CodeWarrior™ Development Studio for ColdFire® Architectures v6.0

Targeting Manual

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1

Introduction

This manual explains how to use CodeWarrior™ development tools to develop applications for the Freescale™ ColdFire® family of integrated microprocessors.

This chapter consists of these sections:

- Read the Developer Notes
- Features
- CodeWarrior Editions
- About this Manual
- Documentation Overview
- Additional Information Resources

Read the Developer Notes

Before using the CodeWarrior IDE, read the developer notes. These notes contain important information about last-minute changes, bug fixes, incompatible elements, or other topics that may not be included in this manual.

NOTE The release notes for specific components of the CodeWarrior IDE are located at location: `{CodeWarrior_Dir}\Release_Notes`, where `{CodeWarrior_Dir}` is the CodeWarrior installation directory.

If you are new to the CodeWarrior IDE, read this chapter and the Getting Started chapter. This chapter provides references to resources of interest to new users; the Getting Started chapter helps you become familiar with the software features.

Features

The CodeWarrior Development Studio for ColdFire Architectures includes these features:

- Latest version of the CodeWarrior IDE, which the *IDE User's Guide* explains.
- Support for the latest ColdFire processors: CFM5213, and variants CFM5211 and CFM5212.

- Support for previous processors of the ColdFire family, such as CFM547x/548x, CFM5307, CFM523x, CFM5282, CFM5275, and CFM5249. For more information, see ColdFire Processor
- Flash-programmer and hardware-diagnostics support. For more information, see Using Hardware Tools.
- USB debugging support through the P&E Micro protocol. For more information, see P&E Microsystems Remote Connections.
- Instruction Set Simulator (ISS) for V2 and V4e processor cores. For more information, see Remote Connections for Debugging and Instruction Set Simulator
- For previous processors of the ColdFire family, support for the simple profiler. For more information, see Using the Simple Profiler and the *Profiler User's Guide*. (This profiler support is not available for CFM5213, CFM5211, or CFM5212 processors.)

CodeWarrior Editions

There are three editions of CodeWarrior™ Development Studio for ColdFire® Architectures, version 6.0. Table 1.1 shows their feature differences.

Table 1.1 CodeWarrior ColdFire 6.0 Edition Features

Feature	Special Edition	Standard Edition	Professional Edition
IDE	Yes	Yes	Yes
Compiles source code	ASM and C	ASM and C	ASM, C, and C++
Code size restrictions	128KB	None	None
Compiler optimization levels	Unlimited	Unlimited	Unlimited
3rd-party plug-ins	No RTOS	No RTOS	Unlimited RTOS plug-ins
CodeWarrior Debugger	Yes	Yes	Yes
Debugger hardware connections	P&E Parallel and USB	P&E Parallel and USB	P&E Parallel, USB, and Lightning; Abatron serial and TCP/IP
V2, V4e simulator	No	Yes	Yes

Table 1.1 CodeWarrior ColdFire 6.0 Edition Features (*continued*)

Feature	Special Edition	Standard Edition	Professional Edition
Flash programmers	CodeWarrior Flash Programmer (129 megabytes) and ColdFire Flasher standalone plug-in	CodeWarrior Flash Programmer and ColdFire Flasher standalone plug-in	CodeWarrior Flash Programmer and ColdFire Flasher standalone plug-in
Real time operating system (RTOS)	Not available	Not available	Plug-ins available
Availability	Free with evaluation board	Available through all channels	Available through all channels. 30-day evaluation copy also available.

About this Manual

Table 1.2 lists the contents of this manual.

Table 1.2 Chapter, Appendix Contents

Chapter/Appendix	Explains
Introduction	New features; contents of this manual; technical support; further documentation
Getting Started	System requirements; overview of CodeWarrior development tools
Application Tutorial	Tutorial for writing and debugging programs
Target Settings	Controlling the compiler and linker
Compilers	ColdFire-specific compiler informationColdFire
ELF Linker and Command Language	Linker and linker command file information
ColdFire Linker Notes	Linker capabilities
Inline Assembly	Compiler support for inline assembly
Debugging	Debugger settings panels; remote debugging connections

Table 1.2 Chapter, Appendix Contents (*continued*)

Chapter/Appendix	Explains
Instruction Set Simulator	Instruction Set Simulator, including configuration for your requirements.
Libraries and Runtime Code	Libraries for ColdFire targets
Using Hardware Tools	Flash programmer and hardware diagnostics tools
Command-Line Tools	Command-line compiler, assembler, linker, and debugger
Using Debug Initialization Files	Debug initialization files
Memory Configuration Files	Defining access for areas of memory

Documentation Overview

Documentation for your CodeWarrior tools comes in three formats:

- **PDF manuals** — in subdirectory `\Help\PDF` of your installation directory.
  - The Target Settings and Debugging chapters of this Targeting Manual are extensions of the *IDE User's Guide*.
  - The Compilers and Inline Assembly chapters of this Targeting Manual are extensions of the *C Compilers Reference*.
  - The Libraries and Runtime Code chapter of this Targeting Manual is an extension of the *MSL C Reference* and the *MSL C++ Reference*.

NOTE For complete information about a particular topic, you may need to look in this Targeting manual and in the corresponding generic CodeWarrior manual. To view any PDF document, you need Adobe® Acrobat® Reader software, which you can download from: `http://www.adobe.com/acrobat`

- **CHM help files** — information in Microsoft® HTML Help CHM format, in folder `\Help` of the CodeWarrior installation directory. To view this information, start the CodeWarrior IDE, then select **Help > Online Manuals** from the main menu bar.
- **CodeWarrior online help** — information about using the IDE and understanding error messages. To access this information, start the CodeWarrior IDE, then select **Help > CodeWarrior Help** from the main menu bar.

Additional Information Resources

- For general information about the CodeWarrior IDE and debugger, see the *IDE User's Guide*.
- For information specific to the C/C++ front-end compiler, see the *C Compilers Reference.*
- For information about Metrowerks standard C/C++ libraries, see the *MSL C Reference* and the *MSL C++ Reference.*
- For instructions on programming in C, C++, Java, and Pascal — all in one environment, see the *Discover Programming* edition of CodeWarrior software.
- For PDF-format documentation about Freescale processors and cores, go to the `\Freescale_Documentation` subdirectory of your CodeWarrior installation directory.
- For Freescale documentation and resources, visit the Freescale, Inc. web site: `http://www.freescale.com`
- For additional electronic-design and embedded-system resources, visit the EG3 Communications, Inc. web site: `http://www.eg3.com`
- For monthly and weekly forum information about programming embedded systems (including source-code examples), visit the *Embedded Systems Programming* magazine web site: `http://www.embedded.com`

2

Getting Started

This chapter helps you install the CodeWarrior™ Development Studio for ColdFire Architectures. It also gives an overview of the CodeWarrior environment and tools.

This chapter consists of these sections:

- System Requirements
- CodeWarrior IDE
- CodeWarrior Development Process

System Requirements

Your host computer system and your target board must meet minimum requirements.

Host Requirements

Your computer (PC) needs:

- 800 MHz Pentium®-compatible microprocessor
- Windows® 2000 or XP operating system
- 512 megabytes of RAM
- CD-ROM drive
- 350 megabytes free memory space, plus space for projects and source code
- Serial port (or Ethernet connector), to connect your PC to the embedded target — for debugging with an Abatron BDI device
- Parallel port (or P&E Lightning board) — to use a wiggler to connect to BDM/JTAG targets
- USB port — P&E Micro to use a USB device through the P&E Micro Protocol.

Target Board Requirements

Your functional embedded system needs:

- ColdFire evaluation board, with a processor such as CFM5213, CFM5282, CFM5407, CFM5235, CFM5271, CFM5307, or CFM5485

- Serial or null-modem cables to connect the host computer and target board; your target board determines the specific cables you need.
- For a BDM/JTAG connection, parallel cables to connect the computer to a wiggler.
- Appropriate power supply for the target board.

CodeWarrior IDE

The CodeWarrior IDE consists of a project manager, a graphical user interface, compilers, linkers, a debugger, a source-code browser, and editing tools. You can edit, navigate, examine, compile, link, and debug code, within the one CodeWarrior environment. The CodeWarrior IDE lets you configure options for code generation, debugging, and navigation of your project.

Unlike command-line development tools, the CodeWarrior IDE organizes all files related to your project. You can see your project at a glance, so organization of your source code files is easy. Navigation among those files is easy, too.

When you use the CodeWarrior IDE, there is no need for complicated build scripts or makefiles. To add or delete source code files from a project, you use your mouse and keyboard, instead of tediously editing a build script.

For any project, you can create and manage several configurations for use on different computer platforms. The platform on which you run the CodeWarrior IDE is called the *host*. From the host, you can use the CodeWarrior IDE to develop code to target various platforms.

Note the two meanings of the term *target*:

- **Platform Target** — The operating system, processor, or microcontroller in which/on which your code will execute.
- **Build Target** — The group of settings and files that determine what your code is, as well as controlling the process of compiling and linking.

The CodeWarrior IDE lets you specify multiple build targets. For example, a project can contain one build target for debugging and another build target optimized for a particular operating system (platform target). These build targets can share project files, even though each build target uses its own settings. After you debug the program, the only actions necessary to generate a final version are selecting the project's optimized build target and using a single `make` command.

The CodeWarrior IDE's extensible architecture uses plug-in compilers and linkers to target various operating systems and microprocessors. For example, the IDE internally calls a C translator, compiler, and linker.

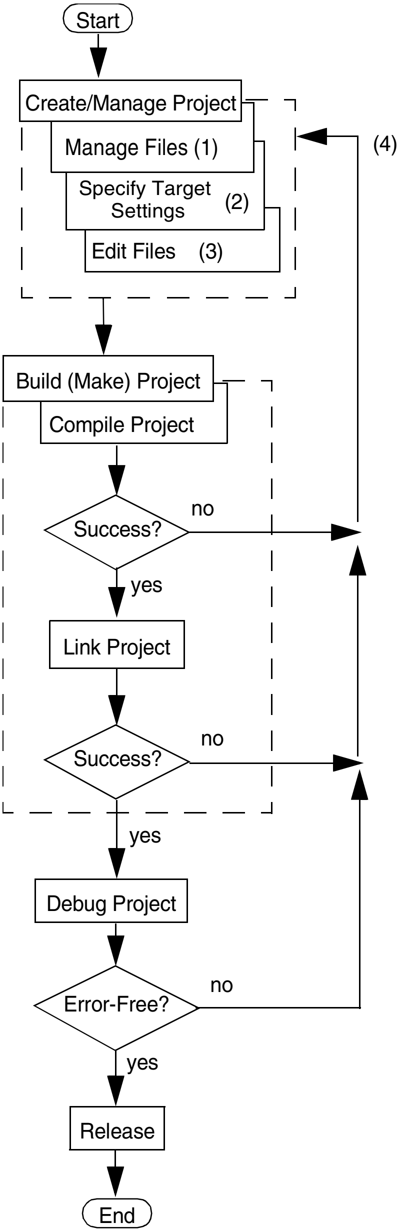
Most features of the CodeWarrior IDE apply to several hosts, languages, and build targets. However, each build target has its own unique features. This manual explains the features unique to the CodeWarrior IDE for Freescale ColdFire processors.

For comprehensive information about the CodeWarrior IDE, see the *Code Warrior IDE User's Guide*.

CodeWarrior Development Process

The CodeWarrior IDE helps you manage your development work more effectively than you can with a traditional command-line environment. Figure 2.1 depicts application development using the IDE.

Figure 2.1 CodeWarrior IDE Application Development



Notes:

(1) Use any combination: stationery (template) files, library files, or your own source files.

(2) Compiler, linker, debugger settings; target specification; optimizations.

(3) Edit source and resource files.

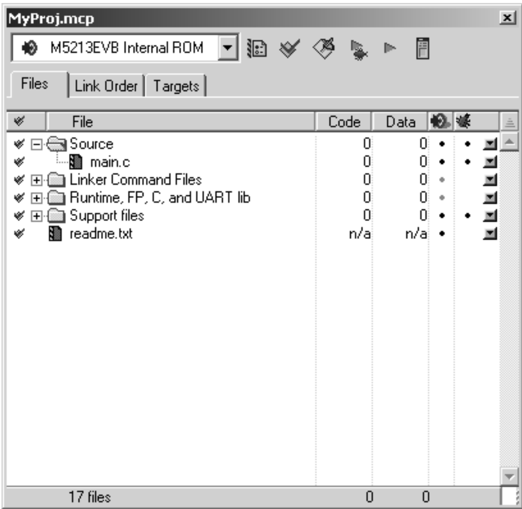
(4) Possible corrections: adding a file, changing settings, or editing a file.

Project Files

A CodeWarrior project consists of source-code, library, and other files. The project window (Figure 2.2) lists all files of a project, letting you:

- Add files
- Remove files
- Specify the link order
- Assign files to build targets
- Have the IDE generate debug information for files

Figure 2.2 Project Window



NOTE Figure 2.2 shows a floating project window. Alternatively, you can dock the project window in the IDE main window or make the project window a child of the main window. You can have multiple project windows open at the same time; if the windows are docked, their tabs let you control which one is at the front of the main window.

The CodeWarrior IDE automatically handles dependencies among project files, storing compiler and linker settings for each build target. The IDE tracks which files have changed since your last build, recompiling only those files during your next project build.

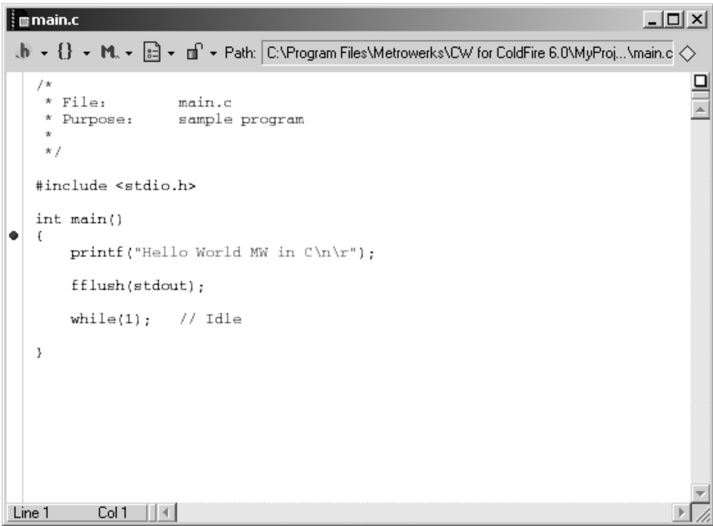
A CodeWarrior project is analogous to a collection of makefiles, as the same project can contain multiple builds. Examples are a debug version and release version of code, both part of the same project. As earlier text explained, *build targets* are such different builds within a single project.

Editing Code

The CodeWarrior text editor handles text files in MS-DOS, UNIX, and MacOS formats.

To edit a source code file (or any other editable project file), double-click its filename in the project window. The IDE opens the file in the editor window (Figure 2.3). This window lets you switch between related files, locate particular functions, mark locations within a file, or go to a specific line of code.

Figure 2.3 Editor Window



NOTE Figure 2.3 shows a floating editor window. Alternatively, you can dock the project window in the IDE main window or make the project window a child of the main window.

Building: Compiling and Linking

For the CodeWarrior IDE, *building* includes both compiling and linking. To start building, you select **Project > Make**, from the IDE main menu bar. The IDE compiler:

- Generates an object-code file from each source-code file of the build target, incorporating appropriate optimizations.

- Updates other files of the build target, as appropriate.
- In case of errors, issues appropriate messages and halts.

When compilation is done, building moves on to linking. The IDE linker:

- Links the object files into one executable file, in the link order you specify.
- In case of errors, issues appropriate error messages and halts.

When linking is done, you are ready to test and debug your application.

NOTE It is possible to compile a single source file. To do so, select the filename in the project window, then select **Project > Compile** from the main menu bar. Another useful option is compiling only the modified files of the build target: select **Project > Bring Up To Date** from the main menu bar.

Debugging

To debug your application, select **Project > Debug** from the main menu bar. The debugger window opens, displaying your program code.

Run the application from within the debugger to observe results. The debugger lets you set breakpoints, to check register, parameter, and other values at specific points of code execution.

NOTE To debug code stored in Flash memory, you first must program the Flash.

When your code executes correctly, you are ready to add features, to release the application to testers, or to release the application to customers.

NOTE Another debugging feature of the CodeWarrior IDE is viewing preprocessor output. This helps you track down bugs caused by macro expansions or another subtlety of the preprocessor. To use this feature, specify the output filename in the project window, then select **Project > Preprocess** from the main menu bar. A new window opens to show the preprocessed file.

Disassembling

To disassemble a compiled or ELF file of your project, select the file's name in the project window, then select **Project > Disassemble**. After disassembling the file, the CodeWarrior IDE creates a `.dump` file that contains the disassembled file's object code in assembly format, and debugging information in Debugging With Attribute Record Format (DWARF). The `.dump` file's contents appear in a new window.

3

Application Tutorial

This chapter takes you through the CodeWarrior™ IDE programming environment. This tutorial does not teach you programming. It instead teaches you how to use the CodeWarrior IDE to write and debug applications for a target platform.

Before you start the tutorial, you must set up your target evaluation board (EVB). Typically, this entails:

- Verifying all jumper-header and switch settings,
- Connecting a serial cable between the EVB and your computer, and
- Connecting EVB power.

NOTE For complete setup instructions, see the EVB's own documentation.

This chapter consists of these sections:

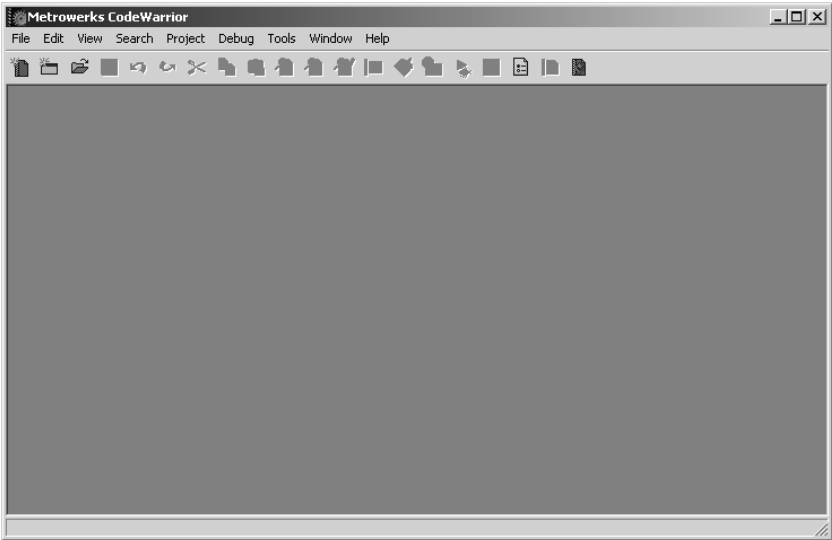
- Create a Project
- Build the Project
- Debug the Application

Create a Project

This section shows how to use stationery to create a new project for a ColdFire EVB, and how to set up the project to make a standalone application. Follow these steps:

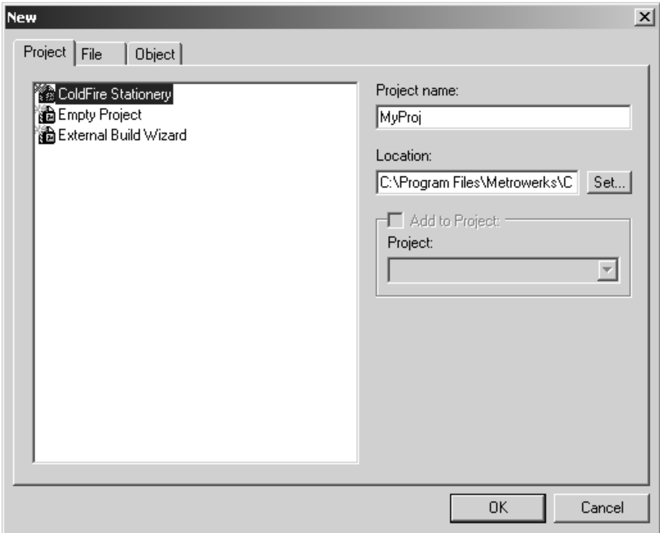
1. Select **Programs > Metrowerks CodeWarrior > CodeWarrior for ColdFire V6.0 > CodeWarrior IDE**. The CodeWarrior IDE starts and the main window (Figure 3.1) appears.

Figure 3.1 CodeWarrior IDE Main Window



2. From the main menu bar, select **File > New.** The **New** dialog box (Figure 3.2) appears.

Figure 3.2 New Dialog Box



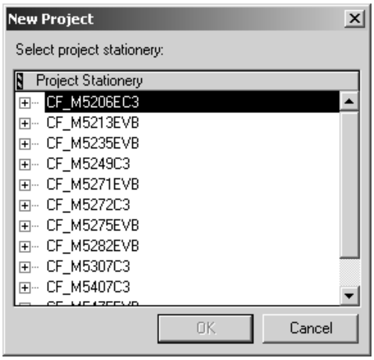
a. Select **ColdFire Stationery**.

b. In the **Project name** text box, type `MyProj`.

NOTE The default project location is the CodeWarrior installation directory. For example, if the project name is **abc** and the installation directory is `CodeWarrior_Dir`, the default location is `CodeWarrior_Dir\abc`. For a different location, click the **Set** button, then use the subsequent dialog box to specify the location. Clicking **OK** returns you to the **New** dialog box, which shows the specified location in the **Location** text box.

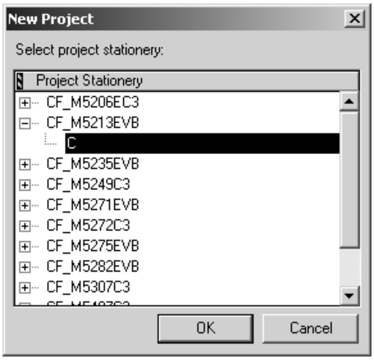
c. Click **OK**. The **New Project** dialog box (Figure 3.3) appears.

Figure 3.3 New Project Dialog Box



3. Specify CF_M5213EVB C stationery.
   a. Click the CF_M5213EVB expand control — the tree structure displays the subordinate option C.
   b. Select **C**, as Figure 3.4 shows.

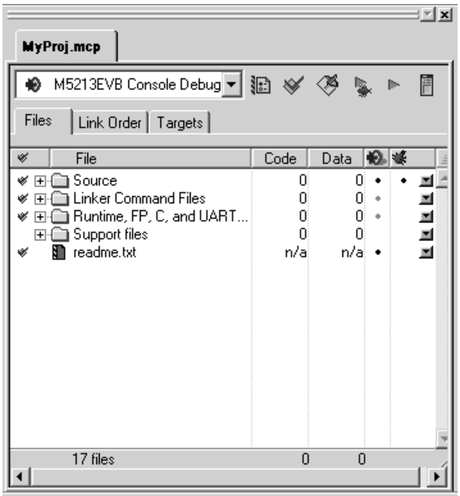
Figure 3.4 New Project Dialog Box: Selecting M5213 C Stationery



NOTE Many possible ColdFire target processors have an external bus, so can use large external RAM devices for debugging applications during development. But M521x processors do not have an external bus, so must accommodate applications in on-chip memory. Although this on-chip RAM accommodates CodeWarrior stationery, it probably is too small for full development of your application. Accordingly, for an M521x processor, you should locate your applications in flash memory. (The Flash Programmer subsection explains how to program a flash device.)

c. Click **OK**. The CodeWarrior IDE creates a new project consisting of the folders and files (header, initialization, common, and so forth) that the M5213 C stationery specifies. The project window (Figure 3.5) appears.

Figure 3.5 Project Window



4. Make sure that the target field (immediately under the project-window tab) specifies M5213EVB Console Debug**.**

NOTE Files in the *project data folder* include information about the project file, various target settings, and object code. Do not change the contents of this folder, or the CodeWarrior IDE could lose project settings.

5. This completes project creation. You are ready to build the project, per the procedure of the next section.

NOTE While your source file (`main.c`) is open in the editor window, you can use all editor features to work with your code.
If you wish, you can use a third-party editor to create and edit your code, provided that this editor saves the file as plain text.
For information about the editor window, touching files, and file synchronization, and removing/adding text files, see *IDE User's Guide.*

Build the Project

This section shows how to select the linker, set up remote debugging, and build (compile and link) your project.

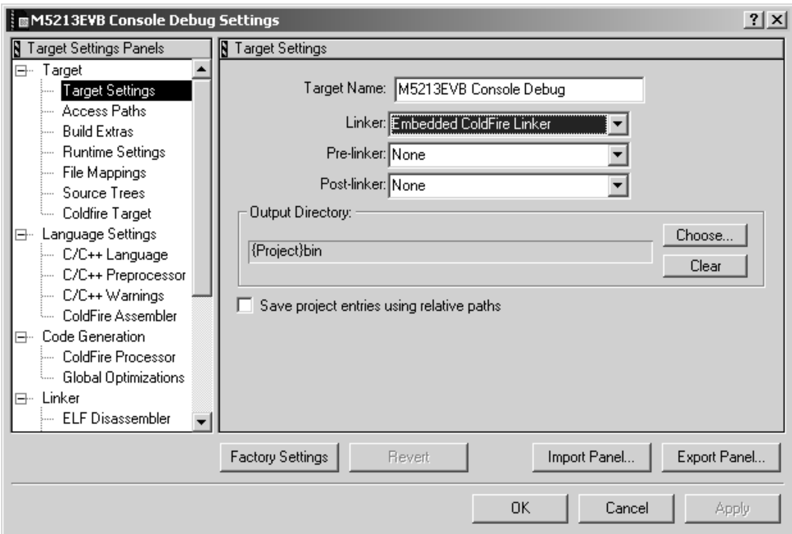
NOTE The stationery for this project includes a default setup for the linker specific to the application's target platform.

Follow these steps:

1. Select the appropriate linker.

   a. Select **Edit > *Target* Settings** (where ***Target*** is the name of the current build target). The ***Target* Settings** window (Figure 3.6) appears.

Figure 3.6 Target Settings Window: Target Settings Panel



   b. From the **Target Settings Panels** list, select **Target Settings**. The **Target Settings** panel moves to the front of the window.

   c. Use the **Linker** list box to specify the Embedded ColdFire Linker.

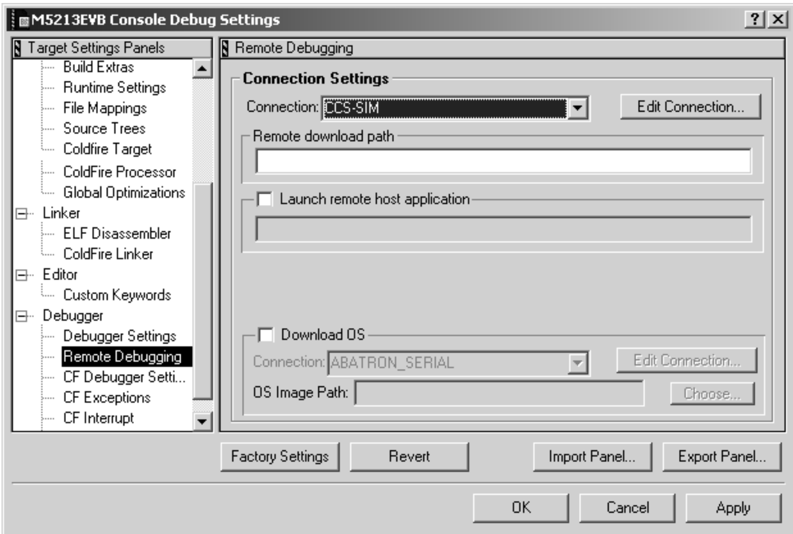
   d. Click **Apply**. The IDE saves the new linker setting for the build target.

NOTE This linker change applies only to the current build target. To use a different build target, you must specify its appropriate linker.

For an actual target board, instead of the simulator, you would need to make board connections by this point.

2. Set Up Remote Debugging.
   a. From the **Target Settings Panels** list, select **Remote Debugging**. The **Remote Debugging** settings panel moves to the front of the **Target Settings** window, as Figure 3.7 shows.

Figure 3.7 Target Settings Window: Remote Debugging Panel



   b. Use the Connection list box to specify **CCS-SIM**.
   c. Click **OK**. The IDE completes the remote debugging setup, and the **Target Settings** window closes.
3. From the main menu bar, select **Project > Make**. The IDE updates all files, links code into the finished application, and displays any error messages or warnings in the **Errors & Warnings** window.

NOTE The **Make** command applies to all source files: the IDE opens them all, the compiler generates object code, then the linker creates an executable file. (The **Compile** command applies only to selected files. The **Bring Up To Date** command compiles all changed files, without linking.)
The Project window lets you view compiler progress, or stop the build.

4. This completes building your project. You are ready for the debugging procedure of the next section.

Debug the Application

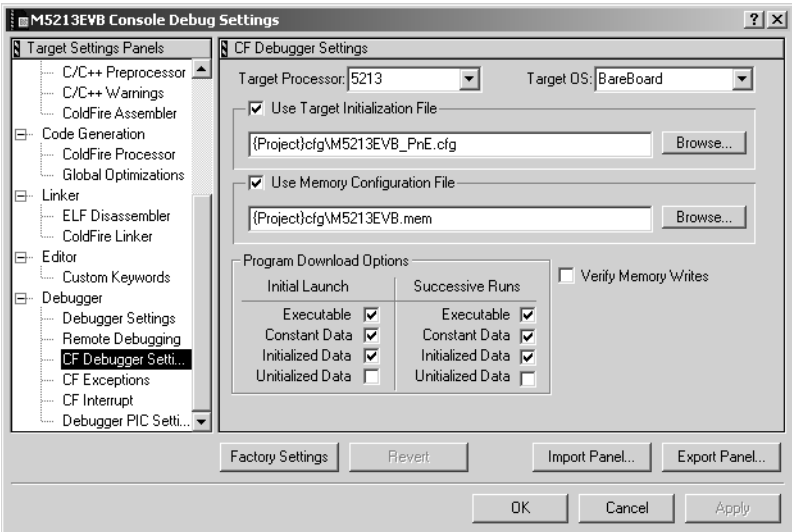
This section explains you how to test whether your application runs as you expect. Topics include starting the debugger, setting a breakpoint, and viewing registers. Follow these steps:

1. Set debugger preferences.

   a. Select **Edit** > ***Target*** **Settings**, (where ***Target*** is the name of the current build target). The **Target Settings** window appears.

   b. From the **Target Settings Panels** list, select **CF Debugger Settings**. The **CF Debugger Settings** panel moves to the front of the window, as Figure 3.8 shows.

Figure 3.8 The CF Debugger Settings Panel



   c. Make sure that the **Target Processor** list box specifies **521x**.

   d. Make sure that the **Target OS** list box specifies **BareBoard**.

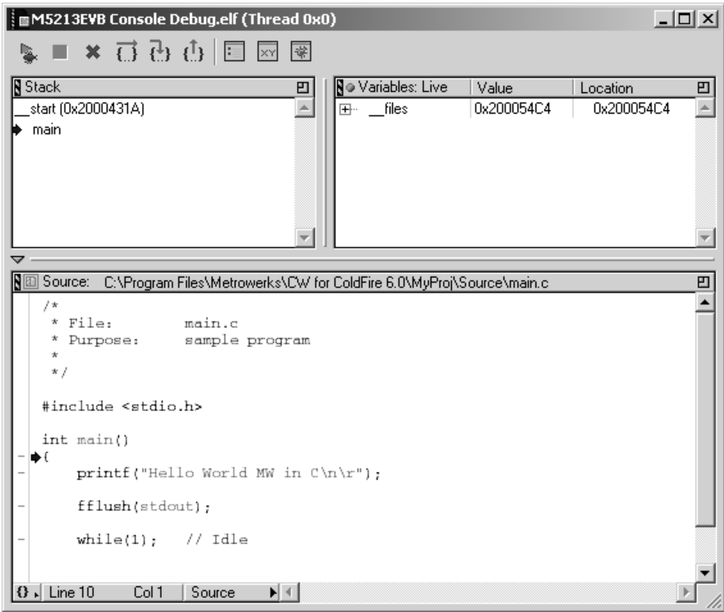
   e. Click **OK**. The IDE saves the debugger settings, and the **Target Settings** window closes.

