arguments

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

### Description

This environment variable is relevant only when absolute files, rather than object files, are directly generated by the macro assembler. When you define this environment variable, the Assembler generates a Freescale S-record file containing records of the specified type (`S1` records when `S1` is specified, `S2` records when `S2` is specified and `S3` records when `S3` is specified).

If you do not set this variable, the assembler generates S records based on the address size. If the address can be coded on two bytes, the assembler generates an `S1` record. If the address is coded on three bytes, the assembler generates an `S2` record. Otherwise the assembler generates an `S3` record.

### Example

```
SRECORD=S2
```

**NOTE** If you set the `SRECORD` environment variable, it is your responsibility to specify the appropriate S-record type. Specifying S1 when your code is loaded at an address greater than `0xFFFF` results in an incorrect S file, in which all addresses are truncated to 2-byte values.

## TEXTFAMILY: Text Font Family

### Tools

Compiler, Assembler, Linker, Decoder, Libmaker, Maker

### Synonym

```
HITEXTFAMILY
```

### Syntax

```
TEXTFAMILY = <FontName>.
```

### Arguments

`<FontName>`: Font family name to use.

### Default

Terminal

### Description

Defines the font family to use. The default font family is “Terminal.”

### Example

```
TEXTFAMILY=Times
```

## TEXTKIND: Text Font Character Set

### Tools

Compiler, Assembler, Linker, Decoder, Libmaker, Maker

### Synonym

`HITEXTKIND`

### Syntax

```
TEXTKIND = ( OEM | ANSI ).
```

### Arguments

`OEM`: Use OEM font character set.

`ANSI`: Use ANSI font character set.

### Default

`OEM`

### Description

Gives the character set, `OEM` or `ANSI`. `OEM` is the default value.

### Example

```
TEXTKIND=ANSI
```

## TEXTPATH: Text Path

### Tools

Compiler, Assembler, SmartLinker, Decoder, Libmaker

### Synonym

None

### Syntax

```
TEXTPATH= {<path>}
```

### Arguments

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

### Description

When you set this environment variable, the application stores the map file it produces in the first directory specified in the path. If `TEXTPATH` is not set, the application stores generated map file in the directory where the `prm` file was found.

### Example

```
TEXTPATH=\sources..\..\headers;\usr\local\txt
```

## TEXTSIZE: Text Font Size

### Tools

Compiler, Assembler, Linker, Decoder, Libmaker, Decoder, Maker

### Synonym

`HITEXTSIZE`

### Syntax

```
TEXTSIZE = <number>
```

### Arguments

`<number>`: Font size to use.

### Default

14

### Description

Defines the size of the font. The default size is 14 point.

### Example

```
TEXTSIZE=12
```

## TEXTSTYLE: Text Font Style

### Tools

Compiler, Assembler, Linker, Decoder, Libmaker, Maker

### Synonym

`HITEXTSTYLE`

### Syntax

```
TEXTSTYLE = ( NORMAL  |  BOLD )
```

### Arguments

`NORMAL`: Use normal font style (not bold or italic).

`BOLD`: Use bold font style.

### Default

NORMAL

### Description

Defines the font style to use, NORMAL or BOLD. The default value is NORMAL.

### Example

```
TEXTSTYLE=BOLD
```

## TMP: Temporary Directory

### Tools

Compiler, Assembler, SmartLinker, Debugger, Libmaker, Burner

### Synonym

None

### Syntax

```
TMP= <directory>
```

### Arguments

`<directory>`: Directory to be used for temporary files.

### Description

This environment variable works in conjunction with the ANSI function `tmpnam()` when the tools must create a temporary file. The `tmpnam()` library function stores the temporary files in the directory specified by the `TMP` environment variable. If the variable is empty or does not exist, the tool stores the temporary files in the current directory. Check this variable if you get an error message `Cannot create temporary file`.

### Example

```
TMP=C:\TEMP
```

### See also

Current Directory

**NOTE** This is a system level (global) environment variable. It cannot be specified in a default environment file (`DEFAULT.ENV`/`.hidefaults`).

## USERNAME: User Name in Object File

### Tools

Compiler, Assembler, SmartLinker, Libmaker

### Synonym

None

### Syntax

```
USERNAME= <user>
```

### Arguments

`<user>`: Name of user.

### Description

Each absolute file contains an entry identifying the user who created the file. Use the decoder to retrieve this information from the absolute files.

### Example

```
USERNAME=PowerUser
```

### See also

COPYRIGHT: Copyright Entry in Absolute File and INCLUDETIME: Creation Time in Object File

B

# Tool Options

Each tool offers a number of options that you can use to control operation. Options are composed of a dash ( - ) followed by one or more letters or numerals. Options not starting with a dash are interpreted as the name of a parameter file to be linked.

Command line options are not case-sensitive. For example, `-W1` is the same as `-w1`.

- SmartLinker Specific: Anything not starting with a dash is the name of a parameter file to be linked. Specify SmartLinker options on the command line or in the `LINKOPTIONS` variable (see LINKOPTIONS: Default SmartLinker Options). Typically, each linker option is specified only once per linking session.

  Setting the `LINKOPTIONS` environment variable appends the option contents to the SmartLinker command line each time a file is linked. Use this option to specify certain required options, so that you do not have to specify them each time a file is linked.

- Burner specific: The burner command line can contain the name of a file to be built with the -F: Execute Command File (Burner), or a list of commands.

  Options before the first command on the command line are recognized. Then, all remaining text is taken as arguments to the command, including options. For example:

  ```
  OPENFILE "fibo.out" format=freescale len=0x1000 SENDBYTE
  1 "fibo.abs.abs" CLOSE
  ```

  Command is executed.

  `-f=fibo.bbl` executes the `fibo.bbl` command file.

  `-f fibo.bbl` is an alternate form of the recommended `-f=fibo.bbl`. This form is allowed for compatibility only.

  `fibo.bbl -f` is not allowed, because the burner interprets `fibo.bbl` as a command with argument `-f`. This generates an error, since no such command exists.

- Options for the Freescale object file format may differ from the options for decoding ELF/DWARF binaries.

- You can specify maker options on the command line or interactively in the Advanced Option Settings dialog box.

# Option Details

The remainder of this section describes each of the options available for the tools. Table B.1 lists the details available for each of the options.

**Table B.1 Option Details**

| Topic | Description |
|---|---|
| Group | Specifies the groups influenced by the option. |
| Syntax | Specifies the option syntax. |
| Arguments | Describes and lists optional and required arguments for the option. |
| Default | (Where used): Shows the default setting for the option.<br>(Where not used): No 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. Shows settings, source code and/or `prm` files where applicable. |
| See also | (Where used): Names related topics. |

**Table B.2 Option Groupings**

| Group | Tools | Description |
|---|---|---|
| HOST | All | Host-related options |
| INPUT | All | Specification of command-line handling, such as macro definitions and unknown-macro expansions. |
| MESSAGES | All | Message handling, such as specification of format, kind, and number of Maker printed messages |
| MODULA-2 | M | Modula-2 make-specific options. (No effect for C users.) |
| NONE | SL | These options cannot be specified interactively. |
| OPTIMIZATIONS | SL | |
| OUTPUT | SL, LM, D, M | Specification of command execution and output print |

**Table B.2 Option Groupings (*continued*)**

| Group | Tools | Description |
|---|---|---|
| STARTUP | SL | These options cannot be specified interactively. |
| VARIOUS | SL, B, M | Does not appear in the dialog box |

# Special Modifiers

You can use special modifiers with some options, although some modifiers may not make sense for all options. Table B.3 lists and describes these modifiers.

**Table B.3 Supported Modifiers**

| Modifier | Description |
|---|---|
| %p | Path including file separator |
| %N | File name in strict 8.3 format |
| %n | File name without extension |
| %E | Extension in strict 8.3 format |
| %e | Extension |
| %f | Path + file name without extension |
| %" | A double quote (") if the file name, path or extension contains a space |
| %' | A single quote (') if the file name, path or extension contains a space |
| %(ENV) | Replaces it with contents of an environment variable |
| %% | Generates a single '%' |

## Examples

For these examples we assume that our actual file name (base file name for the modifiers) is:

`c:\Freescale\my demo\TheWholeThing.myExt`

`%p` gives the path only with a file separator:

`c:\Freescale\my demo\`

`%N` results in the file name in 8.3 format, that is the name with only eight characters:

`TheWhole`

`%n` returns just the file name without extension:

`TheWholeThing`

`%E` gives the extension in 8.3 format, that is, the extension with only three characters:

`myE`

`%e` is used for the whole extension:

`myExt`

`%f` gives the path plus the file name:

`c:\Freescale\my demo\TheWholeThing`

Because the path contains a space, using `%"` or `%'` is recommended: Thus `%"%f%"` gives:

`c:\Freescale\my demo\TheWholeThing`

where `%'%f%'` gives:

`'c:\Freescale\my demo\TheWholeThing'`

When using `%(envVariable)` an environment variable may be used too. A file separator after `%(envVariable)` is ignored if the environment variable is empty or does not exist. For example, `$(TEXTPATH)\myfile.txt` is replaced with:

`c:\Freescale\txt\myfile.txt`

if `TEXTPATH` is set to:

`TEXTPATH=c:\Freescale\txt`

But is set to:

`myfile.txt`

if TEXTPATH does not exist or is empty.

`%%` may be used to print a percent sign. `%e%%` gives:

`myExt%`

## -A: Print Full Listing (Decoder)

### Group

OUTPUT

### Syntax

`-A`

### Arguments

None

### File Format

Only Freescale. ELF Object files are not affected by this option.

### Description

Prints a listing with the header information of the object file.

### Example

```
Listing with command line fibo.o -A:

*** Header information ***
Program Version              2700
Format Version               2
File Id                      129
flags                        0
processor family             11
processor type               1
Unitname                     fibo.abs
Username                     PFR
Program time string          Feb 25 1998
Creation time string         Wed Feb 25 11:43:22 1998
CopyRight

*** Directory information for Absfile***
Is romlib?   0

Init start:end   32774:32774
Code beg:end     32768:32939
Data beg:end     384:4096
Total number of objects   7

At address: 8000 code size: 40
00008000 1410         ORCC  #16
.........
```

## -A: Warning for Missing .DEF File (Maker)

### Group

MODULA-2

### Syntax

`-A`

### Arguments

None

### Description

Invokes a warning for a missing `.DEF` file and affects only the processing of Modula-2 makefiles.

### Example

```
maker test.mod -M -A
```

## -Add: Additional Object/Library File

### Group

INPUT

### Syntax

`-Add <FileList>`

### Arguments

`<FileList>`: Names of an additional object files or libraries.

### Description

Use this option to add additional files to a project without modifying the link parameter file.

If you intend to specify all binary files using the `-Add` command line option, then you must include an empty NAMES block (just NAMES END) in the link parameter file.

SmartLinker links object files added with this option before linking the object files specified in the NAMES block.

### Example

To specify more than one file either use several `-Add` options:

```
linker.exe demo.prm -addFileA.o -addFileB.o
```

Or use braces to bind the list to the `-Add` option:

```
linker.exe demo.prm -add(FileA.o FileB.o)
```

Use braces together with double quotes to add a file in which the name contains spaces:

```
linker.exe demo.prm -add("File A.o" "File B.o")
```

```
linker.exe fibo.prm -addfibo1.o -addfibo2.o
```

This example links the additional object files `fibo1.o` and `fibo2.o` with the `fibo` application.

### See also

NAMES: List Files Building the Application.

**NOTE** To turn off smart linking for the additional object file, use a + sign immediately behind the filename.

## -Alloc: Allocation Over Segment Boundaries (ELF)

### Group

OPTIMIZATION

### Syntax

```
-Alloc ( First | Next | Change )
```

### Arguments

`First` : Use first free location

`Next` : Always use next segment

`Change` : Check when segment changes only

### Default

```
-AllocNext
```

### Description

The linker supports allocating objects from one ELF section into different segments. This option controls where space for the next object is allocated as soon as the first segment is full.

When you use `-AllocNext`, the linker always takes the next segment as soon as the current segment is full. Gaps resulting from this process are not used later. With the `Next` argument, the allocation order corresponds to the definition order in the object files. Objects defined first in a source file are allocated before objects defined later.

When you use `-AllocFirst`, the linker checks space requirements for every object. If the object fits into a previously used, partially filled segment, the linker uses that space. `-AllocFirst` does not maintain the definition order.

When you use `-AllocChange`, the linker checks space requirements only when the object does not fit into the current segment. If the object fits into a previously used, partially filled segment, the linker uses that space. `-AllocChange` does not maintain the definition order, but uses fewer different ranges than `-AllocFirst`.

**NOTE** This option has no effect in the Freescale format. In the Freescale format, the linker always uses the `-AllocNext` strategy. The linker does not maintain allocation order for small variables.

**NOTE** This option has no effect if sections are not split into segments. Then all strategies behave identically.

**NOTE** Some compilers perform code optimization in the assumption that the definition order is maintained in the memory. Such code is not split into multiple segments so no problems result from using this option.

### Example

```
Objects:     AAAA BB CCC D EEE FFFFF
Segments:    "---" "-------" "------------"
AllocNext:   "---" "AAAABB-" "CCCDEEEFFFFF"
AllocChange:"CCC" "AAAABBD" "EEEFFFFF----"
AllocFirst: "BBD" "AAAACCC" "EEEFFFFF----"
```

In this example, objects A (size 4 bytes), B (size 2 bytes), and F (size 5 bytes) must be allocated into three segments of size 3, 7 and 12 bytes. Because object A does not fit into the first segment, `-AllocNext` does not use this space at all. The two other strategies fill this space later. Only `-AllocNext` maintains object order.

## -AsROMLib: Link as ROM Library

### Group

OUTPUT

### Syntax

`-AsROMLib`

### Arguments

`<FileList>`: Names of an additional object files or libraries.

### Description

Set `-AsROMLib` to link the application as a ROM library. This option has the same effect as specifying `AS ROM_LIB` in the linker parameter file.

### Example

```
linker.exe myROMlib.prm -AsROMLib
```

## -B: Generate S-Record file (SmartLinker)

### Group

OUTPUT

### Syntax

`-B`

### Arguments

None

### Default

Disabled

### Description

Setting this option tells the linker to generate an S-record file in addition to an absolute file. The name of the S-record file is the same as the name of the `.abs` file, except that the extension `.SX` is used. The `default.env` variable `SRECORD` may specify an alternative extension.

### Example

```
LINKOPTIONS=-B
```

## -C: Write Disassembly Listing with Source Code (Decoder)

### Group

OUTPUT

### Syntax

```
-C
```

### Arguments

None

### Default

None

### File Format

Only Freescale. (ELF Object files are not affected by this option.)

### Description

This option setting is default for the Freescale object files as input. When this option is specified, the Decoder decoding Freescale object files writes the source code within the disassembly listing.

### Example

```
Listing with command line fibo.o -C (code depends on target):
    8:  unsigned int Fibonacci(unsigned int n)
```

```
    9:  {
   10:    unsigned fib1, fib2, fibo;
   11:    int i;
   12:
00000000 3B            PSHD
00000001 3B            PSHD
   13:    fib1 = 0;
00000002 C7            CLRB
00000003 87            CLRA
   14:    fib2 = 1;
00000004 52            INCB
00000005 6C82          STD   2,SP
   15:    fibo = n;
00000007 EE80          LDX   0,SP
   16:    i = 2;
.................
```

## -C: Ignore Case (Maker)

### Group

INPUT

### Syntax

```
-C
```

### Arguments

None

### Description

The make utility has default case sensitivity. Use this option to disable case sensitivity and treat lowercase characters the same as uppercase characters.

### Example

```
maker test.mak -o
```

In the file `test.mak`:

```
OBJECTFILES = startup.o fibo.o
makeAll:  $(ObjectFiles)
```

This line with -c is equivalent to:

```
makeAll:   $(OBJECTFILES)
```

## -CAllocUnusedOverlap: Allocate Unreferenced Overlap Variables (Freescale)

### Group

OPTIMIZATION

### Syntax

```
-CAllocUnusedOverlap
```

### Arguments

None

### Description

When Smart Linking is switched off, defined but unreferenced overlapped variables are not allocated by default. Such variables do not belong to a specific function, therefore they cannot be allocated overlapped with other variables.

This option only changes the behavior of variables in the special `_OVERLAP` segment. This segment is used only to allocate parameters and local variables for processors which do not have a stack. Not allocating an unreferenced overlap variable is similar to not allocating a variable on the stack for other processors. If you use this stack analogy, then allocating such variables this way corresponds to allocating unreferenced stack variables in global memory.

This option allows allocation of all defined objects. Using this option is not recommended.

### Example

```
LINKOPTIONS=-CAllocUnusedOverlap
```

## -Ci: Link Case Insensitive

### Group

INPUT

### Syntax

```
-Ci
```

### Arguments

None

### Description

With this option, the linker ignores object name capitalization.

This option supports case-insensitive linking of assembly modules. Since all identifiers are linked case insensitive, this also affects C or C++ modules.

**NOTE** This option can cause severe problems when combined with the name mangling of C++. Do not use this option with C++.

This option only affects the comparison of names of linked objects. Section names or the parsing of the link parameter file are unaffected. They remain case sensitive.

### Example

```
void Tim(void);
void main(void) {
   tim(); /* with -ci this call is resolved to Tim */
}
```

The linker matches the `tim` and `Tim` identifiers at link time. However, for the compiler these are still two separate objects and therefore the code above issues an "implicit parameter declaration" warning.

## -Cmd: Libmaker Commands

### Group

OUTPUT

### Syntax

```
"-Cmd" """ <commands> """).
```

### Arguments

`<commands>`: libmaker commands, separated by semicolon.

### Default

None.

### Description

You can either run a libmaker command file (preceded by ‘@’), or use the -Cmd command on the command line to run libmaker commands. Alternatively, you can use the command without the ‘+’ operator as well:

```
-Cmd"a.o b.o c.o = d.lib"
```

Instead of “..” to wrap around the command string, you can use as well:

```
-Cmd(a.o b.o c.o = d.lib)
-Cmd[a.o b.o c.o = d.lib]
-Cmd{a.o b.o c.o = d.lib}
-Cmd'a.o b.o c.o = d.lib'
```

If your file names have spaces or operator characters in the file name, you need to use double quotes for the file name:

```
-Cmd(a.o "my b.o" "c-c.o" = d.lib)
```

You still can use double quotes for the -Cmd option, but in such a case you need to double-double quote files names in double quotes:

```
-Cmd"a.o ""my b.o"" ""c-c.o"" = d.lib"
```

### Example

```
-Cmd"a.o + b.o = c.lib"
```

### See also

-Mar: Freescale Archive Commands (Libmaker)

## -Cocc: Optimize Common Code (ELF)

### Group

OPTIMIZATION

### Syntax

```
-Cocc [ = [ D ] [ C ]]
```

### Arguments

```
D : optimize Data (constants and strings).
C : optimize Code
```

### Description

This option defines the default when optimizing constants and cod. The commands `DO_OVERLAP_CONSTS` and `DO_NOT_OVERLAP_CONSTS` take precedence over the option.

### Example

```
printf("Hello World\n"); printf("\n");
```

`-Cocc` allocates the string "`\n`" inside of the string "`Hello World\n`".

## -CRam: Allocate Non-specified Constant Segments in RAM (ELF)

### Group

OPTIMIZATION

### Syntax

```
-CRam
```

### Arguments

None

### Description

This option allocates constant data segments not explicitly allocated in a `READ_ONLY` segment in the default `READ_WRITE` segment.

This was the default for old versions of the linker, so this option provides a compatible behavior with old linker versions.

### Example

When C source files are compiled with `-CC`, the constants are put into the `ROM_VAR` segment. If the `ROM_VAR` segment is not mentioned in the `prm` file, then without this option, these constants are allocated in `DEFAULT_ROM`. With this option they are allocated in `DEFAULT_RAM`.

## -D: Display Dialog Box (Burner)

### Group

VARIOUS

### Syntax

`"-D".`

### Arguments

None

### Default

None

### Description

This option displays the Burner dialog box. This interface, with its three tabs, allows you to launch the burner from a make file and await user input.

**Figure B.1 Burner Dialog Window Input/Output Tab**

### Example

```
burner.exe -D
```

## -D: Decode DWARF Sections (Decoder)

### Group

OUTPUT

### Syntax

`-D`

### Arguments

None

### Default

Disabled

### File Format

Only ELF. Freescale object files are not affected by this option.

### Description

When you specify this option, DWARF section information is also written to the listing file. Decoding from the DWARF section inserts this information in the listing file. See the following listings for more information.

**Listing B.1 Source/code reference information**

```
.debug_line
  0x4 Version 2
  0x6 PrologLen 1221
  0xa MinInstrLen 1c
  0xb DefIsStmt 0c
  0xc LineBase 0c
  0xd LineRange 4c
  0xe DW2L_OpcodeBase 9c
  0xf Opcodelengths : 0c 1c 1c 1c 1c 0c 0c 0c 1c

Includedir :
 0x19 File  1: Y:\DEMO\WAVE12C\fibo.c, 0, 0, 0
 0x33 File  2: y:\LIB\ELF12C\hidef.h, 0, 0, 0
 0x4c File  3: y:\LIB\ELF12C\default.sgm, 0, 0, 0
 0x69 File  4: y:\LIB\ELF12C\stddef.h, 0, 0, 0
 0x84 Set Addr  867(2151):   ADDR  FILE LINE COL STMT BASIC
 0x8b set column          :   867    1     1   14   0     0
 0x8d advance line        :   867    1     8   14   0     0
 0x8f negate stmt         :   867    1     8   14   1     0
 0x90 negate stmt         :   867    1     8 14   0     0
...
```

**Listing B.2 Argument location for local variables information**

```
.debug_loc
    0 Start 867, End 869  (2)DW_OP_breg15 0(0)
  0xc Start 869, End 86a  (2)DW_OP_breg15 8(8)
 0x18 Start 86a, End 895  (2)DW_OP_breg15 10(a)
 0x24 Start 895, End 896  (2)DW_OP_breg15 0(0)
 0x30 0, 0 : end of location-list
```

**Listing B.3 Symbol Debug information**

```
DWARF: .debug_info (1053) [0x734]
```

```
Compi.Unit Header: size 304, version 2, abbrev 0, addrsize 4
  0xb Abbreviation 128 ,compile_unit
  0xd name          string       fibo.c
 0x14 producer      string       FREESCALE
 0x1b comp_dir      string       Y:\DEMO\WAVE12C
 0x2b language      udata        DW_LANG_C89
 0x2c stmt_list     data4        0(0)
```

**Listing B.4 Frame Debug Information**

```
.debug_frame
    0 CIE Information  0x8 Version 1
  0x9 Augmentor Freescale CFA 1.0
 0x18 CodeAlign: 1, DataAlign: 1, ReturnAddr-Column: 18
 0x1b instruction      PC   FP(Reg) R[ 0] R[ 1] R[ 2] R[ 3] R[ 4] R[ 5]
R[ 6] R[ 7] R[ 8] R[ 9] R[10] R[11] R[12] R[13] R[14] R[15] R[16] R[17]
R[18] R[19] R[20] R[21] R[22] R[23] R[24] R[25] R[26] R[27] R[28] R[29]
R[30] R[31]
0x1bstart-values    84d: 0(15)
 0x1b Def CFA Register reg: 15,
 0x1d Def CFA Offset ofs: 0
 0x1f Offset: reg 18, Ofs: 0
 0x21 Undefined reg: 0
 0x23 Undefined reg: 1
```

**NOTE** Specify the `-E` option when the `-D` option is activated.

## -D: Define a Macro (Maker)

### Group

INPUT

### Syntax

`-D` *`<macroname>`* `=` *`<value>`*

### Arguments

The macro definition string “*<macroname>* = *<value>*”.

