CodeWarrior™ Development Tools Motorola® DSP56800 Embedded Systems Targeting Manual

CWDSP56800TM/D
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Table of Contents

1 Introduction

This manual explains how to use the CodeWarrior™ Integrated Development Environment (IDE) to develop code for the DSP56800 family of processors.

This chapter contains the following sections:

- The CodeWarrior IDE and Its Documentation
- New In This Release
- References

The CodeWarrior IDE and Its Documentation

The CodeWarrior IDE has a simple graphical user interface and versatile tools for developing software. Using the CodeWarrior IDE, you can develop a program, plug-in, library, or other code.

The CodeWarrior IDE lets you assemble source-code files, resource files, library files, and configuration settings in a project without writing a complicated build script or makefile. You can also add or delete source-code files from a project using the 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 that host, you use the CodeWarrior IDE to develop code to target various platforms.

The term target has two meanings in the CodeWarrior IDE:

- Platform Target

  The operating system, processor, or microcontroller for which you write code. If you write code for a particular processor running a specific desktop operating system, you are creating code for a platform target.

- **Build Target**

  The settings and files that determine the contents of your code, as well as the process in which this code compiles and links into the final output.

The IDE allows you specify multiple build targets for a particular platform target. For example, you can compile a debugging version (build target) and an optimized version (build target) of your program for the Windows® operating system (platform target). The build targets can share files in the same project even though each build target uses its own settings. After debugging the program, generating a final version is as simple as selecting the project's build target and using a single `Make` command.

The CodeWarrior IDE has compilers, linkers, a debugger, a source-code browser, and editing tools. You can edit, navigate, examine, compile, link, and debug code all within the CodeWarrior IDE. Options for code generation, debugging, and navigation of your project are all configurable in the CodeWarrior IDE.

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 those features unique to the CodeWarrior IDE for the DSP56800.

For a complete understanding of the CodeWarrior IDE, refer to the CodeWarrior IDE User's Guide for general information and this manual for information specific to DSP56800.

NOTE The CodeWarrior Release Notes contain information about new features, bug fixes, and incompatibilities that do not appear in the documentation because of release deadlines. Release Notes are on the CodeWarrior IDE CD.

New In This Release

Refinements in this version are:

- Addition of board-specific projects to the DSP56800 EABI stationery

- Automatic enabling of debugger
- Addition of Command Converter protocol
- Enhancement of pragma interrupt capability
- Addition of File Mappings panel
- Flagging of pipeline dependencies due to occurrence of errors in inline assembler
- Upgrade of stationeries to support all targets in both Flash and RAM
- Option for adjustment of assembler for delayed load of N-registers
- Enhanced setting of hardware breakpoints
- Automatic re-establishment of hardware breakpoints upon launching the debugger
- Addition of option for debugging a target chip within a JTAG chain

References

- The following manuals are included with this product:
  - *Code Warrior IDE User Guide*
  - *Assembler Reference Manual*
  - *MSL C Reference* (Metrowerks standard C libraries)
- To learn more about the DSP56800 processor, refer to the following manuals:
  - *DSP56800 Family Manual.* Motorola, Inc., 2001
  - *DSP56F801 Hardware User Manual*. Motorola, Inc., 2001
  - *DSP56F803 Hardware User Manual*. Motorola, Inc., 2001
  - *DSP56F805 Hardware User Manual*. Motorola, Inc, 2001
  - *DSP56F807 Hardware User Manual*. Motorola, Inc., 2001
  - *DSP56L811 User's Manual*. Motorola, Inc., 1996
  - *DSP56F824 Hardware User Manual*. Motorola, Inc, 1999
  - *DSP56F826 Hardware User Manual*. Motorola, Inc., 2001
  - *DSP56F827 Hardware User Manual*. Motorola, Inc, 2001

- For more information on the various command converters supported by the CodeWarrior IDE for DSP56800, refer to the following manuals:
  - *Suite56™ Ethernet Command Converter User's Manual*, Motorola, Inc., 2000.
  - *Suite56™ PCI Command Converter User's Manual*, Motorola, Inc., 1999.
  - *Suite56™ Parallel Port Command Converter User's Manual*, Motorola Inc., 1999.

To download electronic copies of these manuals or order printed versions, visit this web address:

```
http://www.motorola.com
```

2

Getting Started

This chapter explains how to install and run the CodeWarrior™ IDE on your Windows® operating system. This chapter also explains how to connect hardware for each of the communications protocols supported by the CodeWarrior debugger.