NOTE The default target initialization and memory configuration files are in subdirectory `\E68K_Support\Initialization_Files`, of the CodeWarrior installation directory.

2. From the IDE main menu, select **Project** > **Debug**. A progress bar appears as the system downloads the output file to the target. The debugger starts; the **Debugger** window (Figure 3.9) appears.

NOTE For a ROM build target, you must load the application to Flash memory before you can perform Step 2.

Figure 3.9 Debugger Window



a. Note the toolbar at the top of the window; it includes command buttons **Run**, **Stop**, **Kill**, **Step Over**, **Step Into**, and **Step Out**.

b. Note the **Stack** pane, at the upper left. This pane shows the function calling stack.

c. Note the **Variables** pane, at the upper right. This pane lists the names and values of any local variables.

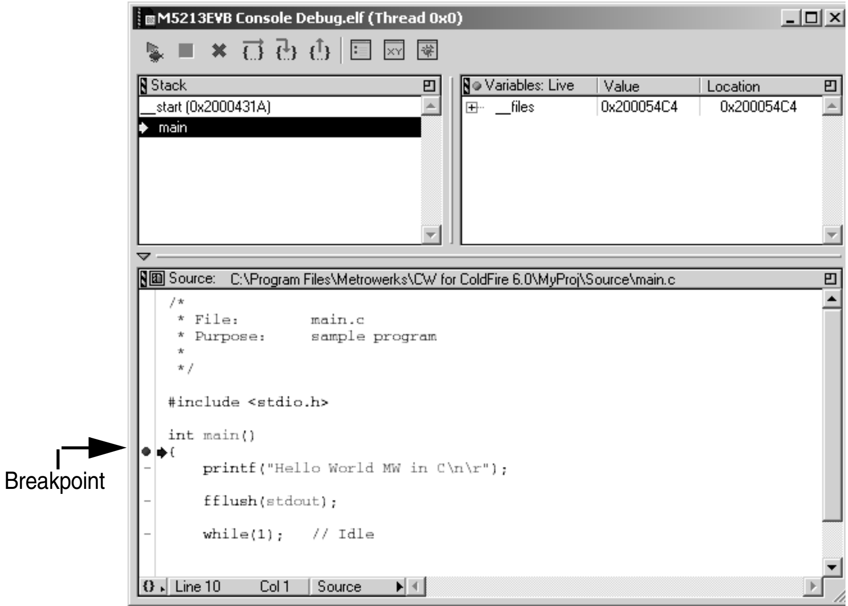
d. Note the **Source** pane, the largest pane of the window. This pane displays source code or assembly code.

3. Set a breakpoint.

   a. In the **Source** pane, find the line containing the open brace ({) character.

   b. In the far left-hand column of this line, click the grey dash. A red circle replaces the dash, indicating that the debugger set a breakpoint at the location. Figure 3.10 shows the red-circle indicator.

Figure 3.10 Setting a breakpoint



4. View registers.

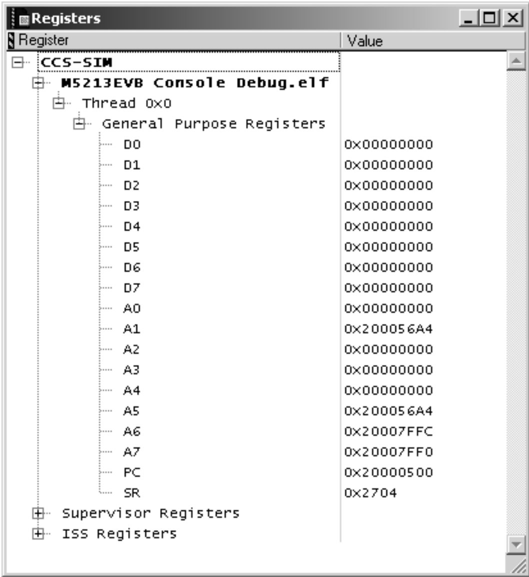
   a. From the main menu bar, select **View** > **Registers**. The **Registers** window (Figure 3.11) appears.

   b. Use the expand controls to drill down through register categories to individual registers — when you reach individual registers, their values appear at the right side of the window.

   c. You may edit register values directly in the **Registers** window.

   d. Close the **Registers** window.

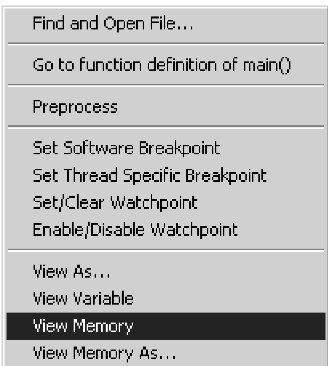
Figure 3.11 Registers Window



5. View memory.

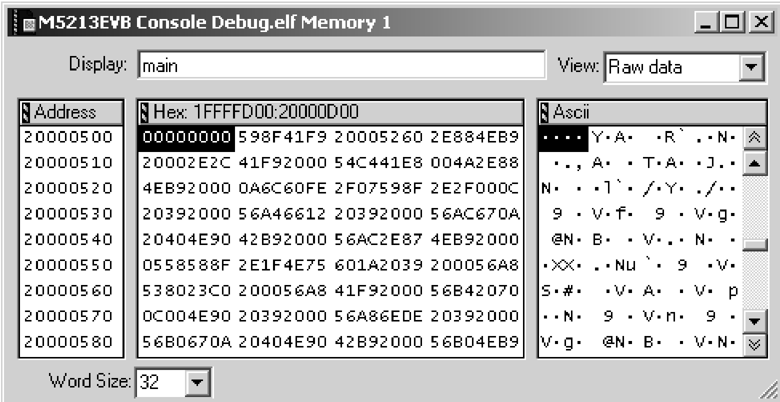
   a. In the **Source** pane of the **Debugger** window, right-click on `main`. The view-memory context menu (Figure 3.12) appears.

Figure 3.12 View Memory Context Menu



b. From this context menu, select **View Memory**. The **View Memory** window Figure 3.13 appears.

Figure 3.13 View Memory Window



c. Note that the **View Memory** window displays hexadecimal and ascii values for several addresses, starting at the address of `main`.

d. In the **Display** text box, type a valid address in RAM or ROM.

e. Press the Enter key. Window contents change, to display memory values starting at the address you entered.

NOTE You can edit the contents of the View Memory window. This window also lets you disassemble a random part of memory.

f. Close the **View Memory** window.

6. Run the application.

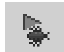
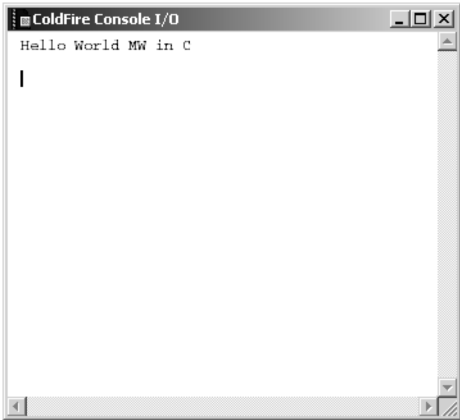
   a. From the main menu bar, select **Project > Run,** or click the **Run** button  of the **Debugger** window. A console window (Figure 3.14) appears, displaying the *Hello-World*-message result of the application.

Figure 3.14 Console Window



   b. Click the **Kill** button  of the **Debugger** window. The debugger stops the application, the IDE stops the debugger, and the Debugger widow closes.

   c. This completes the procedure — you have created and debugged a simple application. You may close any open windows.

4

Target Settings

This chapter explains the settings panels specific to ColdFire software development. Use the elements of these panels to control assembling, compiling, linking, and other aspects of code generation.

This chapter consists of these sections:

- Target Settings Overview
- ColdFire Settings Panels

Target Settings Overview

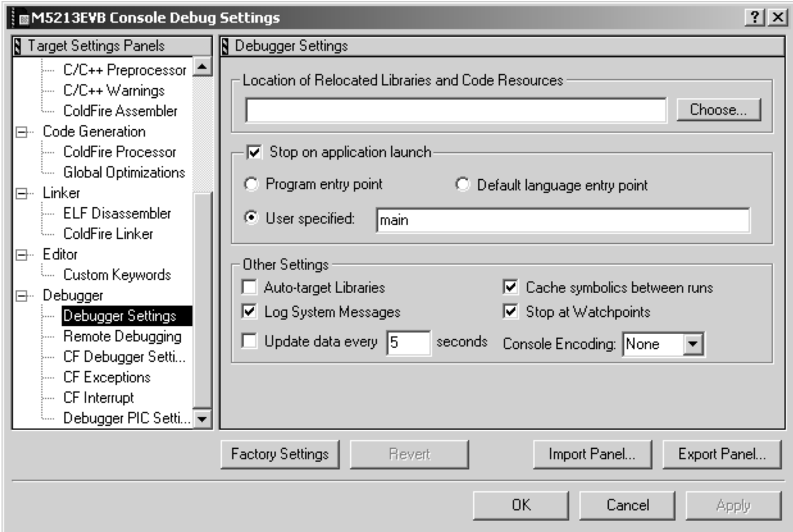
In a CodeWarrior project, each build target has its own settings for compiling, linking, and other parts of code generation. Your controls for these settings are the target settings *panels* that you access through the ***Target*** **Settings** window.

To open this window, select **Edit >** ***Target*** **Settings**, from the main-window menu bar. (***Target*** is a target name, such as CF_Simulator, within your CodeWarrior project.) An alternate way to brig up the ***Target*** **Settings** window is to bring the Targets page to the front of the project window, then double-click the project name.

Figure 4.1 shows this Target Settings window. (The CodeWarrior IDE User's Guide explains all elements of this window.)

Use the tree listing of panels, in the Target Settings Panels pane, to display any settings panel. If necessary, click the expand control to see a category's list of panels. Clicking a panel name immediately puts that panel in the Target Settings pane.

Figure 4.1 Target Settings Window



Note these buttons, at the bottom of the window:

- **Apply** — Implements your changes, leaving the ***Target* Settings** window open. This lets you bring up a different settings panel.
- **OK** — Implements your changes, closing the ***Target* Settings** window. Use this button when you make the last of your settings changes.
- **Revert** — Changes panel settings back to their most recently saved values. (Modifying any panel settings activates this button.)
- **Factory Settings** — Restores the original default values for the panel.
- **Import Panel** — Copies panel settings previously saved as an XML file.
- **Export Panel** — Saves settings of the current panel to an XML file.

ColdFire Settings Panels

Table 4.1 lists the target settings panels specific to developing applications for the ColdFire target. The following section describes these panels in detail.

Table 4.1 ColdFire Target Settings Panels

Target Settings	ColdFire Processor
BatchRunner PreLinker	ELF Disassembler
BatchRunner PostLinker	ColdFire Linker
ColdFire Target	Debugger PIC Settings
ColdFire Assembler	

NOTE For debugger-specific panels **CF Debugger Setting**, **CF Exceptions**, **Debugger Settings**, and **Remote Debugging**, see the Debugging chapter. For information about the **C/C++ Language** and **C/C++ Warnings panels**, see the *C Compilers Reference* manual.
For details on all other panels, see the *IDE User's Guide*.

Target Settings

Use the **Target Settings** panel (Figure 4.2) to define the build target and select the appropriate linker. Table 4.2 explains the elements of this panel.

NOTE You must use this settings panel to select a linker before you can specify the compiler, linker settings, or any other project details.

Figure 4.2 Target Settings Panel

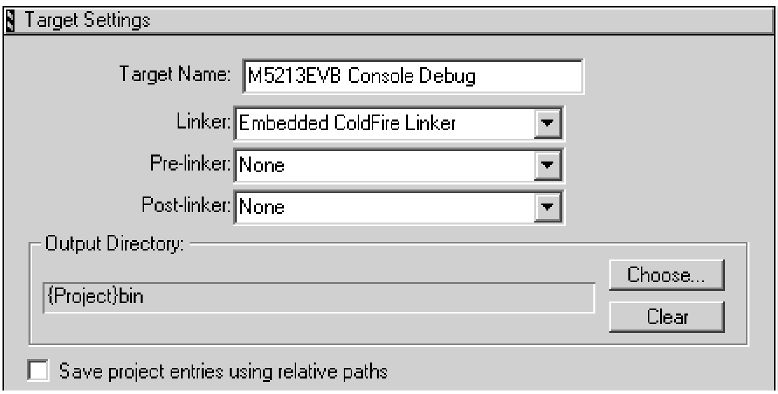


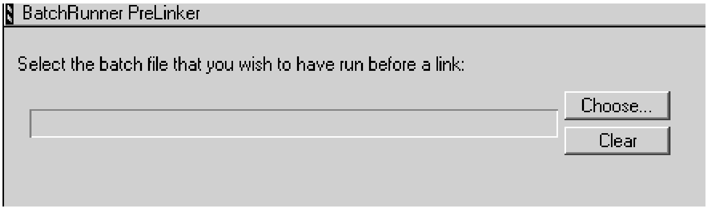
Table 4.2 Target Settings Panel Elements

Element	Purpose	Comments
Target Name text box	Specifies the name of the build target; this name appears subsequently on the Targets page of the project window.	Default: None. This build-target name is *not* the name of your final output file.
Linker list box	Specifies the linker: Select **ColdFire**.	Default: ColdFire. Controls visibility of other relevant panels.
Pre-linker list box	Specifies the pre-linker that performs work on object code before linking.	Default: None. If your project includes Flash programming, select BatchRunner PreLinker. For more information, see BatchRunner PreLinker.
Post-linker list box	Specifies the post-linker that performs additional work on the final executable.	Default: None. Post-linking often includes object code format conversion. If your project includes Flash programming, select BatchRunner PostLinker. For more information, see BatchRunner PostLinker.
Output Directory text box	Specifies the directory for the final linked output file. To specify a non-default directory, click the **Choose** button. To clear this text box, click the **Clear** button.	Default: Directory that contains the project file.
Save project entries using relative paths checkbox	Clear — Specifies minimal file searching; each project file must have a unique name. Checked — Specifies relative file searching; project may include two or more files that have the same name.	Default: Clear.

BatchRunner PreLinker

The **BatchRunner PreLinker** settings panel (Figure 4.3) lets you run a batch file before the IDE begins linking your project. To specify such a batch file, click the **Choose** button, then use the subsequent dialog box to navigate to and select the file. Clicking the **OK** button of the dialog box returns you to this panel, filling in the name of the batch file.

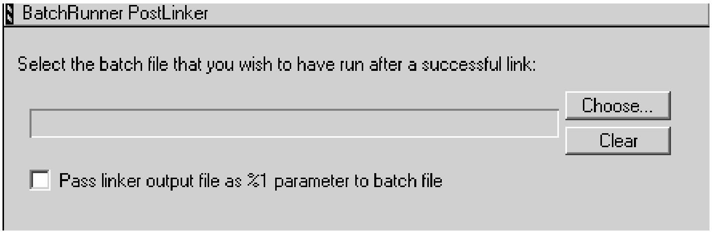
Figure 4.3 BatchRunner PreLinker Panel



BatchRunner PostLinker

The **BatchRunner PostLinker** settings panel (Figure 4.4) lets you run a batch file *after* the IDE builds your project. To specify such a batch file, click the **Choose** button, then use the subsequent dialog box to navigate to and select the file. Clicking the **OK** button of the dialog box returns you to this panel, filling in the name of the batch file.

Figure 4.4 BatchRunner PostLinker Panel



To pass the name of the output file as a parameter to the batch file, check the **Pass linker output file as %1 parameter to batch file** checkbox.

ColdFire Target

Use the **ColdFire Target** panel (Figure 4.5) to specify the type of project file and to name your final output file. Table 4.3 explains the elements of this panel. (To create alternative builds, compiling for different targets, use the `__option()` pre-processor function with conditional compilation.)

Figure 4.5 ColdFire Target Panel

Table 4.3 ColdFire Target Panel Elements

Element	Purpose	Comments
Project Type list box	Specifies the kind of project: Application — executable project Library — static library Shared Library — shared library	Default: Application.
File Name text box	Specifies the name of your final linked output file.	Default: None. Convention: use extension.elf for an application, `.lib` or `.a` for a library.

ColdFire Assembler

Use the **ColdFire Assembler** panel (Figure 4.6) to control the source format or syntax for the CodeWarrior assembler, and to specify the target processor, for which you are generating code. Table 4.4 explains the elements of this panel.

Figure 4.6 ColdFire Assembler Panel

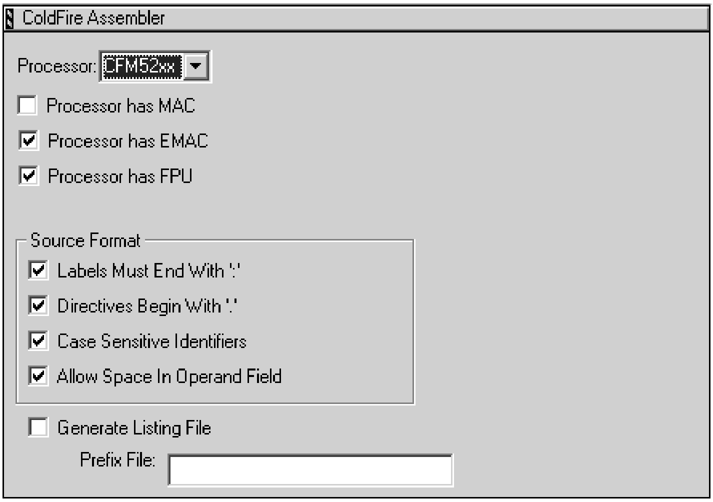


Table 4.4 ColdFire Assembler Panel Elements

Element	Purpose	Comments
Processor list box	Specifies the target processor.	Default: MCF52xx.
Processor has MAC checkbox	Clear — Tells assembler that the target processor does *not* have a multiply accumulator (MAC) unit. Checked — Tells assembler that the target processor *does* have a MAC.	Default: Clear. You can check both the MAC and EMAC checkboxes.
Processor has EMAC checkbox	Clear — Tells assembler that the target processor does *not* have an enhanced multiply accumulator (EMAC) unit. For more information, see the reference manual at `{CodeWarrior_Dir}` `\Freescale_Documentation`, Checked — Tells assembler that the target processor *does* have EMAC.	Default: Clear. You can check both the MAC and EMAC checkboxes.

Table 4.4 ColdFire Assembler Panel Elements (*continued*)

Element	Purpose	Comments
Processor has FPU checkbox	Clear — Tells assembler that the target processor does *not* have a floating-point unit (FPU). Checked — Tells assembler that the target processor *does* have an FPU.	Default: Clear
Labels Must End With ':' checkbox	Clear — System does *not* require labels to end with colons. Checked — System *does* require labels to end with colons.	Default: Checked.
Directives Begin With '.' checkbox	Clear — System does *not* require directives to start with periods. Checked — System *does* require directives to start with periods.	Default: Checked.
Case Sensitive Identifiers checkbox	Clear — Tells assembler to ignore case in identifiers. Checked — Tells assembler to consider case in identifiers.	Default: Checked.
Allow Space In Operand Field checkbox	Clear — Tells assembler to *not* allow spaces in operand fields. Checked — Tells assembler to *allow* spaces in operand fields.	Default: Checked.

Table 4.4 ColdFire Assembler Panel Elements (*continued*)

Element	Purpose	Comments
Generate Listing File checkbox	Clear — Tells assembler to *not* generate a listing file. Checked — Tells assembler to *generate* a listing file.	Default: Clear. A listing file contains the file source, along with line numbers, relocation information, and macro expansions.
Prefix File text box	Specifies the name of the assembly prefix file.	Default: None. Useful for include files that define common constants, global declarations, and function names. Otherwise, the assembler's default prefix file suffices.

ELF Disassembler

Use the **ELF Disassembler** panel (Figure 4.7) to control settings for the disassembly view; you see this view when you disassemble object files. Table 4.5 explains the elements of this panel.

Figure 4.7 ELF Disassembler Panel

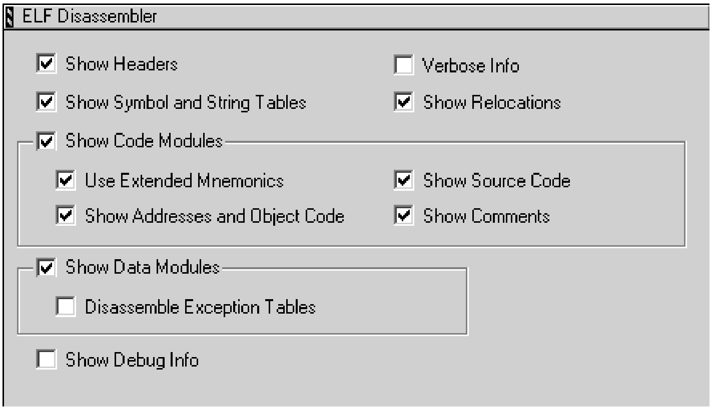


Table 4.5 ELF Disassembler Panel Elements

Element	Purpose	Comments
Show Headers checkbox	Clear — Keeps ELF header information *out* of the disassembled output. Checked — Puts ELF header information *into* the disassembled output.	Default: Checked.
Verbose Info checkbox	Clear — Uses minimum information in disassembled output. Checked — Puts additional information *into* the disassembled output.	Default: Clear. For the `.symtab` section, additional information includes numeric equivalents for descriptive constants. For the `.line`, `.debug`, `.extab`, and `.extabindex` sections, additional information includes an unstructured hex dump.
Show Symbol and String Tables checkbox	Clear — Keeps symbol table *out* of the disassembled module. Checked — Puts symbol table *into* the disassembled module.	Default: Checked.

Table 4.5 ELF Disassembler Panel Elements (*continued*)

Element	Purpose	Comments
Show Relocations checkbox	Clear — Keeps relocation information *out* of the disassembled module. Checked — Puts relocation information *into* the disassembled module.	Default: Checked. Relocation information pertains to the `.real.text` and `.reala.data` sections.
Show Code Modules checkbox	Clear — Keeps any of the four types of ELF code sections *out* the disassembled module; disables the four subordinate checkboxes. Checked — Activates the four subordinate checkboxes. For each checked subordinate checkbox, puts ELF code section *into* the disassembled module.	Default: Checked.
Use Extended Mnemonics checkbox	Clear — Keeps extended mnemonics *out* of the disassembled module. Checked — Puts instruction extended mnemonics *into* the disassembled module.	Default: Checked. This checkbox is active only if the Show Code Modules checkbox is checked.
Show Source Code checkbox	Clear — Keeps source code *out* of the disassembled module. Checked — Lists source code *in* the disassembled module. Display is mixed mode, with line-number information from original C source code.	Default: Checked. This checkbox is active only if the Show Code Modules checkbox is checked.

Table 4.5 ELF Disassembler Panel Elements (*continued*)

Element	Purpose	Comments
Show Addresses and Object Code checkbox	Clear — Keeps addresses and object code *out* of the disassembled module. Checked — Lists addresses and object code *in* the disassembled module.	Default: Checked. This checkbox is active only if the Show Code Modules checkbox is checked.
Show Comments checkbox	Clear — Keeps disassembler comments *out* of the disassembled module. Checked — *Shows* disassembler comments in sections that have comment columns.	Default: Checked. This checkbox is active only if the Show Code Modules checkbox is checked.
Show Data Modules checkbox	Clear — Blocks output of ELF data sections for the disassembled module; disables the Disassemble Exception Tables checkbox. Checked — Outputs `.rodata`, `.bss`, or other such ELF data sections in the disassembled module. Activates the Disassemble Exception Tables checkbox.	Default: Checked.
Disassemble Exception Tables checkbox	Clear — Keeps C++ exception tables *out* of the disassembled module. Checked — Includes C++ exception tables *in* the disassembled module.	Default: Clear. This checkbox is active only if the Show Data Modules checkbox is checked.
Show Debug Info checkbox	Clear — Keeps DWARF symbolics *out* of the disassembled module. Checked — Includes DWARF symbolics *in* the disassembled module.	Default: Clear.

ColdFire Processor

Use the **ColdFire Processor** panel (Figure 4.8) to control code-generation settings. Table 4.6 explains the elements of this panel.

Figure 4.8 ColdFire Processor Panel

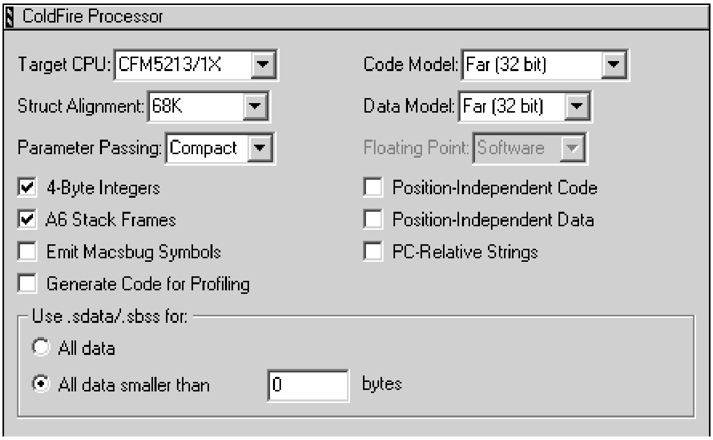


Table 4.6 ColdFire Processor Panel Elements

Element	Purpose	Comments
Target CPU list box	Specifies the target ColdFire processor.	Default: MCF5282.
Code Model list box	Specifies access addressing for data and instructions in the object code: Smart — Relative (16-bit) for function calls in the same segment; otherwise absolute (32-bit). Near (16 bit) — Relative for all function calls. Far (32 bit) — Absolute for all function calls.	Default: Far (32 bit). Far is useful if your source file generates more than 32K of code, or if there is an out-of-range link error message. Near requires adjusting the `.lcf`. For `.lcf` information, see LCF Structure

Table 4.6 ColdFire Processor Panel Elements (*continued*)

Element	Purpose	Comments
Struct Alignment list box	Specifies record and structure alignment in memory: 68K 2-byte — Aligns all fields on 2-byte boundaries, except for fields of only 1 byte. 68K 4-byte — Aligns all fields on 4-byte boundaries. PowerPC 1-byte — Aligns each field on its natural boundary.	Default: 68k 4-byte. This panel element corresponds to the `options align` pragma. Natural-boundary alignment means 1-byte for a 1-byte character, 2-bytes for a 16-bit integer, and so on. NOTE: When you compile and link, alignment should be the same for all files and libraries.
Data Model list box	Specifies global-data storage and reference: Far (32 bit) — Storage in far data space; available memory is the only size limit. Near (16 bit) — Storage in near data space; size limit is 64K.	Default: Far (32 bit). This panel element corresponds the `far_data` pragma.
Parameter Passing list box	Specifies parameter-passing level: Compact — Passes on even-sized boundary for parameters smaller than int (2 for short and char). Standard — Like compact, but always padded to 4 bytes. Register — Passes in scratch registers D0 — D2 for integers, A0 — A1 for pointers and fp0 — fp1 when FPU codegen is selected; this can speed up programs that have many small functions.	Default: Compact. These levels correspond to the `compact_abi`, `standard_abi`, and `register_abi` pragmas. NOTE: Be sure that all called functions have prototypes. When you compile and link, parameter passing should be the same for all files and libraries.

Table 4.6 ColdFire Processor Panel Elements (*continued*)

Element	Purpose	Comments
Floating Point list box	Specifies handling method for floating-point operations: Software — C runtime library code emulates floating-point operations. Hardware — Processor hardware performs floating point operations; only appropriate for processors that have floating-point units.	Default: Software. For software selection, your project must include the appropriate `FP_ColdFire` C runtime library file. Greyed out if your target processor lacks an FPU.
4-Byte Integers checkbox	Clear — Specifies 2-byte integers. Checked — Specifies 4-byte integers.	Default: Checked.
Position-Independent Code checkbox	Clear — Generates relocatable code. Checked — Generates position-independent code (PIC) that is non-relocatable.	Default: Clear. PIC is available with 16- and 32-bit addressing.
A6 Stack Frames checkbox	Clear — Disables call-stack tracing; generates faster and smaller code. Checked — Enables call-stack tracing; each stack frame sets up and restores register A6.	Default: Checked. Checking this checkbox corresponds to using the `a6frames` pragma. Clearing this checkbox is appropriate if you will not use the debugger.
Position-Independent Data checkbox	Clear — Generates relocatable data. Checked — Generates position-independent data (PID) that is non-relocatable.	Default: Clear. PID is available with 16- and 32-bit addressing.
Emit Macsbug Symbols checkbox	Clear — Does *not* generate Macsbug symbols. Checked — Generates Macsbug symbols inside code after RTS statements.	Default: Clear. A Macsbug symbol is the routine name, appended after the routine, in Pascal format. These symbols are appropriate only for older debuggers.

Table 4.6 ColdFire Processor Panel Elements (*continued*)

Element	Purpose	Comments
PC-Relative Strings checkbox	Clear — Does *not* use program-counter relative addressing for storage of function local strings. Checked — *Does* use program-counter relative addressing for storage of function local strings.	Default: Clear. Checking this box corresponds to using the `pcrelstrings` pragma.
Generate code for profiling	Checked — Has the processor generate code for use with a profiling tool. Clear — Prevents the processor from generating code for use with a profiling tool.	Default: Clear. Checking this box corresponds to using the command-line option -profile. Clearing this checkbox is equivalent to using the command-line option -noprofile
Use .sdata/.sbss for area	All data — Select this option button to store all data items in the small data address space. All data smaller than — Select this option button to specify the maximum size for items stored in the small data address space; enter the maximum size in the text box.	Default: All data smaller than/0. Using the small data area speeds data access, but has ramifications for the hardware memory map. The default settings specify *not* using the small data area.

ColdFire Linker

Use the **ColdFire Linker** panel (Figure 4.9) to control the final form of your object code. Table 4.7 explains the elements of this panel.

Figure 4.9 ColdFire Linker Panel

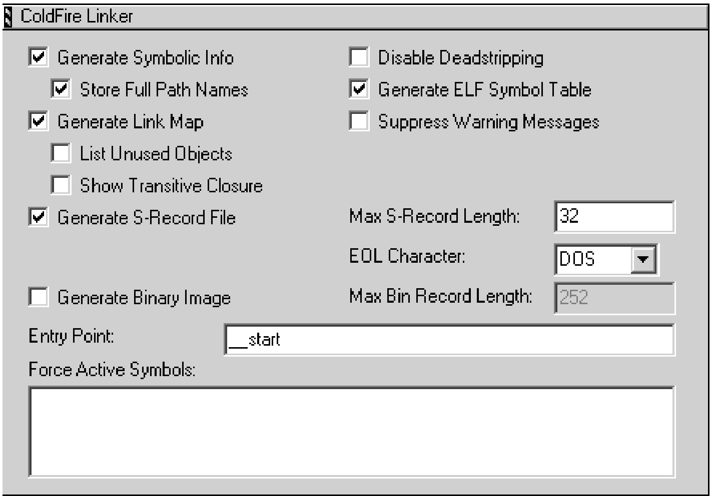


Table 4.7 ColdFire Linker Panel Elements

Element	Purpose	Comments
Generate Symbolic Info checkbox	Clear — Does *not* generate debugging information in the output ELF file. Checked — Puts generated debugging information into the output ELF file.	Default: Checked.
Store Full Path Names checkbox	Clear — In debugging information in the linked ELF file, uses only names of source files. Checked — Includes source-file paths in the debugging information in the linked ELF file.	Default: Checked. Clearing this checkbox saves target memory, but increases the time the debugger needs to find the source files.

Table 4.7 ColdFire Linker Panel Elements (*continued*)

Element	Purpose	Comments
Generate Link Map checkbox	Clear — Does *not* generate a link map. Checked — Does generate a link map (a text file that identifies definition files for each object and function of your output file); activates the List Unused Objects and Show Transitive Closure checkboxes.	Default: Checked. A link map includes addresses of all objects and functions, a memory map of sections, and values of symbols the linker generates. A link map has the same filename as the output file, but with extension `.xMAP`.
List Unused Objects checkbox	Clear — Does *not* include unused objects in the link map. Checked — Does include unused objects in the link map.	Default: Clear. This checkbox is active only if the Generate Link Map checkbox is checked. NOTE: The linker never deadstrips unused assembler relocatables or relocatables built with a non-CodeWarrior compiler. But checking this checkbox gives you a list of such unused items; you can use this list to remove the symbols.
Show Transitive Closure checkbox	Clear — Does *not* include the link map objects that `main()` references. Checked — Recursively lists in the link map all objects that `main()` references.	Default: Checked. This checkbox is active only if the Generate Link Map checkbox is checked. Listings after this table show the effect of this checkbox.
Disable Deadstripping checkbox	Clear — Lets linker remove unused code and data. Checked — Prevents the linker from removing unused code or data.	Default: Clear.