### Description

This option defines command-line macros. Command-line macros define macros and arguments for the make file. A macro defined this way has a higher priority than a macro defined in the makefile. Because you separate the arguments in the command line with spaces, you cannot place spaces in a command-line macro.

### Examples

```
-dCOMP=chc12.exe
-dCOMP=chc12.exe -Li -Wi
-d[MAKE=Maker.exe -s -d(COMP=$(COMP))]
```

## -Disp: Display Mode (Maker)

### Group

OUTPUT

### Syntax

```
-Disp
```

### Arguments

None

### Description

Maker echoes executing commands without calling them. Use this mode to check the dependency graph without affecting any files.

### Example

```
maker test.mak -disp
```

## -Dist: Enable Distribution Optimization (ELF) (SmartLinker)

### Group

OPTIMIZATIONS

### Syntax

```
-Dist
```

### Arguments

None

### Description

This option enables the linker optimizer. Instead of a link, the linker generates a distribution file which contains an optimized distribution.

## -DistFile: Specify Distribution File Name (ELF) (SmartLinker)

### Group

OPTIMIZATIONS

### Syntax

```
-DistFile <file name>
```

### Arguments

`<file name>: Name of the distribution file.`

### Default

```
distr.inc
```

### Description

Enable this option to specify the name of the distribution file. The distribution file lists all distributed functions and specifies how the compiler reallocates them.

### Example

```
LINKOPTIONS=-DistFileMyFile
```

## -DistInfo: Generate Distribution Information File (ELF)

## (SmartLinker)

### Group

OPTIMIZATIONS

### Syntax

```
-DistInfo <file name>
```

### Arguments

`<file name>: Name of the information file.`

### Default

`distr.txt`

### Description

Using this option, the optimizer generates a distribution information file containing a list of all sections and their functions. Available function information includes the old size, optimized size, and new calling convention.

### Example

```
LINKOPTIONS=-DistInfoMyInfoFile
```

## -DistOpti: Choose Optimizing Method (ELF) (SmartLinker)

### Group

OPTIMIZATIONS

### Syntax

```
-DistOpti ( FillBanks | CodeSize )
```

### Arguments

`FillBanks : Priority is to fill the banks.`

`CodeSize : Priority is to minimize the code size.`

### Default

`-DistOptiFillBanks`

### Description

Enable this option to choose the optimizing method. With the `FillBanks` argument the linker minimizes the free space in every bank. `FillBanks` is most effective for functions using the `near` calling convention. Use the `CodeSize` argument to minimize code when free space within the banks is no concern.

### Example

```
LINKOPTIONS=-DistOptiFillBanks
```

## -DistSeg: Specify Distribution Segment Name (ELF) (SmartLinker)

OPTIMIZATIONS

### Syntax

-DistSeg <segment name>

### Arguments

<segment name>: Name of the distribution segment.

### Default

```
DISTRIBUTE
```

### Description

Use this option to specify the name of the distribution segment.

### Example

```
LINKOPTIONS=-DistSegMyDistributionSegment
```

## -E: Define Application Entry Point (ELF) (SmartLinker)

### Group

INPUT

### Syntax

```
-E= <FunctionName>
```

### Arguments

`<FunctionName>` : Name of the function considered to be the entry point in the application.

### Description

This option specifies the name of the application entry point.

The symbol specified must be externally visible (not defined as static in an ANSI-C source file or XREFed in an assembly source file).

### Example

```
LINKOPTIONS=-E=entry
```

This is the same as using the command:

```
INIT entry
```

in the `prm` file.

## -E: Decode ELF sections (Decoder)

### Group

OUTPUT

### Syntax

```
-E
```

### Arguments

None

### File Format

Only ELF. Freescale Object files are not affected by this option.

### Description

When you specify this option, ELF section information is also written to the listing file. Decoding from the ELF section inserts the following information in the listing file:

**Listing B.5 ELF Header Information**

```
File: Y:\DEMO\WAVE12C\fibo.abs
Ident: ELF with 32-bit objects, MSB encoding, Version 1
```

```
Type:  Executable file,   Machine:  Freescale HC12,   Vers:  1
Entry point: 83D
Elf flags: 0
ElfHSiz: 34
ProgHOff:      34,   ProgHSi:      20,   ProgHNu:      6
SectHOff:     E3A,   SectHSi:      28,   SectHNu:      19,
SectHSI:       18
```

Usually the ELF Program header Table is available only for absolute files.

**Listing B.6 ELF Program header Table Information**

```
PROGRAM HEADER TABLE - 6 Items
Starts at:        34, Size of an entry:      20, Ends at:        F4
  NO    TYPE    OFFSET    SIZE VIRTADDR  PHYADDR  MEMSIZE   FLAGS ALIGNMNT
   0 - PT_PHDR     34       C0
   1 - PT_LOAD     F4        0        0       800         4       6        0
   2 - PT_LOAD     F4       AE        0       810        AE       1        0
```

**Listing B.7 ELF Section Header Table Information**

```
SECTION HEADER TABLE - 19 Items
Starts at:       E3A, Size of an entry:      28, Ends at:      1132
String table is in section: 12
 NO NAME           TYPE     FLAGS OFFSET   SIZE   ADDR ALI RECS LINK INFO
 0-                 NULL       0       0      0      0    0    0    0
 1-.common         NOBITS     WA      F4      4    800   0    0    0    0
 2-.init           PROGBITS   AX      F4     3D    810   0    0    0    0
 3-.startData      PROGBITS   AX     131     1A    84D   0    0    0    0
 4-.text           PROGBITS   AX     14B     55    867   0    0    0    0
 5-.copy           PROGBITS   AX     1A0      2    8BC   0    0    0    0
 6-.stack          NOBITS     WA     1A2    100    B00   0    0    0    0
 7-.vectSeg0_vect PROGBITS    AX     1A2      2   FFFE   0    0    0    0
```

**Listing B.8 Symbol Table Information**

```
SYMBOL TABLE: .symtab - 13 Items
Starts at:       1A4, Size of an entry:      10, Ends at:       274
String table is in section: 9
First global symbol is in entry no.: 8
 NO NAME                          VALUE   SIZE BIND   TYPE      SECT
   0-                                 0      0 LOCAL  NOTYPE
   1-                                 0      0 LOCAL  SECTION      1
   2-                                 0      0 LOCAL  SECTION      2
   3-Init                           810     2D LOCAL  FUNC         2
```

```
  4-                                      0     0 LOCAL  SECTION     3
  5-                                      0     0 LOCAL  SECTION     4
```

**Listing B.9 Relocation Section Information**

```
RELOCATION TABLE RELA: .rela.init - 1 Items
Starts at:      2AA, Size of an entry:      C, Ends at:      2B6
Symbol table is in section: 8
Binary code/data is in section: 2
   NO      OFFSET            SYMNDX TYP   ADDEND SYMNAME
   0 -      2163      873         3   3     4107 Init
```

**Listing B.10 Hexadecimal dump from all sections defined in the binary file**

```
HEXDUMP OF: .init FROM 244 TO 305 SIZE 61 (0X3D)
OFFSET  +0 +1 +2 +3 +4 +5 +6 +7 : +8 +9 +A +B +C +D +E +F  ASCII DATA
000000  FE 08 55 FD 08 53 27 10 : 35 ED 31 EC 31 69 70 83  ...U ...
S'.5.1.1ip.
000010 00 01 26 F9 31 03 26 F0 : FE 08 57 EC 31 27 0D ED .&.1.&...
W.1'..
000020 31 18 0A 30 70 83 00 01 : 26 F7 20 EF 3D FC 08 4D 1..0p. .&.
.=..M
000030  26 03 FF 08 51 07 C9 15 : FB 00 04 20 F0          &...Q.... . .
```

## -E: Unknown Macros as Empty Strings (Maker)

### Group

INPUT

### Syntax

-E

### Arguments

None

### Description

This macro discards errors for unknown macros referenced in the makefile. Maker substitutes an unknown macro with an empty string.

### Example

```
maker -m test.mod -e
```

## -Ed: Dump ELF Sections in LST File (Decoder)

### Group

OUTPUT

### Syntax

```
-Ed
```

### Arguments

None

### Default

None

### File Format

Only ELF. Freescale object files are not affected by this option.

### Description

This option generates a HEX dump of all ELF sections.

**NOTE** The related option `-E` shows the information contained in ELF sections in a more readable form.

## -Env: Set Environment Variable

### Group

HOST

### Syntax

```
-Env <Environment Variable> = <Variable Setting>
```

### Arguments

`<Environment Variable>` : Environment variable to be set.

`<Variable Setting>` : Setting of the environment variable.

### Description

This option sets an environment variable. The environment variable may be used in the maker or to overwrite system environment variables.

### Example

```
-EnvOBJPATH=\sources\obj
```

This is the same as:

```
OBJPATH=\sources\obj
```

in `default.env`

To use an environment variable with file names that contain spaces, use the following syntax:

```
-Env"OBJPATH=program files"
```

## -F: Execute Command File (Burner)

### Group

INPUT

### Syntax

`"-F=" <fileName>.`

### Arguments

*`<fileName>`*: Batch Burner command file to be executed.

### Default

None

### Description

This option causes the Burner to execute a Batch Burner command file (usual extension is `.bbl`).

### Example

```
-F=fibo.bbl
```

## -F: Object File Format (Decoder)

### Group

INPUT

### Syntax

```
-F ( A | E | I | H | S )
```

### Arguments

None

### Default

```
-FA
```

### Description

The decoder is able to decode different object file formats. This option defines which object file format should be decoded:

`-FA` : the decoder determines the object file format automatically.

`-FE` : this can be overridden and only ELF files are correctly decoded.

`-FH` : only Freescale files are decoded.

`-FS` : only S-Record files can be decoded.

`-FI` : Intel Hex files can be decoded.

**NOTE** This option defines the Object File Format, which also defines the format of absolute files and libraries. It does not only affect object files. Many other options only effect a specific object file format. See the corresponding option for details.

**NOTE** To decode an S-Record or Intel Hex file, use the option -Proc: Set Processor (Decoder) to specify the processor.

## -FA, -FE, -FH -F6: Object File Format (SmartLinker)

### Group

INPUT

### Syntax

```
-F ( A | E | H | 6 )
```

### Arguments

none

### Default

```
-FA
```

### Description

Using this option the linker is able to link different object file formats. This option defines which object file format the linker uses:

- Using -FA, the linker determines the object file format automatically.
- Using -FE, the linker recognizes only ELF files correctly.
- Using -FH, the linker recognizes only Freescale files correctly.
- Using -F6, the linker produces a V2.6 Freescale absolute file.

**NOTE** It is not possible to build an application consisting of both Freescale and ELF files. Either all files must be in ELF format or all files must be in Freescale format.
The format of the generated absolute file is the same as the format of the object files. ELF object files generate ELF absolute files and Freescale object files generate Freescale absolute files.

## -H: Prints the List of All Available Options (Short Help)

### Group

OUTPUT, VARIOUS

### Syntax

```
-H
```

### Arguments

None

### Description

This option prints the list of all options, sorted by Group. Options in the same group are sorted alphabetically. No other option or source file should be specified with the `-H` option.

### Example

Linker option output of -H:

```
-F       Object File Format
-Fh      Freescale
-FEo     Compatible ELF (DWARF 1.1/DWARF 2.0)
-Fa     Automatic Detection
-F6     Freescale V2.6
```

Burner option output of -H:

```
...
VARIOUS:
-H    Prints this list of options
-V    Prints the Compiler version
...
```

Libmaker option output of -H:

```
HOST:
-Env     Set environment variable
-View    Application Standard Occurrence
            -ViewWindow Window
            -ViewMin Min
            -ViewMax Max
            -ViewHidden Hidden
```

## -I: Ignore Exit Codes (Maker)

### Group

OUTPUT

### Syntax

```
-I
```

### Arguments

None

### Description

This option lets Maker ignore exit codes of the called programs. Maker continues processing even if the called application reports a fatal error or creation of the corresponding process fails. Use this option for testing purposes, where Maker resolves only the dependencies of a make file.

### Example

```
maker -m test.mod -i
```

## -L: Add a Path to Search Path (ELF) (SmartLinker)

### Group

INPUT

### Syntax

```
-L <Directory>
```

### Arguments

`<Directory>` : Name of an additional search directory for object files.

### Description

With this option, the ELF part of this linker searches object files first in all paths given with this option before considering the usual environment variables.

### Example

```
LINKOPTIONS=-Lc:\freescale\obj
```

### See also

OBJPATH: Object File Path

## -L: Produce Inline Assembly File (Decoder)

### Group

OUTPUT

### Syntax

```
-L
```

### Arguments

None

### File Format

Only Freescale. ELF Object files are not affected by this option.

### Description

The output listing is an inline assembly file without additional information, but in C comments.

### Example

Part of Listing with command line `fibo.o -L` (code depends on target):

```
unsigned int Fibonacci(unsigned int n)
{
  unsigned fib1, fib2, fibo;
  int i;
  asm{
                CLRB
                CLRA
                INCB
                STD    2,SP
                LDX    0,SP
                LDY    #2
                SEX    A,D
```

```
                BRA    LBL25
        LBL16:  ADDD   2,SP
                ...
                RTS
            }

}
```

## -L: List Modules (Maker)

### Group

MODULA-2

### Syntax

`-L <listfile>`

### Arguments

File name of the generated listing file

### Description

This option lists compiled files in build order in the file specified in the argument *<listfile>*. This option affects only the processing of Modula-2 makefiles.

### Example

```
maker -m test.mod -ltest.lst
```

## -LibFile

Specifies the name of the file that contains linker-generated library information.

### Syntax

`-LibFile<filename>`

### Arguments

<filename>: Name of the file that has the information about libraries and startup(optional) to be used in second link step.

### Description

When this option is enabled,linker generates file<filename> which has information about the current libraries and also about the files with which they should be replaced with.

## -LibOptions

Enables library information generation.

### Syntax

```
-LibOptions
```

### Arguments

None

### Description

When this option is enabled,linker generates file(default libFile.txt ) which has information about the current library and the startup file and also about the files with which they should be replaced with.

## -Lic: Print License Information

### Group

Various

### Syntax

```
-Lic
```

### Arguments

None

### Description

This options shows the current state of the license information. When no full license is available, the tool runs in demo mode. This information is also displayed in the About box.

### Example

```
-Lic
```

## -LicA: License Information About Every Feature in Directory

### Group

Various

### Syntax

```
-LicA
```

### Arguments

None

### Description

The `-LicA` option prints the license information of every tool or `dll` in the directory where the executable is located. Because the option analyzes every single file in the directory, this may take a long time.

### Example

```
-LicA
```

## -LicBorrow: Borrow License Feature

### Group

HOST

### Syntax

```
-LicBorrow <feature>[ ; <version>] : <Date>
```

### Arguments

`<feature>`: the feature name to be borrowed (e.g. `HI100100`).

`<version>`: optional version of the feature to be borrowed (e.g. `3.000`).

`<date>`: date with optional time until when the feature shall be borrowed (e.g. `15-Mar-2007:18:35`).

### Description

This option allows you to borrow a license feature until a given date/time. Borrowing allows you to use a floating license even if disconnected from the floating license server.

You need to specify the feature name and the date you will return the feature. If the feature you want to borrow is a feature belonging to the tool where you use this option, then you do not need to specify the feature version (because the tool knows the version). To borrow any feature not belonging to the tool, you need to specify the feature version. You can check the status of currently borrowed features in the tool **About** box.

You can borrow features only if you have a floating license and borrowing is enabled on your floating license. See the FLEXlm documentation for details on borrowing.

### Example

```
-LicBorrowHI100100;3.000:12-Mar-2004:18:25
```

## -LicWait: Wait for Floating License from Floating License Server

### Group

HOST

### Syntax

```
-LicWait
```

### Arguments

None

### Description

By default, if a license is not available from the floating license server, then the application returns immediately. When you set `-LicWait`, the application waits until a license is available from the floating license server. This is called blocking.

### Example

```
-LicWait
```

## -M: Generate Map File (SmartLinker)

### Group

OUTPUT

### Syntax

```
-M
```

### Arguments

None

### Description

This option forces map file generation after a successful linking session.

### Example

```
LINKOPTIONS=-M
```

This is the same as using the command:

```
MAPFILE ALL
```

in the `prm` file.

### See also

MAPFILE: Configure Map File Content

## -M: Produce Make File (Maker)

### Group

MODULA-2

### Syntax

```
-M [ <makefile> ]
```

### Arguments

File name of the generated makefile

### Description

This option generates a makefile. If this option immediately follows a file name, Maker writes the makefile to that file; otherwise, the makefile has the same name as the main module, but with suffix .MAK. This makefile uses macros by referencing above environment variables.

### Example

```
maker test.mod -m test.mak
```

## -Mar: Freescale Archive Commands (Libmaker)

### Group

OUTPUT

### Syntax

```
"-Mar" """ <library> [<member>] """.
```

### Arguments

<library>: name of the library.

<member>: list of members for the library to be added.

### Default

None

### Description

This command provides a more 'ar' (archive) like way to create a library out of object files. Instead of the following:

```
-Cmd"a.o b.o c.o = d.lib"
```

You can use:

```
-Mar"d.lib a.o b.o c.o"
```

Unlike the -Cmd command, this command performs no operator processing ('+'/'-'), which makes it easier to deal with file names containing operator characters.

### Example

```
-Mar"c.lib a.o b.o"
```

### See also

-Cmd: Libmaker Commands

## -MkAll: Make Always (Maker)

### Group

INPUT

### Syntax

```
-MkAll
```

### Arguments

None

### Description

This option skips Maker time-checking. Maker rebuilds up-to-date files. Use this option for updating the application after a change not covered by makefile dependencies.

### Example

```
maker test.mak -mkall
```

## -N: Display Notify Box

### Group

MESSAGE

### Syntax

```
-N
```

### Arguments

None

### Description

This option makes the tool display an alert box if an error occurs during linking. This is useful when running a makefile since the linker waits for the user to acknowledge the message, thus suspending makefile processing. (The `N` stands for `Notify`.) This option is

Use this feature for halting and aborting a build using the Make Utility.

### Example

SmartLinker: `LINKOPTIONS=-N`

Burner: `-Fnofile -N`

If an error occurs during linking, an error dialog box opens.

**NOTE** This option is only present on the PC version of the tools. The UNIX version does not accept `-n` as an option string.

## -NoBeep: No Beep in Case of an Error

### Group

MESSAGE

### Syntax

`-NoBeep`

### Arguments

None

### Description

Normally there is a ‘beep’ notification at the end of processing if an error occurs. To silence this error behavior, use this option to switch off the beep.

### Example

None

## -NoCapture: Do Not Redirect stdout of Called Processes (Maker)

### Group

OUTPUT

### Syntax

`-NoCapture`

### Arguments

None

### Description

Maker’s default behavior is to redirect from `stdout` the output text of called applications. Use this option to prevent redirection and text output for errors. This option affects only text output, since Maker does not detect the called application issuing the error.

This option accelerates the make process and older applications that do not support output. Using this option is equivalent to placing "*" at the start of every command line.

### Example

```
maker test.mak -NoCapture
```

## -NoEnv: Do Not Use Environment

### Group

Startup. (This option cannot be specified interactively.)

### Syntax

```
-NoEnv
```

### Arguments

None

### Description

This option can be specified only while starting the application at the command line. It cannot be specified in any other circumstance, including the `default.env` file, and the command line.

When this option is given, the application does not use any environment (`default.env`, `project.ini` or tips file).

### Example

```
linker.exe -NoEnv
```

### See also

Environment Variables

## -NoPath: Strip Path Info (Libmaker)

### Group

OUTPUT

### Syntax

`"-NoPath".`

### Arguments

None

### Default

None

### Description

Use this option to ignore path information in object files. This is useful if you want to move object files to another file location or hide your path structure.

### Example

```
-NoPath
```

## -NoSym: No Symbols in Disassembled Listing (Decoder)

### Group

OUTPUT

### Syntax

`-NoSym`

### Arguments

None

### Description

Prevents symbols from printing in the disassembled listing.

**NOTE** In previous versions of the Decoder, this option was called -N. It was renamed because of a conflict with the common option -N, which was not present in previous versions. The option -NoSym has no effect when decoding .abs files. As the .abs file does not contain any relocation information, it is not possible to display symbol names in the disassembly listing.