This chapter contains the following sections:

- System Requirements
- Installing the CodeWarrior IDE for DSP56800
- Installing DSP56800 Hardware

System Requirements

This section lists system requirements for operating the CodeWarrior IDE for DSP56800 software.

Table 2.1 lists requirements for installing and using the CodeWarrior IDE and the DSP56800 Simulator software.

Table 2.1 Windows Requirements for the CodeWarrior IDE

Hardware	• 133 MHz microprocessor: Intel® Pentium®, AMD™ K6™, or equivalent • 200 MB hard drive space • 32 MB RAM • CD-ROM drive for installation
Software	Windows® 95/98/2000/NT (NT 4.0 recommended)

DSP56800 Hardware Requirements

You can use various DSP56800 hardware configurations with the CodeWarrior IDE. Table 2.2 lists these configurations.

NOTE Each protocol in Table 2.2 is selected from the **M56800 Target Settings** panel.

Table 2.2 DSP56800 Hardware Requirements

Target Connection	Boards Supported	Hardware Provided With Command Converter
Parallel port on-board Command Converter	56824EVM 56F805EVM 56F803EVM 56801EVM 56807EVM 56826EVM 56827EVM	• 25-pin parallel-port interface cable • Power supply, 9–12 Vdc, 500 mA with 2.5 mm receptacle (inside positive)
External Parallel Port Command Converter	56824EVM 56F805EVM 56F803EVM 56L811EVM 56801EVM 56807EVM 56826EVM 56827EVM	• Motorola Parallel Port Command Converter • 25-pin parallel-port interface cable
PCI Command Converter	56824EVM 56F805EVM 56F803EVM 56801EVM 56807EVM 56826EVM 56827EVM	• 25-pin OCD ribbon cable • Target Interface Module • JTAG 14-pin ribbon interface cable

Target Connection	**Boards Supported**	**Hardware Provided With Command Converter**
Ethernet Command Converter	56824EVM 56F805EVM 56F803EVM 56F801EVM 56F807EVM 56F826EVM 56F827EVM	• 10 base T RJ-45 cable • 25-pin OCD ribbon cable • JTAG 14-pin ribbon cable • Target Interface Module
Motorola Application Development System (ADS) Universal Command Converter (UCC) with the ISA bus interface	56824ADS 56F805ADS 56F803ADS 56L811ADS 56801ADS 56807ADS 56826ADS 56827ADS	• One open 16-bit ISA expansion slot • One free I/O address: $0100, $0200, or $0300 • Motorola Application Development System • 37-pin ribbon interface cable (included with ADS) • 14-pin ribbon interface cable (included with ADS)
Domain Technologies SB-56K Multi-DSP Emulator	56824EVM 56F805EVM 56F803EVM 56L811EVM 56801EVM 56807EVM 56826EVM 56827EVM	• Domain Technologies SB-56K Multi-DSP Emulator. Refer to the following website for more information: • `http://www.domaintec.com`
Serial port	56L811EVM	• Motorola DSP56L811EVM board • 9-pin serial-port interface cable • Power supply, 9–12 Vdc, 500 mA with 2.5 mm receptacle (inside positive)

Table 2.3 Jumper Settings for Enabling JTAG Communication Interface

Hardware	Jumper	Setting from default
DSP56L811EVM	JG7	5-6 closed
DSP56824EVM	JG6	1-2 closed
DSP56F805EVM	JG5	1-2 closed
DSP56F803EVM	JG2	1-2 closed
DSP56F801EVM	JG5	1-2 closed
DSP56F807EVM	JG4	1-2 closed
DSP56F826EVM	JG1	1-2 closed
DSP56F827EVM	JG1	1-2 closed

Installing the CodeWarrior IDE for DSP56800

The CodeWarrior installer automatically installs all the necessary components for you to begin development. If you have any questions about the installer, read the instructions on the CodeWarrior CD.

Installing the CodeWarrior IDE

Install the CodeWarrior IDE:

1. Insert the CodeWarrior CD into your computer's CD-ROM drive. If Auto Install is disabled on your computer, run the `setup.exe` program at the root directory on the CD.
2. Follow the CodeWarrior software installation instructions. After installing the CodeWarrior IDE, restart your computer to ensure that the newly installed drivers are available for use.
3. Register the CodeWarrior software. Registered and 30-day evaluation users have separate registering procedures:

- **Registered Users**

  Run the Register CodeWarrior program (MWRegister.exe) from the taskbar, located in the CodeWarrior group. This program is also run as part of the installation procedure as the last step.