Table 4.7 ColdFire Linker Panel Elements (*continued*)

Element	Purpose	Comments
Generate ELF Symbol Table checkbox	Clear — Omits the ELF symbol table and relocation list from the ELF output file. Checked — Includes an ELF symbol table and relocation list in the ELF output file.	Default: Checked.
Suppress Warning Messages checkbox	Clear — Reports all linker warnings. Checked — Reports only fatal warning messages; does not affect display of messages from other parts of the IDE.	Default: Clear.
Generate S-Record File checkbox	Clear — Does not generate an S-record file. Checked — Generates an S3-type S-record file, suitable for printing or transportation to another computer system. Activates the Max S-Record text box and the EOL character list box.	Default: Checked. The S-record has the same filename as the executable file, but with extension `.S19, .S3` records include code, data, and their 4-byte addresses.
Max S-Record Length text box	Specifies maximum number of bytes in S-record lines that the linker generates. The maximum value for this text box is 252.	Default: 80. This text box is active only if the Generate S-Record File checkbox is checked. NOTE: Many embedded systems limit S-record lines to 24 or 26 bytes. A value of 20 to 30 bytes lets you see the S-record on a single page.
EOL Character list box	Specifies the end-of-line character for the S-record file, by operating system: DOS, UNIX, or MAC.	Default: DOS. This text box is active only if the Generate S-Record File checkbox is checked.

Table 4.7 ColdFire Linker Panel Elements (*continued*)

Element	Purpose	Comments
Generate Binary Image checkbox	Clear — Does not create a binary version of the S-record file. Checked — Saves a binary version of the S-record file to the project folder; The binary file has the `.b` filename extension. Activates the Max Bin Record Length text box.	Default: Clear. Binary file format is address (2 bytes), byte count (2 bytes), and data bytes (variable length).
Max Bin Record Length text box	Specifies data-byte length for each binary record. The maximum value is 252.	Default: None. This text box is active only if the Generate Binary Image checkbox is checked.
Entry Point text box	Specifies the program starting point: the first function the debugger uses upon program start.	Default: __start. (This default function is in file `ColdFire__startup.c`. It sets up the ColdFire EABI environment before code execution. Its final task is calling `main()`.
Force Active Symbols text box	Specifies symbols to be included in the output file even if not referenced; makes such symbols immune from deadstripping.	Default: None. Use spaces to separate multiples symbols.

Listing 4.1 and Listing 4.2 show the effect of the **Show Transitive Closure** checkbox.

Listing 4.1 Sample Code for Transitive Closure

```
void alpha1(){
    int a = 1001;
}
void alpha(){
    int b = 1002;
    alpha1();
}
int main(void){
    alpha();
```

```
    return 1;
}
```

If you checked the **Show Transitive Closure** checkbox of the **ColdFire Linker** panel and compiled the source files,

- The linker would generate a link map file, and
- The link map file would include text such as that of Listing 4.2.

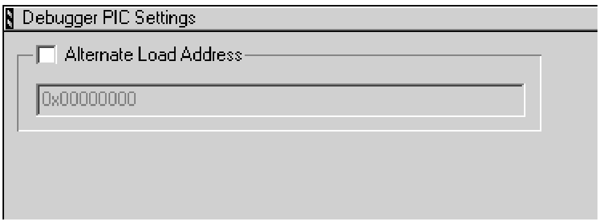
Listing 4.2 Link Map: Effects of Show Transitive Closure

```
# Link map of __start
  1] __start (func, global) found in C_4i_CF_Runtime.a E68k_startup.o
    2] __main (func, global) found in main.c
      3] __alpha (func, global) found in main.c
        4] __alpha1 (func, global) found in main.c
```

Debugger PIC Settings

Use the **Debugger PIC Settings** panel (Figure 4.10) to specify an alternate address where you want your ELF image downloaded on the target.

Figure 4.10 Debugger PIC Settings Panel



Usually, Position Independent Code (PIC) is linked in such a way that the entire image starts at address 0x00000000. To specify a different target address for loading the PIC module:

1. Check the **Alternate Load Address** checkbox — this activates the text box.
2. Enter the address in the text box.

At download time, the debugger downloads your ELF file to this new address of the target.

NOTE The debugger does not verify that your code can execute at the new address. However, the PIC generation settings of the compiler and linker, and the startup routines of your code, correctly set any base registers and perform any appropriate relocations.

5

Compilers

This chapter explains issues of C and C++ code generation for the ColdFire target.

NOTE Special-Edition software compiles assembly and C code, but the code size must not exceed 128 kilobytes.
Standard-Edition software compiles assembly and C code, without any size restriction.
Professional-Edition software compiles assembly, C, and C++ code, without any size restriction.

This chapter consists of these sections:

- Language Extensions
- Integer Formats
- Calling Conventions
- Variable Allocation
- Register Variables
- Pragmas
- Predefined Symbols
- Position-Independent Code

Table 5.1 lists additional documents or chapters that provide information about code generation.

Table 5.1 Additional CodeWarrior Compiler and Linker Documentation

Topic	Reference
CodeWarrior implementation of C/C++	*C Compilers Reference*
C/C++ Language and C/C++ Warnings settings panels	*C Compilers Reference*: chapter Setting C/C++ Compiler Options
Controlling C++ code size	*C Compilers Reference*: chapter C++ and Embedded Systems
Using compiler pragmas	*C Compilers Reference*: chapter Pragmas and Symbols

Table 5.1 Additional CodeWarrior Compiler and Linker Documentation (*continued*)

Topic	Reference
Meeting EC++ specifications	*C Compilers Reference*
Initiating a build, controlling which files are compiled, handling error reports	*IDE User Guide*: chapter Compiling and Linking
Explanation of error messages	*Error Reference*
Inline assembly	Inline Assembly chapter of this Targeting Manual
Standalone assembler	*Assembler Reference*

Language Extensions

This section explains the ColdFire-specific extensions to the standards of the CodeWarrior C/C++ compiler.

You can disable some of these extensions by using options of the **C/C++ Language** panel, which the *C Compilers Reference* manual explains.

PC-Relative Strings

The default compiler configuration is to store all string constants in the global data segment. This configuration corresponds to a clear **PC-Relative Strings** checkbox of the **ColdFire Processor** panel.

But to keep the global data segment smaller, you can check the **PC-Relative Strings** checkbox. Configuring PC-relative strings means that the compiler:

- Stores local-scope string constants in the code segment
- Uses PC-relative instructions to address these strings

The **PC-Relative Strings** checkbox corresponds to the pragma `pcrelstrings`. To check whether this pragma is in effect, use `__option (pcrelstrings)`. Listing 5.1 shows an example of the pragma use.

Listing 5.1 Using PC-relative strings pragma

```
#pragma pcrelstrings on
int f(char *);
int bar()
{
  return f("World"); // "World" allocated in code segment
```

```
                    // (pc-relative)
}
#pragma pcrelstrings reset
```

Declaration Specifiers

A declaration specifier tells the compiler to override a default storage location, regardless of the object's size or initialization. The syntax is:

`__declspec (sectionName) dataType objectName`

where:

`sectionName`

Identifies the storage section for the object

`dataType`

Specifies the data type of the object

`objectName`

Is the name of the variable object to be stored

Listing 5.2 shows examples.

Listing 5.2 Using the __declspec() declaration specifier

```
// create a user-defined section ".mycode"
   #pragma define_section mycode ".mycode" far_absolute RX
__declspec(bss)    int  Large_Array_in_Small_Data_Section[1000];
__declspec(mycode) void Function_in_MyCode_Section()
 {
  printf("Hello from MyCode section!\n");
  }
```

A declaration specifier may use any section, whether pre-defined or user-defined. (For more information about pre-defined and user-defined sections, see define_section.)

A declaration specifier also can use an application binary interface (ABI). An ABI corresponds directly to the parameter-passing option (Standard, Compact or Register) that the **ColdFire Processor Settings** panel specifies. (For information about these ABIs, see ColdFire Processor.)

Integer Formats

The ColdFire compiler lets you specify the number of bytes that the compiler allocates for an `int`. Bring up the **ColdFire Processor** settings panel, then use the **4-Byte Integers** option.

Table 5.2 shows the size and range of the integer types available for ColdFire targets.

Table 5.2 ColdFire Integer Types

Type	Option Setting	Size	Range
`bool`	n/a	8 bits	true or false
`char`	**Use Unsigned Chars** is *off* in the C/C++ Language panel	8 bits	-128 to 127
	Use Unsigned Chars is *on* in the C/C++ Language panel	8 bits	0 to 255
`signed char`	n/a	8 bits	-128 to 127
`unsigned char`	n/a	8 bits	0 to 255
`short`	n/a	16 bits	-32,768 to 32,767
`unsigned short`	n/a	16 bits	0 to 65,535
`int`	**4-Byte Integers** is *off* in the ColdFire Processor panel	16 bits	-32,768 to 32,767
	4-Byte Integers is *on* in the ColdFire Processor panel	32 bits	-2,147,483,648 to 2,147,483,647
`unsigned int`	**4-Byte Integers** is *off* in the ColdFire Processor panel	16 bits	0 to 65,535
	4-Byte Integers is *on* in the ColdFire Processor panel	32 bits	0 to 4,294,967,295

Table 5.2 ColdFire Integer Types (*continued*)

Type	Option Setting	Size	Range
`long`	n/a	32 bits	-2,147,483,648 to 2,147,483,647
`unsigned long`	n/a	32 bits	0 to 4,294,967,295
`long long`	n/a	64 bits	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
`unsigned long long`	n/a	64 bits	0 to 18,446,744,073,709,551,615

Calling Conventions

For ColdFire development, the calling conventions are:

- **Standard** — the compiler uses the default amount of memory, expanding everything to `int` size.
- **Compact** — the compiler tries to minimize memory consumption.
- **Register** — the compiler tries to use memory registers, instead of the stack.

NOTE The corresponding levels for the supported calling conventions are `standard_abi` (the default), `compact_abi`, and `register_abi`. For more ABI information, see ColdFire Processor Panel Elements.

The compiler passes parameters on the stack in reverse order. It passes the return value in different locations, depending on the nature of the value and compiler settings:

- Integer return value: register `D0`.
- Pointer return value: register `A0`.
- Any other return value: temporary storage area. (For any non-integer, non-pointer return type, the calling routine reserves this area in its stack. The calling routine passes a pointer to this area as its last argument. The called function returns its value in this temporary storage area.)

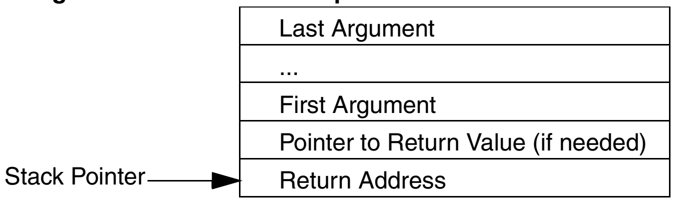
To have the compiler return pointer values in register `D0`, use the pragma `pointers_in_D0`, which the *C Compiler reference guide* explains.

To reset pointer returns, use the pragma `pointers_in_A0`.

> **NOTE** If you use the pragma `pointers_in_A0`, be sure to use correct prototypes. Otherwise, the pragma may not perform reliably.

Figure 5.1 depicts the stack when you use the ColdFire compiler to call a C function.

Figure 5.1 Calling a C Function: Stack Depiction



Variable Allocation

For a ColdFire target, the compiler lets you declare structs and arrays to be any size, but imposes a few limits on how you allocate their space:

- Maximum bitfield size is 32 bits.
- There is no limit to local-variable space for a function. However, access is twice as fast for frames that do not exceed 32 kilobytes. To keep within this limit,
  - Dynamically allocate large variables, or
  - Declare large variables to be `static` (provided that this does not exceed the 32-kilobyte limit on global variables).
- Maximum declaration size for a global variable is 32 kilobytes, unless you use `far` data. You must do one of the following:
  - Dynamically allocate the variable.
  - Use the `far` qualifier when declaring the variable.
  - Select the **Far (32 bit)** option from the **Code** and **Data model** in the **ColdFire Processor settings** panel.

Listing 5.3 shows how to declare a large *struct* or *array*. Keep in mind that declaring large static arrays works only if the device has enough physical memory.

Listing 5.3 Declaring a large structure

```
int i[50000]; // Wrong with ColdFire compiler and the Far Data
              // option in the Processor settings panel is off
far int j[50000]; // ALWAYS OK.
```

```
int *k;
k = malloc(50000 * sizeof(int));  // ALWAYS OK.
```

Register Variables

The ColdFire back-end compiler automatically allocates local variables and parameters to registers, according to frequently of use and how many registers are available.

The ColdFire compiler can use these registers for local variables:

- `A2` through `A5` — for pointers
- `D3` through `D7` — for integers and pointers.
- `FP3` through `FP7` — for 64-bit floating-point numbers (provided that you select **Hardware** in the **Floating Point** list box of the **ColdFire Processor** panel).

If you optimize for speed, the compiler gives preference to variables in loops.

The ColdFire back-end compiler gives preference to variables declared `register`, but does not automatically assign them to registers. For example, if the compiler must choose between an inner-loop variable and a variable declared `register`, the compiler places the inner-loop variable in the register.

Pragmas

For ColdFire development, the compiler supports the standard pragmas that Table 5.3 lists. The C Compilers Reference explains these pragmas, including their syntax.

Table 5.3 Standard Pragmas for ColdFire Development

`a6frames`	`auto_inline`
`align_array_members`	`align`
`ARM_conform`	`cpp_extensions`
`bool`	`dont_reuse_strings`
`cplusplus`	`exceptions`
`direct_destruction`	`far_data`
`enumsalwaysints`	`force_active`
`extended_errorcheck`	`ignore_oldstyle`

Table 5.3 Standard Pragmas for ColdFire Development (*continued*)

`far_vtables`	`lib_export`
`IEEEdoubles`	`macsbug, oldstyle_symbols`
`inline_depth`	`mpwc_newline`
`longlong`	`once`
`mark`	`optimize_for_size`
`mpwc_relax`	`pcrelstrings`
`only_std_keywords`	`pointers_in_D0`
`parameter`	`precompile_target`
`pointers_in_A0`	`require_prototypes`
`pool_strings`	`segment`
`profile`	`static_inlines`
`RTTI`	`unsigned_char`
`unused`	`warn_emptydecl`
`warn_hidevirtual`	`warn_illpragma`
`warn_unusedarg`	`ANSI_strict`

The compiler also supports pragmas that are new — or have new definitions — for ColdFire development. Table 5.4 lists these new pragmas; following text explains them.

Table 5.4 New Pragmas for ColdFire Development

codeColdFire	const_multiply	define_section
emac	explicit_zero_data	interrupt
opt_unroll_count	opt_unroll_instr_count	Predefined Symbols
readonly_strings	SDS_debug_support	section

codeColdFire

Controls organization and generation of ColdFire object code.

```
#pragma codeColdFire processor
```

Parameter

`processor`

Any of these specifier values: `MCF521x`, `MCF5206e`, `MCF5249`, `MCF5272`, `MCF5282`, `MCF5307`, `MCF5407`, `MCF547x`, `MCF548x` — or `reset`, which specifies the default processor.

const_multiply

Enables support for constant multiplies, using shifts and add/subtracts.

```
#pragma const_multiply [ on | off | reset ]
```

Remarks

The default value is `on`.

define_section

Specifies a predefined section or defines a new section for compiled object code.

```
#pragma define_section sname ".istr" [.ustr] [addrmode]
     [accmode]
```

Parameters

`sname`

Identifier for source references to this user-defined section.

`istr`

Section-name string for *initialized* data assigned to this section. Double quotes must surround this parameter value, which must begin with a period. (Also applies to *uninitialized* data if there is no `ustr` value.)

`ustr`

Optional: ELF section name for uninitialized data assigned to this section. Must begin with a period. Default value is the `istr` value.

`addrmode`

Optional: any of these address-mode values:

- `standard` — 32-bit absolute address (default)
- `near_absolute` — 16-bit absolute address
- `far_absolute` — 32-bit absolute address
- `near_code` — 16-bit offset from the PC address
- `far_code` — 32-bit offset from the PC address
- `near_data` — 16-bit offset from the A5 register address
- `far_data` — 32-bit offset from the A5 register address

`accmode`

Optional: any of these letter combinations:

- `R` — readable
- `RW` — readable and writable
- `RX` — readable and executable
- `RWX` — readable, writable, and executable (default)

(No other letter orders are valid: WR, XR, or XRW would be an error.)

Remarks

The compiler predefines the common ColdFire sections that Table 5.5 lists.

Table 5.5 ColdFire Predefined Sections

Applicability	Definition Pragmas
Absolute Addressing Mode	`#pragma define_section text ".text" far_absolute RX`
	`#pragma define_section data ".data" ".bss" far_absolute RW`
	`#pragma define_section sdata ".sdata" ".sbss" near_data RW`
	`#pragma define_section const ".rodata" far_absolute R`
C++, Regardless of Addressing Mode	`#pragma define_section exception ".exception" far_absolute R`
	`#pragma define_section exceptlist ".exceptlist" far_absolute R`

Table 5.5 ColdFire Predefined Sections (*continued*)

PID Addressing Mode	`#pragma define_section text ".text" far_absolute RX`
	`#pragma define_section data ".data" ".bss" far_data RW`
	`#pragma define_section sdata ".sdata" ".sbss" near_data RW`
	`#pragma define_section const ".rodata" far_absolute R`
PIC Addressing Mode	`#pragma define_section text ".text" far_code RX`
	`#pragma define_section data ".data" ".bss" far_absolute RW`
	`#pragma define_section sdata ".sdata" ".sbss" near_data RW`
	`#pragma define_section const ".rodata" far_code R`

Another use for `#pragma define_section` is redefining the attributes of predefined sections:

- To force 16-bit absolute addressing for all data, use

```
#pragma define_section data ".data" near_absolute
```

- To force 32-bit TP-relative addressing for exception tables, use:

```
#pragma define_section exceptlist ".exceptlist" far_code
#pragma define_section exception ".exception" far_code
```

You should put any such attribute-redefinition pragmas a prefix file or other header that all your program's source files will include.

NOTE The ELF linker's **Section Mappings** settings panel must map any user-defined compiler section to an appropriate segment.

emac

Enables EMAC assembly instructions in inline assembly.

```
#pragma emac [ on | off | reset ]
```

Remarks

Enables inline-assembly instructions `mac`, `msac`, `macl`, `msacl`, `move`, and `movclr` for the ColdFire EMAC unit.

The default value is `OFF`.

explicit_zero_data

Specifies storage area for zero-initialized data.

```
#pragma explicit_zero_data [ on | off | reset ]
```

Remarks

The default value `OFF` specifies storage in the `.sbss` or `.bss` section. The value `ON` specifies storage in the `.data` section. The value `reset` specifies storage in the most-recent previously specified section.

Example

```
#pragma explicit_zero_data on
int in_data_section = 0;

#pragma explicit_zero_data off
int in_bss_section = 0;
```

inline_intrinsics

Controls support for inline intrinsic optimizations `strcopy` and `strlen`.

```
#pragma inline_intrinsics [ on | off | reset ]
```

Remarks

In the `strcopy` optimization, the system copies the string via a set of move-immediate commands to the source address. The system applies this optimization if the source is a string constant of fewer than 64 characters, and optimizing is set for speed.

In the `strlen` optimization, a move immediate of the length of the string to the result replaces the function call. The system applies this optimization if the source is a string constant.

The default value is `ON`.

interrupt

Controls compilation for interrupt-routine object code.

```
#pragma interrupt [ on | off | reset ]
```

Remarks

For the value `ON`, the compiler generates special prologues and epilogues for the functions this pragma encapsulates The compiler saves or restores all modified registers (both nonvolatile and scratch). Functions return via `RTE` instead of `RTS`.

You also can also use `__declspec(interrupt)` to mark functions as interrupt routines, for example:

```
__declspec(interrupt) void alpha()
{
//enter code here
}
```

opt_unroll_count

Limits the number of times a loop can be unrolled; fine-tunes the loop-unrolling optimization.

```
#pragma opt_unroll_count [ 0..127 | reset ]
```

Remarks

The default value is 8.

opt_unroll_instr_count

Limits the number of pseudo-instructions; fine-tunes the loop-unrolling optimization.

```
#pragma opt_unroll_instr_count [ 0..127 | reset ]
```

Remarks

There is not always a one-to-one mapping between pseudo-instructions and actual ColdFire instructions.

The default value is 100.

profile

Organizes object code for the profiler library and enables simple profiling.

```
#pragma profile [on| off| reset]
```

Remarks

Corresponds to the **Generate code for profiling** checkbox of the **ColdFire Processor** settings panel.

readonly_strings

Enables the compiler to place strings in the `.rodata` section.

```
#pragma readonly_strings [ on | off | reset ]
```

Remarks

The default value is `ON`.

For the `OFF` value, the compiler puts strings in initialized data sections `.data` or `.sdata`, according to the string size.

SDS_debug_support

Tries to make the DWARF output file compatible with the Software Development System (SDS) debugger. The default value is `OFF`.

```
#pragma SDS_debug_support [ on | off | reset ]
```

section

Activates or deactivates a user-defined or predefined section.

`#pragma section` *`sname`* `begin | end`

Parameters

`sname`

Identifier for a user-defined or predefined section.

`begin`

Activates the specified section from this point in program execution.

`end`

Deactivates the specified section from this point in program execution; the section returns to its default state.

Remarks

Each call to this pragma must include a begin parameter or an end parameter, but not both.

You may use this pragma with `#pragma push` and `#pragma pop` to ease complex or frequent changes to section settings.

NOTE A simpler alternative to `#pragma section` is the `__declspec()` declaration specifier. For more details, see Declaration Specifiers

Predefined Symbols

Metrowerks C and C++ include several preprocessor symbols that give information about the compile-time environment. For information on these symbols, see the *C Compilers Reference*.

Table 5.6 lists additional predefined symbols for ColdFire development.

Table 5.6 Predefined Symbols

Macro	Definition
__embedded__	1, if you compile code for an embedded target.
__BACKENDVERSION__	"3"
__COLDFIRE__	hex id for chip
__profile__	1, if you enable the Generate Profiler Calls setting of the ColdFire Processor panel; 0 if you disable this setting.
__STDABI__	1, if you check the standard passing parameter checkbox of the ColdFire Processor panel; 0 if you clear this checkbox.
__REGABI__	1 if you select the passing parameter setting as register in the ColdFire Processor panel; 0 if you deselect it.

Position-Independent Code

If you specify position-independent code, the compiler generates code that is the same regardless of its load address. Different processes of your application can share such code.

Listing 5.4 Position Independent Code

```
int relocatableAlpha();
int (*alpha)()=relocatableAlpha;
```

Follow these steps to enable the PIC compiler and runtime support:

1. Add a `.picdynrel` section to the linker command file. See Position-Independent Code and Data.
2. Enable PIC generation in the processor settings panel. See ColdFire Target.
3. Customize and recompile the runtime to support your loading routine. See Position-Independent Code.

6

ELF Linker and Command Language

This chapter explains the CodeWarrior Executable and Linking Format (ELF) Linker. Beyond making a program file from your project's object files, the linker has several extended functions for manipulating program code in different ways. You can define variables during linking, control the link order down to the level of single functions, and change the alignment.

You access these functions through commands in the linker command file (LCF). The LCF syntax and structure are similar to those of a programming language; the syntax includes keywords, directives, and expressions.

This chapter consists of these sections:

- LCF Structure
- LCF Syntax
- Commands, Directives, and Keywords

LCF Structure

Linker command files consist of three kinds of segments, which *must* be in this order:

- A *memory* segment, which begins with the `MEMORY{}` directive
- Optional *closure* segments, which begin with the `FORCE_ACTIVE{}`, `KEEP_SECTION{}`, or `REF_INCLUDE{}` directives
- A *sections* segment, which begins with the `SECTIONS{}` directive

Memory Segment

Use the memory segment to divide available memory into segments. Listing 6.1 shows the pattern.

Listing 6.1 Example Memory Segment

```
MEMORY {
    segment_1 (RWX): ORIGIN = 0x80001000, LENGTH = 0x19000
```

```
    segment_2 (RWX): ORIGIN = AFTER(segment_1), LENGTH = 0
    segment_x (RWX): ORIGIN = memory address, LENGTH = segment size
     and so on...
}
```

In this pattern:

- The (`RWX`) portion consists of ELF-access permission flags: `R` = read, `W` = write, or `X` = execute.
- `ORIGIN` specifies the start address of the memory segment — either an actual memory address or, via the AFTER keyword, the name of the preceding segment.
- `LENGTH` specifies the size of the memory segment. The value `0` means *unlimited length*.

The `segment_2` line of Listing 6.1 shows how to use the `AFTER` and `LENGTH` commands to specify a memory segment, even though you do not know the starting address or exact length.

The explanation of the `MEMORY` directive, at MEMORY, includes more information about the memory segment.

Closure Segments

An important feature of the linker is deadstripping unused code and data. At times, however, an output file should keep symbols even if there are no direct references to the symbols. Linking for interrupt handlers, for example, usually is at special addresses, without any explicit, control-transfer jumps.

Closure segments let you make symbols immune from deadstripping. This closure is *transitive*, so that closing a symbol also forces closure on all other referenced symbols.

For example, suppose that:

- Symbol `_abc` references symbols `_def` and `_ghi`,
- Symbol `_def` references symbols `_jkl` and `_mno`, and
- Symbol `_ghi` references symbol `_pqr`

Specifying symbol `_abc` in a closure segment would force closure on all six of these symbols.

The three closure-segment directives have specific uses:

- `FORCE_ACTIVE` — Use this directive to make the linker include a symbol that it otherwise would not include.
- `KEEP_SECTION` — Use this directive to keep a section in the link, particularly a user-defined section.

- `REF_INCLUDE` — Use this directive to keep a section in the link, provided that there is a reference to the file that contains the section. This is a useful way to include version numbers.

Listing 6.2 shows an example of each directive.

Listing 6.2 Example Closure Sections

```
# 1st closure segment keeps 3 symbols in link
FORCE_ACTIVE {break_handler, interrupt_handler, my_function}

# 2nd closure segment keeps 2 sections in link
KEEP_SECTION {.interrupt1, .interrupt2}

# 3rd closure segment keeps file-dependent section in link
REF_INCLUDE {.version}
```

Sections Segment

Use the sections segment to define the contents of memory sections, and to define any global symbols that you want to use in your output file. Listing 6.3 shows the format of a sections segment.

Listing 6.3 Example Sections Segment

```
SECTIONS {
   .section_name : #The section name, for your reference,
   {               # must begin with a period.
      filename.c  (.text) #Put .text section from filename.c,
      filename2.c (.text) #then put .text section from filename2.c,
      filename.c  (.data) #then put .data section from filename.c,
      filename2.c (.data) #then put .data section from filename2.c,
      filename.c  (.bss)  #then put .bss section from filename.c,
      filename2.c (.bss)  #then put .bss section from filename2.c.
      . = ALIGN (0x10);   #Align next section on 16-byte boundary.
   } > segment_1          #Map these contents to segment_1.
   .next_section_name:
   {
      more content descriptions
   } > segment_x          #End of .next_section_name definition
}                         #End of sections segment
```

The explanation of the `SECTIONS` directive, at SECTIONS, includes more information about the sections segment.

LCF Syntax

This section explains LCF commands, including practical ways to use them. Subsections are:

- Variables, Expressions, and Integrals
- Arithmetic, Comment Operators
- Alignment
- Specifying Files and Functions
- Stack and Heap
- Static Initializers
- Exception Tables
- Position-Independent Code and Data
- ROM-RAM Copying
- Writing Data Directly to Memory

Variables, Expressions, and Integrals

In a linker command file, all symbol names must start with the underscore character (_). The other characters can be letters, digits, or underscores. These valid lines for an LCF assign values to two symbols:

```
_dec_num = 99999999;

_hex_num_ = 0x9011276;
```

Use the standard assignment operator to create global symbols and assign their addresses, according to the pattern:

`_symbolicname = some_expression;`

NOTE There must be a semicolon at the end of a symbol assignment statement.
A symbol assignment is valid only at the start of an expression, so a line such as this is not valid:
you cannot use something like this:
`_sym1 + _sym2 = _sym3;`

When the system evaluates an expression and assigns it to a variable, the expression receives the type value *absolute* or a *relocatable*:

- Absolute expression — the symbol contains the value that it will have in the output file.

- Relocatable expression — the value expression is a fixed offset from the base of a section.

LCF syntax for expressions is very similar to the syntax of the C programming language:

- All integer types are `long` or `unsigned long`.
- Octal integers begin with a leading zero; other digits are 0 through 7, as these symbol assignments show:

```
_octal_number = 01374522;
_octal_number2 = 032405;
```

- Decimal integers begin with any non-zero digit; other digits are 0 through 9, as these symbol assignments show:

```
_dec_num = 99999999;
_decimal_number = 123245;
_decvalfour = 9011276;
```

- Hexadecimal integers begin with a zero and the letter x; other digits are 0 through f, as these symbol assignments show:

```
_hex_number = 0x999999FF;
_firstfactorspace = 0X123245EE;
_fifthhexval = 0xFFEE;
```

- Negative integers begin with a minus sign:

```
_decimal_number = -123456;
```

Arithmetic, Comment Operators

Use standard C arithmetic and logical operations as you define and use symbols in the LCF. All operators are left-associative. Table 6.1 lists these operators in the order of precedence. For additional information about these operators, refer to the *C Compiler Reference*.

Table 6.1 LCF Arithmetic Operators

Precedence	Operators
1	`- ˜ !`
2	`* / %`
3	`+ -`
4	`>> <<`

Table 6.1 LCF Arithmetic Operators (*continued*)

Precedence	Operators
5	== != > < <= >=
6	&
7	|
8	&&
9	||

To add comments to your file, use the pound character, C-style slash and asterisk characters, or C++-style double-slash characters, in any of these formats:

```
#  This is a one-line comment
/* This is a
            multiline comment */
* (.text) // This is a partial-line comment
```

Alignment

To align data on a specific byte boundary, use the ALIGN keyword or the ALIGNALL command. Listing 6.4 and Listing 6.5 are examples for bumping the location counter to the next 16-byte boundary.

Listing 6.4 ALIGN Keyword Example

```
file.c (.text)
. = ALIGN (0x10);
file.c (.data)    # aligned on 16-byte boundary.
```

Listing 6.5 ALIGNALL Command Example

```
file.c (.text)
ALIGNALL (0x10);  #everything past this point aligned
                  # on 16 byte boundary
file.c (.data)
```

NOTE If one segment entry imposes an alignment requirement, that segment's starting address must conform to that requirement. Otherwise, there could be

conflicting section alignment in the code the linker produces.
In general, the instructions for data alignment should be lust before the end of the section.

For more alignment information, see ALIGN and ALIGNALL

Specifying Files and Functions

Defining the contents of a sections segment includes specifying the source file of each section. The standard method is merely listing the files, as Listing 6.6 shows.

Listing 6.6 Standard Source-File Specification

```
SECTIONS {
  .example_section :
    {
       main.c  (.text)
       file2.c (.text)
       file3.c (.text)
       # and so forth
```

For a large project, however, such a list can be very long. To shorten it, you can use the asterisk (`*`) wild-card character, which represents the filenames of every file in your project. The line

```
*   (.text)
```

in a section definition tells the system to include the `.text` section from each file.

Furthermore the `*` wildcard does not duplicate sections already specified; you need not replace existing lines of the code. In Listing 6.6, replacing the `# and so forth` comment line with

```
*   (.text)
```

would add the `.text` sections from all other project files, without duplicating the `.text` sections from files `main.c`, `file2.c`, or `file3.c`.