### Example

Part of Listing with command line `fibo.o -NoSym`.

```
DISASSEMBLY OF: '.text' FROM 531 TO 664 SIZE 133 (0X85)
Source file: 'fibo.c'
   19: unsigned int Fibonacci(unsigned int n)
Fibonacci:
00000000 1B98         LEAS  -8,SP
00000002 3B           PSHD
   24:   fib1 = x[0] + f + g;
00000003 FC0000       LDD   $0000
00000006 F30000       ADDD  $0000
00000009 F30000       ADDD  $0000
0000000C 6C88         STD   8,SP
   25:   fib2 = x[1];
0000000E FC0002       LDD   $0002
00000011 6C84         STD   4,SP
```

## -Ns: Configure S-Records (Burner)

### Group

OUTPUT

### Syntax

```
"-Ns" ["=" {"p" | "0" | "7" | "8" | "9"}].
```

### Arguments

"p": no path in S0 record

"0": no S0 record

"7": no S7 record

"8": no S8 record

"9": no S9 record

### Default

None

### Description

Usually an S-Record file contains a S0-Record at the beginning that contains the name of the file and an S7, S8 or S9 record at the end, depending on the address size. For the S3 format, an S7 record is written at the end. For S2 format, an S8 record is written at the end. For the S1 format, an S9 record is written at the end.

This feature is useful for disabling some S-Record generation in case a non-standard S-Record file reader cannot read S0, S7, S8 or S9 records.

In case the option is specified without suboptions (only `-Ns`), no start (S0) and no end records (S7, S8 or S9) are generated.

The option `-Ns=p` removes the path (if present) from the file name in the S0 record.

### Example

```
-Ns=0
```

### See also:

SRECORD: S-Record Type

## -O: Define Absolute File Name (SmartLinker)

### Group

OUTPUT

### Syntax

```
-O <FileName>
```

### Arguments

`<fileName>`: Name of the absolute file which must be generated by the linking session.

### Description

Use this option to define the name of the generated `ABS` file. If you are using the Linker with the CodeWarrior Development Studio, this option is automatically added to the command line passed to the linker. You can see this if you enable *Display generated*

*command lines in message window* in the Linker preference panel in the CodeWarrior IDE.

No extension is added automatically. Specifying the option `-otest` generates a file named `test`. To get the usual `.abs` file extension, use `-otest.abs`.

### Example

```
LINKOPTIONS=-Otest.abs
```

This is the same as using the command:

```
LINK test.abs
```

in the `prm` file,

### See also

LINK: Specify Name of Output File

## -O: Defines Listing File Name (Decoder)

### Group

OUTPUT

### Syntax

```
-O <FileName>
```

### Arguments

`<fileName>`: Name of listing file that must be generated by the decoding session.

### Default

None

### Description

This option defines the name of the output file to be generated.

### Example

```
-O=TEST.LST
```

The decoder generates a file named `TEST.LST`.

## -O: Compile Only (Maker)

### Group

MODULA-2

### Syntax

```
-O
```

### Arguments

None.

### Example

```
maker test.mod -o
```

### Description

Use this macro to have Maker perform only compile steps for a Modula-2 build. Maker does not call the linker. This option affects only Modula-2 makefile processing.

## -OCopy: Optimize Copy Down (ELF) (SmartLinker)

### Group

OPTIMIZATION

### Syntax

```
-OCopy ( On | Off )
```

### Arguments

`On` : Do the optimization.

`Off`: Optimization disabled.

### Default

```
-OCopyOn
```

### Description

This optimization changes the copy-down structure to use as little space as possible.

The optimization assumes that the application performs both the zero out and the copy down step of the global initialization. If a value is set to zero by the zero out, then zero values are removed from the copy down information. The resulting initialization is not changed by this optimization if the default startup code is used.

This switch only has an effect in the ELF Format. The optimizations done in the Freescale format cannot be switched off.

### Example

```
LINKOPTIONS=-OCopyOn
```

## -Options

Enables compiler option generation. The generated options will be used for second step compilation.

### Syntax

```
-Options
```

### Arguments

None

### Description

Linker generates a text file containing a compiler option for the second step (one of the following: `-ConstQualiNear`, `-NonConstQualiNear`, `-Mb`). The content of the file is appended to the compiler options for the second compilation step.

## -OptionFile

Specifies the name of the file that contains the set of linker-generated compiler options.

### Syntax

```
-OptionFile<filename>
```

### Arguments

```
<filename> : Name of the option file.
```

### Description

When this option is enabled, linker places the second step compiler options in the specified file`<filename>`.

## -P2LibFile

Specifies the name of the library information file.

### Syntax

```
-P2libFile<filename>
```

### Arguments

<filename> Name of the library information file.

### Description

When this option is enabled in second link step,linker reads file<filename> which has information about the libraries.

## -Proc: Set Processor (Decoder)

### Group

INPUT

### Syntax

```
-Proc= <ProcessorName>[ : <Derivative>].
```

### Arguments

`<ProcessorName>`: Name of a supported processor.

`<DerivativeName>`: Name of supported derivative.

### Default

None

### Description

This option specifies which processor should be decoded. For object files, libraries and applications, the processor is usually detected automatically. For S-Record and Intel Hex files, however, the decoder cannot determine which CPU the code is for, and therefore the processor must be specified with this option to get a disassembly output. Without this option, only the structure of a S-Record file is decoded.

The following values are supported:

`HC08`, `HC08:HCS08`, `HC11`, `HC12`, `HC12:CPU12`, `HC12:HCS12`, `HC12:HCS12X`, `HC16`, `M68k`, `MCORE`, `PPC`, `RS08`, `8500`, `8300`, `8051` and `XA`

### Example

```
decoder.exe fibo.s19 -proc=HC12
```

## -Prod: Specify Project File at Startup (PC) (No d, no m)

### Group

None. This option cannot be specified interactively.

### Syntax

```
-Prod= <file>
```

### Arguments

`<file>`: Name of a project or project directory.

### Description

This option can only be specified while starting the linker at the command line. It cannot be specified in any other circumstances, including the `default.env` file, the command line, etc.

When you use this option, the linker opens the file as a configuration file. When `<file>` contains only a directory name, the linker appends the default name `project.ini`. When the loading fails, a message box appears.

### Example

```
linker.exe -prod=project.ini
```

## -ReadLibFile

Instructs the linker to read in the library information file that it generated in step one.

### Syntax

```
-ReadLibFile
```

### Arguments

None

### Description

This option is passed in second link step. It tells the linker to read library information file(default libFile.txt).

## -S: Do Not Generate DWARF Information (ELF) (SmartLinker)

### Group

OUTPUT

### Syntax

```
-S
```

### Arguments

None

### Description

This option disables the generation of DWARF sections in the absolute file to save memory space.

### Example

```
LINKOPTIONS=-S
```

**NOTE** If the absolute file does not contain any DWARF information, you will not be able to debug it symbolically.

## -S: Silent Mode (Maker)

### Group

OUTPUT

### Syntax

```
-S
```

### Arguments

None

### Example

```
maker test.mod -s
```

### Description

Maker does not echo executed commands. Use this option to examine only Maker messages or those of the called tools, where an otherwise long list of executed commands is inconvenient.

## -SFixups: Creating Fixups (ELF) (SmartLinker)

### Group

OUTPUT

### Syntax

```
-SFixups
```

### Arguments

None

### Description

Usually, absolute files do not contain any fixups because all fixups are evaluated at link time. But with fixups, the decoder might symbolically decode the content in absolute files. Some debuggers do not load absolute files which contain fixups

because they assume that these fixups are not yet evaluated. But the fixups inserted with this option are actually already handled by this linker.

This option is included to ensure compatibility with previous linker versions.

### Example

```
LINKOPTIONS=-SFixups
```

## -StartUpInfo

Enables startup information generation.

### Syntax

```
-StartUpInfo
```

### Arguments

None

### Description

The information about the current startup file and the replacement startup file will be added to the library file(default libFile.txt) and used during the second compile-link step.

## -StatF: Specify Name of Statistic File (SmartLinker)

### Group

OUTPUT

### Syntax

```
-StatF= <fileName>
```

### Arguments

`<fileName>`: Name for the file to be written.

### Description

With this option set, the linker generates a statistic file. The statistic file reports each allocated object and its attributes. Every attribute is separated by a tab

character, so it can be easily imported into a spreadsheet/database program for further processing.

### Example

```
LINKOPTIONS=-StatF
```

## -T: Show Cycle Count for Each Instruction (Decoder)

### Group

OUTPUT

### Syntax

```
-T
```

### Arguments

None

### Description

If you specify this option, each instruction line contains the count of cycles in '[',']' braces. The cycle count is written before the mnemonics of the instruction. Note that the cycle count display is not supported for all architectures.

### Example

Part of Listing (HC12, ELF) with command line `fibo.o -T`:

```
DISASSEMBLY OF: '.text' FROM 531 TO 664 SIZE 133 (0X85)
Source file: 'X:\CHC12E\DEMO\ELF12C\fibo.c'
   19: unsigned int Fibonacci(unsigned int n)
Fibonacci:
00000000 1B98          [2]    LEAS  -8,SP
00000002 3B            [2]    PSHD
   24:   fib1 = x[0] + f + g;
00000003 FC0000        [3]    LDD   x
00000006 F30000        [3]    ADDD  f
00000009 F30000        [3]    ADDD  g
0000000C 6C88          [2]    STD   8,SP
   25:   fib2 = x[1];
0000000E FC0002        [3]    LDD   x
00000011 6C84          [2]    STD   4,SP
   26:   fibo = 0;
00000013 C7            [1]    CLRB
```

```
00000014 87             [1]     CLRA
00000015 6C86           [2]     STD    6,SP
   27:    i = 2;
00000017 C602           [1]     LDAB   #2
00000019 6C82           [2]     STD    2,SP
```

## -V: Prints Tool Version

### Group

OUTPUT

### Syntax

```
-V
```

### Arguments

None

### Description

Prints the SmartLinker version and the project directory.

Use this option to determine the SmartLinker project directory.

### Example

`-V` produces the following list:

```
Directory: \software\sources\asm
SmartLinker, V5.0.4, Date Apr 20 1997
```

## -View: Application Standard Occurrence (PC)

### Group

HOST

### Syntax

```
-View <kind>
```

### Arguments

<kind> is one of:

`Window` : Application window maintains default window size.

`Min` : Minimizes application window.

`Max` : Maximizes application window.

`Hidden` : Hides application window (only if arguments are used).

### Default

Application started with arguments: Minimized.

Application started without arguments: Window.

### Description

If no arguments are given the application starts as normal window. If the application starts with arguments (e.g. from the maker to compile/link a file) then the application runs minimized to allow batch processing. Use this option to specify window behavior. Using `-ViewWindow` the application appears with its normal window. Using `-ViewMin` the application appears in the task bar. Using `-ViewMax` the application appears maximized (filling the whole screen). Using `-ViewHidden` the application processes arguments (e.g. files to be compiled/linked) invisibly in the back ground (no window/icon in the taskbar visible). However if you use the `-N` option (see -N: Display Notify Box), a dialog box is still possible.

### Example

```
-ViewHidden fibo.prm
```

## -W: Display Window (Burner)

### Group

VARIOUS

### Syntax

`“-W”.`

### Arguments

None

### Default

None

### Description

In the V2.7 Burner, this option was used to show the Batch Burner Window. This option is ignored with the V5.x versions or later.

**NOTE** This option is only provided for compatibility reasons, and is NOT present in the dialog box.

### Example

```
burner.exe -W
```

## -W1: No Information Messages

### Group

MESSAGE

### Syntax

```
-W1
```

### Arguments

None

### Description

Prevents the Linker from printing INFORMATION messages, only WARNING and ERROR messages are printed.

### Example

```
LINKOPTIONS=-W1
```

## -W2: No Information and Warning Messages

### Group

MESSAGE

### Syntax

```
-W2
```

### Arguments

None

### Description

Suppresses all messages of type INFORMATION and WARNING, only ERRORs are printed.

### Example

```
LINKOPTIONS=-W2
```

## -WErrFile: Create “err.log” Error File

### Group

MESSAGE

### Syntax

```
-WErrFile ( On | Off )
```

### Arguments

None

### Default

`err.log` is created/deleted

### Description

The error feedback from the compiler to called tools is done with a return code. In 16-bit Windows environments, this was not possible, so when an error occurred the compiler created an `err.log`, which included error numbers, to signal an error. When no error occurred, the `err.log` file was deleted. Using UNIX or WIN32, a return code is available, so this option is not needed. To use a 16-bit maker with this tool, you must create the error file to signal any error.

### Example

```
-WErrFileOn
```

Creates or deletes `err.log` when the application finishes.

```
-WErrFileOff
```

Existing `err.log` is not modified.

### See also

[-WStdout: Write to Standard Output]

[-WOutFile: Create Error Listing File]

## -Wmsg8x3: Cut File Names in Microsoft Format to 8.3 (PC)

### Group

MESSAGE

### Syntax

```
-Wmsg8x3
```

### Arguments

None

### Description

This option truncates the file name in the Microsoft message to the 8.3 format. Some editors (e.g. early versions of WinEdit) expect the file name in a strict 8.3 Microsoft message format. This means the file name can have at most eight characters with not more than a three characters extension.

### Example

```
x:\mysourcefile.prm(3): INFORMATION C2901: Unrolling
loop
```

With the option `-Wmsg8x3` set, the above message becomes:

```
x:\mysource.c(3): INFORMATION C2901: Unrolling loop
```

## -WmsgCE: RGB Color for Error Messages

### Group

MESSAGE

### Scope

Function

### Syntax

```
-WmsgCE <RGB>
```

### Arguments

`<RGB>`: 24bit RGB (red green blue) value

### Default

```
-WmsgCE16711680 (rFF g00 b00, red)
```

### Description

Use this option to change the error message color. The value specified must be an RGB (Red/Green/Blue) value, and may be specified in decimal. Use the 0X prefix when using hexadecimal. To produce gray errors use `-WmsgCE0x808080`.

### Example

```
-WmsgCE255 changes the error messages to blue.
```

## -WmsgCF: RGB Color for Fatal Messages

### Group

MESSAGE

### Scope

Function

### Syntax

```
-WmsgCF <RGB>
```

### Arguments

`<RGB>`: 24bit RGB (red green blue) value

### Default

`-WmsgCF8388608 (r80 g00 b00, dark red)`

### Description

Use this option to change the fatal message color. The value specified must be an RGB (Red/Green/Blue) value, and may be specified in decimal. Use the 0X prefix when using hexadecimal. To produce gray fatal messages use `-WmsgCF0x808080`.

### Example

`-WmsgCF255` changes the fatal messages to blue.

## -WmsgCI: RGB Color for Information Messages

### Group

MESSAGE

### Scope

Function

### Syntax

```
-WmsgCI <RGB>
```

### Arguments

`<RGB>: 24bit RGB (red green blue) value.`

### Default

`-WmsgCI32768 (r00 g80 b00, green)`

### Description

Use this option to change the information message color. The value specified must be an RGB (Red/Green/Blue) value, and may be specified in decimal. Use the 0X prefix when using hexadecimal. To produce gray information messages use `-WmsgCI0x808080`.

### Example

`-WmsgCI255` changes the information messages to blue.

## -WmsgCU: RGB Color for User Messages

### Group

MESSAGE

### Scope

Function

### Syntax

```
-WmsgCU <RGB>
```

### Arguments

`<RGB>`: 24bit RGB (red green blue) value.

### Default

```
-WmsgCU0 (r00 g00 b00, black)
```

### Description

Use this option to change the user message color. The value specified must be an RGB (Red/Green/Blue) value, and may be specified in decimal. Use the 0X prefix when using hexadecimal. To produce gray user messages use `-WmsgCU0x808080`.

### Example:

`-WmsgCU255` changes the user messages to blue.

## -WmsgCW: RGB Color for Warning Messages

### Group

MESSAGE

### Scope

Function

### Syntax

```
-WmsgCW <RGB>
```

### Arguments

`<RGB>`: 24bit RGB (red green blue) value.

### Default

```
-WmsgCW255 (r00 g00 bFF, blue)
```

### Description

Sets user message color. User messages use `-WmsgCU0x808080`.

Use this option to change the warning message color. The value specified must be an RGB (Red/Green/Blue) value, and may be specified in decimal. Use the 0X prefix when using hexadecimal. To produce gray warning messages use `-WmsgCW0x808080`.

### Example

`-WmsgCW0` changes the warning messages to black.

## -WmsgFb (-WmsgFbv, -WmsgFbm): Set Message File Format for Batch Mode

### Group

MESSAGE

### Syntax

```
-WmsgFb [ v | m ]
```

### Arguments

`v` : Verbose format.

`m` : Microsoft format.

### Default

```
-WmsgFbm
```

### Description

You can start the tool with additional arguments. If you start the tool with arguments (for example, from the Make Tool or with the `%f` argument from WinEdit), the tool links the files in a batch mode; that is, no tool window appears and the tool terminates after job completion.

If the linker is in batch mode the linker writes messages to a file instead of to the screen. This file contains only the linker messages (see examples below). By default, the tools use a Microsoft message format to write the tool messages (errors, warnings, information messages) if the linker is in batch mode. With this option, the default format may be changed from the Microsoft format (only line information) to a more verbose error format with line, column and source information.

### Example

```
LINK fibo2.abs
NAMES fibo.o start12s.o ansis.lib END
PLACEMENT
 .text INTO READ_ONLY 0x810 TO 0xAFF;
   .data INTO READ_WRITE 0x800 TO 0x80F
END
```

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

```
X:\fibo2.prm(7): ERROR L1004: ; expected
```

Setting the format to verbose writes more information in the file:

```
LINKOPTIONS=-WmsgFbv
>> in "X:\fibo2.prm", line 7, col 0, pos 159
       .data INTO READ_WRITE 0x800 TO 0x80F
END
^
ERROR L1004: ; expected
```

## -WmsgFi: Set Message File Format for Interactive Mode

### Group

MESSAGE

### Syntax

```
-WmsgFi [ v | m ]
```

### Arguments

`v` : Verbose format.

`m` : Microsoft format.

### Default

```
-WmsgFiv
```

### Description

If you start the SmartLinker without additional arguments, the SmartLinker is in the interactive mode (that is, a window is visible).

By default, the SmartLinker uses the verbose error file format to write the SmartLinker messages (errors, warnings, information messages).

With this option, you can change the default format from the verbose format (with source, line and column information) to the Microsoft format (only line information), or from Microsoft format to verbose format.

**NOTE** Using the Microsoft format may speed up the compilation, because the SmartLinker has to write less information to the screen.

### Example

```
PLACEMENT
    .text INTO READ_ONLY 0x810 TO 0xAFF;
    .data INTO READ_WRITE 0x800 TO 0x80F
END
```

By default, the following error output appears in the window if the SmartLinker is running in interactive mode:

```
>> in "X:\fibo2.prm", line 7, col 0, pos 159
    .data INTO READ_WRITE 0x800 TO 0x80F
END
^
ERROR L1004: ; expected
```

Set the format to Microsoft to display less information:

```
LINKOPTIONS=-WmsgFim
X:\fibo2.prm(7): ERROR L1004: ; expected
```

### See also

-WmsgFb (-WmsgFbv, -WmsgFbm): Set Message File Format for Batch Mode

## -WmsgFob: Message Format for Batch Mode

### Group

MESSAGE

### Syntax

```
-WmsgFob <string>
```

### Arguments

`<string>`: format string (see Table B.4).

### Default

```
-WmsgFob"%"%f%e%"(%l): %K %d: %m\n"
```

### Description

Use this option to modify the default message format in batch mode. This option supports formats shown in Table B.4 (assumes that the source file is `x:\freescale\sourcefile.prmx`).

**Table B.4 WmsgFob-Supported Format String Symbols**

| Format | Description | Example |
|---|---|---|
| %s | Source Extract | |
| %p | Path | x:\freescale\ |
| %f | Path and name | x:\freescale\sourcefile |
| %n | File name | sourcefile |
| %e | Extension | .prmx |
| %N | File (8 chars) | sourcefi |

**Table B.4 WmsgFob-Supported Format String Symbols (*continued*)**

| Format | Description | Example |
|---|---|---|
| `%E` | Extension (3 chars) | `.prm` |
| `%l` | Line | `3` |
| `%c` | Column | `47` |
| `%o` | Pos | `1000` |
| `%K` | Uppercase kind | `ERROR` |
| `%k` | Lowercase kind | `error` |
| `%d` | Number | `L1051` |
| `%m` | Message | `text` |
| `%"` | " if full name contains a space | `"` |
| `%'` | ' if full name contains a space | |
| `%%` | Percent | `%` |
| `\n` | New line | |

## Example

```
LINKOPTIONS=-WmsgFob"%'%f%e%'(%l): %k %d: %m\n"
```

Produces a message in the following format:

```
x:\freescale\sourcefile.prmx(3): error L1000: LINK not
found
```

## See also

Environment variable: ERRORFILE: Error File Name Specification

-WmsgFb (-WmsgFbv, -WmsgFbm): Set Message File Format for Batch Mode

-WmsgFi: Set Message File Format for Interactive Mode

-WmsgFonp: Message Format for No Position Information

-WmsgFonf: Message Format for no File Information

-WmsgFoi: Message Format for Interactive Mode

## -WmsgFoi: Message Format for Interactive Mode

### Group

MESSAGE

### Syntax

```
-WmsgFoi<string>
```

### Arguments

`<string>`: format string (see Table B.5).

### Default

```
-WmsgFoi"\n>> in \"%"%f%e%"\", line %l, col %c, pos
%o\n%s\n%K %d: %m\n"
```

### Description

Use this option to modify the default message format in interactive mode. Table B.5 shows the supported formats if the source file is `x:\freescale\sourcefile.prmx`.

**Table B.5 WmsgFoi-Supported Format String Symbols**

| Format | Description | Example |
|---|---|---|
| %s | Source Extract | |
| %p | Path | x:\freescale\ |
| %f | Path and name | x:\freescale\sourcefile |
| %n | File name | sourcefile |
| %e | Extension | .prmx |
| %N | File (8 chars) | sourcefi |
| %E | Extension (3 chars) | .prm |
| %l | Line | 3 |
| %c | Column | 47 |
| %o | Pos | 1234 |

**Table B.5 WmsgFoi-Supported Format String Symbols (*continued*)**

| Format | Description | Example |
|---|---|---|
| `%K` | Uppercase kind | `ERROR` |
| `%k` | Lowercase kind | `error` |
| `%d` | Number | `L1000` |
| `%m` | Message | `text` |
| `%”` | ” if full name contains a space | `”` |
| `%’` | ’ if full name contains a space | |
| `%%` | Percent | `%` |
| `\n` | New line | |

### Example

```
LINKOPTIONS=-WmsgFoi”%f%e(%l): %k %d: %m\n”
```

Produces a message in the following format:

```
x:\freescale\sourcefile.prmx(3): error L1000: LINK not
found
```

### See also

Environment variable: ERRORFILE: Error File Name Specification

-WmsgFb (-WmsgFbv, -WmsgFbm): Set Message File Format for Batch Mode

-WmsgFi: Set Message File Format for Interactive Mode

-WmsgFonp: Message Format for No Position Information

-WmsgFonf: Message Format for no File Information

-WmsgFob: Message Format for Batch Mode

## -WmsgFonf: Message Format for no File Information

### Group

MESSAGE

### Syntax

```
-WmsgFonf<string>
```

### Arguments

`<string>`: format string (see Table B.6).

### Default

```
-WmsgFonf"%K %d: %m\n"
```

### Description

When no file information is available for a message (for example, if a message is not related to a specific file), then this message format string is used.

### Example

```
LINKOPTIONS=-WmsgFonf"%k %d: %m\n"
```

Produces a message in following format:

```
information L10324: Linking successful
```

**Table B.6 WmsgFonf-Supported String Format Symbols**

| Format | Description | Example |
|---|---|---|
| - | | |
| %K | Uppercase kind | ERROR |
| %k | Lowercase kind | error |
| %d | Number | L10324 |
| %m | Message | text |
| %% | Percent | % |
| \n | New line | |

## -WmsgFonp: Message Format for No Position Information

### Group

MESSAGE

### Syntax

```
-WmsgFonp <string>
```

### Arguments

`<string>`: format string (see Table B.7).

### Default

```
-WmsgFonp"%"%f%e%": %K %d: %m\n"
```

### Description

When no position information available for a message (e.g. if a message is not related to a certain position), then this message format string is used. Table B.7 shows the supported formats, assuming that the source file is `x:\freescale\sourcefile.prmx`.

**Table B.7 WmsgFonp-Supported String Formats**

| Format | Description | Example |
|---|---|---|
| - | | |
| %p | Path | x:\freescale\ |
| %f | Path and name | x:\freescale\sourcefile |
| %n | File name | sourcefile |
| %e | Extension | .prmx |
| %N | File (8 chars) | sourcefi |
| %E | Extension (3 chars) | .prm |
| %K | Uppercase kind | ERROR |
| %k | Lowercase kind | error |
| %d | Number | L10324 |
| %m | Message | text |
| %" | " if full name contains a space | " |
| %' | ' if full name contains a space | |
| %% | Percent | % |
| \n | New line | |

### Example

```
LINKOPTIONS=-WmsgFonf"%k %d: %m\n"
```

This produces a message in the following format:

```
information L10324: Linking successful
```

### See also

Environment variable: ERRORFILE: Error File Name Specification

-WmsgFb (-WmsgFbv, -WmsgFbm): Set Message File Format for Batch Mode

-WmsgFi: Set Message File Format for Interactive Mode

-WmsgFonp: Message Format for No Position Information

-WmsgFoi: Message Format for Interactive Mode

-WmsgFob: Message Format for Batch Mode

## -WmsgNe: Number of Error Messages

### Group

MESSAGE

### Syntax

```
-WmsgNe <number>
```

### Arguments

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

### Default

50

### Description

Use this option to set the maximum number of error messages, after which the SmartLinker stops the current linking session.

**NOTE** Subsequent error messages which depend on previous error messages may be confusing.

### Example

```
LINKOPTIONS=-WmsgNe2
```

The SmartLinker stops compilation after two error messages.

### See also

-WmsgNi: Number of Information Messages

-WmsgNw: Number of Warning Messages

## -WmsgNi: Number of Information Messages

### Group

MESSAGE

### Syntax

```
-WmsgNi <number>
```

### Arguments

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

### Default

50

### Description

Use this option to specify the maximum number of information messages.

### Example

```
LINKOPTIONS=-WmsgNi10
```

Logs only ten information messages.

### See also

-WmsgNi: Number of Information Messages

-WmsgNw: Number of Warning Messages

-WmsgNe: Number of Error Messages

## -WmsgNu: Disable User Messages

### Group

MESSAGE

### Syntax

```
-WmsgNu [ = { a | b | c | d }]
```

### Arguments

`a` : Disable messages about all included files

`b` : Disable messages about reading files (e.g. the files used as input)

`c` : Disable messages about generated files

`d` : Disable messages about processing statistics (At the end of processing, the application may provide statistical information, such as code size, and RAM/ROM usage.)

`e` : Disable informal messages (e.g. memory model, floating point format)

### Description

The application produces some messages which are not in the normal message categories (WARNING, INFORMATION, ERROR, FATAL). Use this option to disable such messages. Using this option reduces the number of messages and simplifies the error parsing of other tools.

### Example

*`-WmsgNu=c`*

**NOTE** Depending on the application, not all suboptions may make sense. The system ignores these options.

## -WmsgNw: Number of Warning Messages

### Group

MESSAGE

### Syntax

```
-WmsgNw <number
```

### Arguments

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

### Default

50

### Description

Use this option the to specify the number of warning messages.

### Example

```
LINKOPTIONS=-WmsgNw15
```

Logs only 15 warning messages.

### See also

-WmsgNi: Number of Information Messages

-WmsgNw: Number of Warning Messages

-WmsgNe: Number of Error Messages

## -WmsgSd: Setting a Message to Disable

### Group

MESSAGE

### Syntax

```
-WmsgSd <number>
```

### Arguments

`<number>`: Message number to be disabled, for example, 1201

### Default

None

### Description

Use this option to disable a specific message, so it does not appear in the error output.

### Example

```
LINKOPTIONS=-WmsgSd1201
```

Disables the message for no stack declaration.

### See also

-WmsgSi: Setting a Message to Information

-WmsgSw: Setting a Message to Warning

-WmsgSe: Setting a Message to Error

## -WmsgSe: Setting a Message to Error

### Group

MESSAGE

### Syntax

```
-WmsgSe <number>
```

### Arguments

`<number>`: Message number to be an error, for example, 1201

### Description

Allows the user to change a message to an error message.

### Example

```
LINKOPTIONS=-WmsgSe1201
```

### See also

-WmsgSi: Setting a Message to Information

-WmsgSw: Setting a Message to Warning

-WmsgSd: Setting a Message to Disable

## -WmsgSi: Setting a Message to Information

### Group

MESSAGE

### Syntax

```
-WmsgSi <number>
```

### Arguments

`<number>`: Message number to be an information, e.g. 1201.

### Description

Use this option to set a message to an information message.

### Example

```
LINKOPTIONS=-WmsgSi1201
```

### See also

-WmsgSd: Setting a Message to Disable

-WmsgSw: Setting a Message to Warning

-WmsgSe: Setting a Message to Error

## -WmsgVrb: Verbose Mode (Maker)

### Group

MESSAGE

### Syntax

```
-WmsgVrb
```

### Arguments

None

### Default

None

### Description

Maker prints the error messages to an error file, as explained in the section Message/Error Feedback

### Example

```
maker.exe test.mak -WmsgVrb
```

## -WmsgSw: Setting a Message to Warning

### Group

MESSAGE

### Syntax

```
-WmsgSw <number>
```

### Arguments

`<number>`: Error number to be a warning, for example, 1201.

### Description

Use this option to set a message as a warning message.

### Example

```
LINKOPTIONS=-WmsgSw1201
```

### See also

-WmsgSi: Setting a Message to Information

-WmsgSd: Setting a Message to Disable

-WmsgSe: Setting a Message to Error

## -WOutFile: Create Error Listing File

### Group

MESSAGE

### Syntax

```
-WOutFile ( On | Off )
```

### Arguments

None

### Default

Creates an error listing file

### Description

This option controls whether or not the SmartLinker creates an error listing file. The error listing file contains a list of all messages and errors created during a compilation. Since the text error feedback can be handled with pipes to the calling application, it is possible to obtain this feedback without an explicit file. Control the name of the listing file by using the ERRORFILE environment variable (see ERRORFILE: Error File Name Specification).

### Example

```
-WOutFileOn
```

Creates the error file as specified with ERRORFILE.

```
-WOutFileOff
```

Creates no error file.

### See also

-WErrFile: Create “err.log” Error File

-WStdout: Write to Standard Output

## -WStdout: Write to Standard Output

### Group

MESSAGE

### Syntax

```
-WStdout ( On | Off )
```

### Arguments

None

### Default

Writes output to `stdout`.

### Description

In Windows applications, the usual standard streams are available, but text written to them does not appear anywhere unless explicitly requested by the calling application. This option controls whether the SmartLinker writes text written to the error file into the `stdout` as well.

### Example

```
-WStdoutOn
```

Writes all messages to `stdout`.

```
-WErrFileOff
```

Writes nothing to `stdout`.

### See also

-WErrFile: Create “err.log” Error File

-WOutFile: Create Error Listing File

## -X: Write Disassembled Listing Only (Decoder)

### Syntax

```
-X
```

### Arguments

None

### Default

None

### Description

Writes the pure disassembly listing without any source or comments within the listing.

# -Y: Write Disassembled Listing with Source And All Comments (Decoder)

### Syntax

```
-Y
```

### Arguments

None

### Default

None

### File Format

Only Freescale. ELF Object files are not affected by this option.

### Description

Writes the origin source and its comments within the disassembly listing.

C

# Messages

This chapter describes messages produced by the tools. Because of the number of messages produced, some may not have been documented at the time of this release. Messages are sorted according to the tool that produces them. Messages for the assembler and compiler are listed in their respective manuals.

## Types of Generated Messages

Table C.1 describes the five types of generated messages.

**Table C.1 Types of Generated Messages**

| Message Type | Behavior |
|---|---|
| Information | A message prints and compilation continues. |
| Warning | A message prints and processing continues. These messages indicate possible programming errors. |
| Error | A message prints and processing stops. These messages indicate incorrect language usage. |
| Fatal | A message prints and processing aborts. These messages indicate a severe error, which causes processing to stop. |
| Disable | The message is disabled. No message is issued and processing continues. The application ignores the Disabled message. |

## Message Details

If the application prints a message, the message contains a one-character alphabetic message code and a four- or five-digit number. Use the code and number to search for the indicated message. Following message codes are supported:

- A for Assembler
- B for Burner
- C for Compiler

- L for Linker
- LM for Libmaker
- M for Maker

All messages generated by the application are documented in ascending order for quick 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.

`[DISABLE, INFORMATION, WARNING, ERROR]`

This indicates that the message is a warning message by default, but the user might change the message to either DISABLE, INFORMATION or ERROR.

After the message type, there may be an additional entry indicating the related language:

- C++: Message is generated for C++
- M2: Message is generated for Modula-2

Message numbers less than 10000 are common to all tools. Not every compiler can issue all messages. For example, many compilers do not support any type of `struct` return. Those compilers will never issue the message `C2500: Expected: No support of class/struct return type`.

# Burner Message List

The section describes all burner messages.

## B1: Unknown Message Occurred

[FATAL]

### Description

The application tried to issue an undefined message. This is an internal error. Report any occurrences to your distributor.

## B2: Message Overflow, Skipping <kind> Messages

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates the application has reached the maximum allowed number of displayed messages as controlled by the burner options:

- -WmsgNi: Number of Information Messages,
- -WmsgNw: Number of Warning Messages
- -WmsgNe: Number of Error Messages

Further options of this kind are not displayed.

**TIP** Use the options `-WmsgNi`, `-WmsgNw` and `-WmsgNe` to change the number of messages of whatever type the utility accepts.

## B50: Input file ‘<file>’ not found

[FATAL]

### Description

Indicates the Application was unable to find a file needed for processing.

**TIP** Make sure the file really exits. If you are using a file for which the name contains spaces, you must place quotes around the filename.

## B51: Cannot Open Statistic Log File <file>

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates that the application was unable to open a statistic output file, therefore no statistics were generated.

**NOTE** Not all tools support statistic log files. Even if a tool does not support it, the message still exists, but is never issued.

## B52: Error in Command Line '<cmd>

[FATAL]

### Description

Issued when an error occurs while processing the command line.

## B64: Line Continuation Occurred in <FileName>

[DISABLE, <u>INFORMATION</u>, WARNING, ERROR]

### Description

In an environment file, the character '\' at the end of a line is interpreted as line continuation. This line and the next one are interpreted as one line. Because the path separation character of MS-DOS is also '\', paths are often incorrectly written that end with '\'. Instead use a '.' after the last '\' in a path.

### Example

Current `Default.env`:

```
...
LIBPATH=c:\Freescale\lib\
OBJPATH=c:\Freescale\work
...
```

Is interpreted as

```
...
LIBPATH=c:\Freescale\libOBJPATH=c:\Freescale\work
...
```

**TIP** To fix this code, append a '.' at the end of '\'

```
...
LIBPATH=c:\Freescale\lib\.
```

```
OBJPATH=c:\Freescale\work\
...
```

**NOTE** Because this information occurs during the initialization phase of the application, the message prefix might not occur in the error message. It may appear as `64: Line Continuation occurred in <FileName>`.

## B65: Environment Macro Expansion Error '<description>' for <variablename>

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates that a problem occurred during an environment variable macro substitution. Possible causes are that the named macro did not exist, or that some length limitation was reached. Recursive macros may also cause this message.

### Example

Current variables:

```
...
LIBPATH=${LIBPATH}
...
```

**TIP** Check the definition of the environment variable.

## B66: Search Path <Name> Does Not Exist

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates that the tool searched for a file or file path that was not found.

**TIP** - Check the spelling of your paths.
- Update the paths when moving a project.

- Use relative paths in your environment variables.
- Make sure network drives are available.

## B1000: Could Not Open '<FileType>' '<File>'

[ERROR]

### Description

Indicates that the specified file could not be opened.

This message is used for input and output files.

**TIP** For files to be generated, they must be modifiable and sufficient space must be available on the disk. Ensure that the file is not locked by another application and that the path exists.

## B1001: Error in Input File Format

[ERROR]

### Description

Indicates that an error occurred while reading the input file.

**TIP** - Try to generate the input file again.
- Make sure you have enough free disk space.

## B1002: Selected Communication Port is Busy

[ERROR]

### Description

Indicates that the application cannot access the selected communication port.

**TIP** - Find out if another application has locked the serial port.
- Make sure the correct serial port is specified.

## B1003: Timeout or Failure for the Selected Communication

[ERROR]

### Description:

Indicates that a timeout or general failure occurred on the selected communication port.

**TIP** Find out if another application has locked the serial port.

## B1004: Error in Macro '<macro>' at Position <pos>: '<msg>'

[ERROR]

### Description

Indicates that the Burner was unable to resolve a macro. A macro is surrounded by % characters (e.g. `%ABS_FILE%`).

**TIP** - Make sure the macro is defined in the environment.
- Make sure the macro is passed on the command line using the `-Env` option.

## B1005: Error in Command Line at Position <pos>: '<msg>'

[ERROR]

### Description

Indicates that the command line scanner detected an invalid command line.

**TIP** Check the syntax of your command line.

## B1006: ‘<msg>’

[ERROR]

### Description

Indicates that a generic error occurred.

# Libmaker Message List

The section describes all documented libmaker messages.

## LM1: Unknown Message Occurred

### Message Type

[FATAL]

### Description

Indicates that the application tried to issue an undefined message. This is an internal error. Report any occurrences to your distributor.

## LM2: Message Overflow, Skipping <kind> Messages

### Message Type

[INFORMATION]

### Description

Indicates that the application has displayed the maximum number of messages of the specific type, as specified by the options:

- -WmsgNi: Number of Information Messages,
- -WmsgNw: Number of Warning Messages, and
- -WmsgNe: Number of Error Messages.

Additional messages of this type that exceed the specified limit are not displayed.

**TIP** Use the options listed above to specify the number of messages that can be displayed.

## LM50: Input File ‘<file>’ Not Found

### Message Type

[FATAL]

### Description

The Application was not able to find a file needed for processing.

**TIP** Make sure the file really exits. If you are using a file with a name that contains spaces, you must put quotes around the file name.

## LM51: Cannot Open Statistic Log File <file>

### Message Type

[WARNING]

### Description

Indicates that it was not possible to open a statistic output file, therefore no statistics were generated.

**NOTE** Not all tools support statistic log files. Even if a tool does not support it, the message still exists, but is never issued in this case.

## LM52: Error in Command Line <cmd>

### Message Type

[FATAL]

### Description

Indicates that an error while processing the command line.

## LM64: Line Continuation Occurred in <FileName>

### Message Type

[INFORMATION]

### Description

In any environment file, the character '\' at the end of a line is interpreted as a line continuation character. Because the path separation character for MS-DOS is also '\', paths can be incorrectly written if they end with '\'. Use a '.' after the last '\' to distinguish a path from a line continuation character.

### Example

Current `Default.env`:

```
...
LIBPATH=c:\freescale\lib\
OBJPATH=c:\freescale\work
...
```

Is interpreted as

```
...
LIBPATH=c:\freescale\libOBJPATH=c:\freescale\work
...
```

To fix it, append a '.' after the '\'

```
...
LIBPATH=c:\freescale\lib\.
OBJPATH=c:\freescale\work
...
```

**NOTE** Because this information occurs during the initialization phase of the application, the message prefix might not occur in the error message. The message may appear as `64: Line Continuation occurred in <FileName>`.

## LM65: Environment Macro Expansion Message '<description>' for <variablename>

### Message Type

[ERROR]

### Description

Indicates that a problem occurred during an environment variable macro substitution. The named macro may not exist or some length limitation may have been reached. Also recursive macros may cause this message.

### Example

Current variables:

```
...
LIBPATH=${LIBPATH}
...
```

**TIP** Check the definition of the environment variable.

## LM66: Search Path <Name> Does Not Exist

### Message Type

[INFORMATION]

### Description

Indicates that the tool searched for a file that was not found, or that the specified path did not exist.

**TIP** Check the spelling of your paths. Update the paths when moving a project. Use relative paths.

# Decoder Message List

This section lists all decoder messages.

## D1: Unknown Message Occurred

[FATAL]

### Description

Indicates the application tried to issue an undefined message. This is an internal error. Report this message to your distributor.

## D2: Message Overflow, Skipping <kind> Messages

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates the application has issued the maximum number of message types specified with the options:

-WmsgNi: Number of Information Messages

-WmsgNw: Number of Warning Messages

-WmsgNe: Number of Error Messages.

Additional messages of this type are not displayed.

**TIP** Use the options listed above to change the number of messages to display.

## D50: Input File ‘<file>’ Not Found

[FATAL]

### Description

Indicates the application was unable to find a file needed for processing.

**TIP** Make sure the file really exists. If you are using a file with a name that contains spaces, you must enclose the file name in quotes.

## D51: Cannot Open Statistic Log File <file>

```
[DISABLE, INFORMATION, WARNING, ERROR]
```

### Description

Indicates the application was unable to open a statistic output file, therefore no statistics are generated.

**NOTE** Not all tools support statistic log files. Even if a tool does not support it, the message still exists, but is not issued in this case.

## D52: Error in Command Line <cmd>

```
[FATAL]
```

### Description

Indicates an error occurred while processing the command line.

## D64: Line Continuation Occurred in <FileName>

```
[DISABLE, INFORMATION, WARNING, ERROR]
```

### Description

In any environment file, the character '\' at the end of a line is interpreted as line continuation. This line and the next one are handled as one line. Because the path separation character of MS-DOS is also '\', paths that end with '\' are often incorrectly written. Instead, use a '.' after the last '\' unless you really want a line continuation.

### Example

Current `Default.env`:

```
...
LIBPATH=c:\freescale\lib\
OBJPATH=c:\freescale\work
...
```

This is identical to:

```
...
LIBPATH=c:\freescale\libOBJPATH=c:\freescale\work
...
```

To fix it, append a '.' after the '\'

```
...
LIBPATH=c:\freescale\lib\.
OBJPATH=c:\freescale\work
...
```

## D65: Environment Macro Expansion Message '<description>' for <variablename>

`[DISABLE, INFORMATION, WARNING, ERROR]`

### Description

Indicates a problem occurred during an environment variable macro substitution. Possible causes are that the named macro did not exist or a length limitation was reached. Also, recursive macros may cause this message.

### Example

Current variables:

```
...
LIBPATH=${LIBPATH}
...
```

**TIP** Check the definition of the environment variable.

## D66: Search Path <Name> Does Not Exist

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates that the tool looked for a file that was not found, or a path name that does not exist.

**TIP** Check the accuracy of your paths. Update the paths when moving a project. Use relative paths.

## D1000: Bad Hex Input File <Description>

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

Indicates that the decoder detected incorrect entries in the file while decoding an S-Record or an Intel Hex file. The content of `<Description>` gives more detail.

**TIP** Check the descriptive text to ensure that the correct file was passed to the decoder.

## D1001: Because Current Processor is Unknown, No Disassembly is Generated. Use -proc.

[DISABLE, INFORMATION, WARNING, ERROR]

### Description

While decoding n S-Record or an Intel Hex file, the decoder needs to know about the processor used to decode the file with disassembly information. This is needed because these formats do not contain information about the processor.

**TIP** Use the `-Proc` option (see -Proc: Set Processor (Decoder)) to specify the processor.

# Makefile Messages

This section lists and describes error messages that can appear when:

- Maker detects an error in the makefile
- A called application detects an error that Maker catches

## M1: Unknown Message Occurred

### Message Type

[FATAL]

### Description

Maker tried to send an undefined message. This internal error should not occur. Report it to your distributor.

## M2: Message Overflow, Skipping <kind> Messages

### Message Type

[INFORMATION]

### Description

The tool displays the number of messages of the specific kind as controlled with the options -WmsgNi: Number of Information Messages, -WmsgNw: Number of Warning Messages and -WmsgNe: Number of Error Messages. Maker does not display further options of this kind.

**TIP** Use the options `-WmsgNi`, `-WmsgNw` and `-WmsgNe` to change the number of messages.

## M50: Input File ‘<file>’ Not Found

### Message Type

[FATAL]

### Description

The Application did not find a file needed for processing.

**TIP** Make sure the file really exists. If using a file name containing spaces, enclose the file name in quotes.

## M51: Cannot Open Statistic Log File <file>

### Message Type

[WARNING]

### Description

Maker could not open a statistic output file, therefore it generated no statistics.

**NOTE** If a tool does not support statistical log files, the message still exists but Maker does not issue it.

## M64: Line Continuation Occurred in <FileName>

### Message Type

[INFORMATION]

### Description

In any environment file, the backslash character (\) at the end of a line denotes a line continuation. Maker handles this line and the next one as a single line. Because the backslash is also the path-separation character in MS-DOS, paths often incorrectly end in '\'. Use a period ( . ) after the last backslash unless you really want a line continuation.