Another possibility as you define a sections segment, is specifying sections from a named group of files. To do so, use the GROUP keyword:

```
GROUP(fileGroup1) (.text)
GROUP(fileGroup4) (.data)
```

These two lines would specify including the `.text` sections from all `fileGroup1` files, and the `.data` sections from all `fileGroup4` files.

For precise control over function placement within a section, use the OBJECT keyword. For example, to place functions `beta` and `alpha` before anything else in a section, your definition could be like Listing 6.7.

Listing 6.7 Function Placement Example

```
SECTIONS {
  .program_section :
    {
      OBJECT (beta, main.c)    # Function beta is 1st section item
      OBJECT (alpha, main.c)   # Function alpha is 2nd section_item
      * (.text)  # Remaining_items are .text sections from all files
    } > ROOT
```

NOTE For C++, you must specify functions by their mangled names.

If you use the `OBJECT` keyword to specify a function, subsequently using `*` wild-card character does *not* specify that function a second time.

For more information about specifying files and functions, see the explanations OBJECT and SECTIONS.

Stack and Heap

Reserving space for the stack requires some arithmetic operations to set the symbol values used at runtime. Listing 6.8 is a sections-segment definition code fragment that shows this arithmetic.

Listing 6.8 Stack Setup Operations

```
_stack_address = __END_BSS;
_stack_address = _stack_address & ~7; /*align top of stack by 8*/
__SP_INIT = _stack_address + 0x4000;  /*set stack to 16KB*/
```

The heap requires a similar space reservation, which Listing 6.9 shows. Note that the bottom address of the stack is the top address of the heap.

Listing 6.9 Heap Setup Operations

```
___heap_addr = __SP_INIT; /* heap grows opposite stack */
___heap_size = 0x50000; /* heap size set to 500KB */
```

Static Initializers

You must invoke static initializers to initialize static data before the start of `main()`. To do so, use the STATICINIT keyword to have the linker generate the static initializer sections.

In your linker command file, use lines similar to these to tell the linker where to put the table of static initializers (relative to the '`.`' location counter):

```
___sinit__ = .;
STATICINIT
```

The program knows the symbol `___sinit__` at runtime. So in startup code, you can use corresponding lines such as these:

```
#ifdef __cplusplus
/* call the c++ static initializers */
__call_static_initializers();
#endif
```

Exception Tables

You need exception tables only for C++ code. To create one, add the `EXCEPTION` command to the end of your code section — Listing 6.10 is an example.

The program knows the two symbols `__exception_table_start__` and `__exception_table_end__` at runtime.

Listing 6.10 Creating an Exception Table

```
__exception_table_start__ = .;
EXCEPTION
__exception_table_end__ = .;
```

Position-Independent Code and Data

For position-independent code (PIC) and position-independent data (PID), your LCF must include `.picdynrel` and `.piddynrel` sections. These sections specify where to store the PIC and PID dynamic relocation tables.

In addition, your LCF must define these six symbols:

```
__START_PICTABLE    __END_PICTABLE  __PICTABLE_SIZE
__START_PIDTABLE  __END_PIDTABLE    __PIDTABLE_SIZE
```

Listing 6.11 is an example definition for PIC and PID.

Listing 6.11 PIC, PID Section Definition

```
.pictables :
{
. = ALIGN(0x8);
__START_PICTABLE = .;
*(.picdynrel)__END_PICTABLE = .;
__PICTABLE_SIZE = __END_PICTABLE - __START_PICTABLE;
__START_PIDTABLE = .;
*(.piddynrel)__END_PIDTABLE = .;
__PIDTABLE_SIZE = __END_PIDTABLE - __START_PIDTABLE;
} >> DATA
```

ROM-RAM Copying

In embedded programming, it is common that data or code of a program residing in ROM gets copied into RAM at runtime.

To indicate such data or code, use the LCF to assign it two addresses:

- The memory segment specifies the intended location in RAM
- The sections segment specifies the resident location in ROM, via its AT (address) parameter

For example, suppose that we want to copy all initialized data into RAM at runtime. At runtime, the system loads the `.main_data` section containing the initialized data to RAM address `0x80000`, but until runtime, this section remains in ROM. Listing 6.12 shows part of the corresponding LCF.

Listing 6.12 Partial LCF for ROM-to-RAM Copy

```
# ROM location: address 0x0
# RAM location: address 0x800000
# For clarity, no alignment directives in this listing

MEMORY {
  TEXT (RX) : ORIGIN = 0x0, LENGTH = 0
  DATA (RW) : ORIGIN = 0x800000, LENGTH = 0
}

SECTIONS{
  .main :
  {
    *(.text)
    *(.rodata)
  } > TEXT
```

```
# Locate initialized data in ROM area at end of .main.

  .main_data : AT( ADDR(.main) + SIZEOF(.main) )
  {
    *(.data)
    *(.sdata)
    *(.sbss)
  } > DATA

  .uninitialized_data:
  {
    *(SCOMMON)
    *(.bss)
    *(COMMON)
  } >> DATA
```

For program execution to copy the section from ROM to RAM, a copy table such as Listing 6.13 must supply the information that the program needs at runtime. This copy table, which the symbol `__S_romp` identifies, contains a sequence of three word values per entry:

- ROM start address
- RAM start address
- size

The last entry in this table must be all zeros: this is the reason for the three lines `WRITEW(0) ;` before the table closing brace character.

Listing 6.13 LCF Copy Table for Runtime ROM Copy

```
# Locate ROM copy table into ROM after initialized data
_romp_at = _main_ROM + SIZEOF(.main_data);

 .romp : AT (_romp_at)
 {
   __S_romp = _romp_at;
   WRITEW(_main_ROM);          #ROM start address
   WRITEW(ADDR(.main_data));   #RAM start address
   WRITEW(SIZEOF(.main_data)); #size
   WRITEW(0);
   WRITEW(0);
   WRITEW(0);
 }
 __SP_INIT = . + 0x4000;  # set stack to 16kb
 __heap_addr = __SP_INIT; # heap grows opposite stack direction
 __heap_size = 0x10000;   # set heap to 64kb
}                         # end SECTIONS segment
```

```
                    # end LCF
```

Writing Data Directly to Memory

To write data directly to memory, use appropriate `WRITEx` keywords in your LCF:

- `WRITEB` writes a byte
- `WRITEH` writes a two-byte halfword
- `WRITEW` writes a four-byte word.

The system inserts the data at the section's current address. Listing 6.14 shows an example.

Listing 6.14 Embedding Data Directly into Output

```
.example_data_section :
{
   WRITEB 0x48;  /*  'H'  */
   WRITEB 0x69;  /*  'i'  */
   WRITEB 0x21;  /*  '!'  */
```

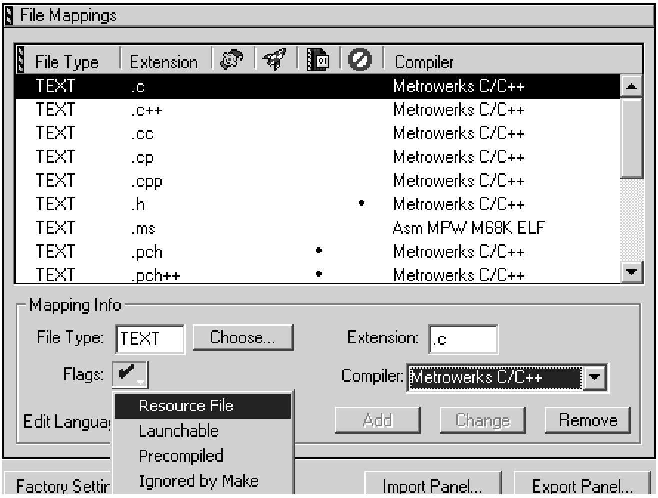
To insert a complete binary file, use the INCLUDE keyword, as Listing 6.15 shows.

Listing 6.15 Embedding a Binary File into Output

```
    _musicStart = .;
    INCLUDE music.mid
    _musicEnd = .;
}  > DATA
```

You must include the binary file in your IDE project. Additionally, the **File Mappings** target settings panel must specify *resource file* for all files that have the same extension as the binary file. Figure 6.1 shows how to make this type designation.

Figure 6.1 Marking a Binary File Type as a Resource File



Commands, Directives, and Keywords

The rest of this chapter consists of explanations of all valid LCF functions, keywords, directives, and commands, in alphabetic order.

Table 6.2 LCF Functions, Keywords, Directives, and Commands

. (location counter)	ADDR	ALIGN
ALIGNALL	EXCEPTION	EXPORTSTRTAB
EXPORTSYMTAB	FORCE_ACTIVE	IMPORTSTRTAB
IMPORTSYMTAB	INCLUDE	KEEP_SECTION
MEMORY	OBJECT	REF_INCLUDE
SECTIONS	SIZEOF	SIZEOF_ROM
WRITEB	WRITEH	WRITEW
WRITES0COMMENT	ZERO_FILL_UNINITIALIZED	

. (location counter)

Denotes the current output location.

Remarks

The period always refers to a location in a sections segment, so is valid only in a sections-section definition. Within such a definition, `'.'` may appear anywhere a symbol is valid.

Assigning a new, greater value to `'.'` causes the location counter to advance. But it is not possible to decrease the location-counter value, so it is not possible to assign a new, lesser value to `'.'` You can use this effect to create empty space in an output section, as the Listing 6.16 example does.

Example

The code of Listing 6.16 moves the location counter to a position 0x10000 bytes past the symbol `__start`.

Listing 6.16 Moving the Location Counter

```
..data :
{
      *.(data)
      *.(bss)
      *.(COMMON)
      __start = .;
      . = __start + 0x10000;
      __end = .;
} > DATA
```

ADDR

Returns the address of the named section or memory segment.

`ADDR (`*`sectionName`*` | `*`segmentName`*`)`

Parameters

`sectionName`

Identifier for a file section.

`segmentName`

Identifier for a memory segment

Example

The code of Listing 6.17 uses the `ADDR` function to assign the address of `ROOT` to the symbol `__rootbasecode` .

Listing 6.17 ADDR() Function

```
MEMORY{
    ROOT   (RWX)  : ORIGIN = 0x80000400, LENGTH = 0
}

SECTIONS{
  .code :
  {
  __rootbasecode = ADDR(ROOT);
     *.(text);
  } > ROOT
}
```

ALIGN

Returns the location-counter value, aligned on a specified boundary.

`ALIGN(alignValue)`

Parameter

`alignValue`

Alignment-boundary specifier; must be a power of two.

Remarks

The `ALIGN` function does *not* update the location counter; it only performs arithmetic. Updating the location counter requires an assignment such as:

```
. = ALIGN(0x10); #update location counter to
                  16-byte alignment
```

ALIGNALL

Forces minimum alignment for all objects in the current segment to the specified value.

`ALIGNALL(alignValue);`

Parameter

`alignValue`

Alignment-value specifier; must be a power of two.

Remarks

`ALIGNALL` is the command version of the `ALIGN` function. It updates the location counter as each object is written to the output.

Example

Listing 6.18 is an example use for `ALIGNALL()` command.

Listing 6.18 ALIGNALL Example

```
.code :
{
    ALIGNALL(16);  // Align code on 16-byte boundary
    *     (.init)
    *     (.text)

    ALIGNALL(64);  //align data on 64-byte boundary
    *     (.rodata)
} > .text
```

EXCEPTION

Creates the exception table index in the output file.

`EXCEPTION`

`Remarks`

Only C++ code requires exception tables. To create an exception table, add the `EXCEPTION` command, with symbols `__exception_table_start__` and `__exception_table_end__`, to the end of your code section segment, just as Listing 6.19 shows. (At runtime, the system knows the values of the two symbols.)

Example

Listing 6.19 shows the code for creating an exception table.

Listing 6.19 Creating an Exception Table

```
__exception_table_start__ = .;
EXCEPTION
__exception_table_end__ = .;
```

EXPORTSTRTAB

Creates a string table from the names of exported symbols.

```
EXPORTSTRTAB
```

Remarks

Table 6.3 shows the structure of the export string table. As with an ELF string table, the system zero-terminates the library and symbol names.

Table 6.3 Export String Table Structure

`0x00`	1 byte
library name	varies
symbol1 name	varies
symbol2 name	varies

Example

Listing 6.20 shows the code for creating an export string table.

Listing 6.20 Creating an Export String Table

```
.expstr:
{
 EXPORTSTRTAB
} > EXPSTR
```

EXPORTSYMTAB

Creates a jump table of the exported symbols.

`EXPORTSYMTAB`

Remarks

Table 6.4 shows the structure of the export symbol table. The start of the export symbol table must be aligned on at least a four-byte boundary.

Table 6.4 Export Symbol Table Structure

Size (in bytes) of export table	4 bytes
Index to *library* name in export string table	4 bytes
Index to *symbol1* name in export string table	4 bytes
Address of *symbol1*	4 bytes
A5 value for *symbol1*	4 bytes
Index to *symbol2* name in export string table	4 *bytes*
Address of *symbolf2*	4 bytes
A5 value for *symbol2*	4 bytes

Example

Listing 6.21 shows the code for creating an export symbol table.

Listing 6.21 Creating an Export Symbol Table

```
.expsym:
{
 EXPORTSYMTAB
} > EXPSYM
```

FORCE_ACTIVE

Starts an optional LCF closure segment that specifies symbols the linker should *not* deadstrip.

`FORCE_ACTIVE{ symbol[, symbol] }`

Parameter

`symbol`

Any defined symbol.

IMPORTSTRTAB

Creates a string table from the names of imported symbols.

`IMPORTSTRTAB`

Remarks

Table 6.5 shows the structure of the import string table. As with an ELF string table, the system zero-terminates the library and symbol names.

Table 6.5 Import String Table Structure

`0x00`	1 byte
library name	varies
symbol1 name	varies
symbol2 name	varies

Example

Listing 6.22 shows the code for creating an import string table.

Listing 6.22 Creating an Import String Table

```
.impstr:
{
 IMPORTSTRTAB
} > IMPSTR
```

IMPORTSYMTAB

Creates a jump table of the imported symbols.

`IMPORTSYMTAB`

Remarks

Table 6.6 shows the structure of the import symbol table. The start of the import symbol table must be aligned on at least a four-byte boundary.

Table 6.6 Import Symbol Table Structure

Size (in bytes) of import table	4 bytes
Index to *library1* name in import string table	4 bytes
Number of entries in *library1*	4 bytes
Index to *symbol1* name in import string table	4 bytes
Address of *symbol1* vector in export string table	4 bytes
Index to *symbol2* name in import string table	4 bytes
Address of *symbol2* vector in export string table	4 *bytes*
Index to *library2* name in import string table	4 bytes
Number of entries in *library2*	4 bytes

Example

Listing 6.23 shows the code for creating an import symbol table.

Listing 6.23 Creating an Import Symbol Table

```
.expsym:
{
 IMPORTSYMTAB
} > EXPSYM
```

INCLUDE

Include a specified binary file in the output file.

`INCLUDE` *`filename`*

Parameter

`filename`

Name of a binary file in the project. The File Mappings target settings panel must specify resource file for all files that have the same extension as this file.

Remarks

For more information and an example, see the subsection Writing Data Directly to Memory

KEEP_SECTION

Starts an optional LCF closure segment that specifies sections the linker should *not* deadstrip.

```
KEEP_SECTION{ sectionType[, sectionType] }
```

Parameter

`sectionType`

Identifier for any user-defined or predefined section.

MEMORY

Starts the LCF memory segment, which defines segments of target memory.

```
MEMORY { memory_spec[, memory_spec] }
```

Parameters

`memory_spec`

```
segmentName (accessFlags) : ORIGIN = address,
 LENGTH = length [> fileName]
```

`segmentName`

Name for a new segment of target memory. Consists of alphanumeric characters; can include the underscore character.

`accessFlags`

ELF-access permission flags — `R` = read, `W` = write, or `X` = execute.

`address`

A memory address, such as 0x80000400, or an `AFTER` command. The format of the `AFTER` command is `AFTER (name[, name]);` this command specifies placement of the new memory segment at the end of the named segments.

`length`

Size of the new memory segment: a value greater than zero. Optionally, the value zero for *autolength*, in which the linker allocates space for all the data and code of the segment. (Autolength cannot increase the amount of target memory, so the feature can lead to overflow.)

`fileName`

Optional, binary-file destination. The linker writes the segment to this binary file on disk, instead of to an ELF program header. The linker puts this binary file in the same folder as the ELF output file. This option has two variants:

- `> fileName:` writes the segment to a new binary file.
- `>> fileName:` appends the segment to an existing binary file.

Remarks

The LCF contains only one `MEMORY` directive, but this directive can define as many memory segments as you wish.

For each memory segment, the `ORIGIN` keyword introduces the starting address, and the `LENGTH` keyword introduces the length value.

There is no overflow checking for the autolength feature. To prevent overflow, you should use the `AFTER` keyword to specify the segment's starting address.

If an `AFTER` keyword has multiple parameter values, the linker uses the highest memory address.

For more information, see the subsection Memory Segment.

Example

Listing 6.24 is an example use of the `MEMORY` directive.

Listing 6.24 MEMORY Directive Example

```
MEMORY {
```

```
    TEXT (RX)   :  ORIGIN = 0x00003000, LENGTH = 0
    DATA (RW)   :  ORIGIN = AFTER(TEXT), LENGTH = 0
    }
```

OBJECT

Sections-segment keyword that specifies a function. Multiple `OBJECT` keywords control the order of functions in the output file.

`OBJECT (`*`function`*`, `*`sourcefile.c`*`)`

Parameters

`function`

Name of a function.

`sourcefile.c`

Name of the C file that contains the function.

Remarks

If an `OBJECT` keyword tells the linker to write an object to the output file, the linker does not write the same object again, in response to either the `GROUP` keyword or the '*' wildcard character.

REF_INCLUDE

Starts an optional LCF closure segment that specifies sections the linker should *not* deadstrip, if program code references the files that contain these sections.

`REF_INCLUDE{ `*`sectionType`*`[, `*`sectionType`*`] }`

Parameter

`sectionType`

Identifier for any user-defined or predefined section.

Remarks

Useful if you want to include version information from your source file components.

SECTIONS

Starts the LCF sections segment, which defines the contents of target-memory sections. Also defines global symbols to be used in the output file.

```
SECTIONS { section_spec[, section_spec] }
```

Parameters

`section_spec`

> *`sectionName`* `: [AT (`*`loadAddress`*`)] {contents}`
> `>` *`segmentName`*

`sectionName`

> Name for the output section, such as `mysection`. Must start with a period.

`AT (loadAddress)`

> Optional specifier for the load address of the section. The default value is the relocation address.

`contents`

> Statements that assign a value to a symbol or specify section placement, including input sections. Subsections Arithmetic, Comment Operators, Specifying Files and Functions, Alignment, and `.` (location counter) explain possible `contents` statements.

`segmentName`

> Predefined memory-segment destination for the contents of the section. The two variants are:
>
> - `> segmentName`: puts section contents at the beginning of memory segment `segmentName`.
> - `>> segmentName`: appends section contents to the end of memory segment `segmentName`.

Remarks

For more information, see the subsection Sections Segment.

Example

Listing 6.25 is an example sections-segment definition.

Listing 6.25 SECTIONS Directive Example

```
SECTIONS {
```

```
  .text : {
            _textSegmentStart = .;
            alpha.c (.text)
            . = ALIGN (0x10);
            beta.c (.text)
            _textSegmentEnd = .;
  }
  .data : { *(.data) }
  .bss  : { *(.bss)
            *(COMMON)
  }
}
```

SIZEOF

Returns the size (in bytes) of the specified segment or section.

`SIZEOF(`*`segmentName`* `|` *`sectionName`*`)`

Parameters

`segmentName`

Name of a segment.

`sectionName`

Name of a section.

SIZEOF_ROM

Returns the size (in bytes) that a segment occupies in ROM.

`SIZEOF_ROM (`*`segmentName`*`)`

Parameter

`segmentName`

Name of a ROM segment.

Remarks

Always returns the value 0 until the ROM is built. Accordingly, you should use `SIZEOF_ROM` only within an expression inside a `WRITEB`, `WRITEH`, `WRITEW`, or `AT` function.

Furthermore, you need `SIZEOF_ROM` only if you use the `COMPRESS` option on the memory segment. Without compression, there is no difference between the return values of `SIZEOF_ROM` and `SIZEOF`.

WRITEB

Inserts a byte of data at the current address of a section.

`WRITEB (`*`expression`*`);`

Parameter

`expression`

Any expression that returns a value `0x00` to `0xFF`.

WRITEH

Inserts a halfword of data at the current address of a section.

`WRITEH (`*`expression`*`);`

Parameter

`expression`

Any expression that returns a value `0x0000` to `0xFFFF`

WRITEW

Inserts a word of data at the current address of a section.

`WRITEW (`*`expression`*`);`

Parameter

`expression`

Any expression that returns a value `0x00000000` to `0xFFFFFFFF`.

WRITES0COMMENT

Inserts an S0 comment record into an S-record file.

`WRITES0COMMENT "`*`comment`*`"`

Parameter

`comment`

Comment text: a string of alphanumerical characters `0-9`, `A-Z`, and `a-z`, plus space, underscore, and dash characters. Double quotes *must* enclose the comment string. (If you omit the closing double-quote character, the linker tries to put the entire LCF into the `S0` comment.)

Remarks

This command, valid only in an LCF sections segment, creates an S0 record of the form:

`S0aa0000bbbbbbbbbbbbbbbbdd`

- `aa` — hexadecimal number of bytes that follow
- `bb` — ASCII equivalent of `comment`
- `dd` — the checksum

This command does not null-terminate the ASCII string.

Within a comment string, do not use these character sequences, which are reserved for LCF comments: `#` `/*` `*/` `//`

Example

This example shows that multi-line `S0` comments are valid:

```
WRITES0COMMENT "Line 1 comment

Line 2 comment"
```

ZERO_FILL_UNINITIALIZED

Forces the linker to put zeroed data into the binary file for uninitialized variables.

`ZERO_FILL_UNINITIALIZED`

Remarks

This directive must be between directives `MEMORY` and `SECTIONS`; placing it anywhere else would be a syntax error.

Using linker configuration files and the `define_section` pragma, you can mix uninitialized and initialized data. As the linker does not normally write uninitialized data to the binary file, forcing explicit zeroing of uninitialized data can help with proper placement.

Example

The code of Listing 6.26 tells the linker to write uninitialized data to the binary files as zeros.

Listing 6.26 ZERO_FILL_UNINITIALIZED Example

```
MEMORY {
  TEXT   (RX) :ORIGIN = 0x00030000, LENGTH = 0
  DATA   (RW) :ORIGIN = AFTER(TEXT), LENGTH = 0
}

ZERO_FILL_UNINITIALIZED


SECTIONS {
  .main_application:
  {
    *(.text)
    .=ALIGN(0x8);
    *(.rodata)
    .=ALIGN(0x8);
  } > TEXT
...
}
```

7
ColdFire Linker Notes

The ColdFire linker converts a set of relocatable object files into a single object file. This chapter explains some of the linker capabilities.

This chapter consists of these sections:

- Program Sections
- Deadstripping
- Link Order
- Executable files in Projects
- S-Record Comments

Program Sections

Object files contain code and data that the linker must store in *program sections* of target memory. The default arrangement is that linker puts all program code into the `.text` program section, but you can use `#pragma section` to specify storage.

A program section is a logical grouping for a type of program code that the compiler produces. Table 7.1 lists several code types.

Table 7.1 Code Section Type

Section Type	Contents
`.text`	Executable code
`.data, .sdata`	Initialized data
`.bss, .sbss`	Uninitialized, but reserved data. At the start of program execution, the runtime code clears segments of these types to zero.
`.rodata`	Read-only data

The system stores `.sdata` and `.sbss` types in the small data section. Access to the small data section is faster than access to other sections, but involves consequences for the memory map. Addressing for `.sbss` and `.sdata` sections always is 16-bit, A5-relative. The **ColdFire Processor** panel lets you specify the maximum size for variables to be stored in the small data section. Thee *ColdFire Reference Manual* gives more information about *near data*, a term for the contents of the small data section.

Deadstripping

As the ColdFire linker links object files into one executable file, it recognizes portions of code that execution cannot possibly reach. *Deadstripping* is removing such unreachable code — that is, not including the portions in the executable fie. The CodeWarrior linker performs this deadstripping on a per-function basis.

The CodeWarrior linker deadstrips unused code and data from *only* object files that a CodeWarrior C/C++ compiler generates. The linker never deadstrips assembler-relocatable files, or C/C++ object files from a different compiler.

Deadstripping is particularly useful for C++ programs, or for linking to large, general-purpose libraries. Libraries (archives) built with the CodeWarrior C/C++ compiler only contribute the used objects to the linked program. If a library has assembly or other C/C++ compiler built files, only those files that have at least one referenced object contribute to the linked program. The linker always ignores unreferenced object files.

Well-constructed projects probably do not contain unused data or code. Accordingly, you can reduce the time linking takes by disabling deadstripping:

- To disable deadstripping completely, check the **Disable Deadstripping** checkbox of the **ColdFire Linker** panel.
- To disable deadstripping for particular symbols, enter the symbol names in the **Force Active Symbols** text box of the **ColdFire Linker** Panel. (For more information on ColdFire Linker panel, see the subsection ColdFire Linker.)
- To disable deadstripping for individual sections of the linker command file, use the `KEEP_SECTION()` directive. As code does not directly reference interrupt-vector tables, a common use for this directive is disabling deadstripping for these interrupt-vector tables. The subsection Closure Segments provides additional information about the `KEEP_SECTION()` directive.

NOTE To deadstrip files from standalone assembler, you must make each assembly functions start its own section (for example, a new `.text` directive before functions) and using an appropriate directive.

Link Order

To specify link order, use the **Link Order** page of the Project window. (For certain targets, the name of this page is **Segments**.)

Regardless of the order that the **Link Order** page specifies, the ColdFire linker always processes C/C++ or assembler source files before it processes relocatable (.o) files or archive (.a) files. This means that the linker uses a symbol definition from a source file, rather than a library-file definition for the same symbol.

There is an exception, however: if the source file defines a weak symbol, the linker uses a global-symbol definition from a library. (`#pragma overload` creates weak symbols.)

Well constructed projects usually do not have strong link-order dependencies.

Executable files in Projects

It may be convenient to keep executable files in a project, so that you can disassemble it later. As the linker ignores executable files, the IDE portrays them as out of date — even after a successful build. The IDE out-of-date indicator is a check mark in the *touch* column, at the left side of the project window.

Dragging/dropping the final elf and disassembling it is a useful way to view the absolute code.

S-Record Comments

You can insert one comment can at the beginning of an S-Record file via the linker-command-file directive WRITES0COMMENT. Subsection WRITES0COMMENT provides more information.

8

Inline Assembly

This chapter explains support for inline assembly language programming — a feature of all CodeWarrior compilers.

(The standalone assembler, different software component, is not a topic of this chapter. For information on the stand-alone assembler, refer to the *Assembler Guide.)*

This chapter consists of these sections:

- Inline Assembly Syntax
- Inline Assembly Directives

Inline Assembly Syntax

Syntax explanation topics are:

- Statements
- Additional Syntax Rules
- Preprocessor Features
- Local Variables and Arguments
- Returning From a Routine

Statements

All internal assembly statements must follow this syntax:

```
[LocalLabel:] (instruction | directive) [operands];
```

Other rules for statements are:

- The assembly instructions are the standard ColdFire instruction mnemonics.
- Each instruction must end with a newline character or a semicolon (`;`).
- Hexadecimal constants must be in C style: `0xABCDEF` is a valid constant, but `$ABCDEF` is not.
- Assembler directives, instructions, and registers are *not* case-sensitive. To the inline assembler, these statements are the same:

```
move.l   b, DO
MOVE.L   b, d0
```

- To specify assembly-language interpretation for a block of code in your file, use the `asm` keyword.

NOTE To make sure that the C/C++ compiler recognizes the `asm` keyword, you must clear the **ANSI Keywords Only** checkbox of the **C/C++ Language** panel.

Listing 8.1 and Listing 8.2 are valid examples of inline assembly code:

Listing 8.1 Function-Level Sample

```
long int b;
struct mystruct {
  long int a;
} ;
static asm long f(void)      // Legal asm qualifier
{
  move.l   struct(mystruct.a)(A0),D0 // Accessing a struct.
  add.l    b,D0    // Using a global variable, put return value
                   // in D0.
  rts              // Return from the function:
                   // result = mystruct.a + b
}
```

Listing 8.2 Statement-Level Sample

```
long square(short a)
{
   asm {
     move.w  a,d0     // fetch function argument 'a'
     mulu.w  d0,d0    // multiply
     return           // return from function (result is in D0)
   }
}
```

NOTE Regardless of its settings, the compiler never optimizes assembly-language functions. However, to maintain integrity of all registers, the compiler notes which registers inline assembly uses.

Additional Syntax Rules

These rules pertain to labels, comments, structures, and global variables:

- Each label must end with a colon; labels may contain the `@` character. For example, `x1:` and `@x2:` would be valid labels, but `x3` would not — it lacks a colon.
- Comments must use C/ C++ syntax: either starting with double slash characters (`//`) or enclosed by slash and asterisk characters (`/*` ... `*/`).
- To refer to a field in a structure, use the `struct` construct:

  ```
  struct(structTypeName.fieldName) structAddress
  ```

  For example, suppose that `A0` points to structure `WindowRecord`. This instruction moves the structure's `refCon` field to `D0`:

  ```
  move.l   struct(WindowRecord.refCon) (A0), D0
  ```

- To refer to a global variable, merely use its name, as in the statement

  ```
  move.w      x,d0     // Move x into d0
  ```

Preprocessor Features

You can use all preprocessor features, such as comments and macros, in the inline assembler. But when you write a macro definition, remember to:

- End each assembly statement with a semicolon (`;`) — (the preprocessor ignores newline characters).
- Use the `%` character, instead of `#`, to denote immediate data, — the preprocessor uses `#` as a concatenate operator.

Local Variables and Arguments

Handling of local variables and arguments depends on the level of inline assembly. However, *for optimization level 1 or greater*, you can force variables to stay in a register by using the symbol `$`.

Function-Level

The function-level inline assembler lets you refer to local variables and function arguments yourself, handles such references for you.

For *your own* references, you must explicitly save and restore processor registers and local variables when entering and leaving your inline assembly function. You cannot refer to the variables by name, but you can refer to function arguments off the stack pointer. For example, this function moves its argument into `d0`:

```
asm void alpha(short n)
```

```
{
  move.w      4(sp),d0 //   n
  // . . .
}
```

To let the *inline assembler* handle references, use the directives `fralloc` and `frfree`, according to these steps:

1. Declare your variables as you would in a normal C function.
2. Use the `fralloc` directive. It makes space on the stack for the local stack variables. Additionally, with the statement `link #`*x*`,a6`, this directive reserves registers for the local register variables.
3. In your assembly, you can refer to the local variables and variable arguments by name.
4. Finally, use the `frfree` directive to free the stack storage and restore the reserved registers. (It is somewhat easier to use a C wrapper and statement level assembly.)

Listing 8.3 is an example of using local variables and function arguments in function-level inline assembly.

Listing 8.3 Function-level Local Variables, Function Arguments

```
static asm short f(short n)
{
  register short a; // Declaring a as a register variable
  short b;          //  and b as a stack variable
  // Note that you need semicolons after these statements.
  fralloc +         // Allocate space on stack, reserve registers.
  move.w  n,a       // Using an argument and local var.
  add.w   a,a
  move.w  a,D0
  frfree            // Free space that fralloc allocated
  rts
}
```

Statement-Level

Statement-level inline assembly allows full access to local variables and function arguments without using the `fralloc` or `frfree` directives.

Listing 8.4 is an example of using local variables and function arguments in statement-level inline assembly. You may place statement-level assembly code anywhere in a C/C++ program.

Listing 8.4 Statement-Level Local Variables, Function Arguments

```
long square(short a)
{
  long result=0;
  asm {
    move.w  a,d0       // fetch function argument 'a'
    mulu.w  d0,d0      // multiply
    move.l  d0,result  // store in local 'result' variable
  }
  return result;
}
```

Returning From a Routine

Every inline assembly function (not statement level) should end with a return statement. Use the `rts` statement for ordinary C functions, as Listing 8.5 shows.