### Example

```
Current Default.env:
...
LIBPATH=c:\freescale\lib\
OBJPATH=c:\freescale\work
...
which Maker interprets as:
...
LIBPATH=c:\freescale\libOBJPATH=c:\freescale\work
...
```

**TIP** Append a period (.) behind the backslash (\).

```
...
LIBPATH=c:\freescale\lib\.
OBJPATH=c:\freescale\work
...
```

**NOTE** Because this information occurs during the Maker's initialization phase, the `M` may not occur in the error message but may appear as `64: Line Continuation occurred in <FileName>`.

## M65: Environment Macro Expansion Error '<description>' for <variablename>

### Message Type

[INFORMATION]

### Description

Indicates that a problem occurred during an environment-variable macro substitution. Possible causes are that the named macro did not exist or some length limitation occurred. Recursive macros may also cause this message.

### Example

```
Current Default.env:
...
LIBPATH=${LIBPATH}
...
```

**TIP** Check the definition of the environment variable.

## M66: Search Path <Name> Does Not Exist

### Message Type

[INFORMATION]

### Description

Indicates that the tool was unable to find a file. The search failed because the tool was searching for a non-existent path.

**TIP** Check the spelling of your paths.
Update the paths when moving a project.
Use relative paths in your environment variables.
Make sure network drives are available.

## M5000: User Requested Stop

### Message Type

[ERROR]

### Description

The user clicks the **Stops the current make process** icon. A message dialog prompts you to continue or interrupt the current make process.

## M5001: Error in Command Line

### Message Type

[ERROR]

### Description

Maker detected a syntax error in the command line. Maker scans only the tokens that start with a dash ( - ) (which signals options) but leaves the other names in command line unscanned. Because Maker assumes that these tokens represent filenames, it answers only option errors with this message. It prints M5019 for other syntactical errors.

### Example

```
maker -Y
## Y is an illegal option
```

**TIP** Call Maker with the `-h` argument for a list of options.

## M5002: Can't Return to <makefile> at End of Include File

### Message Type

[ERROR]

### Description

The makefile executed before opening the include file and Maker cannot reopen it again.

**TIP** Make sure the makefile exists.

## M5003: Illegal Dependency

### Message Type

[ERROR]

### Description

Only identifiers or filenames can reside in the dependency list. Maker reports other tokens as invalid.

### Example

```
makeall:
 inout.o message.o main.o (*)
```

**TIP** Name your targets with identifiers.

## M5004: Illegal Macro Reference

### Message Type

[ERROR]

### Description

You used a name for a macro that is not an identifier. You must name all your macros with identifiers.

### Example

```
makeall:
  cc src.c $(***)
```

## M5005: Macro Substitution Too Complex

### Message Type

[ERROR]

### Description

Maker cannot resolve the macro in a table overflow.

**TIP** Organize your makefile structure. Use template makefiles called from Maker with command-line macros as arguments.

## M5006: Macro Reference Not Closed

### Message Type

[ERROR]

### Description

Macro has no right brace to close the macro.

### Example

```
makeall:
  cc src.c $(MYMAC
```

**TIP** Add a right brace.

## M5007: Unknown Macro: <macroname>

### Message Type

[ERROR]

### Description

Maker did not recognize `<macroname>` as a declared macro.

## M5008: Macro Definition or Command Line Too Long

### Message Type

[ERROR]

### Description

Maker cannot read a line in the makefile because it is too long.

## M5009: Illegal Include Directive

### Message Type

[ERROR]

### Description

The include directive has too many arguments.

### Example (invalid)

```
INCLUDE macros.inc utils.inc
```

**TIP** Divide the include into multiple includes:

```
INCLUDE macros.inc
INCLUDE utils.inc
```

## M5010: Illegal Line

### Message Type

[ERROR]

### Description

Maker encountered a syntax error in the makefile. The line starts with an invalid token sequence.

### Example (invalid)

```
makeAll: Compile Link
echo "-- all done   ## command has to start with spaces
```

## M5011: Illegal Suffix for Inference Rule

### Message Type

[ERROR]

### Description

The rule has incorrect syntax.

### Example (correct)

```
.c.o :
  $(CC) $(CFLAGS) $*.c
```

## M5012: Include File Not Found: <includefile>

### Message Type

[WARNING]

### Description

The filename given as an argument of the `INCLUDE` command does not specify an existing file.

**TIP** Verify the accuracy of the path settings in your `default.env` file; verify that the environment variable `DefaultDir` in the File `MCUTOOLS.INI` did not set the default directory.

## M5013: Include File Too Long: <includefile>

### Message Type

[ERROR]

### Description

Maker cannot include the specified file because it is too big.

**TIP** Divide your included file into several smaller files.

## M5014: Circular Macro Substitution in <macroname>

### Message Type

[ERROR]

### Description

Maker detected a circular reference in the macro substitution.

## M5015: Colon ( : ) Expected

### Message Type

[ERROR]

### Description

Always mark a target declaration with a colon after the target identifier, followed by the dependencies.

## M5016: Filename After INCLUDE Expected

### Message Type

[ERROR]

### Description

Maker detected a token after the `INCLUDE` command that is not a filename which conforms to a Maker identifier.

**TIP** Do not use non-alphanumeric characters in filenames, even if the operating system allows them.

## M5017: Circular Include, File <includefile>

### Message Type

[ERROR]

### Description

Maker does not allow circular include references in a makefile.

### Example

```
.mak file includes A.inc. A.inc includes B.inc. B.inc
includes C.inc. C.inc includes A.inc
```

## M5018: Entry Doesn't Start at Column 0

### Message Type

[ERROR]

### Description

Entries (Identifier: dependencies.) must start at the first column of a line.

## M5019: No Makefile Found

### Message Type

[ERROR]

### Description

The makefile specified in the argument list does not exist.

**TIP** Verify the accuracy of the path settings in your `default.env` file; also verify that the default directory, set by the `DefaultDir` environment variable in the `MCUTOOLS.INI` file, is not set.

## M5020: Fatal Error During Initialization

### Message Type

[ERROR]

### Description

The Maker initialization procedure failed.

**TIP** Restore a previously functional configuration.

## M5021: Nothing to Make: No Target Found

### Message Type

[ERROR]

### Description

The Maker did not specify a target.

## M5022: Don't Know How to Make <target>

### Message Type

[ERROR]

### Description

The target-dependency list contains an identifier that does not exist as a file and does not reside in the target list of the makefile.

**TIP** This message sometimes appears even if target or file dependencies exist. Maker dependency resolutions do not always find all targets, especially when you work with multiply layered rules. For this reason, structure the makefile another way and check the settings in your `default.env` file.

## M5023: Circular Dependencies Between <target1> and <target2>

### Message Type

[ERROR]

### Description

`<target1>` is in the transitive closure of circular dependencies. For example, build `<target1>` `<target1>`. `<target2>` is the last target handled before Maker detects the circular dependencies.

### Example

```
XX:   AA BB
AA:   FF EE
BB:   DD
DD:   XX
EE:
FF:
## XX is dependent (transitive closure) on
AA,BB,FF,EE,DD,XX
```

## M5024: Illegal Option

### Message Type

[ERROR]

### Description

The option specified in the command line has an incorrect format.

### Example

```
Maker test.mak -DCC+\HC12\CHC12.EXE
```

instead of

```
Maker test.mak -DCC=\HC12\CHC12.EXE
```

**TIP** With `-h`, Maker prints all available options with the expected argument list.

## M5027: Making Target <target>

### Message Type

[INFORMATION]

### Description

Maker currently builds the specified target.

**TIP** The two special targets `BEFORE` and `AFTER` execute just before and after the top target. Use them for initiations and cleanup.

## M5028: Command Line Too Long: <commandline>

### Message Type

[ERROR]

### Description

The command line passed to Maker is too long for Maker.

## M5029: Illegal Target Name: <targetname>

### Message Type

[ERROR]

### Description

You specified an invalid name as the target, which can happen when using multiple command-line arguments. Maker takes the first argument as a make file name and all remaining arguments as target names. If some target names are invalid, this message appears. If you ignore this message with the message move options, then Maker ignores the invalid target name.

# Exec Process Messages

This section explains messages that can appear when a command in a target's build-command list fails.

## M5100: Command Line Too Long for Exec

### Message Type

[ERROR]

### Description

The length of a command in the target's command list in the makefile is too long to execute.

## M5101: Two File Names Expected

### Message Type

[ERROR]

### Description

Some Maker commands (such as `Copy` or `Ren`) need two filenames as arguments. This error message occurs when the command did not contain two filenames.

## M5102: Input File Not Found

### Message Type

[ERROR]

### Description

A built-in file command required to open a source file for reading was unable to find that source file.

## M5103: Output File Not Opened

### Message Type

[ERROR]

### Description

A built-in file command required to open or create a destination file for writing failed to open or create that destination file.

**TIP** Check the settings in your `default.env` file.

## M5104: Error While Copying

### Message Type

[ERROR]

### Description

While copying one file, another failed in the block-copy loop. Maker opened the file but the blockwise write operation failed.

**TIP** Check the attributes of the destination file.

## M5105: Renaming Failed

### Message Type

[ERROR]

### Description

Maker failed to rename a file.

Potential causes are:

- Inappropriate filenames as arguments
- The source file does not exist, or another process is using it
- The destination file name is already in use.

**TIP** Check the file (including its attributes) to rename the file.

## M5106: File Name Expected

### Message Type

[ERROR]

### Description

Maker expects an argument of a built-in command to specify an existing file, but it has an illegal format for a file name.

**TIP** Use only names and extensions allowed for C-identifiers, even if your operating system permits more character types for filenames.

## M5107: File Does Not Exist

### Message Type

[ERROR]

### Description

Maker expects a built-in command argument to specify an existing file, but the file does not exist.

**TIP** Check the settings in your `default.env` file.

## M5108: Called Application Detected an Error

### Message Type

[ERROR]

### Description

The application that Maker called detected an error not reported in detail in its error output, or Maker did not find the error output.

**TIP** Use a file named EDOUT, or another file that you specify using the environment variable ERRORFILE, in your default.env file. Maker prints the lines in this file starting with ERROR, FATAL, WARNING or INFORMATION if enabled in the Maker.

## M5109: Echo <commandline>

### Message Type

[INFORMATION]

### Description

This message appears when Maker calls an application. The entire macro-expanded command line displays.

## M5110: Called Application Caused a System Error

### Message Type

[ERROR]

### Description

The program that Maker executed exited with an operating-system error.

## M5111: Change Directory (cd) Failed

### Message Type

[ERROR]

### Description

The built-in cd command was unable to change the directory.

**TIP** Make sure the specified directory exists. Check your working directory when using relative paths.

## M5112: Called Application: <error>

### Message Type

[ERROR]

### Description

The called application detected an error and wrote it to the error-output file. Maker prints the error message if you enable the message type in Maker.

### Example

```
ERROR M5112: called application detected an error: "ERROR
C1005: Illegal storage class!"
```

The string quoted is the called program's message.

**TIP** Try to run the application manually with the specified arguments. You can reclassify the called program's message class to `ERROR`, `WARNING`, or `INFORMATION`; you can also disable it.

## M5113: Called Application: <warning>

### Message Type

[WARNING]

### Description

The called application issued a warning and wrote it to the error output file. Maker prints the warning message if you enable its message type in Maker.

### Example

```
WARNING M5113: called application: "WARNING C1038:
Cannot be friend of myself"
```

The string quoted is the called program's message. If you classify M5113 as an error, Maker prints message as:

```
ERROR M5113: called application: "WARNING C1038: Cannot
be friend of myself"
```

**TIP** Try to run the application manually with the specified arguments. You can reclassify the called program's message class to `ERROR`, `WARNING`, or `INFORMATION`; you can also disable it.

## M5114: Called Application: <information>

### Message Type

[INFORMATION]

### Description

The called application issued information and wrote it to its error output file. Maker prints the information message in Maker.

### Example

```
INFORMATION M5114: called application: "INFORMATION
C1390: Implicit virtual function"
```

The string quoted is the called program's message.

**TIP** Try to run the application manually with the specified arguments. You can reclassify the called program's message class to `ERROR`, `WARNING`, or `INFORMATION`; you can also disable it.

## M5115: Called Application: <fatal>

### Message Type

[ERROR]

### Description

The called application detected a fatal error and wrote the message to its error output file. Maker prints the fatal warning message if you enabled that message type in Maker.

### Example

```
ERROR M5115: called application: "FATAL C1403: Out of
memory"
```

The string quoted is the called program's message.

**TIP** Try to run the application manually with the specified arguments. You can reclassify the called program's message class to `ERROR`, `WARNING`, or `INFORMATION`; you can also disable it.

## M5116: Could Not Delete File

### Message Type

[WARNING]

### Description

The built-in `del` command was unable to delete the specified argument file.

**TIP** Make sure that the file exists and that its attributes allow Maker to delete it.

## M5117: Path Was Not Found

### Message Type

[ERROR]

### Description

Maker was unable to restore an old directory that changed with the built-in command `cd` after the end of the command-list scope.

**TIP** Make sure the old directory exists. It must exist to use `cd`.

## M5118: Could Not Create Process: <diagnostic>

### Message Type

[ERROR]

### Description

The operating system issues this message when the called process cannot run. The detailed message resides in `<diagnostic>`.

## M5119: Exec <commandline>

### Message Type

[INFORMATION]

### Description

Maker issues this message after it calls an application. The entire macro-expanded command line displays.

## M5120: Running Version with Limited Number of Execution Calls. Number of Allowed Execution Calls Exceeded

### Message Type

[FATAL]

### Description

This message does not appear when you have a fully registered version of Maker. A non-registered demonstration version has processing limitations. The demonstration version has a limit of five command calls. If you exceed this limit in one run, M5120 appears and the make process stops.

## M5121: The Files <file1> and <file2> Are Not Identical

### Message Type

[INFORMATION]

### Description

An `fc` or `fctext` built-in command detected that two files are not identical.

## M5122: The Files <file1> and <file2> Are Identical

### Message Type

[INFORMATION]

### Description

A `fc` or `fctext` built-in command detected that two files are identical.

## M5153: Processing Make Files Under Win32s Is Not Supported by the Maker

### Message Type

[FATAL]

### Description

Maker cannot synchronize the execution of commands with its own processing under Win32s and cannot run under Win32s. This error occurs because a 32-bit application running under Win32s with the 32-bit API cannot detect a completed called application. The Maker issues this message if you try to run a makefile under Win32s and stops execution.

# Modula-2 Maker Messages

This section explains messages that can appear when the build process for Modula-2 fails.

## M5700: Environment Variable COMP Not Set

### Message Type

[ERROR]

### Description

The `COMP` environment variable defines the Modula-2 compiler. When you do not set this variable, the Modula-2 Maker can run only in silent mode (option `-s`).

## M5701: Environment Variable LINK Not Set

### Message Type

[ERROR]

### Description

The `LINK` environment variable defines the linker. When you do not set this variable, the Maker can run only in silent (option `-s`) or in compile-only mode (option `-c`).

## M5702: Neither Source Nor Symbol File Found: <source file>

### Message Type

[ERROR]

### Description

The compiler found neither the object file nor the source file, and was unable to build the target.

**TIP** Check the settings in your `default.env` file.

## M5703: Circular Imports in Definition Modules

### Message Type

[ERROR]

### Description

The transitive closure of a module's import list includes the module itself (a circular dependency list).

**TIP** Layer your application and put basic types included from different layers into separate modules.

## M5704: Can't Recompile <source file> (No Source Found)

### Message Type

[ERROR]

### Description

The compiler was unable to find the specified source file.

**TIP** Determine whether the source file exists in a location other than expected. Also check the settings in your `default.env` file.

## M5705: No Make File Generated (Top Module Not Found)

### Message Type

[WARNING]

### Description

The compiler was unable to write the makefile for the Modula-2 project because you did not specify the top target.

**TIP** Check the settings in your `default.env` file.

## M5706: Couldn't Open the Listing File <list file>

### Message Type

[WARNING]

### Description

A file error occurred upon opening or closing the listing file for Modula-2 Make.

**TIP** Check the settings in your `default.env` file.

## M5708: Couldn't Open the Makefile

### Message Type

[ERROR]

### Description

The makefile does not exist, or the make process was unable to open it for reading.

**TIP** The default extension for Modula-2 makefiles is `.MOD`.

**TIP** Check the settings in your `default.env` file.

## M5761: Wrote Makefile <makefile>

### Message Type

[INFORMATION]

### Description

Maker prints this information if no error occurred and the Modula-2 Maker succeeded in creating the makefile.

## M5762: Wrote Listing File <listfile>

### Message Type

[INFORMATION]

### Description

Maker prints this information if no error occurred and the Modula-2 Maker succeeded in creating the listing file.

## M5763: Compilation Sequence

### Message Type

[INFORMATION]

### Description

Announces the print listing to the Maker standard output instead of to a file listing.

# D

# Tool Commands

## SmartLinker Commands

This section describes each SmartLinker parameter command. Each command description includes the following:

- **Syntax**: Description of the command syntax.
- **Description**: Detailed description of the command.
- **Example**: Example of how to use the command.

Some commands are available only in ELF/DWARF format, and some commands only in Freescale object file format. This is indicated with the object file format in parenthesis (ELF) or (Freescale).

If a command is available only for a specific language, it is also indicated. For example, **M2** denotes that the feature is available only for Modula-2 linker parameter files.

Additionally, it is also noted if the behavior of a command is different for Freescale and ELF/DWARF formats.

---

### AUTO_LOAD: Load Imported Modules (Freescale, M2)

#### Syntax

```
AUTOLOAD ON | OFF
```

#### Description:

The optional `AUTO_LOAD` command affects linking only when there are Modula-2 modules present. When `AUTO_LOAD` is switched `ON`, the linker automatically loads and processes all modules imported in some Modula-2 modules. It is not necessary to enumerate all object files of Modula-2 applications. The linker assumes that the object file name of a Modula-2 module is the same as the module name with the `.o` extension. Modules automatically loaded by the linker (i.e. imported in a Modula-2 Module present in the `NAMES` list) must not appear in the `NAMES` list. The default setting is ON.

You must switch `AUTO_LOAD OFF` when linking with a ROM library. If switched ON, the linker automatically loads the missing object files, and disregards the objects in the ROM library.

**NOTE** You must also switch `AUTO_LOAD OFF` if the object file names are not the same as the module names, because this prevents the linker from finding the object files.

### Example:

```
AUTOLOAD ON
```

## CHECKSUM: Checksum Computation (ELF)

### Syntax

```
Checksum= CHECKSUM {ChecksumEntry} END.
ChecksumEntry= CHECKSUM_ENTRY
     ChecksumMethod
     [INIT Number]
     [POLY Number]
     OF MemoryArea
     OF MemoryArea
     OF MemoryArea
     ...
     ..
     INTO MemoryArea
     [UNDEFINED Number]
   END.
ChecksumMethod= METHOD_CRC_CCITT | METHOD_CRC8
| METHOD_CRC16 | METHOD_CRC32
| METHOD_ADD [SIZE <Size>] | METHOD_XOR.
```

### Description:

This command instructs the linker to compute `checksum` over some memory areas. All necessary information for this is specified in this structure.

**NOTE** The specified `OF MemoryArea` usually also has its separate `SEGMENTS` entry. Use the `FILL` directive to fill all gaps and ensure a predictable result.

### Example

```
SEGMENTS
MY_ROM = READ_ONLY   0xE020 TO 0xFEFF FILL 0xFF;
....
END
CHECKSUM
  CHECKSUM_ENTRY METHOD_CRC_CCITT
    OF READ_ONLY 0xE020 TO 0xEEFF
    OF READ_ONLY 0xEF00 TO 0xFEFF
    INTO    READ_ONLY   0xE010 SIZE 2
    UNDEFINED 0xff
  END
END
```

The checksum computes only over areas with `READ_ONLY` and `CODE` qualifiers. Checksum computations support the following methods:

- `METHOD_XOR` – XORs the elements of the memory areas together. The size of the `INTO_AREA` defines the element size.
- `METHOD_ADD` – Adds the elements of the memory areas together. The optional `SIZE` argument defines the element size. If you do not specify the `SIZE` option, the linker uses the size of the `INTO_AREA` instead.
- `METHOD_CRC_CCITT` – Computes a 16-bit cyclic redundancy check (CRC) checksum according to CRC CCITT over all bytes in the areas. The `INTO_AREA` size must be 2 bytes.
- `METHOD_CRC16` – Computes a 16-bit CRC checksum according to the commonly used CRC 16 over all bytes in the areas. The `INTO_AREA` size must be 2 bytes.
- `METHOD_CRC32` – Computes a 32-bit CRC checksum according to the commonly used CRC 32 over all bytes in the areas. The `INTO_AREA` size must be 4 bytes.

The linker uses the optional `[INIT Number]` entry as the initial value in checksum computation. If it is not specified, the linker uses the default value of `0xffffffff` for CRC checksums and 0 for addition and XOR.

The optional `[POLY Number]` entry allows you to specify alternative polynomials for the CRC checksum computation.

`OF MemoryArea`: The area for which to compute the checksum.

`INTO MemoryArea`: The area into which to store the computed checksum. This area must be distinct from any other placement in the `prm` file and from the `OF MemoryArea`.

The linker uses the optional `[UNDEFINED Number]` value when no memory is available at certain places. Use the `FILL` directive to prevent this linker behavior (for an example see above).

### Example 1

```
CHECKSUM
    CHECKSUM_ENTRY
        METHOD_CRC_CCITT
        OF READ_ONLY 0xE020 TO 0xEEFF
        OF READ_ONLY 0xEF00 TO 0xFEFF
        INTO    READ_ONLY   0xE010 SIZE 2
        UNDEFINED 0xff
    END
END
```

This entry causes the computation of a checksum of areas 0xE020 to 0xEEFF and 0xEF00 to 0xFEFF, and stores the checksum value at address 0xE010.

The linker calculates the checksum according to the CRC CCITT.

### Example 2

Assume the following memory content:

```
0x1000 02 02 03 04
```

Then the XOR 1-byte checksum from 0x1000 to 0x1003 is `0x07 (=0x02^0x02^0x03^0x04).`

**NOTE** `METHOD_XOR` is the fastest computation method; `METHOD_ADD` is the next fastest computation method. However, for both `METHOD_XOR` and `METHOD_ADD`, multiple regular 1-bit changes can cancel each other out. The CRC methods avoid this weakness.
For example, if you clear both 0x1000 and 0x1001, then the XOR checksum does not change. Similar cases exist for ADD checksum as well.

**NOTE** `METHOD_XOR` and `METHOD_ADD` also support using larger element sizes to compute the checksum.

By default, the linker uses the size of `INTO MemoryArea` as the element size. However for `METHOD_ADD` you can explicitly specify the size (in bytes) as less than the `INTO MemoryArea` size.

With an element size of 2, the checksum of the example is 0x0506 (`= 0x0202 ^ 0x0304`).

**NOTE** Larger element sizes allow faster computation of the checksums on 16- or 32-bit machines.

The `OF MemoryArea` size and address must be multiples of the element size.

CRC-based methods compute the checksum values in bytes.

Often, the actual size of the area to be checked is not known in advance.

Depending on how much C source code the compiler generates, the placements may be relatively full.

**NOTE** This method does not support varying element sizes. Instead, fill unused areas in the placement with the `FILL` directive to a known value. This increases overhead as the checksum computes these fill areas as well.

## CHECKKEYS: Check Module Keys (Freescale, M2)

### Syntax

```
CHECKKEYS ON | OFF
```

### Description

If the optional `CHECKKEYS` command is switched `ON` (default), the linker compares module keys of the Modula-2 modules in the application and issues an error message if it detects an inconsistency (symbol file newer than the object file). `CHECKKEYS OFF` turns off this module key check.

### Example

```
CHECKKEYS ON
```

## DATA: Specify the RAM Start (Freescale)

### Syntax

```
DATA Address
```

### Description

**NOTE** Older linker parameter files support this command. This command will not be supported in future releases.

Use this command to specify the default ROM start address. The specified address must be in hexadecimal notation. The linker translates this command internally as:

```
DATA 0x????' => 'DEFAULT_RAM INTO READ_WRITE 0x???? TO
0x????
```

The unknown end address of `DEFAULT_RAM` causes the linker to specify or attempt to find out the end address itself.

### Example

```
START 0x1000
```

## DEPENDENCY: Dependency Control

### Syntax

```
DEPENDENCY {Dependency} END.
Dependency = ROOT {ObjName} END
| ObjName USES {ObjName} END
| ObjName ADDUSE {ObjName} END
| ObjName DELUSE {ObjName} END.
```

### Description

The DEPENDENCY keyword allows the modification of automatically-detected dependency information.

Use this command to add new roots (`ROOT` keyword) and overwrite (`USES`), extend (`ADDUSE`), or remove (`DELUSE`) existing dependencies.

The dependency information serves two purposes:

- Smart Linking – Links only the objects that depend on roots.
- Overlapping local variables and parameters – Some small 8-bit processors use global memory instead of stack space to allocate local variables and parameters. The linker uses the dependency information to allocate local variables of different functions to the same addresses, provided the functions are never active simultaneously.

### ROOT Keyword

Use the `ROOT` keyword to specify a group of root objects.

A `ROOT` entry with a single object functions the same as using the object in an `ENTRIES` section (see ENTRIES: List of Objects to Link with Application). A `ROOT` entry with several objects functions the same as using the object in an `OVERLAP_GROUP` entry (see OVERLAP_GROUP: Application Uses Overlapping (ELF)). If you use several objects in one root group, only one object of the group is active at a time. Use this information to improved variable overlap allocation. The linker allocates function variables of the same group in the same area. To avoid this, either use several ROOT blocks or add the objects in the ENTRIES section.

### Example: Overlapped Allocation of Variables (Not Applicable for all Targets)

**Listing D.1 C source**

```
void main(void) { int i; ....}
void interrupt int1(void) { int j; ... }
void interrupt int2(void) { int k; ... }
prm file:
...DEPENDENCY
  ROOT main END
  ROOT int1 int2 END
END
```

In this example, the linker allocates the variables of the function `main` and all its dependents first, then allocates the variables of `int1` and `int2` into the same area. This means `j` and `k` may overlap.

### USES Keyword

The `USES` keyword defines all dependencies for a single object. Only the given dependencies are used. Any unlisted dependencies are ignored. If a needed dependency is not specified after the `USES`, the linker issues error messages.

### Example: Overlapped Allocation of Variables (Not Applicable for all Targets)

**Listing D.2 C Source**

```
void f(void(* fct)(void)) { int i; ... fct();...}
void g(void) { int j;... }
void h(void) { int k;... }
void main(void) { f(g); f(h); }
```

**Listing D.3 prm File**

```
DEPENDENCY
  f USES g h END
END
```

This `USES` statement assures that the variable `i` of `f` does not overlap any of the variables of `g` or `h`.

**NOTE** The automatic detection does not work for functions called by a function pointer initialized outside of the function, as in this case.

The `USES` keyword hides any compiler-specified dependencies. If the code of `f` (not shown above) calls any additional functions, `USES` generates errors. It is usually better to use `ADDUSE` than `USES`.

## ADDUSE Keyword

Use the `ADDUSE` keyword to add additional dependencies to those that are automatically detected. Use `ADDUSE` to ensure that no dependencies are lost. Generated application code may use more memory, but considers all known dependencies.

## Example: Overlapped Allocation of Variables (Not Applicable for all Targets)

**Listing D.4 C Source**

```
void f(void(* fct)(void)) { int i; ... fct();...}
void g(void) { int j;... }
void h(void) { int k;... }
void main(void) { f(g); f(h); }
```

**Listing D.5 prm File**

```
DEPENDENCY
  f ADDUSE g h END
END
```

This code adds only new dependencies.

For smart linking, automatic detection covers almost all cases. You only need to link additional depending objects if objects are accessed by a fixed address.

### Example: (Smart Linking)

#### Listing D.6 C Code

```
int i @ 0x8000;
void main(void) {
  *(int*)0x8000 = 3;
}
```

To tell the linker to link `i` as well as `main`, add the following line to the link parameter file:

```
DEPENDENCY main ADDUSE i END
```

### DELUSE Keyword

Use the `DELUSE` keyword to remove single dependencies from the set of automatically-detected dependencies.

To get a list of all automatically-detected dependencies, comment out any `DEPENDECY` blocks in the prm file, switch on map file generation and look at the `OBJECT-DEPENDENCIES SECTION` in the generated map file.

Automatic dependency generation can generate unnecessary dependencies because some runtime behavior is not taken into account.

### Example:

#### Listing D.7 C Source

```
void MainWaitLoop(void) { int i; for (;;) { ... } }
void _Startup(void) { int j; InitAll();
 MainWaitLoop(void); }
```

#### Listing D.8 prm File

```
DEPENDENCY
  _Startup DELUSE MainWaitLoop END
  ROOT _Startup MainWaitLoop END
END
```

Because `MainWaitLoop` takes no parameters and never returns, the linker can allocate the local variable `i` overlapped with `_Startup`. The `ROOT` directive specifies that the locals of the two functions can be allocated at the same addresses.

### Overlapping of Local Variables and Parameters

The most common application of the DEPENDENCY command is for overlapping.

### See Also:

OVERLAP_GROUP: Application Uses Overlapping (ELF)

## ENTRIES: List of Objects to Link with Application

### Syntax (ELF):

```
ENTRIES
    [FileName " :"](*|objName)
    {[FileName ":"](*|objName)}
END
```

### Syntax (Freescale):

```
ENTRIES objName {objName} END
```

### Description

Use the ENTRIES block to specify a list of objects that must always be linked with the application, even when they are never referenced. The specified objects are used as additional entry point in the application. The linker links all objects referenced within these objects with the application.

The optional ENTRIES block cannot be specified more than once in a prm file.

Table D.1 describes the supported notations.

**Table D.1 Notations and Descriptions**

| Notation | Description |
|---|---|
| <Object Name> | Links the specified global object with the application. |
| <File Name>:<Object Name> (ELF) | Links the specified local object defined in the specified binary file with the application. |
| <File Name>:* (ELF) | Links all objects defined within the specified file with the application. |
| * (ELF) | Links all objects with the application. This switches OFF smart linking for the application. |

### ELF-Specific Issues

If a file name specified in the ENTRIES block is not present in the NAMES block, the linker inserts the file name in the list of binary files building the application.

#### Example:

```
NAMES
  startup.o
END

ENTRIES
  fibo.o:*
END
```

In this example, the linker builds the application from the files fibo.o and startup.o.

File names specified in the ENTRIES block may also be present in the NAMES block.

#### Example:

```
NAMES
  fibo.o startup.o
END

ENTRIES
  fibo.o:*
END
```

In this example, the linker builds the application from the files fibo.o and startup.o. The file fibo.o specified in the NAMES block is the same file specified in the ENTRIES block.

**NOTE** We strongly recommend that you avoid switching smart linking OFF when the ANSI library is linked with the application. The ANSI library contains the implementation of all runtime functions and ANSI-standard functions. This generates a large amount of code not needed by the application.

## HAS_BANKED_DATA: Application Has Banked Data (Freescale)

### Syntax

```
HAS_BANKED_DATA
```

### Description

(HC12 only)

In the Freescale object file format, use this entry to specify that all pointers in zero out and copy down must be 24 bits in size.

The ELF object file format ignores this entry.

### Example

```
HAS_BANKED_DATA
```

## HEXFILE: Link Hex File with Application

### Syntax

```
HEXFILE <fileName> [OFFSET <hexNumber>]
```

### Arguments

`<fileName>`: Any valid file name. The linker searches for this file in the current directory first, and then in the directories specified in the `GENPATH` environment variable.

`<hexNumber>`: If specified, adds this number to the address found in each record of the hex file. The result is the address to which the linker copies the data bytes.

### Description

Use this command to link an S-Record or Intel Hex file with the application.

```
HEXFILE fiboram.s1 OFFSET 0xFFFF9800 /* 0x800 - 0x7000 */
```

The above code adds the optional offset specified in the `HEXFILE` command to each record in the Freescale S-record file, and encodes the code at address 0x7000 at address 0x800. The offset 0xFFFF9800 used above is the unsigned representation of -0x68000. To calculate it, use a hex-capable calculator and subtract 0x7000 from 0x800.

**NOTE** In the Freescale format, the linker does not perform any checking to avoid overwriting any portion of normal linked code by data from hex files.

### Example

```
HEXFILE fiboram.s1 OFFSET 0xFFFF9800 /* 0x800 - 0x7000 */
```

## INIT: Specify Application Init Point

### Syntax

```
INIT  FuncName
```

### Description

This command defines the initialization entry point for the application. The `INIT` command is mandatory for assembly application and optional otherwise. It cannot be specified more than once in the prm file.

When you specify the `INIT` command in the prm file, the linker uses the specified function as application entry point. This is either the main routine or a startup routine calling the main routine.

When `INIT` is not specified in the prm file, the linker looks for a function named `_Startup` and uses it as the application entry point.

### Example

```
INIT MyGlobStart /* Specify a global variable as
application          entry point.*/
```

### ELF Specific issues:

You can specify any static or global function as entry point.

### ELF Specific Example:

```
INIT myFile.o:myLocStart /* Specify a local variable
as application entry point.*/
```

Do not use this command for ROM libraries. Specifying an `INIT` command in a ROM library prm file generates a warning.

## LINK: Specify Name of Output File

### Syntax

```
LINK <NameOfABSFile> ['AS ROM_LIB']
```

### Description

The `LINK` command defines the name of the file generated by the link session. This command is mandatory and can only be specified once in a prm file.

After a successful link session the linker creates the file `NameOfABSFile`. If you defined the `ABSPATH` environment variable (see ABSPATH: Absolute Path), the linker generates the absolute file in the first directory listed there. Otherwise, the linker writes the file to the directory in which the parameter file was found. If a file with this name already exists, it is overwritten.

A successful linking session also creates a map file with the same base name as `NameOfABSFile` and with extension `.map`. If you defined the `TEXTPATH` environment variable (see TEXTPATH: Text Path), the linker generates the .map file in the first directory listed there. Otherwise, the linker writes the file to the directory where the parameter file was found. If a file with this name already exists, it is overwritten.

If you include `AS ROM_LIB` after the name of the absolute file, the linker generates a ROM library instead of an absolute file (see ROM Libraries). A ROM library is an absolute file which cannot be executed alone.

Prm files require the `LINK` command. If you omit the `LINK` command, the SmartLinker generates an error message unless you specify the `-O` option on the command line (see -O: Define Absolute File Name (SmartLinker)).

**NOTE** If you start the linker from the CodeWarrior IDE, the linker automatically adds the `-O` option. If you specify the `-O` option on the command line, it has higher priority than the `LINK` command.

### Example

```
LINK fibo.abs

NAMES  fibo.o startup.o END
SECTIONS
    MY_RAM = READ_WRITE 0x1000 TO 0x18FF;
    MY_ROM = READ_ONLY  0x8000 TO 0x8FFF;
    MY_STK = READ_WRITE 0x1900 TO 0x1FFF;
PLACEMENT
```

```
    DEFAULT_ROM    INTO   MY_ROM;
    DEFAULT_RAM    INTO   MY_RAM;
    SSTACK         INTO   MY_STK;
END
VECTOR ADDRESS 0xFFFE _Startup /* set reset vector */
```

In this case, the linker generates `fibo.ABS` and `fibo.map` after successfully linking from the previous prm file.

## MAIN: Name of Application Root Function

### Syntax

```
MAIN FuncName
```

### Description

The optional `MAIN` command cannot be specified more than once in the prm file. This command defines the root function for an ANSI-C application (the function invoked at the end of the startup function).

When you do not specify `MAIN` in the prm file, the linker looks for a function named `main` to use as the application root.

### Example

```
MAIN MyGlobMain /* Specify a global variable as
application root.*/
```

### ELF-Specific issues:

You can specify any static or global function as application root function.

### ELF-Specific Example:

```
MAIN myFile.o:myLocMain /* Specify a local variable as
application root.*/
```

This command is not required for ROM libraries. Specifying the `MAIN` command in a ROM Libraries prm file generates a warning.

## MAPFILE: Configure Map File Content

### Syntax (ELF):

```
MAPFILE (ALL|NONE|TARGET|FILE|STARTUP_STRUCT|SEC_ALLOC|
OBJ_ALLOC|SORTED_OBJECT_LIST|OBJ_DEP|OBJ_UNUSED|
COPYDOWN|OVERLAP_TREE|STATISTIC|MODULE_STATISTIC)
[,{(ALL|NONE|TARGET|FILE|STARTUP_STRUCT|SEC_ALLOC|OBJ_A
LLOC
|OBJ_DEP|OBJ_UNUSED|COPYDOWN|OVERLAP_TREE|STATISTIC|MOD
ULE_STATISTIC)}]
```

### Syntax (Freescale):

```
MAPFILE (ON|OFF)
```

### Description

Use this optional command to control `.map` file generation. The default condition activates the command `MAPFILE ALL`, indicating that a map file must be created, containing all linking time information.

Table D.2 and Table D.3 describe the available map file specifiers.

**Table D.2 Map File Specifiers and Descriptions (ELF Specific)**

| Specifier | Description |
|---|---|
| ALL | Generates a map file containing all available information |
| COPYDOWN | Writes information about the initialization value for objects allocated in RAM to the map file (COPYDOWN section) |
| FILE | Includes information about the files building the application in the map file (FILE section) |
| NONE | Generates no map file |
| OBJ_ALLOC | Includes information about the allocated objects in the map file (OBJECT ALLOCATION section) |
| SORTED_OBJECT_LIST | Generates a list of all allocated objects, sorted by address, and includes it in the map file (OBJECT LIST SORTED BY ADDRESS section) |

**Table D.2 Map File Specifiers and Descriptions (ELF Specific) (*continued*)**

| Specifier | Description |
|---|---|
| OBJ_UNUSED | Includes a list of all unused objects in the map file (`UNUSED OBJECTS` section) |
| OBJ_DEP | Includes a list of dependencies between the objects in the application in the map file (`OBJECT DEPENDENCY` section) |
| DEPENDENCY_TREE | Shows the allocation of overlapped variables (`DEPENDENCY TREE` section) |
| SEC_ALLOC | Includes information about the sections used in the application in the map file (`SECTION ALLOCATION` section) |
| STARTUP_STRUCT | Includes information about the startup structure in the map file (`STARTUP` section). |
| MODULE_STATISTIC | Includes information about how much ROM/RAM specific modules (compilation units) use. |
| STATISTIC | Includes statistic information about the link session in the map file (`STATISTICS` section) |
| TARGET | Includes information about the target processor and memory model in the map file (`TARGET` section) |

See The Map File for detailed descriptions of information generated by each specifier.

## ELF-Specific Issues:

Specifying `ALL` in the `MAPFILE` command includes all available sections in the map file.

## Example

The following commands are all equivalent. Each of these commands generates a map file containing all the possible information about the linking session.

```
MAPFILE ALL
MAPFILE TARGET, ALL
MAPFILE TARGET, ALL, FILE, STATISTIC
```

Specifying `NONE` in the `MAPFILE` command prevents the linker from generating the map file.

### Example

The following commands are all equivalents. No map file is generated.

```
MAPFILE NONE
MAPFILE TARGET, NONE
MAPFILE TARGET, NONE, FILE, STATISTIC
```

### Freescale-Specific Issues:

For compatibility with old-style Freescale-format prm files, the `MAPFILE` command supports the following arguments:

- `MAPFILE OFF` is equivalent to `MAPFILE NONE`
- `MAPFILE ON` is equivalent to `MAPFILE ALL`

**Table D.3 Map File Specifiers and Descriptions (Freescale Specific)**

| Specifier | Description |
|---|---|
| OFF | Generates no map file |
| ON | Generates a map file containing all information available |

## NAMES: List Files Building the Application

### Syntax

```
NAMES <FileName>['+'|'-'] {<FileName>['+'|'-']} END
```

### Description

The `NAMES` block contains a list of binary files building the application. This block is mandatory and can only be specified once in a prm file.

The linker reads all files given between `NAMES` and `END`. The linker searches for the files first in the project directory, then in the directories specified in the `OBJPATH` environment variable (see OBJPATH: Object File Path) and finally in the directories specified in the `GENPATH` environment variable (see GENPATH: Define Paths to Search for Input Files). The files may be either object files, absolute or ROM Library files, or libraries.

You may specify additional files by using the `-Add` option (see -Add: Additional Object/ Library File). The linker links object files specified with the `-Add` option before linking the files mentioned in the `NAMES` block.

The SmartLinker links only the referenced objects (variables and functions) to the application. You can specify any number of files in the `NAMES` block, however the application contains only the functions and variables really used.

The plus sign after a file name (e.g. `<FileName>+`) switches smart linking OFF for the specified file. This links all the objects defined in this file, even unused objects, with the application.

Specifying a minus sign after an absolute file name (e.g. `<FileName>-`) tells the linker not to use the absolute file in the application startup, that is, the linker does not initialize global variables defined in the absolute file during application startup (see Using ROM Libraries).

Do not include a space or spaces between the file name and the plus or minus sign.

### Example

```
LINK fibo.abs

NAMES  fibo.o startup.o END
SEGMENTS
    MY_RAM = READ_WRITE 0x1000 TO 0x18FF;
    MY_ROM = READ_ONLY  0x8000 TO 0x8FFF;
    MY_STK = READ_WRITE 0x1900 TO 0x1FFF;
PLACEMENT
    DEFAULT_ROM   INTO  MY_ROM;
    DEFAULT_RAM   INTO  MY_RAM;
    SSTACK        INTO  MY_STK;
END
VECTOR ADDRESS 0xFFFE _Startup /* set reset vector */
```

In this example, the linker builds the application `fibo` from the files `fibo.o` and `startup.o`.

## OVERLAP_GROUP: Application Uses Overlapping (ELF)

### Syntax

```
OVERLAP_GROUP {<Objects>} END
```

### Description

Use the `OVERLAP_GROUP` only for overlapping locals. See also Overlapping Locals.

In some cases the linker cannot detect that functions have no dependencies, and does not overlap local variables which might benefit from overlapping. Use OVERLAP_GROUP block to specify a group of functions which do not overlap.

OVERLAP_GROUP is only available in the ELF object file format. However, you can achieve the same functionality with the DEPENDENCY command (see DEPENDENCY: Dependency Control, ROOT Keyword) available in the Freescale format.

### Example:

Assume the default implementations of the C startup routines:

- _Startup: the main entry point of the application. It calls first Init and then uses _startupData to call main.
- Init: Uses the information in _startupData to generate the zero out
- _startupData: The linker fills this data-structure with information, such as the address of the main function and identity of areas to be handled by zero out in Init.
- main: The main startup point of C code

The following dependencies exist between these objects:

- _Startup depends on _startupData and Init
- Init depends on _startupData
- _startupData depends on main.

Assume the following entry in the prm file:

```
/* _Startup is a group of its own */
OVERLAP_GROUP _Startup END
```

When investigating _Startup, linker does not know that Init does not call main. According to the dependency information, it might call main, so the linker does not overlap the variables of Init and main.

But in this case, the linker builds the following OVERLAP_GROUP:

```
/* Overlap the variables of main and the variables of
_Startup */
OVERLAP_GROUP main _Startup END
```

This way, the linker overlaps the variables of Init and main because the linker allocates main first and then allocates _Startup.

For the HC05 with the usual startup code, this entry saves eight bytes in the OVERLAP_GROUP segment. To modify the usual startup code so that _Startup and main do not overlap, insert OVERLAP_GROUP _Startup END into the prm file.

**NOTE** You can configure the names of the `_Startup` function, `main` and `_startupData` to a non-default name in the prm file.

### Example:

Assume that a processor has two interrupt priorities: Interrupt 1 priorities and Interrupt 0 priorities.

Assume the two functions `IntPrio1A` and `IntPrio1B` handle interrupt 1 priority requests.

Assume the two functions `IntPrio0A` and `IntPrio0B` handle the interrupt 0 priority requests.

Since two functions on the same priority level can never be active at the same time, use two `OVERLAP_GROUP`s to overlap the functions of the same level.

```
OVERLAP_GROUP IntPrio1A IntPrio1B END

OVERLAP_GROUP IntPrio0A IntPrio0B END
```

### See also

DEPENDENCY: Dependency Control

## PLACEMENT: Place Sections into Segments

### Syntax (ELF)

```
PLACEMENT

SectionName{,sectionName} (INTO | DISTRIBUTE_INTO)
SegSpec{,SegSpec};

{SectionName{,sectionName} (INTO | DISTRIBUTE_INTO)
SegSpec{,SegSpec};}

END
```

### Description

The `PLACEMENT` block is mandatory in a prm file and it cannot be specified more than once.