Listing 8.5 Assembly Function Return

```
asm void f(void)
{   add.l      d4, d5}        // Error, no RTS statement

asm void g(void)
{   add.l      d4, d5
    rts}                      // OK
```

For statement-level returns, see "return" on page 118 and "naked" on page 117.

Inline Assembly Directives

Table 8.1 lists special assembler directives that the ColdFire inline assembler accepts. Explanations follow the table.

Table 8.1 Inline Assembly Directives

dc	ds	entry
fralloc	frfree	macine
naked	opword	return

NOTE Except for dc and ds, the inline assembly directives are available only for function/routine level.

dc

Defines blocks of constant expressions as initialized bytes, words, or longwords. (Useful for inventing new opcodes to be implemented via a loop,)

`dc[.(b|w|l)] constexpr (,constexpr)*`

Parameters

`b`

Byte specifier, which lets you specify any C (or Pascal) string constant.

`w`

Word specifier (the default), which lets you specify any 16-bit relative offset to a local label.

`l`

Longword specifier.

`constexpr`

Name for block of constant expressions.

Example

```
asm void alpha(void)
{
x1: dc.b  "Hello world!\n" // Creating a string
x2: dc.w  1,2,3,4          // Creating an array
x3: dc.l  3000000000       // Creating a number
}
```

ds

Defines a block of bytes, words, or longwords, initialized with null characters. Pushes labels outside the block.

`ds[.(b|w|l)] size`

Parameters

`b`

Byte specifier.

`w`

Word specifier (the default).

`l`

Longword specifier.

`size`

Number of bytes, words, or longwords in the block.

Example

This statement defines a block big enough for the structure `DRVRHeader`:

```
ds.b   sizeof(DRVRHeader)
```

entry

Defines an entry point into the current function. Use the `extern` qualifier to declare a global entry point and use the `static` qualifier to declare a local entry point. If you leave out the qualifier, `extern` is assumed (Listing 8.6).

```
entry [extern|static] name
```

Parameters

`extern`

Specifier for a global entry point (the default).

`static`

Specifier for a local entry point.

`name`

Name for the new entry point.

Example

Listing 8.6 defines the new local entry point `MyEntry` for function `MyFunc`.

Listing 8.6 Entry Directive Example

```
static long MyEntry(void);
static asm long MyFunc(void)
```

```
{
    move.l   a,d0
    bra.s    L1
    entry    static MyEntry
    move.l   b,d0
L1: rts
}
```

fralloc

Lets you declare local variables in an assembly function.

`fralloc [+]`

Parameter

`+`

Optional ColdFire-register control character.

Remarks

This directive makes space on the stack for your local stack variables. It also reserves registers for your local register variables (with the statement `link #x,a6`).

Without the + control character, this directive pushes modified registers onto the stack.

With the + control character, this directive pushes all register arguments into their ColdFire registers.

Counterpart to the `frfree` directive.

frfree

Frees the stack storage area; also restores the registers (with the statement `unlk a6`) that `fralloc` reserved.

`frfree`

machine

Specifies the CPU for which the compiler generates its inline-assembly instructions.

`machine processor`

Parameter

`processor`

`MCF547x`, `MCF5249`, `MCF5272`, `MCF5280`, `MCF5282`, `MCF5307`, `MCF5407`, `MCF5213`, or `MCF5206e`

Remarks

If you use this directive to specify a target processor, additional inline-assembler instructions become available — instructions that pertain only to that processor. For more information, see the Freescale processor user's manual

naked

Suppresses the compiler-generated stackframe setup, cleanup, and return code.

`naked`

Remarks

Functions with this directive cannot access local variables by name. They should not contain C code that implicitly or explicitly uses local variables or memory.

Counterpart to the `return` directive.

Example

Listing 8.7 is an example use of this directive.

Listing 8.7 Naked Directive Example

```
long square(short)
{
  asm{
    naked              // no stackframe or compiler-generated rts
    move.w   4(sp),d0  // fetch function argument from stack
    mulu.w   d0,d0     // multiply
    rts                // return from function: result in D0
  }
```

```
}
```

opword

Writes machine-instruction constants directly into the executable file, without any error checking.

`opword constant[,constant]`

Parameter

`constant`

Any appropriate machine-code value.

Example

`opword 0x7C0802A6` — which is equivalent to the instruction `mflr r0`.

return

Inserts a compiler-generated sequence of stackframe cleanup and return instructions. Counterpart to the `naked` directive.

`return instruction[, instruction]`

Parameter

`instruction`

Any appropriate C instruction.

9

Debugging

This chapter explains aspects of debugging that are specific to the ColdFire architectures. For more general information about the CodeWarrior debugger, see the *IDE User's Guide*.

To start the CodeWarrior debugger, select **Project > Debug**. The debugger window appears; the debugger loads the image file that the current build target produces. You can use the debugger to control program execution, insert breakpoints, and examine memory and registers.

NOTE The automatic loading of the previous paragraph depends on the load options you specify, and on whether your application code is in ROM or Flash memory.

This chapter consists of these sections:

- Target Settings for Debugging
- Remote Connections for Debugging
- BDM Debugging
- Debugging ELF Files without Projects
- Special Debugger Features

Target Settings for Debugging

Several target settings panels control the way the debugger works:

- CF Debugger Settings Panel
- Remote Debugging Panel
- CF Exceptions Panel
- Debugger Settings Panel
- CF Interrupt Panel

To access these panels, select **Edit >** ***Target*** **Settings**, from the main menu bar. (***Target*** is the current build target in the CodeWarrior project.) The ***Target*** **Settings** window (Figure 9.1) appears.

Figure 9.1 Target Settings Window

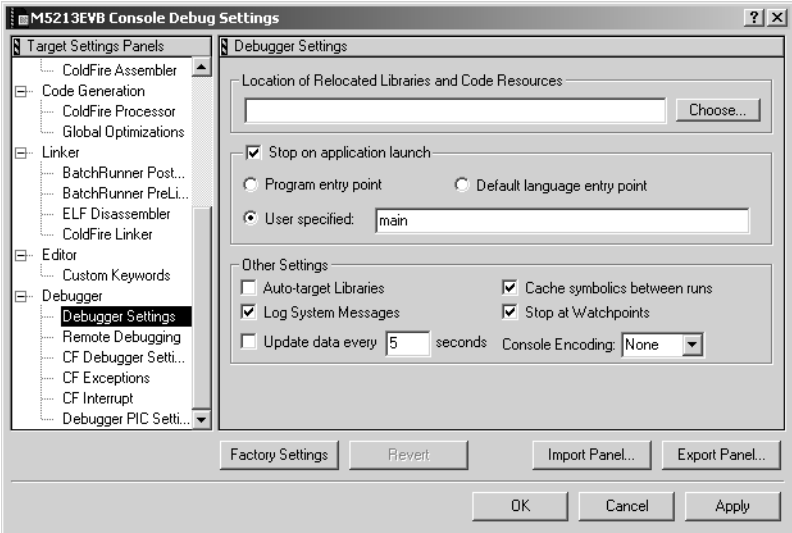


Table 9.1 lists additional panels that can affect debugging.

Table 9.1 Additional Settings Panels That May Affect Debugging

Panel	Impact	See
C/C++ Warnings	compiler warnings	*C Compilers Reference*
ColdFire Linker	controls symbolics, linker warnings	ColdFire Linker
ColdFire Processor	optimizations	ColdFire Processor
Global Optimizations	optimizations	*IDE User's Guide*

CF Debugger Settings Panel

Use the **CF Debugger Settings** panel (Figure 9.2) to select debugger hardware and control interaction with the target board. Table 9.2 explains the elements of this panel.

Figure 9.2 CF Debugger Settings Panel

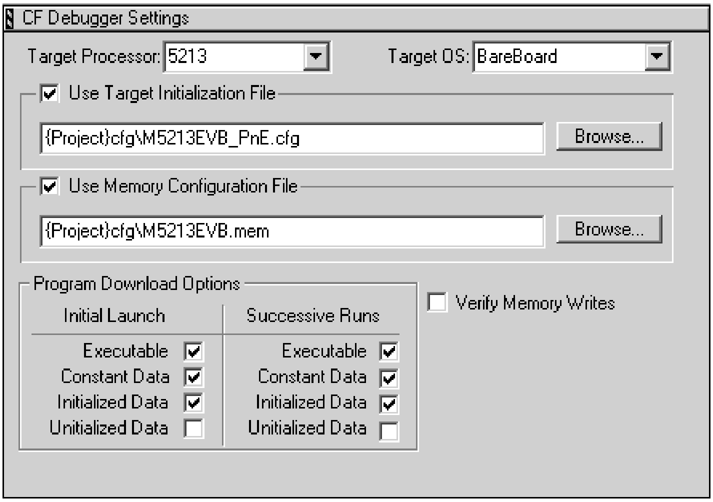


Table 9.2 CF Debugger Settings Panel Elements

Element	Purpose	Comments
Target Processor list box	Specifies the target processor.	Your stationery selection automatically makes this specification.
Target OS list box	Specifies a real-time operating system; for bare board development, select BareBoard.	Default: BareBoard. If you have Professional-Edition software and install an RTOS, that RTOS becomes a selection of this list box. (Special- and Standard-Edition software, however, does not support an RTOS.)

Table 9.2 CF Debugger Settings Panel Elements (*continued*)

Element	Purpose	Comments
Use Target Initialization File checkbox	Clear — Specifies *not* using a target initialization file; deactivates file subordinate text box and Browse button. Checked — Tells the debugger to use the specified target initialization file. To enter a pathname in the text box, click the Browse button, then use the file-select dialog box to specify the file.	Default: checked. The initialization file is in subdirectory `\E68K_Support\Initialization_Files`, of the CodeWarrior installation directory (or directory that contains your project). Clear this checkbox, if you are using an Abatron-based remote connection. Make sure this checkbox is checked, if you are using a P&E Micro-based remote connection.
Use Memory Configuration File checkbox	Clear — Specifies *not* using a memory configuration file; deactivates file subordinate text box and Browse button. Checked — Tells the debugger to use the specified memory configuration file. To enter a pathname in the text box, click the Browse button, then use the file-select dialog box to specify the file.	Default: Unchecked. The memory configuration file is in subdirectory `\E68K_Support\Initialization_Files`, of the CodeWarrior installation directory (or directory that contains your project). Do not check this checkbox, if you are using a Abatron-based remote connection. Check this checkbox, if you are using a P&E Micro-based remote connection.
Initial Launch: Executable checkbox	Clear — Does *not* download program executable code or text sections for initial launch. Checked — Downloads program executable code and text sections for initial launch.	Default: Checked. Initial launch is the first time you debug the project after you start the debugger from the IDE.
Initial Launch: Constant Data checkbox	Clear — Does *not* download program constant data sections for initial launch. Checked — Downloads program constant data sections for initial launch.	Default: Checked. Initial launch is the first time you debug the project after you start the debugger from the IDE.

Table 9.2 CF Debugger Settings Panel Elements (*continued*)

Element	Purpose	Comments
Initial Launch: Initialized Data checkbox	Clear — Does *not* download program initialized data sections for initial launch. Checked — Downloads program initialized data sections for initial launch.	Default: Checked. Initial launch is the first time you debug the project after you start the debugger from the IDE.
Initial Launch: Uninitialized Data checkbox	Clear — Does *not* download program uninitialized data sections for initial launch. Checked — Downloads program uninitialized data sections for initial launch.	Default: Clear. Initial launch is the first time you debug the project after you start the debugger from the IDE.
Successive Runs: Executable checkbox	Clear — Does *not* download program executable code or text sections for successive runs. Checked — Downloads program executable code and text sections for successive runs.	Default: Clear. Successive runs are debugging actions after initial launch. Note that rebuilding the project returns you to the initial-launch state.
Successive Runs: Constant Data checkbox	Clear — Does *not* download program constant data sections for successive runs. Checked — Downloads program constant data sections for successive runs.	Default: Clear. Successive runs are debugging actions after initial launch. Note that rebuilding the project returns you to the initial-launch state. NOTE: If you check this checkbox, avoid cycling board power. Doing so can prevent application rebuilding and code reloading, making debugging unnecessarily difficult.
Successive Runs: Initialized Data checkbox	Clear — Does *not* download program initialized data sections for successive runs. Checked — Downloads program initialized data sections for successive runs.	Default: Checked. Successive runs are debugging actions after initial launch. Note that rebuilding the project returns you to the initial-launch state.

Table 9.2 CF Debugger Settings Panel Elements (*continued*)

Element	Purpose	Comments
Successive Runs: Uninitialized Data checkbox	Clear — Does *not* download program uninitialized data sections for successive runs. Checked — Downloads program uninitialized data sections for successive runs.	Default: Checked. Successive runs are debugging actions after initial launch. Note that rebuilding the project returns you to the initial-launch state.
Verify Memory Writes checkbox	Clear — Does not confirm that a section written to the target matches the original section. Checked — Confirms that any section written to the target matches the original section.	Default: Clear.

Remote Debugging Panel

Use the **Remote Debugging** panel (Figure 9.3) to set up connections for remote debugging. Table 9.3 explains the elements of this panel. Text following the figure and table provides more information about adding and changing remote connections.

NOTE Special- and Standard-Edition software support only P&E Microsystems parallel and USB remote connections. For any other type of remote connection, you must have Professional-Edition software.

Figure 9.3 Remote Debugging Panel

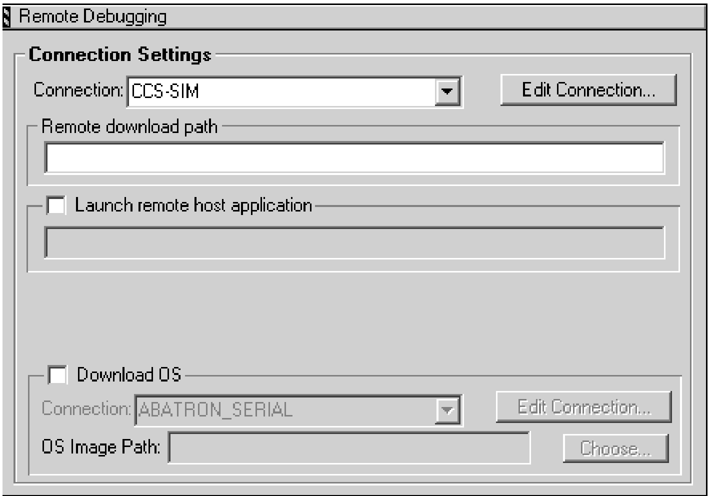


Table 9.3 Remote Debugging Panel Elements

Element	Purpose	Comments
Connection list box	Specifies the remote-connection type: the remote debugger, along with its default settings.	Possible remote connections include Abatron Serial or TCP/IP; CCS-SIM; and P&E Microsystems Parallel, USB, and Lightning. However, you must add any such additional connection before it is available in this list box.
Edit Connection button	Starts process of adding a remote connection, or changing settings of an existing remote connection.	For instructions, see text after this table.
Remote download text box	Specifies the absolute path to the directory in which to store downloaded files. This option does not apply to bareboard development.	Default: None.

Table 9.3 Remote Debugging Panel Elements (*continued*)

Element	Purpose	Comments
Launch remote host application checkbox	Clear — Prevents the IDE from starting a host application on the remote computer. Checked — IDE starts a host application on the remote computer. (Also enables the corresponding text box, for the absolute path to the remote host application:) This option does not apply to bareboard development.	Default: Clear
Download OS checkbox	Clear — Prevents downloading a bootable image to the target system. Checked — Downloads the specified bootable image to the target system. (Also enables the Connection list box and OS Image Path text box.)	Default: Clear
Connection list box	Specifies the remote-connection type for downloading the bootable image to the target board.	Disabled if the Download OS checkbox is clear. Lists only the remote connections you add via the Remote Connections panel.
OS Image path	Specifies the host-side path of the bootable image to be downloaded to the target board.	Disabled if the Download OS checkbox is clear.

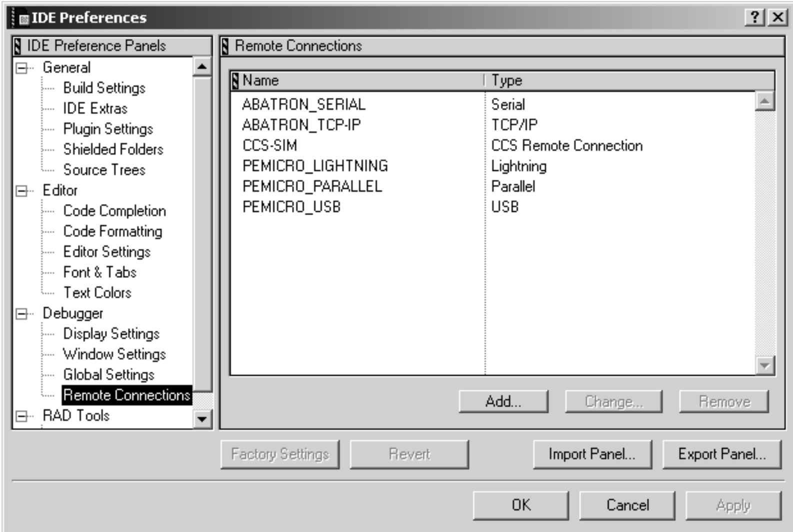
Adding Remote Connections

NOTE Special- and Standard-Edition software support only P&E Microsystems USB remote connection. For any other type of remote connection, you must have Professional-Edition software.

To add a remote connection, use the **Remote Connections** panel:

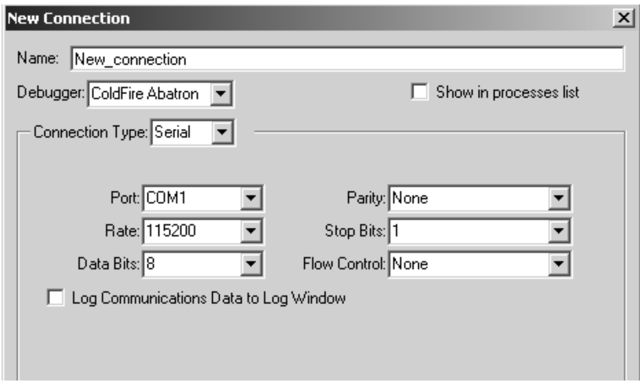
1. Select **Edit > Preferences**. The **IDE Preferences** window appears.
2. From the **IDE Preferences Panels** list, select **Remote Connections**. The **Remote Connections** panel moves to the front of the **IDE Preferences** window. Figure 9.4 shows the **IDE Preferences** window at this point.

Figure 9.4 IDE Preferences Window: Remote Connections Panel



3. Click the **Add** button. The **New Connection** dialog box (Figure 9.5) appears.

Figure 9.5 New Connection Dialog Box



4. In the **Name** text box, enter a name for the new connection.
5. Use the **Debugger** list box to specify the debugger for the new remote connection: ColdFire Abatron, ColdFire P&E Micro, or ColdFire CCS (the simulator).
6. Check the **Show in processes list** checkbox to add this new connection to the official list. (To see this list of processes, select **View > Systems > List**.) Checking this

checkbox also adds this new connection to the remote-connection list that pops up when you debug certain kinds of files.)

7. Use the Connection Type list box to specify the type — the remaining fields of the dialog box change appropriately.
8. Use the remaining fields of the New Connection dialog box to make any appropriate changes to the default values for connection type, port, rate, and so forth.
9. Click **OK**. The dialog box closes; the **Remote Connections** panel window displays the new connection.
10. This completes adding the new connection. You may close the **IDE Preferences** window.

Changing Remote Connections

To change to an already-configured remote connection, use the **Remote Debugging** panel (Figure 9.3):

1. Click the arrow symbol of the **Connection** list box. The list of connections appears.
2. Select another connection. The list collapses; the list box displays your selection.
3. Click the **Edit Connections** button. A dialog box appears, showing the configuration of the remote connection.
4. Use the dialog box to make any appropriate configuration changes.
5. Click **OK**. The dialog box closes, confirming your configuration changes.

NOTE Any changes you make using the **Remote Debugging** panel apply to all targets that use the specified connection.

CF Exceptions Panel

The **CF Exceptions** panel (Figure 9.6) is available only with P&E Microsystems remote connections. Use this panel to specify hardware exceptions that the debugger should catch. Table 9.4 explains the elements of this panel.

Before you load and run the program, the debugger inserts its own exception vector for each exception you check in this panel. To use your own exception vectors instead, you should clear the corresponding checkboxes.

If you check any boxes, the debugger reads the Vector_Based_Register (VBR), finds the corresponding existing exception vector, then writes a new vector at that register location. The address of this new vector is offset 0x408 from the VBR address. For example, if the VBR address is 0x0000 0000, the new vector at address 0x0000 0408 covers the checked exceptions.

The debugger writes a Halt instruction and a Return from Exception instruction at this same location.

NOTE If your exceptions are in Flash or ROM, do not check any boxes of the **CF Exceptions** panel.
Abatron remote connections ignore this panel, using instead the exception definitions in the Abatron firmware.

Figure 9.6 CF Exceptions Panel

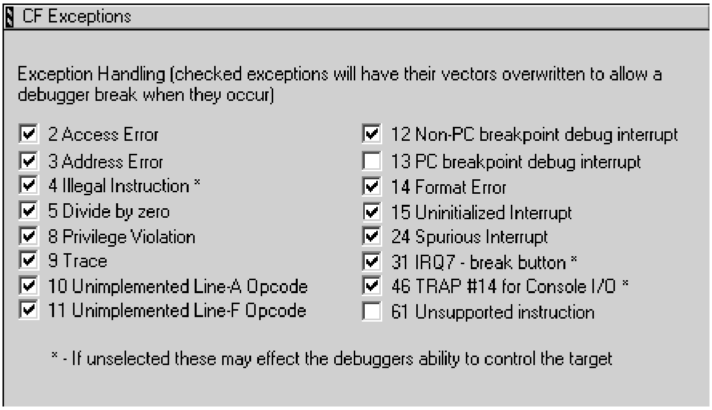


Table 9.4 CF Exceptions Panel Elements

Element	Purpose	Comments
2 Access Error checkbox	Clear — Ignores access errors. Checked — Catches and displays access errors.	Default: Checked
3 Address Error checkbox	Clear — Ignores address errors. Checked — Catches and displays address errors.	Default: Checked
4 Illegal Instruction checkbox	Clear — Ignores invalid instructions. Checked — Catches and displays invalid instructions.	Default: Checked
5 Divide by zero checkbox	Clear — Ignores an attempt to divide by zero. Checked — Catches and displays any attempt to divide by zero.	Default: Checked

Table 9.4 CF Exceptions Panel Elements (*continued*)

Element	Purpose	Comments
8 Privilege Violation checkbox	Clear — Ignores privilege violations. Checked — Catches and displays privilege violations.	Default: Checked
10 Unimplemented Line-A Opcode checkbox	Clear — Ignores unimplemented line-A opcodes. Checked — Catches and displays unimplemented line-A opcodes.	Default: Checked
11 Unimplemented Line-F Opcode checkbox	Clear — Ignores unimplemented line-F opcodes. Checked — Catches and displays unimplemented line-F opcodes.	Default: Checked
12 Non-PC breakpoint debug interrupt checkbox	Clear — Ignores non-PC breakpoint debug interrupts. Checked — Catches and displays non-PC breakpoint debug interrupts.	Default: Checked
13 PC breakpoint debug interrupt checkbox	Clear — Ignores PC breakpoint debug interrupts. Checked — Catches and displays PC breakpoint debug interrupts.	Default: Clear
14 Format Error checkbox	Clear — Ignores format errors. Checked — Catches and displays format errors.	Default: Checked
15 Uninitialized Interrupt checkbox	Clear — Ignores uninitialized interrupts. Checked — Catches and displays uninitialized interrupts.	Default: Checked
24 Spurious Interrupt checkbox	Clear — Ignores spurious interrupts. Checked — Catches and displays spurious interrupts.	Default: Checked
31 IRQ7 - break button checkbox	Clear — Ignores use of the IRQ7 break button. Checked — Catches and displays uses of the IRQ7 break button.	Default: Checked

Table 9.4 CF Exceptions Panel Elements (*continued*)

Element	Purpose	Comments
46 TRAP #14 for Console I/O checkbox	Clear — Ignores trap 14 for console I/O. Checked — Catches and displays uses of trap 14 for console I/O.	Default: Clear.
61 Unsupported instruction checkbox	Clear — Ignores unsupported instructions. Checked — Catches and displays unsupported instructions.	Default: Clear.

Debugger Settings Panel

Use the **Debugger Settings** panel (Figure 9.7) to select and control the debug agent. Table 9.5 explains the elements of this panel.

Figure 9.7 Debugger Settings Panel

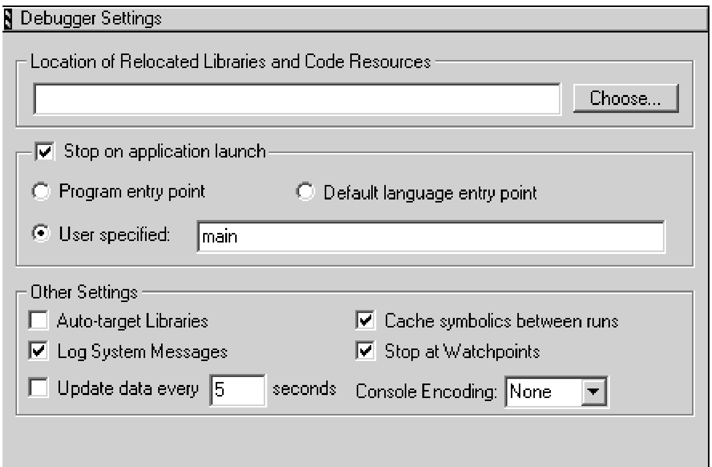


Table 9.5 Debugger Settings Panel Elements

Element	Purpose	Comments
Location of Relocated Libraries and Code Resources text box	Specifies the pathname of libraries or other resources related to the project. Type the pathname into this text box. Alternatively, click the Choose button, then use the subsequent dialog box to specify the pathname.	Default: None
Stop on application launch checkbox	Clear — Does not specify any debugging entry point; deactivates the subordinate options buttons and text box. Checked — Specifies the debugging entry point, via a subordinate option button: **Program entry point**, **Default language entry point**, or **User specified**.	Default: Checked, with Default language entry point option button selected. If you select the User specified option button, type the entry point in the corresponding text box.
Auto-target Libraries checkbox	Clear — Does *not* use auto-target libraries. Checked — Uses auto-target libraries.	Default: Clear
Log System Messages checkbox	Clear — Does *not* log system messages. Checked — Logs system messages.	Default: Checked
Update data every checkbox	Clear — Does not update data; deactivates the subordinate text box. Checked — Regularly updates data; enter the number of seconds in the subordinate text box.	Default: Clear
Cache symbolics between runs checkbox	Clear — Does *not* store symbolic values in cache memory between runs. Checked — After each run, stores symbolic values in cache memory.	Default: Checked
Stop at Watchpoints checkbox	Clear — Does *not* stop at watchpoints. Checked — Stops at watchpoints.	Default: Checked
Console Encoding list box	Specifies the type of console encoding.	Default: None

CF Interrupt Panel

Debugging an application involves single-stepping through code. But if you do not modify interrupts that are part of normal code execution, the debugger could jump to interrupt-handler code, instead of stepping to the next instruction.

So before you start debugging, you must mask some interrupt levels, according to your processor. To do so, use the **CF Interrupt** panel (Figure 9.8); Table 9.6 explains the elements of this panel.

Figure 9.8 CF Interrupt Panel

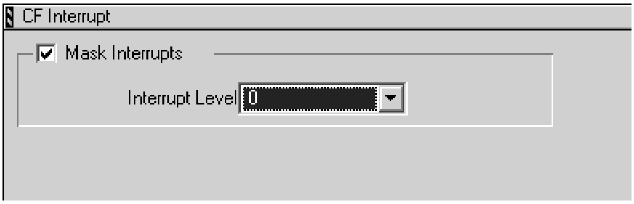


Table 9.6 CF Interrupt Panel Elements

Element	Purpose	Comments
Mask Interrupts checkbox	Clear — Ignores interrupts. Checked — Masks interrupts of the specified and lower levels, but allows higher-level interrupts.	Default: Clear.
Interrupt Level list box	Specifies the interrupt level, from 0 (low) to 7 (high).	Default: 0.

NOTE The exact definitions of interrupt levels are different for each target processor, and masking all interrupts can cause inappropriate processor behavior. This means that finding the best interrupt level to mask can involve trial and error.

Be alert for any code statements that change the interrupt mask: stepping over such a statement can modify your settings in this panel.

Remote Connections for Debugging

To debug an application on the remote target system, you must use a remote connection.

For Special- and Standard-Edition software, the ColdFire debugger uses a plug-in architecture to support the P&E Microsystems Parallel and USB remote-connection protocols.

For Professional-Edition software, the ColdFire debugger uses a plug-in architecture to support any of these remote-connection protocols:

- Abatron Serial
- Abatron TCP-IP
- P&E Microsystems Parallel
- P&E Microsystems USB
- P&E Microsystems Lightning
- Simulator (CCS-SIM)

Before you debug a project, you must configure or modify the settings of your remote-connection protocol. Follow these steps:

1. From the main menu bar, select **Edit >** ***Target*** **Settings**. The ***Target*** **Settings** window appears.
2. Select **Target Settings Panels > Debugger > Remote Debugging**. The **Remote Debugging** panel moves to the front of the window.
3. Use the **Connection** list box to specify a remote connection.
4. Click the **Edit Connection** button. A corresponding remote connection dialog box appears.
5. Use the dialog box to input communication settings, according to text below.

Abatron Remote Connections

Figure 9.9 shows the configuration dialog box for an Abatron *serial* remote connection. Figure 9.10 show the configuration dialog box for an Abatron *TCP/IP* remote connection. Table 9.6 explains the elements of these dialog boxes.

Figure 9.9 Serial Abatron Remote-Connection Dialog Box

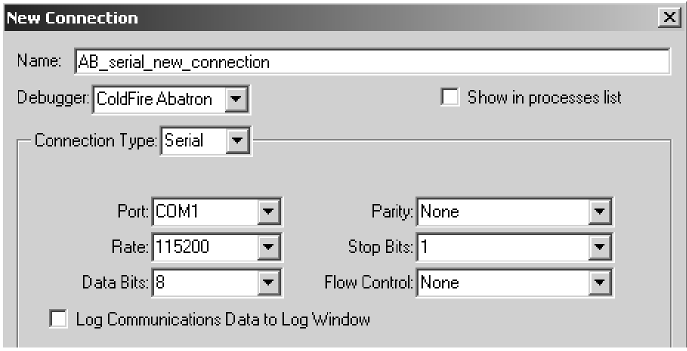


Figure 9.10 TCP/IP Abatron Remote-Connection Dialog Box

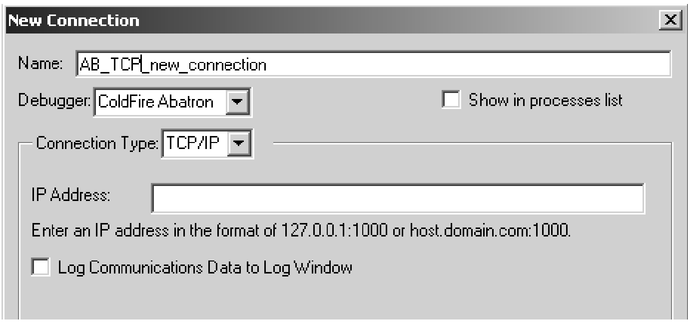


Table 9.7 Abatron Dialog-Box Elements

Element	Purpose	Comments
Name text box	Identifies the remote connection.	For an existing connection, already has a value.
Debugger list box	Identifies the debugger.	For an existing connection, already specifies ColdFire Abatron
Show in processes list checkbox	Clear — Leaves the connection off the official list. Checked — Adds connection to the official list (select View > Systems > List); also adds connection to the pop-up list for debugging certain kinds of file.	Default: Clear

Table 9.7 Abatron Dialog-Box Elements (*continued*)

Connection Type list box	Specifies serial or TCP/IP.	Changing this value changes the subordinate elements of the dialog box, as Figure 9.9 and Figure 9.10 show.
Port list box	Specifies the serial port: COM1, COM2, COM3, ... or COM256.	Default: COM1.
Rate list box	Specifies transfer speed: 300, 1200, 2400, 9600, 9,200, 38,400, 57,600, 115,200, or 230,400 baud.	Default: 38,400 baud
Data Bits list box	Specifies number of data bits per character: 4, 5, 6, 7, or 8.	Default: 8
Parity list box	Specifies parity type: None, Odd, or Even.	Default: None
Stop Bits list box	Specifies number of stop bits: 1, 1.5, or 2	Default: 1
Flow Control list box	Specifies flow-control type: None, Hardware (RTS/CTS), or Software (XONN, XOFF).	Default: None
Log Communications Data to Log Window	Clear — Does not copy communications in log window. Checked — Copies communications in log window.	Default: Clear
IP Address text box	Specifies IP address.	Must be in format 127.0.0.1:1000 or in format host.domain.com:1000.