Each placement statement between the `PLACEMENT` and `END`, defines:

- (ELF) A relation between logical sections and physical memory ranges, called segments.

- (Freescale) A relation between logical segments and physical memory ranges called sections. Standard terminology for Freescale uses a SECTIONS block, rather than a SEGMENTS block; the ELF linker accepts this syntax.

### Example (ELF)

```
SEGMENTS
  ROM_1  = READ_ONLY 0x800 TO 0xAFF;
  ROM_2  = READ_ONLY 0xB00 TO 0xCFF;
END
PLACEMENT
  DEFAULT_ROM INTO ROM_1, ROM_2;
END
```

In this example, the linker allocates the objects from DEFAULT_ROM section in ROM_1 segment first. As soon as the ROM_1 segment is full, allocation continues in section ROM_2.

You can split a statement inside of the PLACEMENT block over several lines. The statement terminates as soon as the linker detects a semicolon.

Always define the SEGMENTS block before defining the PLACEMENT block, because segments referenced in the PLACEMENT block must be defined in the SEGMENTS block.

Some restrictions apply on the commands specified in the PLACEMENT block:

- When you specify the .copy section in the PLACEMENT block, specify it as the last section in the section list.
- When you specify the .stack section in the PLACEMENT block, the prm file requires an additional STACKSIZE command if the stack is not the single section specified in the placement statement.
- Always specify the predefined sections .text and .data in the PLACEMENT block. These files retrieve the default placement for code or variable sections. The linker allocates all code or constant sections not appearing in the PLACEMENT block into the same segment list as the .text section. The linker allocates all variable sections not appearing in the PLACEMENT block into the same segment list as the .data section.

### Example (Freescale)

```
SECTIONS
  ROM_1  = READ_ONLY 0x800 TO 0xAFF;
PLACEMENT
  DEFAULT_ROM, ROM_VAR INTO ROM_1;
END
```

In this example, the linker allocates the objects from DEFAULT_ROM segment first and then allocates the objects from the ROM_VAR segment.

Object allocation starts with the first section in the list; the linker allocates objects to the first memory range in the list as long as available memory can accommodate the object. If a section is full (i.e., the next object to be allocated is too large for the available space in the section), allocation continues with the next section in the list.

## PRESTART: Application Prestart Code (Freescale)

### Syntax

```
PRESTART (["+"] HexDigit {HexDigit} | OFF)
```

### Description

This optional command allows the modification of the default `init` code generated by the linker at the very beginning of the application. Normally this code looks like:

```
DisableInterrupts.
On some processor, setup page registers
JMP StartupRoutine ("_Startup" by default)
```

Use the `PRESTART` command to replace all code before `JMP` by the code given by the Hex numbers following the keyword. If you add + after `PRESTART`, the linker inserts the code just before `JMP` but does not replace the standard code sequence.

**NOTE** Do not write a sequence of hexadecimal numbers in C (or Modula-2) format after the `PRESTART` command. Write an even number of hexadecimal digits. Example:
`PRESTART + 4E714E71`

`PRESTART OFF` turns off prestart code completely, i.e., the first instruction executed is the first instruction of the startup routine.

### Example

```
PRESTART OFF
```

## SECTIONS: Define Memory Map (Freescale)

### Syntax

```
SECTIONS {(READ_ONLY|READ_WRITE|NO_INIT|PAGED)
   <startAddr> (TO <endAddr> | SIZE <size>)}
```

### Description

Specify the optional `SECTIONS` block in the prm file only once. Follow the `SECTIONS` block immediately by the `PLACEMENT` block.

The `SECTIONS` command allows you to assign meaningful names to address ranges. Subsequently you can use these names in `PLACEMENT` statements, thus increasing the readability of the parameter file.

Each address range you define is associated with one of the following:

- Qualifier (see Qualifier Handling)
- Start and end address
- Start address and a size

**NOTE** The ELF linker accepts `SECTION` syntax as an alias for `SEGMENTS` syntax.

### Section Qualifier

The following qualifiers are available for sections:

- `READ_ONLY`: used for address ranges which are initialized at program load time. The application (`*.abs`) contains content only for this qualifier.
- `READ_WRITE`: used for address ranges initialized by the startup code at runtime. The linker initializes memory area defined with this qualifier with 0 at application startup. Information about `READ_WRITE` section initialization is stored in a `READ_ONLY` section.
- `NO_INIT`: used for address ranges where read/write accesses are allowed. The linker does not initialize memory area defined with this qualifier at application startup. This is useful if your target has a battery-buffered RAM or to speed up application startup.
- `PAGED`: used for address ranges where read/write accesses are allowed. The linker does not initialize memory area defined with this qualifier at application startup. Additionally, the linker does not control overlap between segments defined with the `PAGED` qualifier. When you use overlapped segments, it is your

responsibility to select the correct page before accessing the data allocated on a page.

**Table D.4 Section Qualifiers**

| Qualifier | Initialized Variables | Non-Initialized Variables | Constants | Code |
|---|---|---|---|---|
| `READ_ONLY` | Not applicable (1) | Not applicable (1) | Content written to target address | Content written to target address |
| `READ_WRITE` | Content written into copy down area, along with information defining startup location. Area contained in zero out information (3, 4) | Area contained in zero out information (4) | Content written into copy down area, along with information defining startup location. Area contained in zero out information (3, 4) | Not applicable (1, 2) |
| `NO_INIT` | Not applicable (1) | Handled as allocated. Nothing generated. | Not applicable (1) | Not applicable (1) |
| `PAGED` | Not applicable (1) | Handled as allocated. Nothing generated. | Not applicable (1) | Not applicable (1) |

1. These cases are unintended, although the linker allows some of them. If allowed, the qualifier controls what is written into the application.
2. To allocate code in a RAM area, declare the area as `READ_ONLY`.
3. Initialized objects and constants in `READ_WRITE` sections also need RAM memory and space in the copy down area. The copy down contains the information about object initialization in the startup code.
4. The zero out information defines which areas to initialize with 0 at startup. Because the zero out contains only an address and a size per area, it is usually much smaller than a copy down area, which also contains the (non-zero) content of the objects to be initialized.

### Example

```
SECTIONS
  ROM    = READ_ONLY  0x1000 SIZE 0x2000;
  CLOCK  = NO_INIT    0xFF00 TO   0xFFFF;
  RAM    = READ_WRITE 0x3000 TO   0x3EFF;
  Page0  = PAGED      0x4000 TO   0x4FFF;
  Page1  = PAGED      0x4000 TO   0x4FFF;
END
```

In this example:

- The ROM section is a `READ_ONLY` memory area. It starts at address 0x1000 and its size is 0x2000 bytes (from address 0x1000 to 0x2FFF).
- The RAM section is a `READ_WRITE` memory area. It starts at address 0x3000 and ends at 0x3FFF (size = 0x1000 bytes). Application startup allocates all variables in this segment with 0.
- The CLOCK section is a `READ_WRITE` memory area. It starts at address 0xFF00 and ends at 0xFFFF (size = 100 bytes). Variables allocated in this segment are not initialized at application startup.
- The `Page0` and `Page1` sections are `READ_WRITE` memory areas. These are overlapping segments. It is your responsibility to select the correct page before accessing any data allocated in one of these segments. Variables allocated in this segment are not be initialized at application startup.

## SEGMENTS: Define Memory Map (ELF)

### Syntax

```
SEGMENTS {(READ_ONLY|READ_WRITE|NO_INIT|PAGED)
           <startAddr> (TO <endAddr> | SIZE <size>)
           [RELOCATE_TO Address]
           [ALIGN <alignmentRule>]
           [FILL <fillPattern>]
          {(DO_OPTIMIZE_CONSTS | DO_NOT_OPTIMIZE_CONSTS)
             { CODE | DATA }
           }
          }
END
```

### Description

The optional SEGMENTS block cannot be specified more than once in a prm file.

Use the SEGMENTS command to assign meaningful names to address ranges. You can then use these names in subsequent PLACEMENT statements, thus increasing the readability of the parameter file.

Each address range you define is associated with:

- A qualifier.
- A start and end address or a start address and a size.
- An optional relocation rule
- An optional alignment rule
- An optional fill pattern.
- Optional constant optimization with Common Code commands.

### Segment Qualifier

The following qualifiers are available for segments:

- READ_ONLY: used for address ranges which are initialized at program load time.
- READ_WRITE: used for address ranges which are initialized by the startup code at runtime. The linker initializes memory area defined with this qualifier with 0 at application startup.
- NO_INIT: used for address ranges where read/write accesses are allowed. The linker does not initialize memory area defined with this qualifier at application startup. This may be useful if your target has a battery-buffered RAM or to speed up application startup.
- PAGED: used for address range where read/write accesses are allowed. The linker does not initialize memory area defined with this qualifier at application startup. Additionally, the linker does not control overlap between segments defined with the PAGED qualifier. When using overlapped segments, it is your responsibility to select the correct page before accessing the allocated data.

# Qualifier Handling

**Table D.5 Qualifier Handling**

| Qualifier | Initialized Variables | Non-Initialized Variables | Constants | Code |
|---|---|---|---|---|
| READ_ONLY | Not applicable (1) | Not applicable (1) | Content written to target address | Content written to target address |
| READ_WRITE | Content written into copy down area, along with startup location information. Area contained in zero out information (3, 4) | Area contained in zero out information (4) | Content written into copy down area, along with startup location information. Area contained in zero out information (3, 4) | Not applicable (1, 2) |
| NO_INIT | Not applicable (1) | Handled as allocated. Nothing generated. | Not applicable (1) | Not applicable (1) |
| PAGED | Not applicable (1) | Handled as allocated. Nothing generated. | Not applicable (1) | Not applicable (1) |

1. These cases are unintended, although the linker allows some of them. If allowed, the qualifier controls what is written into the application.
2. To allocate code in a RAM area, declare this area as READ_ONLY.
3. Initialized objects and constants in READ_WRITE sections need RAM memory and space in the copy down area. The copy down contains the information about object initialization process in the startup code.
4. The zero out information identifies areas to initialize with 0 at startup. Because the zero out contains only an address and a size per area, it is usually much smaller than a copy down area, which also contains the (non-zero) content of the objects to be initialized.

### Example

```
SEGMENTS
  ROM   = READ_ONLY  0x1000 SIZE 0x2000;
  CLOCK = NO_INIT    0xFF00 TO   0xFFFF;
  RAM   = READ_WRITE 0x3000 TO   0x3EFF;
  Page0 = PAGED      0x4000 TO   0x4FFF;
  Page1 = PAGED      0x4000 TO   0x4FFF;
END
```

In this example:

- The ROM segment is a READ_ONLY memory area. It starts at address 0x1000 and its size is 0x2000 bytes (from address 0x1000 to 0x2FFF).
- The RAM segment is a READ_WRITE memory area. It starts at address 0x3000 and ends at 0x3FFF (size = 0x1000 bytes). This example initializes all variables allocated in this segment with 0 at application startup.
- The CLOCK segment is a READ_WRITE memory area. It starts at address 0xFF00 and ends at 0xFFFF (size = 100 bytes). Variables allocated in this segment are not initialized at application startup.
- The Page0 and Page1 segments are READ_WRITE memory areas. These are overlapping segments. It is your responsibility to select the correct page before accessing any data allocated in one of these segments. The linker does not initialize variables allocated in this segment at application startup.

## Defining a Relocation Rule

Use the relocation rule if a segment is moved to a different location at runtime. With the relocation rule, you instruct the linker to use different runtime addresses for all objects in a segment.

This is useful when at runtime the code is copied and executed at a different address than the linked location. One example is a Flash programmer which must run out of RAM. Another example is a boot loader, which moves the actual application to a different address before running it.

Specify a relocation rule as follows:

```
RELOCATE_TO Address
```

Use <Address> to specify the runtime address of the object.

### Example

```
SEGMENTS
    CODE_RELOC   = READ_ONLY 0x8000 TO 0x8FFF RELOCATE_TO 0x1000;
...
END
```

In this example, references to functions in `CODE_RELOC` use addresses from 0x1000 to 0x1FFF area, but the code is programmed from 0x8000 to 0x8FFF.

With `RELOCATE_TO`, you can execute code at an address different from where it was allocated. The code need not be position independent (PIC), however, non-PIC code may not run at its allocation address, as all references in the code refer to the `RELOCATE_TO` address.

**NOTE** Usually the `RELOCATE_TO` address is in RAM. The linker does not check for overlaps in the `RELOCATE_TO` address area. Set up the prm file so that no overlapping is possible.

## Defining an Alignment Rule

You can associate an alignment rule with each segment in the application. Use this feature when specific alignment rules are expected on a certain memory range.

Specify an alignment rule as follows:

```
ALIGN [<defaultAlignment>] [{'['(<Number>|
    <Number> 'TO' <Number>|
    ('<' | '>' | '<=' | '>=')<Number>)']:'<alignment>}]
```

Use the `defaultAlignment` argument to specify the alignment factor for objects not matching any condition in the following alignment list. If you do not specify an alignment list, the default alignment factor applies to all objects allocated in the segment. The default alignment factor is optional.

### Example

```
SEGMENTS
    RAM_1   = READ_WRITE 0x800 TO 0x8FF
              ALIGN 2 [1:1];
    RAM_2   = READ_WRITE 0x900 TO 0x9FF
              ALIGN [2 TO 3:2] [>= 4:4];
    RAM_3   = READ_WRITE 0xA00 TO 0xAFF
              ALIGN 1 [>=2:2];
END
```

In this example:

- `RAM_1` segment: Aligns all objects of size equal to 1 byte on 1-byte boundaries. Aligns all other objects on 2-byte boundaries.
- `RAM_2` segment: Aligns all objects of size equal to 2 or 3 bytes on 2-byte boundaries. Aligns all objects of size greater than or equal to 4 bytes on 4-byte boundaries. Objects of size equal to 1 byte follow the default processor alignment rule.
- `RAM_3` segment: Aligns all objects of size greater than or equal to 2 bytes on 2-byte boundaries. Aligns all other objects on 1-byte boundaries.

Alignment rules that apply during object allocation are described in the alignment chapter.

## Defining a Fill Pattern

You can associate a fill pattern with each segment in the application. This can be useful for automatically initializing uninitialized variables in the segments with a predefined pattern.

Specify a fill pattern as follows:

```
FILL <HexByte> {<HexByte>}
```

**NOTE** Any segment defined with the `FILL` command in the `SEGMENTS` portion of the prm file fills only if the segment is also used in the `PLACEMENT` section of the prm file. If necessary, add a dummy entry to the `PLACEMENT` section.

### Example

```
SEGMENTS
    RAM_1   = READ_WRITE 0x800 TO 0x8FF
              FILL 0xAA 0x55;
END
PLACEMENT
    DUMMY   INTO RAM_1
END
```

This example initializes uninitialized objects and filling bytes with the pattern 0xAA55.

If the size of an object to initialize is greater than the size of the specified pattern, the pattern repeats as many time as necessary to fill the objects. In this example, an object with a size of 4 bytes initializes with 0xAA55AA55.

If the size of an object to initialize is less than the size of the specified pattern, the pattern truncates to match the size of the object. In this example, an object with a size of 1 byte initializes with 0xAA.

When the value specified in an element of a fill pattern does not fit into a byte, it truncates to a byte value.

### Example

```
SEGMENTS
    RAM_1   = READ_WRITE 0x800 TO 0x8FF
              FILL 0xAA55;
END
```

This example initializes uninitialized objects and filling bytes with the pattern 0x55. The specified fill pattern truncates to a 1-byte value.

Fill patterns are useful for assigning an initial value to the padding bytes inserted between two objects during object allocation. This allows marking from the unused position with a specific marker and detecting them inside of the application.

For example, you can initialize an unused position inside a section of code with the hexadecimal code for the NOP instruction.

## Optimizing Constants with Common Code

You can allocate constants having the same byte pattern to the same addresses. The most common usage is to allocate some string in another string.

### Example

```
const char* hwstr="Hello World";
const char* wstr= "World";
```

The string `Hello World` contains the string `World` exactly. When the constants are optimized, `wstr` points to `hwstr+6`.

In the Freescale format, the linker only optimizes strings. In the ELF format, all constant objects, including strings, constants and code, can be optimized.

For all segments you can specify whether to optimize code or data (only constants and strings). If nothing is specified, `-Cocc` controls the default (see -Cocc: Optimize Common Code (ELF)).

### Examples

**Listing D.9 C-Source File**

```
void print1(void) {
  printf("Hello");
}
void print2(void) {
  printf("Hello");
}
```

**Listing D.10 Prm File**

```
SECTIONS
    ...
    MY_ROM = READ_ONLY 0x9000 TO 0xFEFF DO_OVERLAP_CONSTS CODE DATA;
END
```

If you optimize data only, the string `Hello` appears once in the ROM-image. Optimizing both code and data allocates the `print1` and `print2` functions at the same address. However, if you optimize code only (this is not the case here), then `print1` and `print2` are not optimized because they use different instances of the string `Hello`.

If you optimize code only, the linker issues the warning:

```
L1951: Function print1 is allocated inside of print2 with
offset 0. Debugging may be affected.
```

The linker issues this warning because the debugger cannot distinguish between `print1` and `print2`, so the wrong function might display while debugging. This does not, however, affect the runtime behavior.

The linker detects certain branch distance optimizations done by the compiler because of the special fixups used. If the linker detects this type of optimization, neither the caller and the callee are moved into other functions. However, other functions can still be moved into them.

**NOTE** Switching off the compiler optimizations can produce smaller applications, if the compiler optimizations prevent linker optimizations.

In C++, several language constructs result in identical functions in different compilation units. Different instances of the same template may have identical code. Compiler-generated functions, and inline functions not actually inlined, are defined in every compilation unit. Finally, constants defined in header files are static in C++, so they are also contained once in every object file.

## STACKSIZE: Define Stack Size

### Syntax

```
STACKSIZE Number
```

### Description

The `STACKSIZE` command is optional in a prm file and it cannot be specified more than once. Additionally, you cannot specify both `STACKTOP` and `STACKSIZE` commands in the same prm file (see STACKTOP: Define Stack Pointer Initial Value).

The `STACKSIZE` command defines the size requested for the stack. We recommend using this command if you do not care where the stack is allocated but only how large it is.

When the stack is defined using a `STACKSIZE` command alone, the stack is placed next to the section `.data`.

**NOTE** In the Freescale object file format allows the synonym `STACK` instead of `STACKSIZE`. This is for compatibility only, and may be removed in a future version.

### Example

```
SECTIONS
  MY_RAM = READ_WRITE 0xA00 TO 0xAFF;
  MY_ROM = READ_ONLY  0x800 TO 0x9FF;
PLACEMENT
  DEFAULT_ROM INTO MY_ROM;
  DEFAULT_RAM INTO MY_RAM;
END
STACKSIZE 0x60
```

In this example, if the section `.data` is 4 bytes wide (from address 0xA00 to 0xA03), the section `.stack` is allocated next to it, from address 0xA63 down to address 0xA04. The stack initial value is set to 0xA62.

When the stack is defined through a `STACKSIZE` command associated with the placement of the `.stack` section, the stack is supposed to start at the segment start address incremented by the specified value and is defined down to the start address of the segment, where `.stack` has been placed.

### Example

```
SECTIONS
  MY_STK = NO_INIT    0xB00 TO 0xBFF;
  MY_RAM = READ_WRITE 0xA00 TO 0xAFF;
  MY_ROM = READ_ONLY  0x800 TO 0x9FF;
PLACEMENT
  DEFAULT_ROM INTO MY_ROM;
  DEFAULT_RAM INTO MY_RAM;
  SSTACK      INTO MY_STK;
END
STACKSIZE 0x60
```

This example allocates the `SSTACK` section from address 0xB5F down to address 0xB00. The initial stack value is set to 0xB5E.

# STACKTOP: Define Stack Pointer Initial Value

## Syntax

```
STACKTOP Number
```

## Description

The optional `STACKTOP` command cannot be specified more than once in a prm file. Additionally, you cannot specify both `STACKTOP` and `STACKSIZE` (see STACKSIZE: Define Stack Size) in a prm file.

The `STACKTOP` command defines the initial value for the stack pointer.

## Example

Define `STACKTOP` as:

```
STACKTOP 0xBFF
```

This initializes the stack pointer with 0xBFF at application startup.

Defining the stack using a `STACKTOP` command alone affects the default stack size. Stack size depends on the processor and is big enough to store the target processor PC.

Defining the stack using a `STACKTOP` command associated with the placement of the `.stack` section starts the stack at the specified address, and includes the start address of the segment where `.stack` is placed.

## Example

```
SEGMENTS
  MY_STK = NO_INIT    0xB00 TO 0xBFF;
  MY_RAM = READ_WRITE 0xA00 TO 0xAFF;
  MY_ROM = READ_ONLY  0x800 TO 0x9FF;
END
PLACEMENT
  DEFAULT_ROM   INTO MY_ROM;
  DEFAULT_RAM   INTO MY_RAM;
  SSTACK        INTO MY_STK;
END
STACKTOP 0xB7E
```

This example defines the stack pointer from address 0xB7E to address 0xB00.

## START: Specify the ROM Start (Freescale)

### Syntax

```
START Address
```

### Description

**NOTE** This command supports old-style linker parameter files. Future releases may not support this command.

Use this command to specify start location of the default ROM. `Address` must be in hexadecimal notation. Internally this command translates into:

```
START 0x????' => 'DEFAULT_ROM INTO READ_ONLY 0x???? TO
0x????
```

Because the end address of `DEFAULT_ROM` is unknown, the linker attempts to specify/find the end address itself.

**NOTE** An error message during linking stating that `START` is undefined indicates that no visible application entry point exists for the linker (e.g., the `main` routine is defined as static).

### Example

```
START 0x1000
```

## VECTOR: Initialize Vector Table

### Syntax

```
VECTOR (InitByAddr | InitByNumber)
```

### Description

The `VECTOR` command is optional in a prm file and can be specified more than once.

A vector is a small piece of memory, having the size of a function address. This command allows you to initialize the processor's vectors while downloading the absolute file.