NOTE For an Abatron remote connection, be sure to *clear* the checkboxes **Use Target Initialization File** and **Use Memory Configuration File**, of the **CF Debugger Settings** panel.

P&E Microsystems Remote Connections

Figure 9.11, Figure 9.12, and Figure 9.13 show the configuration dialog boxes for PE Micro remote connections. Table 9.8 explains the elements of these dialog boxes.

Figure 9.11 P&E Micro Remote Connection (Parallel)

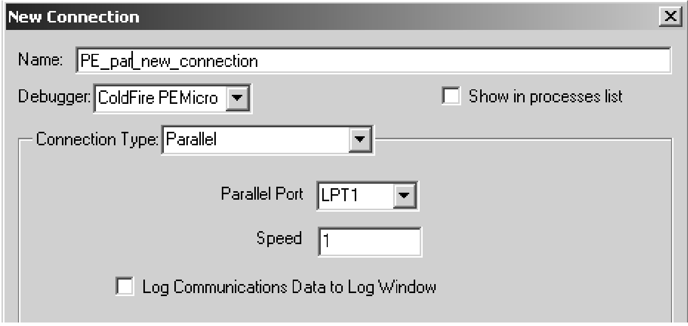


Figure 9.12 P&E Micro Remote Connection (USB)

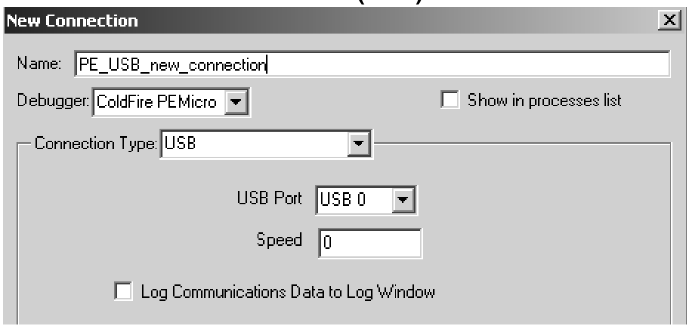


Figure 9.13 P&E Micro Remote Connection (Lightning)

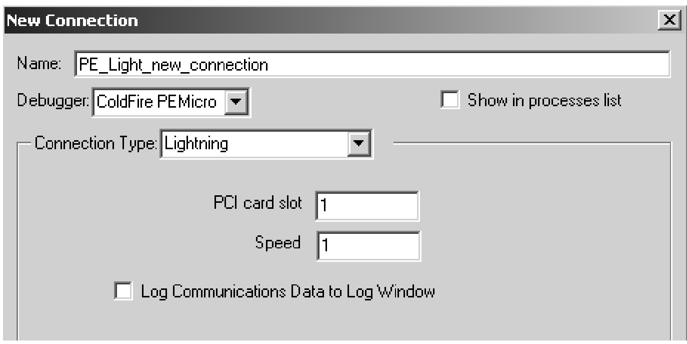


Table 9.8 P&E Micro Dialog-Box Elements

Element	Purpose	Comments
Name text box	Identifies the remote connection.	For an existing connection, already has a value.
Debugger list box	Identifies the debugger.	For an existing connection, already specifies ColdFire P&E Micro
Show in processes list checkbox	Clear — Leaves the connection off the official list. Checked — Adds connection to the official list (select View > Systems > List); also adds connection to the pop-up list for debugging certain kinds of file.	Default: Clear
Connection Type list box	Specifies Parallel, USB, or Lightning.	Changing this value changes the subordinate elements of the dialog box, as Figure 9.11, Figure 9.12, and Figure 9.13 show.
Parallel Port list box	Specifies the parallel port: LPT1, LPT2, LPT3, or LPT4.	Default: LPT1.
Speed text box (in parallel dialog box)	Integer that modifies the data stream transfer rate: 0 specifies the fastest rate. The greater the integer, the slower the rate.	For a parallel remote connection there is no firm mathematical relationship, so you may need to experiment to find the best transfer rate. In case of problems, try value 25.
USB Port list box	Specifies the USB port: USB 0, USB 1, USB 2, or USB 4.	Default: USB 0
Speed text box (in USB dialog box)	Integer N that specifies the data stream transfer rate per the expression (1000000/(N+1)) hertz.	0 specifies 1000000 hertz, or 1 megahertz. 1 (the default) specifies 0.5 megahertz. 31 specifies the slowest transfer rate: 0.031 megahertz.
PCI card slot list box	Specifies PCI slot that the board uses.	Default: 1
Speed text box (in Lightning dialog box)	Integer N that specifies the data stream transfer rate per the expression (33000000/(2*N+5)) hertz.	0 specifies 6600000 hertz, or 6.6 megahertz. 1 (the default) specifies 4.7 megahertz. 31 specifies the slowest transfer rate: 0.49 megahertz.

Table 9.8 P&E Micro Dialog-Box Elements (*continued*)

Flow Control list box	Specifies flow-control type: None, Hardware (RTS/CTS), or Software (XONN, XOFF).	Default: None
Log Communications Data to Log Window	Clear — Does not copy communications in log window. Checked — Copies communications in log window.	Default: Clear
IP Address text box	Specifies IP address.	Must be in format 127.0.0.1:1000 or in format host.domain.com:1000.

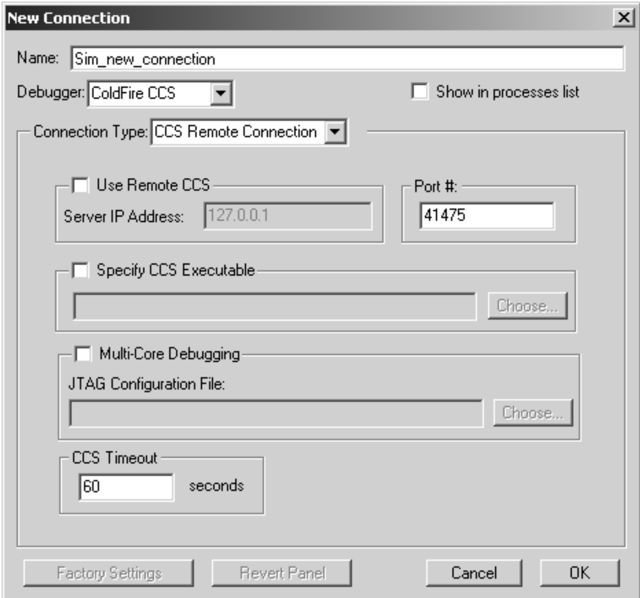
NOTE For a P&E Micro remote connection, be sure to *check* the checkboxes **Use Target Initialization File** and **Use Memory Configuration File**, of the **CF Debugger Settings** panel.

ISS Remote Connection

NOTE Special-Edition software does not support the ISS. To use the ISS, you must have Standard- or Professional-Edition software.

Figure 9.14 shows the configuration dialog box for ColdFire Instruction Set Simulator (ISS) remote connections. Table 9.9 explains the elements of this dialog box.

Figure 9.14 ISS Remote Connection



NOTE To use the ISS for V2 and V4e cores, create a CCS remote connection. Alternatively, use the default **CCS - SIM** connection from the **Remote Connection** panel list.

Table 9.9 ISS Dialog-Box Elements

Elements	Purpose	Comments
Name text box	Identifies the remote connection.	For an existing connection, already has a value.
Debugger list box	Identifies the debugger.	For an existing connection, already specifies ColdFire CSS
Show in processes list checkbox	Clear — Leaves the connection off the official list. Checked — Adds connection to the official list (select View > Systems > List); also adds connection to the pop-up list for debugging certain kinds of file.	Default: Clear

Table 9.9 ISS Dialog-Box Elements (*continued*)

Elements	Purpose	Comments
Connection Type list box	Specifies CSS Remote Connection	Changing this value changes other elements of the dialog box.
Use Remote CCS checkbox	Clear — Launches the CSS locally. Checked — Starts debug code on a remote target; activates Server IP Address text box.	ISS must be running and connected to a remote target device.
Server IP Address text box	Specifies IP address of the remote machine, in format 127.0.0.1:1000 or host.domain.com:1000.	Available only if you check the Use Remote CCS checkbox.
Port # text box	Specifies the port number the CSS uses	Use only 40969 — the number of the port pre-wired for the simulator.
Specify CCS Executable checkbox	Clear — Uses the default CSS executable file. Checked — Lets you specify a different CCS executable file, activating the text box and Choose button. To do so, click the Choose button, then use the subordinate dialog box to select the executable file. Clicking OK puts the pathname in the text box.	Does not pertain to the simulator.
Multi-Core Debugging checkbox	Clear — Does *not* debug code on a multicore target. Checked — Lets you specify the JTAG chain for debugging on a multicore target, activating the text box and Choose button. To do so, click the Choose button, then use the subordinate dialog box to select the executable file. Clicking OK puts the pathname in the text box.	Does not apply to the simulator.
CCS Timeout text box	Specifies the number of seconds the CSS should wait for a connection to go through, before trying the connection again.	

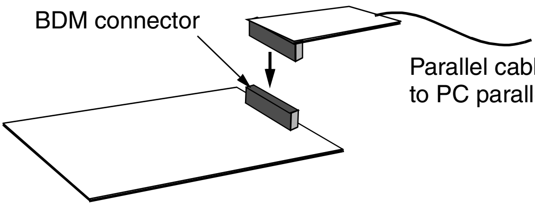
BDM Debugging

This section explains connections for Background Debugging Mode (BDM) debugging of a ColdFire target board.

Connecting a P&E Microsystems Wiggler

Figure 9.15 depicts connections for a P&E wiggler.

Figure 9.15 P&E Wiggler Connections



Follow these steps:

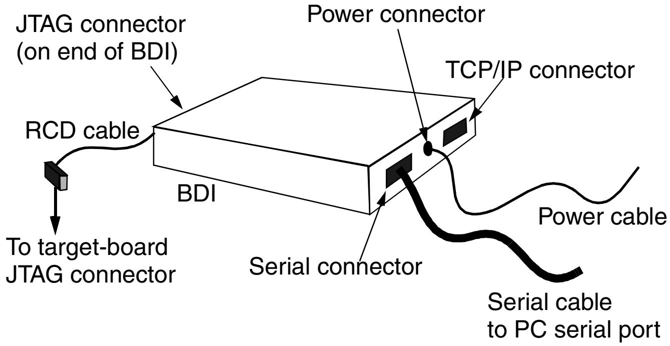
1. Plug the wiggler onto the target-board BDM connector.
2. Connect the parallel cable to the wiggler.
3. Connect the other end of the parallel cable to a parallel port of your PC.
4. This completes wiggler connection. The wiggler automatically installs a default set of drivers and interface dlls on your PC.

NOTE You must have the correct wiggler for your target. If necessary, contact P&E Microsystems for assistance.
The drivers and interface dlls for P&E Microsystems wigglers are available as well in subdirectory `bin\Plugins\Support\ColdFire\pemicro` of your CodeWarrior installation directory.

Connecting an Abatron BDI Device

Figure 9.16 depicts connections for an Abatron BDI device.

Figure 9.16 Abatron BDI Connections



Follow these steps:

1. Connect the BDI device to your computer.
   a. Serial connection: Connect a serial cable between the BDI serial connector and a serial port of the PC, as Figure 9.16 shows.
   b. TCP/IP connection: Connect a TCP/IP cable between the BDI TCP/IP connector and an appropriate port of your PC.
2. Connect the appropriate RCD cable between the BDI JTAG connector and the JTAG connector of your target board. (The board JTAG connector is a 26-pin Berg-type connector.)

NOTE Certain target boards, such as the MCF5485, MCF5475, MCF5235, and MCF5271, require a different RCD cable than do other ColdFire boards. To make sure that your cable is correct, see the Abatron reference manual or visit `http://www.abatron.ch.`

3. Connect the power cable between the BDI power connector and a 5-volt, 1-ampere power supply, per the guidance of the Abatron user manual.
4. This completes cable connections.

NOTE Before using an Abatron remote connection, you must
1. Make sure that you have the correct drivers and configuration utility for your target board.
2. Use Abatron software to configure the BDI device, per the guidance of the Abatron user manual.

Before you use the BDI for ROM/Flash debugging, you must check the **Use Breakpoint Logic** checkbox of the **BDI Working Mode** dialog box.

Debugging ELF Files without Projects

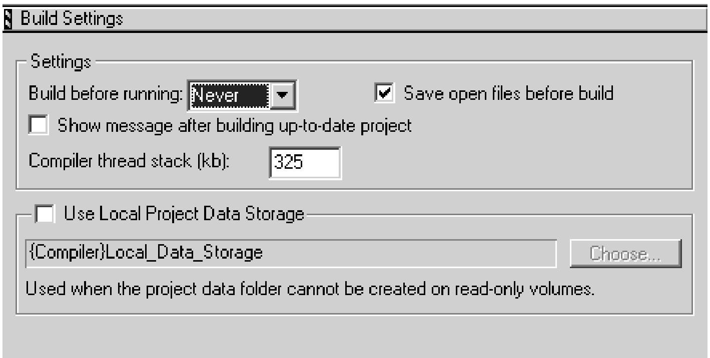
The CodeWarrior debugger can debug an ELF file that you created in a different environment. But before you begin, you must update IDE preferences and customize the default XML project file. (The CodeWarrior IDE uses the XML file to create a project with the same target settings for any ELF file that you open to debug.)

Updating IDE Preferences

Follow these steps:

1. From the main menu bar, select **Edit > Preferences**. The **IDE Preferences** window appears.
2. From the **IDE Preferences Panels** pane, select **Build Settings**. The **Build Settings** panel (Figure 9.17) moves to the front of the window.

Figure 9.17 Build Settings Panel

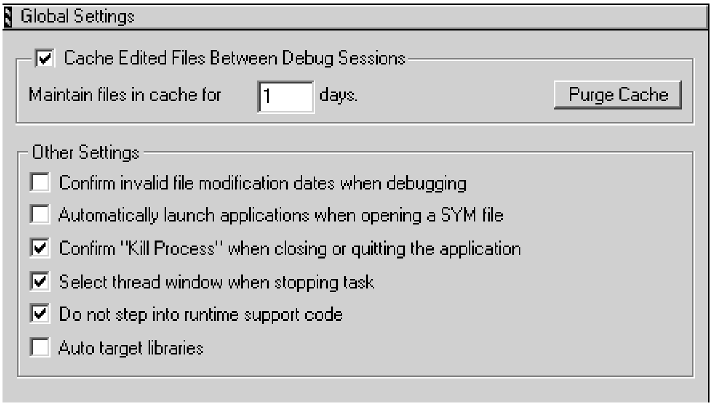


3. Make sure that the **Build before running** list box specifies `Never`.

NOTE Selecting `Never` prevents the IDE from building the newly created project, which is useful if you prefer to use a different compiler.

4. Select **Edit > Preferences > Global Settings**. The **Global Settings** panel (Figure 9.18) moves to the front of the window.

Figure 9.18 Global Settings Panel



5. Make sure that the **Cache Edited Files Between Debug Sessions** checkbox is clear.
6. Close the **IDE Preferences** window.
7. This completes updating IDE preference settings; you are ready to customize the default XML project file.

Customizing the Default XML Project File

CodeWarrior software creates a new CodeWarrior project for any ELF file that you open to debug. To create the new project, the software uses the target settings of the default XML project file:

`bin\plugins\support\CF_Default_Project.xml`

For different target settings, you must customize this default XML file. Follow these steps:

1. Import the default XML project file.
   a. Select **File > Import Project** — a file-select dialog box appears.
   b. Navigate to subdirectory `bin\plugins\support`.
   c. Select file `CF_Default_Project.xml`.
   d. Click **OK** — a new project window appears for file `CF_Default_Project.xml`.
2. Change target settings of the new project.
   a. Select **Edit >** ***Target*** **Settings** — the ***Target*** **Settings** window appears.
   b. From the **Target Settings Panels** pane, select any panel — that panel moves to the front of the window.
   c. Review/update panel settings.

   d. Repeat substeps b and c for all other appropriate panels.
   e. When all settings are correct, click **OK** — the **Target Settings** window closes; the system updates project settings.
3. Close the project window.
4. Export the modified target settings.
   a. Select **File > Export Project** — a file-select dialog box appears.
   b. Navigate to subdirectory `bin\plugins\support.`
   c. Select the file you just modified: `CF_Default_Project.xml`.
   d. Click **OK** — the system saves your modified file `CF_Default_Project.xml` over the old file.
5. This completes XML-file customization — the new `CF_Default_Project.xml` file includes your target-settings changes; you are ready to debug an ELF file.

Debugging an ELF File

Once you have updated IDE preferences and customized the default XML file, you are ready to debug an ELF file (that includes symbolics information). Follow these steps:

1. Confirm that a remote connection exists for the ColdFire target.
2. Open Windows Explorer.
3. Navigate to the ELF file.
4. Drag the ELF file to the IDE main window — the IDE uses the default XML file to create a new project, opening a new project window.

NOTE As ELF-file DWARF information does not include full pathnames for assembly (`.s`) files; the IDE cannot find these files when it creates the project. But when you debug the project, the IDE does find the assembly files that reside in a directory that is a project access path. If any assembly files still lack full pathnames, you can add their directory to the project manually, so that the IDE finds the directory whenever you open the project.

5. Select **Project > Debug** — the IDE starts the debugger; the debugger window appears.
6. Begin debugging.

Additional ELF-Debugging Considerations

Any of these points may make your debugging more efficient:

- Once the IDE creates a .mcp project for your ELF file, you can open that project instead of dropping your ELF file onto the IDE.
- To delete an old access path that no longer applies to the ELF file, use either of two methods:
  - Use the **Access Path** target settings panel to remove the access path from the project manually.
  - Delete the existing project for the ELF file, then drag the ELF file to the IDE to recreate a project.
- To have the project include only the current files, you must manually delete project files that no longer apply to the ELF.
- To recreate a project from an ELF file:
  - If the project is open, close it.
  - Delete the project (.mcp) file.
  - Drag the ELF file to the IDE — the IDE opens a new project, based on the ELF file.

Special Debugger Features

This section explains debugger features that are unique to ColdFire-platform targets.

ColdFire Menu

To see the unique Coldfire debugger menu, select **Debug** > **ColdFire**. Table 9.10 lists its selections.

Table 9.10 ColdFire Debug Menu

Selection	Explanation
Reset Target	Sends a reset signal to the target processor. (Not available unless the target processor supports this signal.)
Save Memory	Saves target-board data to disk, as a binary image file.
Load Memory	Writes previously saved, binary-file data to target-board memory.
Fill Memory	Fills a specified area of memory with a specified value.

Table 9.10 ColdFire Debug Menu (*continued*)

Selection	Explanation
Save Registers	Saves contents of specified register to a text fie.
Restore Registers	Writes previously saved register contents back to the registers.
Watchpoint Type	Specifies the type: Read — A read from the specified memory address stops execution. Write — A write to the specified memory address stops execution. Read/Write — Either a read from or write to the specified memory address stops execution. (Not available unless the target processor and debug connection support watchpoints.s this signal.)

Working with Target Hardware

To have the IDE work with target hardware, use Debug-menu selections Connect and Attach.

Connect

This selection tells the IDE to read the contents of target-board registers and memory; these contents help you determine the state of the processor and target board. You can use this selection in combination with the **Load/Save Memory** and **Fill Memory** selections of the ColdFire menu to create a memory dump, load memory contents, or initialize memory with specific patterns of data.

You can have the IDE connect to a target board that uses **ColdFire Abatron** or **ColdFire P&E Micro** protocols.

The Connect selection works with a remote connection that you define in a project:

1. Bring forward the project you want to use. (The project must have at least one remote connection defined for the target hardware.)
2. Select **Debug > Connect** — a **Thread** window appears, showing where the IDE stops program execution.
3. Use the **Thread** window, with other IDE windows, to see register views and memory contents.

Attach

This selection gives the debugger control of the application running on the target hardware. For example, suppose that a large application is running on the target hardware, using its project as the host.

Selecting **Debug > Attach to Process** attaches the project to the running application. The IDE loads the symbolics information from the host application, allowing source-level debugging of the application running on the target hardware.

Using the Simple Profiler

You can use the IDE profiling tool to analyze your code. Follow these steps:

1. Specify profiling, in *one* of these ways:
   a. In the ColdFire Processor panel, check the Generate code for profiling checkbox.
   b. Use the `#pragma profile on` directive before the function definition and use the `#pragma profile off` directive after the function definition.
   c. Use the `-profile` option or the `#pragma` directives with the command-line compiler.
2. If you use the `#pragma` directives, add the profiler libraries to your project. (These libraries are in subdirectory `\E68K_Support\Profiler\` of your CodeWarrior installation directory.)
3. In your source code, use the `#include` directive to include header file `Profiler.h`. (This file is in subdirectory `\E68K_Support\Profiler\include\` of your CodeWarrior installation directory.)
4. You are ready to use the profiler, via these calls:
   a. `ProfilerInit` — initializes the profiler.
   b. `ProfilerClear` — removes existing profiling data.
   c. `ProfilerSetStatus` — turns profiling on (1) or off (0).
   d. `ProfilerDump("filename")` — dumps the profile data to a profiler window or to the specified file.
   e. `ProfilerTerm` — exits the profiler.

Listing 9.1 shows an example of using these calls in source code.

Listing 9.1 Using the Profiler in Source Code

```
#include "profiler.h"
void main()
{
```

```
    ProfilerInit(collectDetailed, bestTimeBase,5,10);
    ProfilerClear();
    ProfilerSetStatus(1);
    function_to_be_profiled();
    ProfilerSetStatus(0);
    ProfilerDump("profiledump");
    ProfilerTerm();
}
```

The profiler libraries use the external function `getTime` to measure the actual execution time.

The source-code file `timer.c` shows a semi-hosting example of the `getTime` function. This file is in the subdirectory `\E68K_support\Profiler\Support\` of your CodeWarrior installation directory.

10

Instruction Set Simulator

This chapter explains how to use the Instruction Set Simulator (ISS). Using the ISS with the CodeWarrior™ debugger, you can debug code for a ColdFire target.

Additionally, if you run the ISS on your host computer, you can share target-board access with remote users of the CodeWarrior debugger.

In the same way, you can access the target board of any remote computer that is running the ISS, provided that you know the IP address and ISS port number of that remote computer.

NOTE Special-Edition software does not support the ISS; to use the ISS, you must have Standard- or Professional-Edition software.

Do not move the ISS folders or files from its location in subdirectory `\Bin\Plugins\Support\Sim`, of your CodeWarrior installation directory. You can start the ISS only from the CodeWarrior debugger.

This chapter consists of these sections:

- Features
- Using the Simulator
- ISS Configuration Commands
- Sample Configuration File
- ISS Limitations

Features

Your CodeWarrior software supports the Instruction Set Simulator (ISS) for V2 and V4e cores.

ColdFire V2

For V2 cores the ISS features are:

- *Instruction set* — modeling only of the original ColdFire v2 instruction set, *without* ISA+ support of the 5282 processor.

- *MAC* — modeling of the MAC *without* the EMAC of the 5282 processor. (This affects register accesses.)
- *Cache* — modeling of the original ColdFire v2 direct-mapped instruction cache, *without* modeling of the 5282 instruction and data cache.
- *Format exceptions* — not implemented.
- *IPSBAR Functionality (5282 Peripherals)* — modeling of the IPSBAR register and Synchronous DRAM Controller (SDRAMC) module. (No modeling of other 5282 peripherals or related behavior.)
- *IPSBAR register fields* — all implemented.
- *SDRAMC registers* — five present:
  - DCR
  - DACR0
  - DACR1
  - DMR0
  - DMR1
- *DCR* — this model includes reads from and writes to this register, but ignores all internal fields of this register.
- *DACRx* — this model includes reads from and writes to these fields. (The SDRAMC model covers functionality only of DACRx register fields BA and CBM, ignoring other fields.)
- *DMRx* — this model includes reads from and writes to these fields. (The SDRAMC model covers functionality only of DMRx register fields BAM and V, ignoring other fields.)
- *KRAM*, *KROM* — support as much as 512 kilobytes of memory.
- *Memory wait states* — supported.
- *A-line exceptions* — not generated, as this model includes MAC.

NOTE The V2 ISS has pipeline delays that can lead to debugger defects.

ColdFire V4e

For V4e cores the ISS features are:

- *Instruction set* — modeling for all instructions.
- *EMAC* — modeling of the EMAC.
- *FPU* — not supported.

- Cache — modeling of the ColdFire V4e four-way set-associative instruction and data caches. (Caches always are physically tagged and physically addressed.)
- *MMU model* — partially supported.
- *WDEBUG instruction* — not supported, as the model does not support the WDEBUG module.
- *WDDATA instruction* — not supported, as the model does not support the WDDATA module.
- *PULSE instruction* — not supported, as the model does not support the PULSE debug module.
- *IPSBAR Functionality (5282 Peripherals)* — modeling of the IPSBAR register. (No modeling of other peripherals or related behavior.)
- *A-line exceptions* — not generated, as this model includes EMAC.
- *F-line exceptions* — not generated, as this model includes an FPU.
- *Clock multiplier* — not supported.
- *Memory wait states* — not supported.

NOTE Pipeline delay can lead to appearance problems in the debugger variable viewer.

Using the Simulator

When you use a local ISS connection for debugging, the IDE starts the ISS automatically; the ISS icon  appears on the taskbar.

Right-click the icon to access the ISS pop-up menu. Its selection are:

- **Configure** — opens the ISS configuration options dialog box
- **Show console** — displays the ISS console window. (Another way to open this console window is double-clicking the ISS icon.)
- **Hide console** — hides the ISS console window
- **About CCSSIM2** — displays version information
- **Quit CCS** — stops the ISS.

Console Window

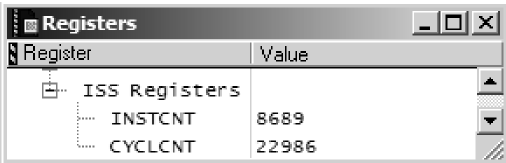
Use the ISS console window to view and change server connection options. You may type commands at the command line, or select them from the menu bar.

NOTE Do not use the console window to modify settings during a debug session. This would affect the debug state.

Viewing ISS Registers

To view the ISS registers, select **View** > **Registers** — the **Registers** window (Figure 10.1) appears.

Figure 10.1 Register Window: ISS Register Values



You may edit the ISS register values that this window shows.

- `INSTCNT` (Instruction Count) is the number of instructions executed in a debug session.
- `CYCLCNT` (Cycle Count) is the number of elapsed clock cycles in a debug session.

NOTE These registers are unique to ISS projects; other projects do not have these registers.

ISS Configuration Commands

The ISS reads configuration information from configuration files `ColdFire2.cfg` (V2 core) and `ColdFire4.cfg` (V4e core). Both files are in subdirectory `\Bin\Plugins\Support\Sim\ccssim2\bin` of your CodeWarrior installation directory.

NOTE Do not change the location of the configuration files, or the ISS may not work properly.

If you cannot use the ISS to start a debug session, you probably must reduce the memory that file `ColdFire2.cfg` or `ColdFire4.cfg` defines. And for an MCF5282 or other processor core that had IPSBAR, you must use the `ipsbar` command to configure the settings.

The configuration files consist of text commands, each on a single line:

- Some argument values are numerical.
- Possible boolean argument values are `true` (or `yes`) and `false` (or `no`).
- Comment lines must start with the # character.

The rest of this section consists of explanations for the ISS configuration commands:

- bus_dump
- cache_size
- ipsbar
- kram_size
- krom_size
- krom_valid
- mbar
- mbus_multiplier
- memory
- sdram

bus_dump

Controls dumping bus signals to the `processor.bus_dump` file. bus_dump switch

```
bus_dump switch
```

Parameter

`switch`

Boolean value `yes` (or `true`) or `no` (or `false`).

Remarks

If environment variable `CF_REG_DUMP` is set, a `yes` or `true` switch value for this command also dumps the CPU register values to the `processor.reg_dump` file.

Example

```
bus_dump true
```

cache_size

Configures the cache size.

`cache_size size_parameter`

Parameter

`size_parameter`

Default value 0 (off), or another code number for the size, per Table 10.1.

Table 10.1 Cache Size Parameter Conversion

size_parameter	Kilobytes	size_parameter	Kilobytes
0	0	4	4
1	0.5	5	8
2	1	6	16
3	2	7	32

Example

```
cache_size 7
```

ipsbar

Provides beginning address and offset, enabling V4-core IPSBAR registers. (The V4 counterpart command is `mbar`.)

`ipsbar switch`

Parameter

`switch`

Boolean value `yes` (or `true`) or `no` (or `false`).

Example

```
ipsbar true
```

kram_size

Configures the KRAM size.

`kram_size size_parameter`

Parameter

`size_parameter`

Code number for the size, per Table 10.2.

Table 10.2 kram Size Parameter Conversion

size_parameter	Kilobytes	size_parameter	Kilobytes
0	0	6	16
1	0.5	7	32
2	1	8	64
3	2	9	128
4	4	10	256
5	8	11	512

Example

```
kram_size 7
```

krom_size

Configures the KROM size.

`krom_size size_parameter`

Parameter

`size_parameter`

Code number for the size, per Table 10.3.

Table 10.3 krom Size Parameter Conversion

size_parameter	Kilobytes	size_parameter	Kilobytes
0	0	6	16
1	0.5	7	32
2	1	8	64
3	2	9	128
4	4	10	256
5	8	11	512

Example

```
krom_size 11
```

krom_valid

Controls KROM mapping to address $0 at boot-up.

```
krom_valid switch
```

Parameter

`switch`

Boolean value `yes` (or `true`) or `no` (or `false`).

Example

```
krom_valid true
```

mbar

Provides beginning address and offset, enabling V2-core MBAR registers. (The V4 counterpart command is `ipsbar`.)

```
mbar switch
```

Parameter

`switch`

Boolean value `yes` (or `true`) or `no` (or `false`).

Example

```
mbar true
```

mbus_multiplier

For a V2-core processor, multiplies the core clock speed.

`mbus_multiplier value`

Parameter

`value`

Any integer between 1 and 10.

Example

```
mbus_multiplier 10
```

memory

Configures sections of external memory.

`memory start end wait_states line_wait_states`

Parameters

`start`

Starting address of the contiguous section of memory.

`end`

Ending address of the contiguous section of memory.

`wait_states`

Number of wait states inserted for normal access (for V2 ISS only).

`line_wait_states`

Number of wait states inserted for line access (for V2 ISS only).

Remarks

There may be any number of MBUS memories, each with different *wait states* settings.

You must provide `wait_states` and `line_wait_states` values for a V2 ISS, but you should not provide these values for a V4 ISS.

Examples

```
memory 0x00000000 0x0fffffff 0 0
memory 0x200000000 0x3000ffff 0 0
```

sdram

Configures SDRAM.

```
sdram bank_bits num_bytes wait_states line_wait_states
```

Parameters

`bank_bits`

Number of bank bits used (only two banks are allowed).

`num_bytes`

Number of bytes allocated.

`wait_states`

Number of wait states inserted for normal access (for V2 ISS only).

`line_wait_states`

Number of wait states inserted for line access (for V2 ISS only).

Example

```
sdram 2 0x8000 0 0
```

Sample Configuration File

Listing 10.1 shows configuration file `ColdFire2.cfg`.

Listing 10.1 ColdFire2.cfg File Example

```
#Example Configuration File
memory 0x0000 0x7fff 0 0
```

```
kram_size 8
bus_dump on
sdram 2 0x8000 0 0
ipsbar true
```

ISS Limitations

These limitations apply to the ISS:

- You cannot set hardware breakpoints, because debugging is not happening on an actual hardware board.
- You cannot set watchpoints in source code.
- You cannot use the *Attach* feature while you use the ISS.
- The **Run Without Debugger** button  does not work, if you use the ISS to run your application.

11 Libraries and Runtime Code

The CodeWarrior development environment includes a variety of libraries: ANSI-standard libraries for C and C++, runtime libraries, and other code. This chapter explains how to use these libraries for ColdFire development.

This chapter consists of these sections:

- MSL for ColdFire Development
- Runtime Libraries

NOTE With respect to the Metrowerks Standard Libraries (MSL) for C and C++, this chapter is an extension of the *MSL C Reference* and the *MSL C++ Reference*. Consult those manuals for general information.

MSL for ColdFire Development

In addition to compiled binaries, the CodeWarrior development tools include source and project files for MSL. This lets you modify libraries, if necessary.

Using MSL for ColdFire

Your CodeWarrior installation CD includes the Metrowerks Standard Libraries (MSL), a complete C and C++ library that you can use in your embedded projects. The CD includes all the source files necessary to build MSL as well as project files for different MSL configurations.

NOTE If an MSL version already is on your computer, the CodeWarrior installer installs only the additional MSL files necessary for ColdFire projects.

The MSL libraries already are compiled for different languages, processor types, Applications Binary Interface (ABI) requirements, I/O requirements, and integer sizes. Table 11.1 lists strings in MSL filenames, showing appropriate uses for the precompiled library files.

Table 11.1 MSL Suitability

Filename String	Appropriate Use
`C`	C applications
`C++`	C++ applications
`ColdFire`	Any ColdFire processor
`EC++`	EC++ applications
`NC`	Applications without I/O
`PI`	Position-independent code and data
`StdABI`	Standard ABI
`FPU`	Floating Point Unit in hardware

NOTE ABI corresponds directly to the parameter-passing setting of the **ColdFire Processor Settings** panel (Standard, Compact or Register).

To use MSL, you must use a version of the runtime libraries, which subsection Runtime Libraries explains.

You should not modify any of the MSL source files: if your memory configuration requires changes, make the changes in the runtime libraries.

Table 11.2 lists the MSL files by general category:

- MSL C libraries — in subdirectory `\E68K_Support\msl\MSL_C\MSL_E68k\Lib` of your CodeWarrior installation directory. There also are PIC/PID versions of these files, which include the filename string `PI`.
- MSL C++ libraries — in subdirectory `\E68K_Support\msl\MSL_C++\MSL_E68k\Lib` of your CodeWarrior installation directory.
- MSL EC++ libraries — in subdirectory `\E68K_Support\msl\(MSL_EC++)\MSL_E68k\Lib` of your CodeWarrior installation directory.

Table 11.2 MSL Files

Category	Subcategory	Files
C	Coldfire C	`C_4i_CF_MSL.a`
		`C_4i_CF_StdABI_MSL.a`
		`C_TRK_4i_CF_MSL.a`
		`C_TRK_4i_CF_StdABI_MSL.a`
	ColdFire 54xx C	`C_4i_CF_FPU_MSL.a`
		`C_4i_CF_FPU_StdABI_MSL.a`
		`C_TRK_4i_CF_FPU_MSL.a`
		`C_TRK_4i_CF_StdABI_FPU_MSL.a`
C++	ColdFire C++	C++_4i_CF_MSL.a
		C++_4i_CF_StdABI_PI_MSL.a
		C++_4i_CF_PI_MSL.a
		C++_4i_CF_StdABI_MSL.a
	ColdFire 54xx C	C++_4i_CF_FPU_MSL.a
		C++_4i_CF_FPU_StdABI_MSL.a
		C++_4i_CF_FPU_PI_MSL.a
		C++_4i_CF_FPU_StdABI_PI_MSL.a
EC++	ColdFire EC++	EC++_4i_CF_MSL.a
		EC++_4i_CF_StdABI_MSL.a
	ColdFire 54xx EC++	EC++_4i_CF_FPU_MSL.a
		EC++_4i_CF_FPU_StdABI_MSL.a

Additional Aspects

The next few subsections identify and explain subordinate and additional ways to use the MSL.

Serial I/O and UART Libraries

The ColdFire Metrowerks Standard Libraries support console I/O through the serial port. This support includes:

- Standard C-library I/O.
- All functions that do not require disk I/O.
- Memory functions `malloc()` and `free()`.

To use C or C++ libraries for console I/O, you must include a special serial UART driver library in your project. These driver library files are in folder `E68K_Tools\MetroTRK\Transport\m68k\`.

Table 11.3 lists target boards and corresponding UART library files.

Table 11.3 Serial I/O UART Libraries

Board	Filename
CF5206e SBC	`mot_sbc_5206e_serial\Bin\UART_SBC_5206e_Aux.a`
CF5206e LITE	`mot_5206e_lite_serial\Bin\UART_5206e_lite_Aux.a`
CF5307 SBC	`mot_sbc_5307_serial\Bin\UART_SBC_5307_Aux.a`
CF5407 SBC	`mot_sbc_5407_serial\Bin\UART_SBC_5407_Aux.a`
CF5249 SBC	mot_sbc_5249_serial\Bin\UART_SBC_5249_Aux.a

Memory, Heaps, and Other Libraries

The heap you create in your linker command file becomes the default heap, so it does not need initialization. Additional memory and heap points are:

- To have the system link memory-management code into your code, call `malloc()` or `new()`.
- Initialize multiple memory pools to form a large heap.
- To create each memory pool, call `init_alloc()`. (You do not need to initialize the memory pool for the default heap.)

You may be able to use another standard C library with CodeWarrior projects. You should check the `stdarg.h` file in this other standard library and in your runtime libraries. Additional points are:

- The CodeWarrior ColdFire C/C++ compiler generates correct variable-argument functions only with the header file that the MSL include.
- You may find that other implementations are also compatible.

- You may also need to modify the runtime to support a different standard C library; you must include `__va_arg.c`.
- Other C++ libraries are not compatible.

NOTE If you are working with any kind of embedded OS, you may need to customize MSL to work properly with that OS.

Runtime Libraries

Every ColdFire project must include a runtime library, which provides basic runtime support, basic initialization, system startup, and the jump to the main routine. RAM-based debug is the primary reason behind runtime-library development for ColdFire boards, so you probably must modify a library for your application.

Find your setup in Table 11.4, then include the appropriate runtime library file:

- For a C project, use the file that starts with C_.
- For a C++ project, use the file that starts with Cpp_.
- All these files are in folder `\E68K_Support\Runtime\(Sources).`

Table 11.4 C, C++ Runtime Libraries

Processor	Std ABI	Int Size	Library
ColdFire without FPU or MCF54xx	no	4 byte	`C_4i_CF_Runtime.a` `Cpp_4i_CF_Runtime.a`
	yes	4 byte	`C_4i_CF_StdABI_Runtime.a` `Cpp_4i_CF_StdABI_Runtime.a`
ColdFire with FPU or MCF54xx	no	4 byte	C_4i_CF_FPU_Runtime.a Cpp_4i_CF_FPU_Runtime.a
	yes	4 bytes	C_4i_CF_FPU_StdABI_Runtime.a Cpp_4i_CF_FPU_StdABI_Runtime.a

NOTE ABI corresponds directly to the parameter-passing setting of the **ColdFire Processor Settings** panel (Standard, Compact or Register).
If your target supports floating points, you should use an FPU-enabled runtime library file.

Position-Independent Code

To use position-independent code or position-independent data in your program, you must customize the runtime library. Follow these steps:

1. Load project file `MSL_RuntimeCF.mcp`, from the folder `\E68K_Support\runtime`.
2. Modify runtime functions.
   a. Open file `E68K_startup.c`.
   b. As appropriate for your application, change or remove runtime function `__block_copy_section`. (This function relocates the PIC/PID sections in the absence of an operating system.)
   c. As appropriate for your application, change or remove runtime function `__fix_addr_references`. (This function creates the relocation tables.)
3. Change the prefix file.
   a. Open the C/C++ preference panel for your target.
   b. Make sure this panel specifies prefix file `PICPIDRuntimePrefix.h`.
4. Recompile the runtime library for your target.

Once you complete this procedure, you are ready to use the modified runtime library in your PIC/PID project. Source-file comments and runtime-library release notes may provide additional information.

Board Initialization Code

Your CodeWarrior development tools come with several basic, assembly-language hardware initialization routines, which may be useful in your programs.

You need not include this code when you are debugging, as the debugger or debug kernel already performs the same board initialization.

You should have your program do as much initialization as possible, minimizing the initializations that the configuration file performs. This facilitates the transition from RAM-based debugging to Flash/ROM.

12

Using Hardware Tools

This chapter explains the CodeWarrior IDE hardware tools, which you can use board bring-up, test, and analysis.

This chapter consists of these sections:

- Flash Programmer
- Hardware Diagnostics

Flash Programmer

Use the CodeWarrior flash programmer to program target-board flash memory with code from any CodeWarrior IDE project, or with code from any individual executable files. The CodeWarrior debugger provides some flash-programming features, such as `view/modify`, `memory/register`, and `save memory content to a file`. The CodeWarrior flash programmer does not duplicate this functionality.

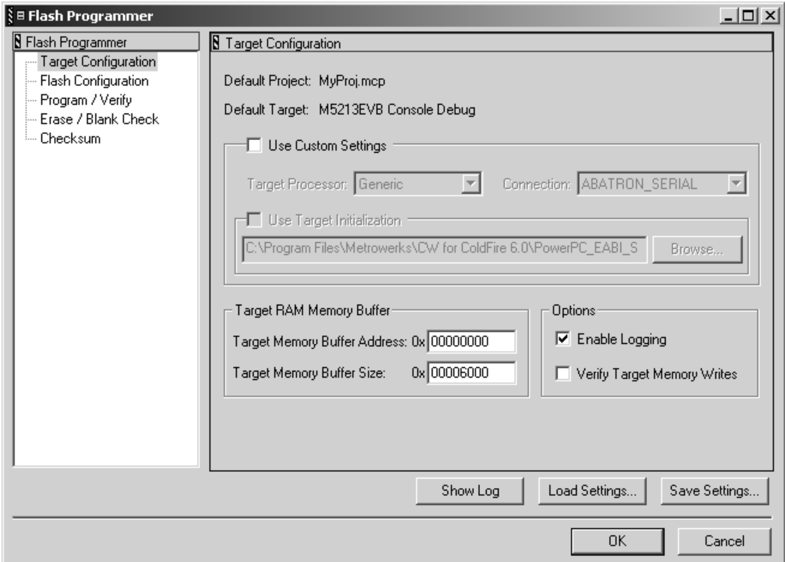
The flash programmer runs as a CodeWarrior plug-in, using the CodeWarrior debugger protocol API to communicate with the target boards. The CodeWarrior flash programmer lets you use the same IDE to program the flash of any of the embedded target boards.

NOTE For Special-Edition software, the CodeWarrior flash programmer is limited to 128 kilobytes. There is no such limitation for Standard-Edition or Professional-Edition software.
Each software edition also comes with an optional ColdFire flash programmer, available in subdirectory `\bin\Pugins\Support\Flash_Programmer` of the CodeWarrior installation directory.

Follow these steps:

1. Make sure to build the application you want to program into flash memory.
2. From the IDE main menu bar, select **Tools > Flash Programmer** — the **Flash Programmer** window (Figure 12.1) appears.

Figure 12.1 Flash Programmer Window: Target Configuration Panel

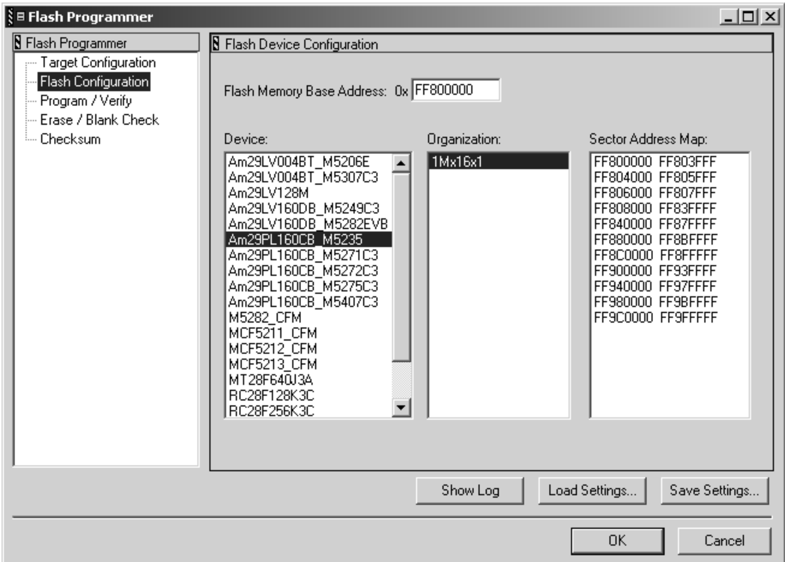


3. If the Target Configuration panel is not visible, select if from the list at the left — the panel moves to the front of the **Flash Programmer** window.
4. Verify Target Configuration settings.
   a. If the Default Project field specifies your project, skip ahead to substep c.
   b. Otherwise, from the main menu bar, select **Project > Set as default project** to specify your project.
   c. If the Default Target field specifies the correct Flash target, skip ahead to substep d.
   d. Otherwise, from the main menu bar, select **Project > Set as default target** to specify the correct Flash target.
   e. Make sure that the Use Custom Settings checkbox is clear.
   f. Click the **Load Settings** button — the system updates other settings for the default project and target.

5. Configure the flash device.

   a. From the pane list at the left of the **Flash Programmer** window, select **Flash Configuration** — the Flash Configuration panel moves to the front of the window, as Figure 12.2 shows.

Figure 12.2 Flash Programmer Window: Flash Device Configuration Panel



   b. Make sure that the Device list box specifies your target processor.

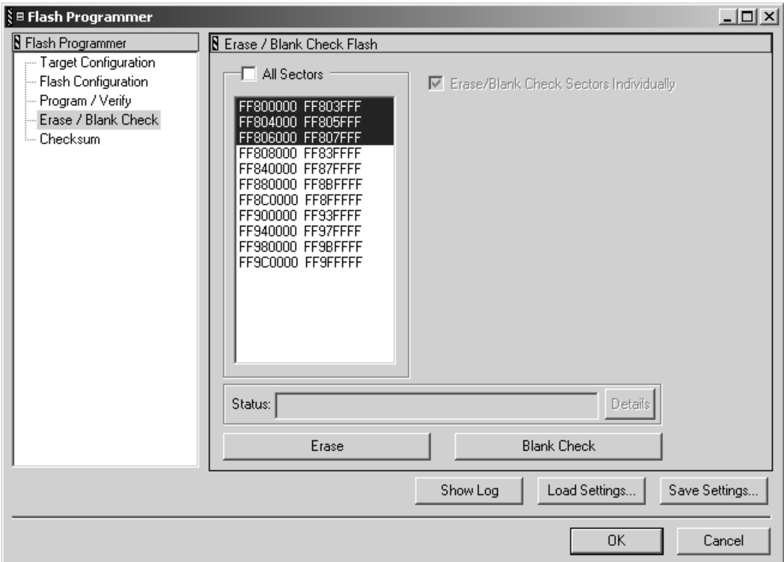
   c. Make sure that the Flash Memory Base Address text box specifies the appropriate base address.

   d. The Organization and Sector Address Map boxes display appropriate additional information.

6. Erase the destination flash-memory sectors.

    a. From the pane list at the left of the **Flash Programmer** window, select **Erase/ Blank Check** — the Erase/Blank Check panel moves to the front of the window, as Figure 12.3 shows.

Figure 12.3 Flash Programmer Window: Erase/Blank Check Flash Panel



    b. In the panel's list box, select the sectors you want to erase. (To select them all, check the All Sectors checkbox.)

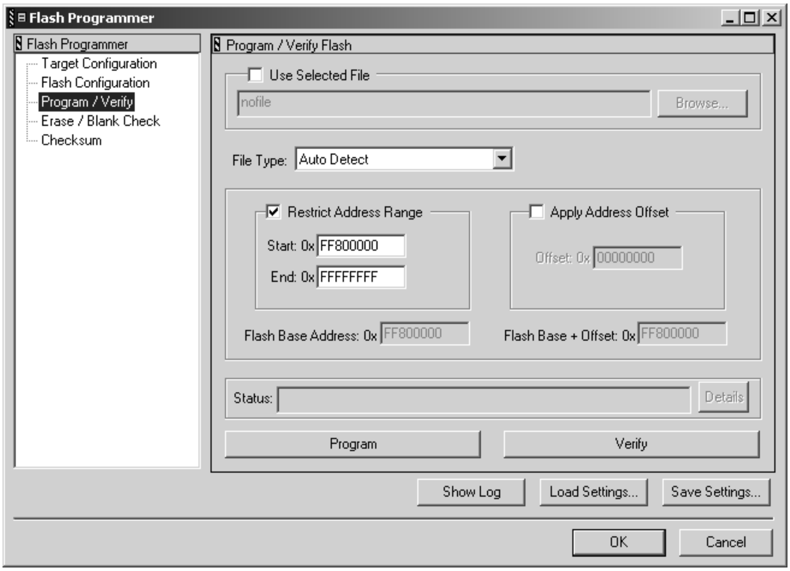
    c. Click the **Erase** button — the flash programmer erases the sectors.

    d. (Optional) To confirm erasure, select the same sectors, then click the **Blank Check** button — a message reports the status of the sectors.

7. Flash your application.

   a. From the pane list at the left of the **Flash Programmer** window, select **Program/ Verify** — the Program/Verify Flash panel moves to the front of the window, as Figure 12.4 shows.

Figure 12.4 Flash Programmer Window: Program/Verify Flash Panel



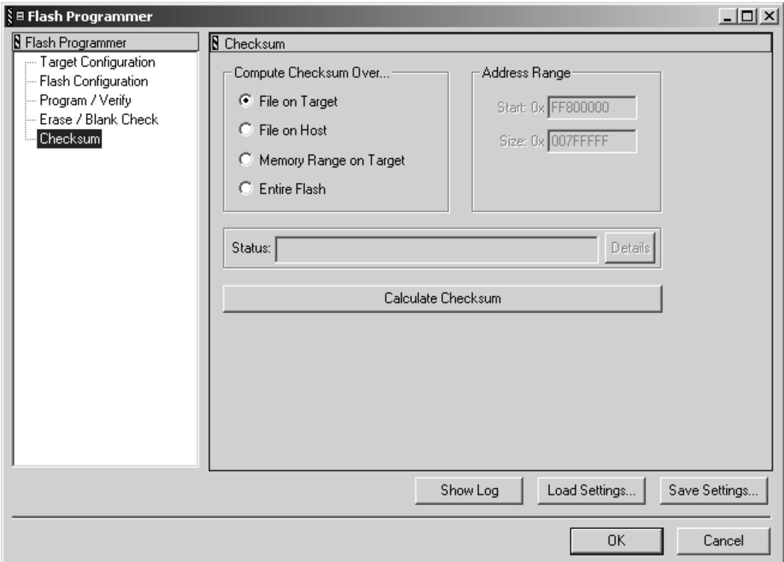
   b. Make sure that the Use Selected File checkbox is clear.

   c. Click the **Program** button — the flash programmer programs your application into the target sectors of flash memory.

   d. (Optional) To confirm programming, click the **Verify** button — the flash programmer compares the data now in flash sectors to the image file on disk.

8. (Optional) For an additional test of programmed flash sectors, run a checksum.
   a. From the pane list at the left of the **Flash Programmer** window, select **Checksum** — the Checksum panel moves to the front of the window, as Figure 12.5 shows.

Figure 12.5 Flash Programmer Window: Checksum Panel



   b. In the Compute Checksum Over area, select the appropriate option button: File on Target, File on Host, Memory Range on Target, or Entire Flash.
   c. If this selection activates the Address Range text boxes, enter the appropriate Start and Size values.
   d. Click the **Calculate Checksum** button — the flash programmer runs the checksum calculation; a message tells you the result.
9. This completes flash programming.

Hardware Diagnostics

Use the CodeWarrior hardware diagnostics tool to obtain several kinds of information about the target board.

Select **Tools > Hardware Diagnostics** from the IDE main menu bar — the **Hardware Diagnostics** window (Figure 12.6) appears.

Figure 12.6 Hardware Diagnostics window: Configuration Panel

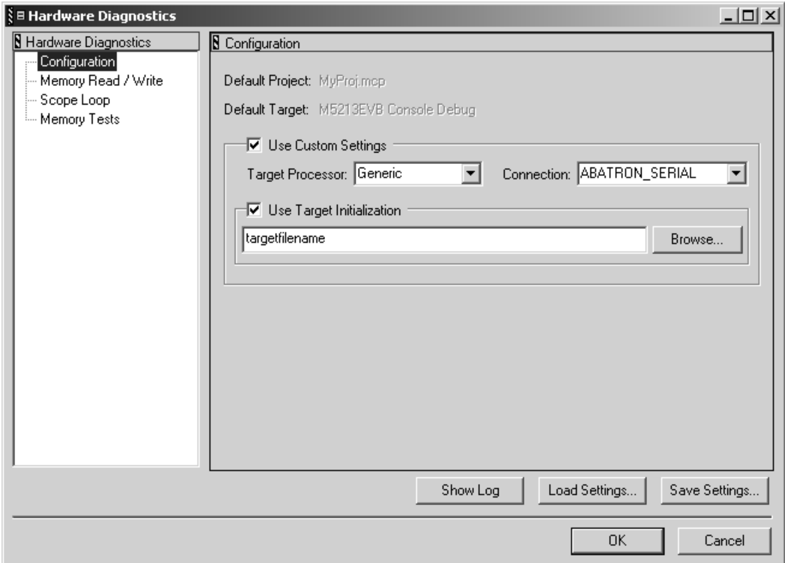


Figure 12.6 shows the Configuration panel. Click any name in the list pane to bring the corresponding panel to the front of the window:

- Memory Read/Write Test — which Figure 12.7 shows.
- Scope Loop Test — which Figure 12.8 shows.
- Memory Tests — which Figure 12.9 shows.

Figure 12.7 Hardware Diagnostics window: Memory Read/Write Test Panel

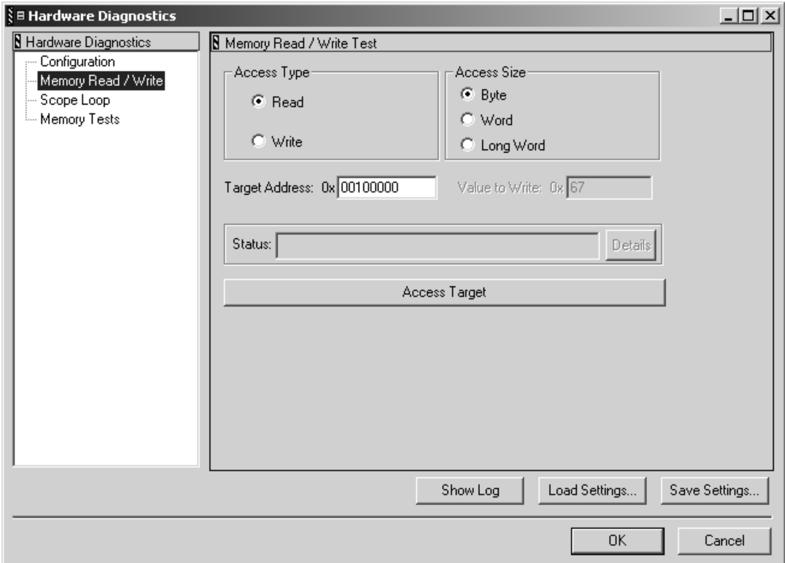


Figure 12.8 Hardware Diagnostics window: Scope Loop Test Panel

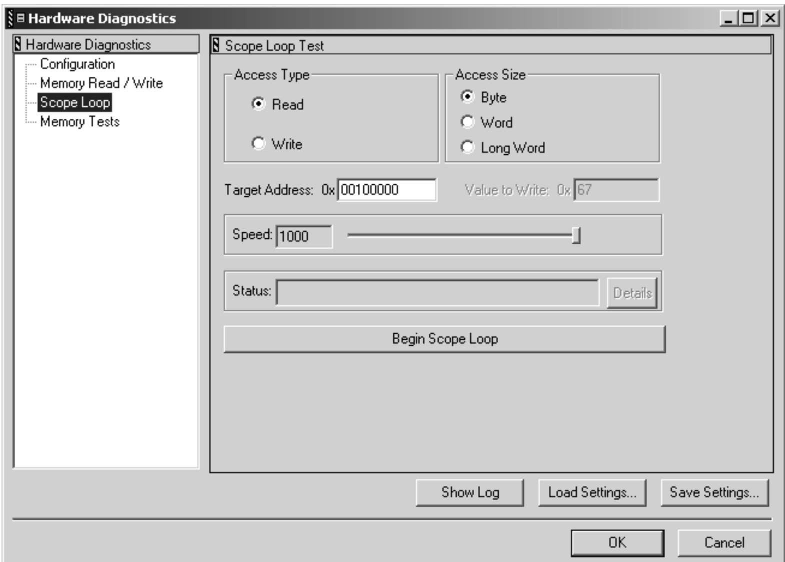
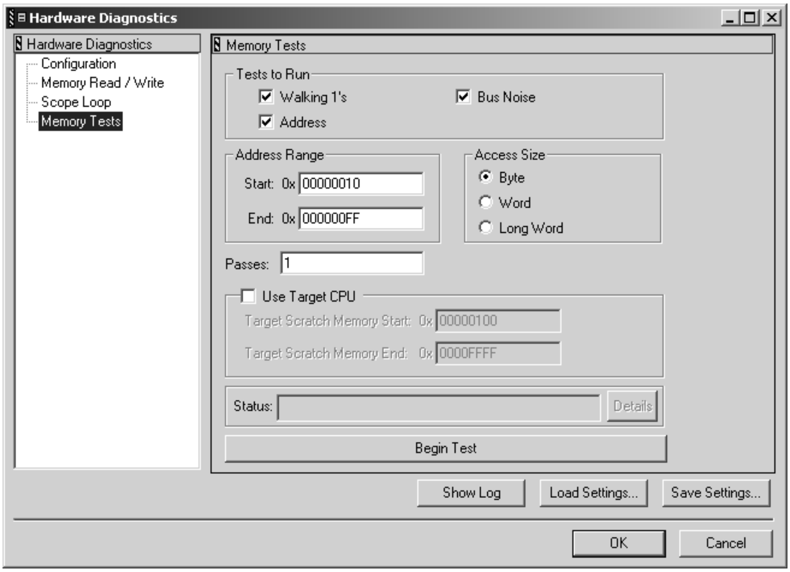


Figure 12.9 Hardware Diagnostics window: Memory Tests Panel



The **Hardware Diagnostics** window lists global options for the hardware diagnostic tools; these preferences apply to every open project file. For more information about each hardware-diagnostics panel, see the *IDE User's Guide* .

13

Command-Line Tools

Your CodeWarrior software includes a command-line compiler, assembler, and linker. This chapter describes how to use these tools to build applications.

This chapter consists of these sections:

- Command-Line Executables
- Environment Variables
- Compiling and Linking

Command-Line Executables

Command-line tools let you do anything that you can do with IDE-hosted tools, but the command-line implementation is different. For example, you use a makefile instead of an IDE project; you use command-line switches instead of IDE settings panels to specify options. However, you can script the IDE so that the automation environment and the GUI share common files.

The command-line tools are a set of executable files:

- `mwccmcf.exe` — the ColdFire compiler
- `mwasmmcf.exe` — the ColdFire assembler
- `mwldmcf.exe` — the ColdFire linker/disassembler

These files are in folder `\E68K_Tools\Command_Line_Tools`

Environment Variables

Use environment variables to store pathnames to the libraries you commonly use. This shortens the command lines for many tasks.

The syntax for defining an environment variable is:

```
set EV_Name=pathname[;pathname]
```

where

`EV_Name`

Name of the new environment variable.

`pathname`

Full pathname of a file. Semicolons must separate multiple pathname values.

NOTE Omit any quote marks from environment-variable definitions that include spaces. As Windows does not strip out quotes, they can lead to warnings or error messages.

If you use Makefiles, you can define the following as Makefile variables instead.

Listing 13.1 is a sample definition for the C/C++ compiler environment variable `MWCIncludes`. Using this variable would add all its constituent paths to the system path.

Listing 13.1 Example C/C++ Compiler Variable Definition

```
set MWCIncludes=
%MWDIR%\E68K_Tools\MetroTRK\Transport\M68k\mot_sbc_5407_serial\bin;
%MWDIR%\E68K_Support\Runtime\Inc;
%MWDIR%\E68K_Support\Msl\Msl_c\MSL_Common\Include;
%MWDIR%\E68K_Support\Msl\Msl_c++\MSL_Common\Include;
```

Listing 13.2 is a sample definition for the linker environment variable `MWLibraries`. Using this variable would add all its constituent paths to the system path.

Listing 13.2 Example Linker Variable Definition 1

```
set MWLibraries=
%MWDIR%\E68K_Support\Msl\Msl_c\Msl_E68k\Lib;
%MWDIR%\E68K_Support\Msl\Msl_c++\Msl_E68k\Lib;
%MWDIR%\E68K_Support\Runtime\
```

Listing 13.3 is a sample definition for the linker environment variable `MWLibraryFiles`. Using this variable would add the named files to the end of the link order.

Listing 13.3 Example Linker Variable Definition 2

```
set MWLibraryFiles =
fp_coldfire.o;
C_4i_CF5407_Runtime.a;
C_4i_CF5407_StdABI_MSL.a;
```

Compiling and Linking

If you use the IDE, you use preference panels to configure linker and project settings. With the command-line tools, you configure these settings by including appropriate switches in the command line.

At the end of compiling, the compiler automatically invokes the linker. The link order is the order in which your command line lists files. Remember that you still need a valid linker command file.

Table 13.1 lists the general options for compiling debug versions of ColdFire C applications.

Table 13.1 Typical Operations for Debugging

Tool	Option	Purpose
Assembler	`-D DEBUG`	Defines DEBUG
	`-g`	Generates DWARF output.
	`-proc MCF5485`	Sets the processor.
Compiler	`-abi compact`	Specifies compact mode.
	`-fp soft`	Specifies software floating point.
	`-g`	Generates DWARF output.
	`-lang c`	Specifies C source.
	`-model far`	Specifies 32-bit references.
	`-opt level=0`	Specifies no optimizations.
	`-proc MCF5407`	Sets the processor.
	`-r`	Requires prototypes.
	`-RTTI off`	Turns off C++ runtime typing.
	`-wchar_t off`	Specifies no built-in C++ type.

Table 13.1 Typical Operations for Debugging (*continued*)

Tool	Option	Purpose
Linker	`-application`	Specifies full application, not a library.
	`-dis`	Generates disassembly.
	`-g`	Generates DWARF output.
	`-map`	Generates link file map.
	`-o a.out`	Specifies output filename.
	`-srec`	Creates S-record file
	`-sreceol dos`	Specifies \r\n EOL separators.
	`-sreclength 80`	Specifies 80-character record length.
	`-warnings on`	Turns warnings on.

For more real-world uses of the command-line tools, examine any of the examples in folder,

`(Examples)\ColdFire\ColdFire_Command_Line_Tools`

For information about the parameters of these options, use the `help` option to cite the option, in this format:

`-help opt=`*`optionname`*

where

`optionname`

The option for which you are seeking further information.

This `help` line, for example, requests the possible values for the `-proc` keyword — that is, the list of possible target processors:

```
mwccmcf -help opt=proc
```

The system response is a list such as:

```
MCF5213
MCF548x
MCF5206e
MCF5249
MCF5272
MCF5280
MCF5282
```

```
MCF5307
MCF5407
```

The following is a complete list of command line switches for each tool component.

- Assembler Options
- Compiler Options
- Linker Options

Assembler Options

Table 13.2 lists the options of the command-line assembler.