A `VECTOR` command consists of a vector location part (containing the location of the vector) and a vector target part (containing the value to store in the vector).

You can specify the vector location part:

- Through a vector number. Vector number-to-address mapping is target specific.
  - For targets with vectors starting at 0, this command allocates the vector at `<Number> * <Size of a Function Pointer>`.
  - For targets with vectors located from 0xFFFE and allocated downwards, `VECTOR 0` maps to 0xFFFE. Generally the address is `0xFFFE-<Number> * 2`.
  - For HC05 the `RESETVECTOR` environment variable specifies `VECTOR 0` address. All other vectors are calculated from `VECTOR 0`. 0xFFFE is the default address.
  - For all other supported targets, `VECTOR` numbers automatically map to vector locations natural for this target.
- Through a vector address. In this case, specify the `ADDRESS` keyword in the vector command.

You can specify the vector target part:

- As a function name
- As an absolute address.

## Example

```
VECTOR ADDRESS 0xFFFE _Startup
VECTOR ADDRESS 0xFFFC 0xA00
VECTOR 0 _Startup
VECTOR 1 0xA00
```

If the size of a function pointer is coded on two bytes, then this example:

- Initializes the vector located at address 0xFFFE with the address of the function `_Startup`.
- Initializes the vector located at address 0xFFFC with the absolute address 0xA00.

The address of vector numbers is target specific.

- For an HC16:
  - Initializes vector number 0 (located at address 0x000) with the address of the function `_Startup`.
  - Initializes vector number 1 (located at address 0x002) with the absolute address 0xA00.
- For an HC08 or HC12:
  - Vector number 0 is located at address 0xFFFE.

– Vector number 1 is located at address 0xFFFC.

You can specify an additional offset when the vector target is a function name. This initializes the vector with the address of the object + the specified offset.

### Example

```
VECTOR ADDRESS 0xFFFE CommonISR OFFSET 0x10
```

This example initializes the vector located at address 0xFFFE with the address of the function `CommonISR + 0x10 Byte`. If `CommonISR` starts at address 0x800, this initializes the vector with 0x810.

This notation is very useful for common interrupt handlers.

All objects specified in a `VECTOR` command are entry points in the application. They are always linked with the application, as well as the objects they refer to.

# Batch Burner Commands

This section describes valid parameter values that can be used in commands. For more details about commands, refer to the file `FIBO.BBL`, which shows how to write a script.

Following commands are available:

- baudRate: Baudrate for Serial Communication
- busWidth: Data Bus Width
- CLOSE: Close Open File or Communication Port
- dataBit: Number of Data Bits
- destination: Destination Offset
- DO: For Loop Statement List
- ECHO: Echo String onto Output Window
- ELSE: Else Part of If Condition
- END: For Loop End or If End
- FOR: For Loop
- format: Output Format
- header: Header File for PROM Burner
- IF: If Condition
- len: Length to be Copied
- OPENCOM: Open Output Communication Port
- OPENFILE: Open Output File

- origin: EEPROM Start Address
- parity: Set Communication Parity
- PAUSE: Wait until Key Pressed
- SENDBYTE: Transfer Bytes
- SENDWORD: Transfer Words
- SLINELEN: SRecord Line Length
- SRECORD: S-Record Type
- swapByte: Swap Bytes
- THEN: Statementlist for If Condition
- TO: For Loop End Condition
- undefByte: Fill Byte for Binary Files

## baudRate: Baudrate for Serial Communication

### Syntax

```
baudRate assign <baud>
```

### Arguments

`<baud>`: valid baudrate.

### Default

```
baudrate = 9600
```

### Description

Sets the transmission speed. This parameter must not be used when the burner output is redirected to a file. Valid identifier values are 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400 (default is 9600).

Use this command only if output is sent to a communication port.

### Example

```
baudRate = 19200
```

### See also

- dataBit: Number of Data Bits
- parity: Set Communication Parity

- header: Header File for PROM Burner
- OPENCOM: Open Output Communication Port

## busWidth: Data Bus Width

### Syntax

```
busWidth assign ( 1 | 2 | 4 )
```

### Arguments

A bus width of 1, 2 or 4

### Default

```
busWidth = 1
```

### Description

Most EPROMs are 1 byte wide. To burn an application into EPROMs, you need 1, 2 or 4 EPROMs depending on the width of the data bus of the target system used. The Burner program allows you to select the data bus width using the identifier `busWidth`. Only 1, 2 and 4 are valid values for the parameter `busWidth` (the default is 1).

### Example

```
busWidth = 4
```

## CLOSE: Close Open File or Communication Port

### Syntax

```
CLOSE
```

### Arguments

None

### Default

None

### Description

Use `CLOSE` to close a file opened by OPENFILE: Open Output File or COM port opened with OPENCOM: Open Output Communication Port.

### Example

```
CLOSE
```

### See also

- OPENFILE: Open Output File
- OPENCOM: Open Output Communication Port

## dataBit: Number of Data Bits

### Syntax

```
dataBit assign ( 7 | 8 )
```

### Arguments

7 or 8 data bits.

### Default

```
dataBit = 8
```

### Description

Sets the number of data bits. This parameter must not be used when the burner output is redirected to a file. Valid identifier values are 7 or 8 (default is 8).

Use this command only if the output is sent to a communication port.

### Example

```
dataBit = 7
```

### See also

- baudRate: Baudrate for Serial Communication
- parity: Set Communication Parity
- header: Header File for PROM Burner
- OPENCOM: Open Output Communication Port

## destination: Destination Offset

### Syntax

```
destination assign <offset>
```

### Arguments

`<offset>`: offset to be added

### Default

```
destination = 0
```

### Description

Use this command to add an additional offset to the address field of an S-Record or a Intel Hex Record.

### Example

```
destination = 0x2000
```

### See also

- len: Length to be Copied
- origin: EEPROM Start Address

## DO: For Loop Statement List

### Syntax

```
“FOR” Ident Assign SimpleExpr
“TO” SimpleExpr “DO” StatementList "END"
```

### Arguments

None

### Default

None

### Description

This command starts the FOR statement list. As `ident` only `i` may be used, and the burner replaces each occurrence of # in the loop with the actual value of `i`.

### Example

```
FOR i=0 TO 10 DO
  ECHO "#"
END
```

### See also

- FOR: For Loop
- TO: For Loop End Condition
- END: For Loop End or If End

## ECHO: Echo String onto Output Window

### Syntax

```
ECHO [<string>]
```

### Arguments

`<string>`: a string written to the output window

### Default

None

### Description

With this command you can write a string to the output window. If you do not specify a string, the burner writes an empty line.

### Example

```
ECHO
ECHO "hello world!"
```

## ELSE: Else Part of If Condition

### Syntax

```
IF RelExpr THEN StatementList
[ ELSE StatementList] END
```

### Arguments

None

### Default

None

### Description

This command starts the optional `ELSE` part of an `IF` conditional section.

### Example

```
FOR i=0 TO 10 DO
  IF i==7 THEN
    ECHO "i is 7"
  ELSE
    ECHO "#"
  END
END
```

### See also

- END: For Loop End or If End
- IF: If Condition
- THEN: Statementlist for If Condition

## END: For Loop End or If End

### Syntax

```
FOR Ident Assign SimpleExpr
TO SimpleExpr DO StatementList END
```

or

```
IF RelExpr THEN StatementList
[ ELSE StatementList] END
```

### Arguments

None

### Default

None

### Description

This command ends either a `FOR` loop or `IF` condition.

### Example

```
FOR i=0 TO 10 DO
  IF i==7 THEN
    ECHO "i is 7"
  END
  ECHO "#"
END
```

### See also

- IF: If Condition
- THEN: Statementlist for If Condition
- ELSE: Else Part of If Condition
- TO: For Loop End Condition
- DO: For Loop Statement List
- FOR: For Loop

# FOR: For Loop

## Syntax

```
FOR Ident Assign SimpleExpr
TO SimpleExpr DO StatementList END
```

## Arguments

None

## Default

None

## Description

This command starts a `FOR` loop.

## Example

```
FOR i=0 TO 10 DO
  IF i==7 THEN
    ECHO "i is 7"
  END
  ECHO "#"
END
```

## See also

- TO: For Loop End Condition
- DO: For Loop Statement List
- END: For Loop End or If End

## format: Output Format

### Syntax

```
format assign ( freescale | intel | binary )
```

### Arguments

Format, either Freescale S, Intel Hex or Binary.

### Default

```
format = freescale
```

### Description

The Burner supports three different data transfer formats: S-Records, Intel Hex-Format and binary format. With the binary format the output destination must be a file. Valid identifiers are: Freescale, intel, binary (the default is Freescale)

### Example

```
format = binary
```

## header: Header File for PROM Burner

### Syntax

```
header assign <fileName>
```

### Arguments

`<fileName>`: header file to be sent to serial port

### Default:

```
header =
```

### Description

Specifies an initialization file for the PROM burner. Do not use this parameter when the burner output is redirected to a file. This file is sent byte by byte (binary) without modification to the PROM burner before anything else is sent.

This command is only used if the output is sent to a communication port.

### Example

```
header = "myheader.txt"
```

### See also

- baudRate: Baudrate for Serial Communication
- parity: Set Communication Parity
- header: Header File for PROM Burner
- dataBit: Number of Data Bits
- OPENCOM: Open Output Communication Port

## IF: If Condition

### Syntax

```
IF RelExpr THEN StatementList
[ ELSE StatementList] END
```

### Arguments

None

### Default

None

### Description

This command starts an `IF` conditional section.

### Example

```
FOR i=0 TO 10 DO
  IF i==7 THEN
    ECHO "i is 7"
  END
  ECHO "#"
END
```

#### See also

- END: For Loop End or If End
- THEN: Statementlist for If Condition
- ELSE: Else Part of If Condition

## len: Length to be Copied

#### Syntax

```
len assign <number>
```

#### Arguments

`<number>`: length to be copied.

#### Default

```
len = 0x10000
```

#### Description

Range of program code to be copied. You can also specify length using the ANSI-C or Modula-2 notation for hexadecimal constants (default is 0x10000).

#### Example

If an application is linked between address $3000 and $4000 and the EEPROM start address is $2000 (origin), then `len` must be set to $2000. The code is stored at address $1000 relative to the EEPROM start address.

If the EPROM start address is $3000 (origin) then `len` must be set to $1000. The code is stored at the beginning of the EEPROM.

#### Example

```
len = 0x2000
```

#### See also

- destination: Destination Offset
- origin: EEPROM Start Address

## OPENCOM: Open Output Communication Port

### Syntax

```
OPENCOM <port>
```

### Arguments

`<port>`: valid COM port number (1, 2, 3, 4).

### Default

None

### Description

With this command, the Burner sends the output to the specified communication port. To close the port opened, use CLOSE: Close Open File or Communication Port.

### Example

```
OPENCOM 2
```

### See also

- baudRate: Baudrate for Serial Communication
- parity: Set Communication Parity
- header: Header File for PROM Burner
- dataBit: Number of Data Bits
- OPENFILE: Open Output File
- CLOSE: Close Open File or Communication Port

## OPENFILE: Open Output File

### Syntax

```
OPENFILE <file>
```

### Arguments

`<file>`: valid file name.

### Default

None

### Description

With this command, the Burner sends the output to the specified file. To close the file, use CLOSE: Close Open File or Communication Port command.

### Example

```
OPENFILE "myFile.s19"
```

### See also

- OPENCOM: Open Output Communication Port
- CLOSE: Close Open File or Communication Port

## origin: EEPROM Start Address

### Syntax

```
origin assign <address>
```

### Arguments

`<address>`: start address.

### Default

```
origin = 0
```

### Description

Initialized with the EPROM start address in the target system. You can specify the start address using ANSI C or Modula-2 notation for hexadecimal constants (default is 0).

### Example:

```
origin = 0xC000
```

### See also

- len: Length to be Copied
- destination: Destination Offset

## parity: Set Communication Parity

### Syntax

```
parity assign ( none | even | odd )
```

### Arguments

parity none, even or odd.

### Default

```
parity = none
```

### Description

Sets the parity used for transfer. Do not use this parameter when the burner output is redirected to a file. Valid identifier values are none, odd, and even (default is none).

Use this command only if the output is sent to a communication port.

### Example

```
parity = even
```

### See also

- baudRate: Baudrate for Serial Communication
- dataBit: Number of Data Bits
- header: Header File for PROM Burner
- OPENCOM: Open Output Communication Port

## SENDBYTE: Transfer Bytes

### Syntax

```
SENDBYTE <number> <file>
```

### Arguments

`<number>`: valid byte number (1, 2, 3, 4)

`<file>`: valid source file name.

### Default

None

### Description

This command starts the transfer.

If the data format is binary, the destination must be a file. The size of the file is the size specified by `len` divided by the `busWidth`. All undefined bytes are initialized with $FF or with the value specified by undefByte: Fill Byte for Binary Files.

If a data bus width of 1 byte is selected, the following command must be used to transfer the code:

```
SENDBYTE 1 "InFile.abs"
```

If the data bus is 2 bytes wide, the code is split into two parts; the command `SENDBYTE 1 "InFile.abs"` transfers the even part of the code (corresponding to D8 to D15) while the command `SENDBYTE 2 "InFile.abs"` transfers the odd part, which corresponds to the LSB (D0 to D7).

If the data bus is 4 bytes wide, the command `SENDBYTE 1 "InFile.abs"` transfers the MSB (D24 to D31), while the command `SENDBYTE 4 "InFile.abs"` sends the LSB (D0 to D7).

If using 16-bit EPROMs, you must use the commands `SENDWORD 1 "InFile.abs"` and `SENDWORD 2 "InFile.abs"`. If necessary, high and low byte can be swapped by initializing `swapBytes` with `yes`.

### Example

```
SENDBYTE 1 "myApp.abs"
```

### See also

- busWidth: Data Bus Width
- SENDWORD: Transfer Words

## SENDWORD: Transfer Words

### Syntax

```
SENDWORD <number> <file>
```

### Arguments

`<number>`: valid word number (1, 2)

`<file>`: valid source file name.

### Default

None

### Description

This command starts the transfer.

If the data format is binary, the destination must be a file. The size of the file is the size specified by `len` divided by the `busWidth`. All undefined bytes are initialized with $FF or value specified by undefByte: Fill Byte for Binary Files.

If a data bus width of 1 byte is selected, the following command must be used to transfer the code:

```
SENDBYTE 1 "InFile.abs"
```

If the data bus is 2 bytes wide, the code is split into two parts; the command `SENDBYTE 1 "InFile.abs"` transfers the even part of the code (corresponding to D8 to D15) while the command `SENDBYTE 2 "InFile.abs"` transfers the odd part, which corresponds to the LSB (D0 to D7).

If the data bus is 4 bytes wide, the command `SENDBYTE 1 "InFile.abs"` transfers the MSB (D24 to D31), while the command `SENDBYTE 4 "InFile.abs"` sends the LSB (D0 to D7).

Using 16-bit EPROMs, the commands `SENDWORD 1 "InFile.abs"` and `SENDWORD 2 "InFile.abs"` must be used. If necessary, the high and low byte can be swapped by initializing swapBytes with yes.

### Example

```
SENDWORD 1 "myApp.abs"
```

### See also

- SENDBYTE: Transfer Bytes
- busWidth: Data Bus Width

## SLINELEN: SRecord Line Length

### Syntax

```
SLINELEN assign <number>
```

### Arguments

`<number>`: valid line length (1, 2,)

### Default

```
<number> == 32
```

### Description

This command configures how many bytes written are on a single SRECORD line. This command only effects SRECORD file generation.

### Example

With SLINELEN 16, the burner generates:

```
S1132000000000000101000000000000000000000CA
S11320100008800208208000000000010204081006B
```

With SLINELEN 8, the burner generates:

```
S10B20000000000001010000D2
S10B20080000000000000000CC
S10B20100008800208208000092
S10B201800000001020408109D
```

### See also

- format: Output Format

## SRECORD: S-Record Type

### Syntax

```
SRECORD= ( Sx | S1 | S2 | S3 )
```

### Arguments

`Sx` : Automatic choose between S1, S2 or S3 records

`S1` : use S1 records

`S2` : use S2 records

`S3` : use S3 records

### Default

```
SRECORD=Sx
```

### Description

This command is for S-Record output format.

Normally the Burner chooses the matching S-Record type depending on the addresses used. However, with this option a certain type may be forced because the PROM burner only supports one type.

If Sx is active, the burner is in automatic mode:

if the highest address is >= 0x1000000, then S3 records are used,

if the highest address is >= 0x10000, then S2 records are used,

otherwise S1 records are used.

### Example

```
SRECORD=S2
```

### See also

- format: Output Format

## swapByte: Swap Bytes

### Syntax

```
swapByte assign ( on | off )
```

### Arguments

`on` : enables byte swapping

`off` : disables byte swapping

### Default

```
swapByte = off
```

### Description

If necessary, the high and low byte can be exchanged when 16-bit or 32-bit EPROMs are used.

### Example

```
swapByte = on
```

### See also

- busWidth: Data Bus Width

## THEN: Statementlist for If Condition

### Syntax

```
IF RelExpr THEN StatementList
[ ELSE StatementList] END
```

### Arguments

None

### Default

None

### Description

This command starts an IF conditional section.

### Example

```
FOR i=0 TO 10 DO
  IF i==7 THEN
    ECHO “i is 7”
  END
  ECHO “#”
END
```

### See also

- END: For Loop End or If End
- IF: If Condition
- ELSE: Else Part of If Condition

## TO: For Loop End Condition

### Syntax

```
FOR Ident Assign SimpleExpr
TO SimpleExpr DO StatementList END
```

### Arguments

None

### Default

None

### Description

Specifies the `FOR` loop end condition. As `ident`, only `i` may be used, and each occurrence of `#` in the loop is replaced with the actual value of `i`.

### Example

```
FOR i=0 TO 10 DO
  ECHO "#"
END
```

### See also

- FOR: For Loop
- DO: For Loop Statement List
- END: For Loop End or If End

## undefByte: Fill Byte for Binary Files

### Syntax

```
undefByte assign <number>
```

### Arguments

`<number>`: 8bit number

### Default

```
undefByte = 0xFF
```

### Description

This command assigns the default fill byte to undefined bytes in binary output files.

This command is only used for binary files.

### Example

```
undefByte = 0x33
```

### See also

- format: Output Format

## PAUSE: Wait until Key Pressed

### Syntax

```
PAUSE [<string>]
```

### Arguments

`<string>`: a string written to output window

### Default

None

### Description

This command causes the batch burner language program to wait until a key is pressed. An optional message text may be specified. For Windows, a dialog box appears:

**Figure D.1 Burner Pause Dialog Box**

### Example

```
PAUSE "please press a key."
```

# E

# EBNF Notation

This chapter gives a brief overview of the Extended Backus–Naur Form (EBNF) notation, which is frequently used in this manual to describe file formats and syntax rules.

## Introduction to EBNF

EBNF is frequently used in this reference manual to describe file formats and syntax rules. Therefore a short introduction to EBNF is given here.

### EBNF Example

```
ProcDecl     =  PROCEDURE "(" ArgList ")".
ArgList      =  Expression {"," Expression}.
Expression   =  Term ("*"|"/") Term.
Term         =  Factor AddOp Factor.
AddOp        =  "+"|"-".
Factor       =  (["-"] Number)|"(" Expression ")".
```

The EBNF language is a formalism that can be used to express the syntax of context-free languages. An EBNF grammar is a set of rules called *productions* of the form:

```
LeftHandSide = RightHandSide.
```

The left-hand side is a so-called non-terminal symbol, the right-hand side describes its composition.

EBNF consists of the following symbols:

- Terminal symbols (terminals for short) are the basic symbols which form the language described. In above example, the word `PROCEDURE` is a terminal. Punctuation symbols of the language described (not of EBNF itself) are quoted (they are terminals, too), while other terminal symbols are printed in **boldface**.
- Non-terminal symbols (non-terminals) are syntactic variables and must be defined in a production, i.e. they must appear on the left-hand side of a production somewhere. In the above example, there are many non-terminals, e.g. `ArgList` or `AddOp`.
- The vertical bar "|" denotes an alternative, i.e. either the left or the right side of the bar can appear in the language described, but one of them must. The third production

above means “an expression is a term followed by either a "*" or a "/" followed by another term”.

Parts of an EBNF production enclosed by "[" and "]" are optional. They may appear exactly once in the language, or they may be skipped. The minus sign in the last production above is optional, both -7 and 7 are allowed.

- The repetition is another useful construct. Any part of a production enclosed by "{" and "}" may appear any number of times in the language described (including zero, i.e. it may also be skipped). `ArgList` above is an example: an argument list is a single expression or a list of any number of expressions separated by commas. (Note that the syntax in the example does not allow empty argument lists)
- For better readability, normal parentheses may be used for grouping EBNF expressions, as is done in the last production of the example. Note the difference between the first and the second left bracket: the first one is part of EBNF itself, the second one is a terminal symbol (it is quoted) and therefore may appear in the language described.
- A production is always terminated by a period.

# EBNF Syntax

We can now give the definition of EBNF in EBNF itself:

```
Production      =  NonTerminal "=" Expression ".".
Expression      =  Term {"|" Term}.
Term            =  Factor {Factor}.
Factor          =  NonTerminal
                   | Terminal
                   | "(" Expression ")"
                   | "[" Expression "]"
                   | "{" Expression "}".
Terminal        =  Identifier | """ <any char> """.
NonTerminal     =  Identifier.
```

The identifier for a non-terminal can be any name you like, terminal symbols are either identifiers appearing in the language described or any character sequence that is quoted.

# Extensions

In addition to this standard definition of EBNF, we use the following notational conventions:

- The counting repetition: Anything enclosed by "{" and "}" and followed by a superscripted expression *x* must appear exactly *x* times. *x* may also be a non-terminal. In the following example, exactly four stars are allowed:

```
Stars = {"*"}4.
```

- The size in bytes. Any identifier immediately followed by a number *n* in square brackets ("[" and "]") may be assumed to be a binary number with the most significant byte stored first, having exactly *n* bytes. Example:

```
Struct=RefNo FilePos[4].
```

- In some examples, we enclose text by `"<"` and `">"`. This text is a meta–literal, i.e. whatever the text says may be inserted in place of the text. (cf. `<any char>` in the above example, where any character can be inserted).

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