Table 13.2 Command-Line Assembler Options

Option	Purpose
`-bl_16`	Sets `bra.l` to 16-bits (default is 32 bits).
`-c_preprocess`	Specifies C preprocessing.
`-endian <little|big>`	Specifies target byte ordering.
`-gnu`	Specifies Gnu-compatible assembly.
`-list <filename>`	Specifies the name or pathname for the listing file.
`-model abs|bigpic|pic|pid`	Specifies the memory model.
`-nocase`	Specifies that indentifiers are *not* case sensitive.
`-nocode`	Specifies only a syntax check; *no* code generation.
`-nocolons`	Permits labels that do not end in the colon character.
`-nodebug`	Suppresses debug-information generation.
`-noperiod`	Permits directives that do not start with a period character.
`-nospace`	Prohibits space characters in operand fields.
`-o <filename>`	Specifies the name or pathname for the output file.
-p <hex longword>	Defines a longwords that specifies the processors.
`-preprocess`	Specifies only preprocessing (macro expansions and conditionals).

Table 13.2 Command-Line Assembler Options

Option	Purpose
`-shared`	Specifies shared libraries.
`-w[arnings]`	Turns of notes and warnings (error messages still appear).

Compiler Options

Table 13.3 lists the options of the command-line compiler. The compiler passes all options to the linker, except as the table notes.

NOTE Optimization keyword values except `off`, `on`, `all`, `space`, and `speed` are for backwards compatibility. To supersede other optimization options, use `-opt level=xxx`.

Table 13.3 Command-Line Compiler Options

Category	Option	Purpose

General	`-help [keyword[,...]]`
	`all`
	`group=keyword`
	`[no]compatible`
	`[no]deprecated`
	`[no]ignored`
	`[no]normal`
	`[no]obsolete`
	`[no]spaces`
	`search=keyword`
	`tool=keyword[,...]`
	`all`
	`both`
	`other|skipped`
	`this`
	`usage`
		Displays corresponding help information:
		All standard options.
		All groups that include keyword.
		Compatibility options.
		Deprecated options.
		Ignored options.
		Only standard options.
		Obsolete options.
		Inserts blank lines between options.
		All options that include keyword.
		Options by tool:
		all options available for this tool,
		options available in all tools,
		options passed to another tool
		options this tool executes (default).
		Usage information.

	`-maxerrors max`	Specifies the maximum number of error messages to print. 0 (the default) means no maximum. (Not global)
	-maxwarnings max	Specifies the maximum number of warnings to print. 0 (the default) means no maximum. (Not global)

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	-msgstyle keyword gcc IDE mpw parseable std	Sets message style per keyword value: Use GCC-like style. Use CodeWarrior IDE-like style. Use MPW style. Use context-free, machine-parseable style. Use standard style (default).
	-[no]stderr	Specifies separate `stderr`, `stdout` streams; if `-nostderr` is in effect, `stderr` goes to `stdout`.
	-[no]wraplines	Specifies message word wrapping.
	-progress	Shows progress and version.
	-search	Searches access paths for source, object, or library files that the command line specifies.
	-timing	Collects timing statistics.
	-v[erbose]	Specifies cumulative, verbose information; implies `-progress`.
	-version	Shows tool version, configuration, and build date.
Preprocessing, Precompiling, and Input File Control	-c	Specifies compiling only, without linking.
	`-[no]codegen`	Specifies object-code generation.
	`-[no]convertpaths`	Interprets `#include` filepaths of other operating systems. Characters / and : separate directories, so cannot be in filenames.

	`-cwd keyword`
	`explicit`
	`include`
	`proj`
	`source`
		Specifies searching priority per keyword:
		No implicit directories: only `I`, `-ir` paths.
		Start in directory of referencing file.
		Start in current working directory (default).
		Start in source-file directory.
		(Not global)

	`-D+ | -d[efine] name[=value]`	Defines symbol name to value 1 or to specified value. (Not global)
	`-[no]defaults`	Specifies passing to linker (default); same as `-[no]stdinc`.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	`-dis[assemble]`	Specifies passing to all tools, disassembled files to `stdout`.
	`-E`	Specifies preprocessing source files.
	`-EP`	Specifies preprocessing and stripping out line directives.
	`-ext extension`	Specifies extension for generated object files; maximum 14 characters. A leading period character specifies appending this extension; no leading period specifies replacing the source-file extension.
	-gccinc[ludes]	Specifies GCC `#include` semantics: adds `-I` paths to the system list if `-I-` is not specified. #includes search starts in referencing-file directory. (Same as -cwd include)
	-i- | -I-	Changes target for `-I` access paths to the system list; implies `-cwd explicit`. Double-quote characters (`#include "..."`) specify searching user paths then system paths. Angle characters (`#include <...>`) specify searching only system paths.
	-I+ | -i path	Appends access path to the current `#include` list.
	-ir path	Appends a recursive access path to the current `#include` list.
	-[no]keepobj[ects]	Keeps object files generated after invoking the linker. Without this option, the system always deletes temporary intermediate object files after the link stage.
	-M | -make	Specifies scanning source files for dependencies and emitting a makefile; does *not* generate object code.
	-MD	Specifies scanning source files for dependencies, writing a dependency map to a file, then generating object code.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	_MM	Specifies scanning source files for dependencies and emitting a makefile. Does *not* list system include files, does *not* generate object code.
	-MMD	Specifies scanning source files for dependencies, writing a dependency map to a file, then generating object code. Does *not* list system include files.
	-nofail	Specifies that work continue, despite errors in earlier files.
	-nolink	Specifies compiling only, *no* linking.
	-noprecompile	Prevents precompiling based on filename extensions.
	-nosyspath	Specifies searching both user and system path lists, so that `#include <...>` is like `#include "..."`.
	-o file | dir	Specifies the filename or directory for output files or text. If the linker is called, specifies the output filename for the linker.
	-P	Specifies preprocessing and sending the output to a file, *without* generating code.
	-precompile file | dir	Specifies generating a precompiled header from the source, writing the header to the specified file or putting the header in the specified directory. If this option does not specify a file or directory, the system derives a header filename from the source filename. The alternative argument `""` specifies writing the header to the location that the source specifies.
	-preprocess	Specifies preprocessing source files.
	-prefix file	Specifies prefixing the specified text file or precompiled header onto all source files.
	-S	Specifies passing to all tools, disassembling and sending output to a file.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	-[no]stdinc	Specifies standard system include paths, per `%MWCIncludes%` environment variable, adding them after all system `-I` paths. (Default)
	-U+ | -u[ndefine] name	Undefines the specified symbol.

Front-End C/C++ Language	`-ansi keyword`
	`off`
	
	`on | relaxed`
	
	`strict`
		Specifies ANSI conformance, per keyword:
		Same as `-stdkeywords on`, `-enum min`, and `-strict off`. (Default)
		Same as `-stdkeywords off`, `-enum min`, and `-strict on`.
		Same as `-stdkeywords off`, `-enum int`, and `-strict on`.

	`-ARM on | off`	Specifies checking code for ARM conformance. (Default is `off`.)
	-bool on | off	Enables the C++ `bool` type, `true` and `false` constants. (Default is `off`.)
	-char signed | unsigned	Specifies sign of chars. (Default is `unsigned`.)
	-Cpp_exceptions on|off	Enables or disables C++ exceptions. (Default is `on`.)
	-dialect|-lang keyword c c++ ec++	Specifies source-language treatment per keyword: Always treat source as C. Always treat source as C++. Generate warnings for C++ features outside embedded C++ subset (implies `dialect cplus`).
	-enum min | int	Specifies minimum or `int` word size for enumeration types. (Default is `int`.)

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	-inline keyword onlsmart nonel off auto noauto all deferred level=n	Specifies inline options per keyword: Turns on inlining for inline functions. (Default) Turns off inlining. Automatically inlines small functions, even without inline specification. No auto inlining. (Default) Turns on aggressive inlining. Defers inlining until the end of compilation; permits inlining in two directions. Inlines functions to `n` levels, 0--8. (0 means `-inline on`.)
	-[no]mapcr	Reverse maps for Macintosh MPW compatibility, so that `\n==13` and `\r==10`.
	-msext on | off	Controls Microsoft VC++ extensions: redefining macros; `XXX::yyy` syntax for method `yyy` of class `XXX`; extra commas; ignoring casts to same type; treating as equal function types that have equivalent parameters lists but different types; pointer-integer conversions. (Default for non-x86 targets is `off`.),
	-[no]multibyte[aware]	Enables multi-byte character encodings for source text, comments, and strings.
	-once	Prevents processing header files a second time.
	`-pragma ...`	Defines a pragma for the compiler.
	`-r[equireprotos]`	Requires prototypes.
	`-relax_pointers`	Relaxes pointer type-checking rules.
	`-RTTI on | off`	Specifies runtime typing information for C++. (Default is `on`.)
	`-som`	Enables Apple's Direct-to SOM implementation.
	-som_env_check	Enables automatic SOM-environment and new-allocation checking; implies `-som`.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	-stdkeywords on | off	Permits only standard keywords. (Default is `off`.)
	-str[ings] keyword[,...] [no]reuse [no]pool	Specifies string-constant options per keywords: Reuse strings; equivalent strings are same object (Default) Pool strings into a single data object.
	-strict on | off	Controls strict ANSI checking. (Default is `off`.)
	-trigraphs on | off	Controls recognition of trigraphs. (Default is `off`.)
	-wchar_t on | off	Controls treating wchar_t as a built-in C++ type. (Default is `on`.)
Optimizer	`-O`	Same as `-O2`.
	-O+keyword[,...] 0 1 2 3 4 p s	Specifies optimization level per keyword values: Same as `-opt off`. Same as `-opt level=1`. Same as `-opt level=2`. Same as `-opt level=3`. Same as `-opt level=4`. Same as `-opt speed`. Same as `-opt space`. (You can combine options, as in `-O4,p`.)

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	-opt keyword[,...]	Specifies optimization level per keyword values:
	off | none	Suppresses all optimizations. (Default)
	on	Same as `-opt level=2`.
	all | full	Same as `-opt speed, level=4`.
	[no]space	Optimize for space.
	[no]speed	Optimize for speed.
	l[evel]=num	Optimize by `num` level value: 0 — no optimizations (Default); 1 — global register allocation, peephole, deadcode elimination; 2 — 1, plus common subexpression elimination, copy propagation; 3 — 2, plus loop transformations, strength reduction, loop-invariant code motion; 4 — 3, plus repeated common subexpression elimination, in-depth loop-invariant code motion.
	[no]cse | [no]commonsubs	Eliminate common subexpressions.
	[no]deadcode	Remove dead code.
	[no]deadstore	Remove dead assignments.
	[no]lifetimes	Compute variable lifetimes.
	[noloop[invariants]	Remove loop invariants.
	[no]propagation	Propagate constant and copy assignments.
	[no]strength	Optimize by strength reduction (using an index variable to change multiplication to addition).
	[no]dead	Remove dead code and dead assignments.
	display | dump	Display complete list of active optimizations.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
ColdFire	-[no]a6	Generate A6 stack frames for this tool. (Default)
	-abi keyword standard register compact	Specifies application-binary interface per keyword value: Standard (MPW) ABI (Default). Register ABI. Compact ABI.
	-align keyword mc68k mc68k4byte power[pc] array[members]	Specifies structure/array alignment per keyword value: MC68K — 2 bytes unless field is 1 byte (Default); MC68K 4-byte — 4 bytes unless field is smaller; Power PC — align per field size; Array — align per array members.
	-fp soft | hard	Specifies floating-point options: `soft` (the default) means generate calls to the software FP emulation library; `hard` means generate MC68881 FP instructions.
	-intsize 2 | 4	Specifies the number of bytes per integer. (Default is `2`.)
	-mb on | off	Specifies generating MacsBug information. (Default is `off`.)
	-model keyword[,...] near far nearCode farCode nearData farData smartCode | codeSmart	Specifies code and data-model generation options per keyword value: 16-bit references to code and data (Default); 32-bit references to code and data; 16-bit references to code (Default); 32-bit references to code; 16-bit references to data (Default); 32-bit references to data; 16- or 32-bit references to code, according to called-routine visibility from current scope or file.
	-pcrelstrings	Specifies putting string constants into code, generating PC-relative references for function addresses. Default is A5 or A4 register offsets.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
	-[no]pic	Specifies generating position-independent code references.
	-[no]pid	Specifies generating position-independent data references.
	-proc[essor] keyword	Specifies target processor by keyword. Values are `68020`, `68328`, `68349`, `CPU32`, `MCF5206e`, `MCF5307`, `MCF5407`, `MCF5272`, `MCF457x`, and `MCF5213`.
	-sdata size	Specifies placing objects smaller than `size` bytes in the small-data (`.sdata`) section. Default size value in `0`.

Table 13.3 Command-Line Compiler Options (*continued*)

Category	Option	Purpose
C/C++ Warnings	-w[arn[ings]] keyword[,...]	Specifies warnings per keyword value:
	off	Passes to all tools; turns off warnings.
	on	Passes to all tools; turns on most warnings.
	[no]cmdline	Passes to all tools; command-line driver/ parser warnings.
	[no]err[or] | [no]iserr[or]	Passes to all tools; treats warnings as errors.
	all	Turns on all warnings, requires prototypes.
	[no]pragmas | [no]illpragmas	Controls inappropriate-pragma warnings.
	[no]empty[decl]	Controls empty-declaration warnings.
	[no]possible | [no]unwanted	Controls warnings about possible unwanted side effects.
	[no]unusedarg	Controls unused-argument warnings.
	[no]unusedvar	Controls unused-variable warnings.
	[no]unused	Controls unused-arguments and unused-variable warnings.
	[no]extracomma | [no]comma	Controls extra-comma warnings.
	[no]pedantic | [no]extended	Controls pedantic error-checking warnings.
	[no]hidevirtual | [no]hidden[virtual]	Controls hidden virtual-function warnings.
	[no]implicit[conv]	Controls implicit-arithmetic-conversion warnings.
	[no]notinlined	Controls warnings about `inline` functions not inlined.
	[no]largeargs	Controls warnings about passing large arguments to unprototyped functions.
	[no]structclass	Controls warnings about inconsistent `class`, `struct` use.
	[no]padding	Controls warnings about padding added between `struct` members.
	[no]notused	Controls warnings about non-use of a non-void-returning function.
	[no]unusedexpr	Controls warnings about using expressions as statements without side effects.
	display | dump	Displays list of active warnings.

Linker Options

Table 13.4 lists the options of the command-line linker.

Table 13.4 Command-Line Linker Options

Category	Option	Purpose

General	`-help [keyword[,...]]`
	`all`
	`group=keyword`
	`[no]compatible`
	`[no]deprecated`
	`[no]ignored`
	`[no]normal`
	`[no]obsolete`
	`[no]spaces`
	`search=keyword`
	`usage`
		Displays help information per keyword values:
		All standard options.
		All groups that include keyword.
		Compatibility options.
		Deprecated options.
		Ignored options.
		Only standard options.
		Obsolete options.
		Inserts blank lines between options.
		All options that include keyword.
		Usage information.

	`-maxerrors max`	Specifies the maximum number of error messages to print. 0 (the default) means no maximum. (Not global)
	-maxwarnings max	Specifies the maximum number of warnings to print. 0 (the default) means no maximum. (Not global)
	-msgstyle keyword gcc IDE mpw parseable std	Sets message style per keyword value: Use GCC-like style. Use CodeWarrior IDE-like style. Use MPW style. Use context-free, machine-parseable style. Use standard style (default).
	-progress	Shows progress and version.
	-search	Searches access paths for source, object, or library files that the command line specifies.
	-[no]stderr	Specifies separate `stderr`, `stdout` streams; if `-nostderr` is in effect, `stderr` goes to `stdout`.
	-timing	Collects timing statistics.
	-v[erbose]	Specifies cumulative, verbose information; implies `-progress`.
	-version	Shows tool version, configuration, and build date.
	-[no]wraplines	Specifies message word wrapping.

Table 13.4 Command-Line Linker Options (*continued*)

Category	Option	Purpose
Linker	-dis[assemble]	Specifies disassembling object code *without* linking; implies `-nostdlib`.
	-L+ | -l path	Adds specified library search path. (Default is to search working directory then system directories. Search paths have global scope over the command line; searching follows path order in the command line.
	-lr	Adds a recursive library search path.
	-l+file	Adds a library before system libraries, searching for `lib<file>.<ext>`, where `<ext>` is the typical library extension.l
	-nodefaults	Same as `-[no]stdlib`. (Default)
	-[no]fail	Specifies continuing importing or disassembling, despite errors in earlier files.
	`-[no]stdlib`	Specifies using system-library access paths (per `%MWLibraries%` environment variable), adding system libraries (per `%MWLibrariesFiles%` environment variable). (Default)
	`-S`	Specifies disassembling and sending output to a file, *without* linking. Implies `-nostdlib`.
ELF Linker	`-[no]dead[strip]`	Controls deadstripping of unused code. (Default)
	`-force_active symbol[,...]`	Specifies a list of symbols as undefined; useful to force linking of static libraries.
	`-keep[local] on | off`	Controls keeping relocations and output segment names generated during the link as local symbols. (Default is `on`.)
	`-m[ain] symbol`	Sets the main entry point for the application or shared library. Maximum `symbol` length is 63 characters. The `symbol` value " " specifies no entry point.

Table 13.4 Command-Line Linker Options (*continued*)

Category	Option	Purpose

	`-map [keyword[,...]]`
	
	`closure`
	`unused`
		Specifies generating a link map file, per keyword values:
		Calculates symbol closures.
		Lists unused symbols.

	`-srec`	Specifies generating an S-record file. (The linker ignores this option if it generates static libraries.)

	`-sreceol keyword`
	
	`mac`
	`dos`
	`unix`
		Sets the end-of-line separator style for the S-record file, per the keyword value:
		Macintosh: `\r`.
		DOS: `\r\n`. (Default).
		Unix: `\n`.
		(This option implies `-srec`.)

	-sreclength length	Specifies the length of S-records. `Length` value range is 8 — 252, but must be a multiple of 4. Default length is 64.
	-o file	Specifies name of the output file.
ColdFire	-application	Specifies generating an application. (Default)
	-library	Specifies generating a static library.
	-[no]pic	Specifies generating position-independent code references.
	-[no]pid	Specifies generating position-independent data references. (Default)
	-proc[essor] keyword	Specifies target processor by keyword. Values are `68020`, `68328`, `68349`, `CPU32`, `MCF5206e`, `MCF5307`, `MCF5407`, `MCF5272`, and `MCF457x`
	_shared	Specifies generating a shared library.

Table 13.4 Command-Line Linker Options (*continued*)

Category	Option	Purpose
Debugging Control	-g	Specifies generating debugging information; same as `-sym on`.
	-sym keyword[,...] off on	Specifies debugging options, per keyword values: Do not generate debugging information. (Default) Generate debugging information.

Table 13.4 Command-Line Linker Options (*continued*)

Category	Option	Purpose
Warning	-w[arn[ings]] keyword[,...] off on [no]cmdline [no]err[or] | [no]iserr[or] display | dump	Specifies warnings per keyword value: Turns off warnings. Turns on all warnings. Controls command-line parser warnings. Treats warnings as errors. Displays list of active warnings.
ELF Disassembler	-show keyword[,...] only none all [no]code | [no] text [no]comments [no]extended [no]data [no] debug | [no] sym [no]exceptions [no]headers [no]hex [no]names [no]relocs [no]source [no]xtables [no]verbose	Specifies disassembly options, per keyword values: Restricts display, as in `-show only code`. Prevents display. Displays everything. (Default) Controls display of code of code or text sections. Controls display of comment field in code; implies `-show code`. Controls display of extended mnemonics; implies `-show code`. Controls display of data; with `-show verbose`, shows hex dumps of sections. Controls display of symbolics information. (Default) Controls display of exception tables; implies `-show data`. Controls display of ELF headers. Controls display of addresses and opcodes in code disassembly; implies `-show code`. Controls display of symbol table. (Default) Controls display of resolved relocations in code and relocation tables (Default) Controls display of 4 source lines around each function in disassembly; implies `-show code`. (Default) With `-show verbose`, controls display of entire source file in output. Controls display of exception tables. Controls display of verbose information, including hex dump of program segments, in applications. (Default)

Data Auto-Alignment

If you assemble with alignment enabled, the assembler automatically aligns data items on a *natural* boundary for the data size, and for the target processor family. The ColdFire assembler follows this scheme:

- 8-bit items (`.byte` directive) — No alignment needed.
- 16-bit items (`.word` directive)— Aligned to a16-bit (even address) boundary.
- 32-bit items (such as the `.long` directive) — Also aligned to 16-bit boundary.

The ColdFire assembler is unusual, using a 16-bit natural boundary for 32-bit quantities. (This is for compatibility with the inherited 680x0 interpretation.) Consider the Listing 13.4 example:

Listing 13.4 Auto-Alignment Example

```
        .data
        .globl   b1,l1,b2,l2
b1:     .byte    0xab
l1:     .long    0x12345678
b2:     .byte    0xcd
l2:       ;; <-- label "l2" on different line to directive
        .long    0x87654321
```

This assembles to this sequence of bytes:

```
0x00000000:  ab 00
0x00000002:  12 34
0x00000004:  56 79
0x00000006:  cd 00
0x00000008:  87 65
0x0000000a:  43 21
```

in which the two `0x00` bytes are padding the assembler added, to make sure that the 32-bit, `.long` items are at even addresses.

The example also demonstrates an important subtlety shown by the addresses of the symbols created for the labels:

```
b1:   0x00000000
l1:   0x00000002
b2:   0x00000006
l2:   0x00000007
```

As the example code had the labels `b1`, `l1` and `b2` on the same line as their data directives, these labels are directly attached to the data items. This means that the auto-alignment also applies to the labels. Accordingly, the symbol `l1` refers to the address of the 32-bit data item after the `0x00` padding byte.

But the example code had label `l2` on a line by itself, so it is *not* attached to the data item given by the next line's directive. So the symbol `l2` is attached to the value of the *location counter* before auto-alignment of the following item: `l2` refers to the address of the `0x00` padding byte.

The assembler does not use unique flags for each processor; some flag values specify versions of the core. Examples are:

- ColdFire version 2 core — `0x400`
- ColdFire version 3 core — `0x800`
- ColdFire version 4 core — `0x1000`

The assembler has extra flags for ColdFire MAC and EMAC extensions:

- MAC instructions — `0x100000`
- EMAC instructions — `0x200000`

Other flag issues are:

- You can combine flag values, so that `0x100800` denotes a version 3 core with MAC instructions.
- For ColdFire processor numbers, the second digit indicates the core number, so that 5307 has a version-3 core.
- An alternative to command-line processor specification is using the `.option` directive in the source file:

  ```
  .option processor AAA
  ```

  where `AAA` is name of processor, such as `MCF5282`, `MCF5307`, `MCF5407`, or `MCF547x`. This is a friendlier wrapping for the numeric processor flags. The system internally maps each processor name to one of the version v2, v3 or v4 cores.

A

Using Debug Initialization Files

This appendix explains background debugging mode (BDM) support for the ColdFire reference boards. BDM controls the processor, accessing both memory and I/O devices via a simple serial, *wiggler* interface. BDM can be very useful during initial debugging of control system hardware and software; it also can simplify production-line testing and end-product configuration.

Specifically, this appendix explains how to use debug initialization files with the P&E Micro wiggler. Debug initialization files contain commands that initialize the target board to write the program to memory, once the debugger starts the program.

Each time you start the debugger, and each time you select **Debug > Reset Target**, the system processes a debug initialization file. Such a file perform such functions as initializing registers and memory in targets that do not yet have initialization code in ROM.

This appendix consists of these sections:

- Common File Uses
- Command Syntax
- Command Reference

You specify whether to use a debug initialization file — and which to use — via the **ColdFire Target Settings** panel.

Common File Uses

The most common use for debug initialization files is configuring the essential set of memory-control registers, so that downloads and other memory operations are possible. This is appropriate if your target system or evaluation board does not yet have initialization code in target ROM. It also can be an appropriate way to override an existing initialization after a reset.

To create this section of the debug initialization file, you mirror the values that the processor chip-select, pin-assignment, and other memory control registers should have after execution of initialization code. However, the set of registers that need initialization varies by processor. For details, see your processor data book, as well as the sample files in the CodeWarrior subdirectory `\E68K_Tools\Initialization_Files`.

Other uses and guidance items are:

- Sample files are specific to processor, debug agents (such as *wigglers*) and, in some cases, evaluation board. Use the samples templates for your own files.
- Use a debug initialization file *only* to initialize memory setup. Trying to use such a file for additional initialization, such as for on-board peripherals or setup ports, would *prevent* these other initializations during normal execution. As the program does not use BDM in normal execution, it would not initialize such peripherals, so the program could fail to execute properly.
- Put non-memory and non-exception-setup initialization instructions in the `init_hardware` function of processor startup code instead of in a debug initialization file. Another valid place for such instructions is your own start routine. These methods take care of initialization, even if you run your program without the wiggler.
- Once debugging is done, your startup code must initialize the memory management unit, setting up the memory appropriately for non-debugger program execution.
- Listing A.1 is a sample BDM initialization file for the MCF5272C3 board.

Listing A.1 Sample BDM Initialization file

```
; Set VBR to start of future SDRAM
; VBR is an absolute CPU register
; SDRAM is at 0x00000000+0x0400000

writecontrolreg 0x0801   0x00000000

; Set MBAR to 0x10000001
; MBAR is an absolute CPU register, so if
; you move MBAR, you must change all subsequent
; writes to MBAR-relative locations

writecontrolreg 0x0C0F  0x10000001

; Set SRAMBAR to 0x20000001
; SRAMBAR is an absolute CPU register, the
; location of chip internal 4k of SRAM

writecontrolreg 0x0C04  0x20000001

; Set ACR0 to 0x00000000

writecontrolreg 0x04   0x00000000
```

```
; Set ACR1 to 0x00000000

writecontrolreg 0x05   0x00000000

; 2MB FLASH on CS0 at 0xFFE00000

writemem.l 0x10000040 0xFFE00201
writemem.l 0x10000044 0xFFE00014

; CS7 4M byte SDRAM
; Unlike 5307 and 5407 Cadre 3 boards,
; the 5272 uses CS7 to access SDRAM

writemem.l 0x10000078 0x00000701
writemem.l 0x1000007C 0xFFC0007C

; Set SDRAM timing and control registers
; SDCTR then SDCCR

writemem.l 0x10000184 0x0000F539
writemem.l 0x10000180 0x00004211

; Wait a bit

delay 600

writemem.l 0x10000000 0xDEADBEEF

; Wait a bit more

delay 600
```

Command Syntax

The syntax rules for commands in a debug initialization file are:

- The system ignores space characters and tabs.
- The system ignores character case in commands.
- Numbers may be in hexadecimal, decimal, or octal format:
  - Hexadecimal values must start with `0x`, as in `0x00002222`, `0xA`, or `0xCAfeBeaD`.
  - Decimal values must start with a numeral `1` through `9`, as in `7`, `12`, `526`, or `823643`.

  - Octal values must start with a zero, as in `0123`, or `0456`.
- Start comments with a colon (;), or pound sign (#). Comments end at the end of the line.

Command Reference

This section explains the commands valid for debug initialization files:

- Delay
- ResetHalt
- ResetRun
- Stop
- writeaddressreg
- writecontrolreg
- writedatareg
- writemem.b
- writemem.l
- writemem.w

NOTE Old data initialization files that worked with a Macraigor interface may not work with a P&E interface because command `writereg SPRnn` changed to `writecontrolreg 0xNNNN`. Please update files accordingly.

Delay

Delays execution of the debug initialization file for the specified time.

```
Delay <time>
```

Parameter

`time`

Number of milliseconds to delay.

Example

This example creates a half-second pause in execution of the debug initialization file:

```
Delay 500
```

ResetHalt

Resets the target, putting the target in debug state.

```
ResetHalt
```

ResetRun

Resets the target, letting the target execute from memory.

```
ResetRun
```

Stop

Stops program execution, putting the target in a debug state.

```
Stop
```

writeaddressreg

Writes the specified value to the specified address register.

```
writeaddressreg <registerNumber> <value>
```

Parameters

`registerNumber`

Any integer, 0 through 7, representing address register A0 through A7.

`value`

Any appropriate register value.

Example

This example writes hexadecimal `ff` to register A4:

```
writeaddressreg 4 0xff
```

writecontrolreg

Writes the specified value to the address of a control register.

```
writecontrolreg <address> <value>
```

address is the address of the control register.

Parameters

`address`

Address of any control register.

`value`

Any appropriate value.

Example

This example writes hexadecimal `c0f` to control-register address `20000001`:

```
writecontrolreg 0xc0f 0x20000001
```

writedatareg

Writes the specified value to the specified data register.

```
writedatareg <registerNumber> <value>
```

Parameters

`registerNumber`

Any integer, 0 through 7, representing data register D0 through D7.

`value`

Any appropriate register value.

Example

This example writes hexadecimal `ff` to register D3:

```
writedatareg 3 0xff
```

writemem.b

Writes the specified byte value to the specified address in memory.

`writemem.b <address> <value>`

Parameters

`address`

One-byte memory address.

`value`

Any one-byte value.

Example

This example writes decimal `255` to memory decimal address `2345`:

```
writemem.b 2345 255
```

writemem.l

Writes the specified longword value to the specified address in memory.

`writemem.l <address> <value>`

Parameters

`address`

Four-byte memory address.

`value`

Any four-byte value.

Example

This example writes hexadecimal `00112233` to memory hexadecimal address `00010000`:

```
writemem.l 0x00010000 0x00112233
```

writemem.w

Writes the specified word value to the specified address in memory.

`writemem.w <address> <value>`

Parameters

`address`

Two-byte memory address.

`value`

Any two-byte value.

Example

This example writes hexadecimal `12ac` to memory hexadecimal address `00010001`:

```
writemem.w 0x00010001 0x12ac
```

B

Memory Configuration Files

In your overall memory map there can be *gaps* or *holes* between physical memory devices. If the debugger tries a read or write to an address in such a hole, the system would issue an error message, and debugging might not even be possible.

To prevent such developments, use a memory configuration file (MCF). An MCF identifies valid memory address ranges to the debugger, and even specifies valid access types.

A sample memory configuration file is `\E68K_Support\Initialization_Files\MCF5485EVB.mem` of the CodeWarrior installation directory.

This appendix consists of these sections:

- Command Syntax
- Command Explanations

Command Syntax

The syntax rules for commands in a memory configuration file are:

- The system ignores space characters and tabs.
- The system ignores character case in commands.
- Numbers may be in hexadecimal, decimal, or octal format:
  - Hexadecimal values must start with `0x`, as in `0x00002222`, `0xA`, or `0xCAfeBeaD`.
  - Decimal values must start with a numeral `1` through `9`, as in `7`, `12`, `526`, or `823643`.
  - Octal values must start with a zero, as in `0123`, or `0456`.
- Comments can be in standard C or C++ format.

Command Explanations

This section explains the commands you can use in a memory configuration file:

- range
- reserved
- reservedchar

range

Specifies a memory range for reading or writing.

`range <loAddr> <hiAddr> <sizeCode> <access>`

Parameters

`loAddr`

Starting address of memory range.

`hiAddr`

Ending address of memory range.

`sizeCode`

Size, in bytes, for memory accesses by the debug monitor or emulator.

`access`

`Read`, `Write`, or `ReadWrite`.

Example

These range commands specify three adjacent ranges: the first read-only, with 4-byte access; the second write-only, with 2-byte access; and the third read/write, with 1-byte access.

```
range    0xFF000000 0xFF0000FF 4 Read
range    0xFF000100 0xFF0001FF 2 Write
range    0xFF000200 0xFFFFFFFF 1 ReadWrite
```

reserved

Reserves a range of memory, preventing reads or writes.

`reserved <loAddr> <hiAddr>`

Parameters

`loAddr`

Starting address of reserved memory range.

`hiAddr`

Ending address of reserved memory range.

Remarks

If the debugger tries to write to any address in the reserved range, no write takes place.

If the debugger tries to read from any address in the reserved range, the system fills the memory buffer with the reserved character. (Command `reservedchar` defines this reserved character.)

Example

This command prevents reads or writes in the range 0xFF00024 — 0xFF00002F:

```
reserved 0xFF000024 0xFF00002F
```

reservedchar

Specifies a reserved character for the memory configuration file.

`reservedchar <char>`

Parameter

`char`

Any one-byte character.

Remarks

If an inappropriate read occurs, the debugger fills the memory buffer with this reserved character.

Example

```
reservedchar 0xBA
```

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