- **30-day Evaluation Users**

  Visit the following website and enter your validation code (located on the CodeWarrior tools CD case):

  `http://www.metrowerks.com/key/eval/`

  You will receive a license key by email after you submit the evaluation form on the website.

4. Install the license key as follows:

   a. Locate the `license.dat` file in your CodeWarrior installation folder. The file is located at the root of the CodeWarrior installation directory, so if you have installed the CodeWarrior software at the default installation path, you can find it here:

```
C:\Program Files\Metrowerks\CodeWarrior\license.dat
```

It is important that this file remain at this location.

   b. Use any standard text editor to open this file. For example, NotePad.

   c. Copy or type the key starting on a new line at the bottom of this file. For example, if your dummy license key was:

```
FEATURE dummykey metrowerks 1.000 permanent uncounted 0335B9E8897F\
         VENDOR_STRING="Dummy key for placeholder" HOSTID=ANY
```

And the existing IDE license key is:

```
FEATURE Win32_CWIDE_Limited metrowks 4.2 permanent uncounted \
        2C3C43468173 HOSTID=ANY
FEATURE Win32_CWIDE_Unlimited metrowks 4.2 permanent uncounted \
        D8C287BC5B1B HOSTID=ANY
```

After you register with Metrowerks, Inc. (license@metrowerks.com), you will receive a new key. Replace the dummy license key with the new key. For example, if your new license key is:

```
FEATURE Win32_Plugins_DSP56800 metrowks 5.0 1-feb-2002 uncounted \
        61178DDE2D29 HOSTID=ANY
FEATURE Win32_Plugins_DSP56800Comp metrowks 5.0 1-feb-2002 uncounted \
        2BC235F509D8 HOSTID=ANY
```

After pasting or typing in the new key, the file contains:

```
FEATURE Win32_CWIDE_Limited metrowks 4.2 permanent uncounted \
        2C3C43468173 HOSTID=ANY
FEATURE Win32_CWIDE_Unlimited metrowks 4.2 permanent uncounted \
        D8C287BC5B1B HOSTID=ANY
FEATURE Win32_Plugins_DSP56800 metrowks 5.0 1-feb-2002 uncounted \
        61178DDE2D29 HOSTID=ANY
FEATURE Win32_Plugins_DSP56800Comp metrowks 5.0 1-feb-2002 uncounted \
        2BC235F509D8 HOSTID=ANY
```

d. Any future keys can likewise be appended to the bottom of this file.

If you encounter difficulty in installing this key, please contact Metrowerks Customer support at:

Ph: (800) 377-5416

Fax: (512) 873-4901

`email: license@metrowerks.com`

NOTE Do not move the license.dat file after installation.

What Gets Installed

Table 2.4 describes the folders that are installed as part of the full standard CodeWarrior IDE for DSP56800 installation. Each folder is located in your CodeWarrior installation directory.

Table 2.4 Contents Installed with the CodeWarrior IDE for DSP56800

Directory name	Contents
`Bin`	The CodeWarrior IDE application and associated plug-in tools.
`CodeWarrior Manuals`	The CodeWarrior documentation tree.
`CodeWarrior Examples`	Target specific example projects and code.
`CW Release Notes`	Release notes for the CodeWarrior IDE and each tool.

Directory name	Contents
`M56800_EABI_Tools`	Drivers for the ADS Universal Command Converter and ADS parallel port drivers. Additional default files used by the CodeWarrior IDE for the DSP56800 stationery.
`CodeWarrior Help`	All the core help files for the IDE, as well as target specific help. All help files are accessed through the Help menu or F1 help.
`Licensing`	The registration program and additional licensing information.
`M56800 Support`	Includes Metrowerks Standard Library (MSL), a subset of the standard MSL adapted specifically for DSP56800.
`Motorola Documentation`	Documentation specific to the Motorola DSP568xx series.
`Stationery`	Default settings that are used to create DSP56800 projects. Each target stationery item is set to a specific debugging protocol.

Installing DSP56800 Hardware

This section explains how to connect the DSP568xx hardware to your computer. Parallel port connections are explained in the *Kit Installation Guide* for each individual DSP568xxEVM board. All descriptions assume the default jumper settings, as explained in the *Hardware User Manual* for your product, unless otherwise stated.

NOTE Parallel port connections with boards that support direct parallel port connections are not covered in this chapter. Refer to the *Kit Installation Guide* or *Hardware User Manual* for your specific board. You can use the DSP56800 Simulator provided with the CodeWarrior IDE instead of installing additional DSP568xx hardware.

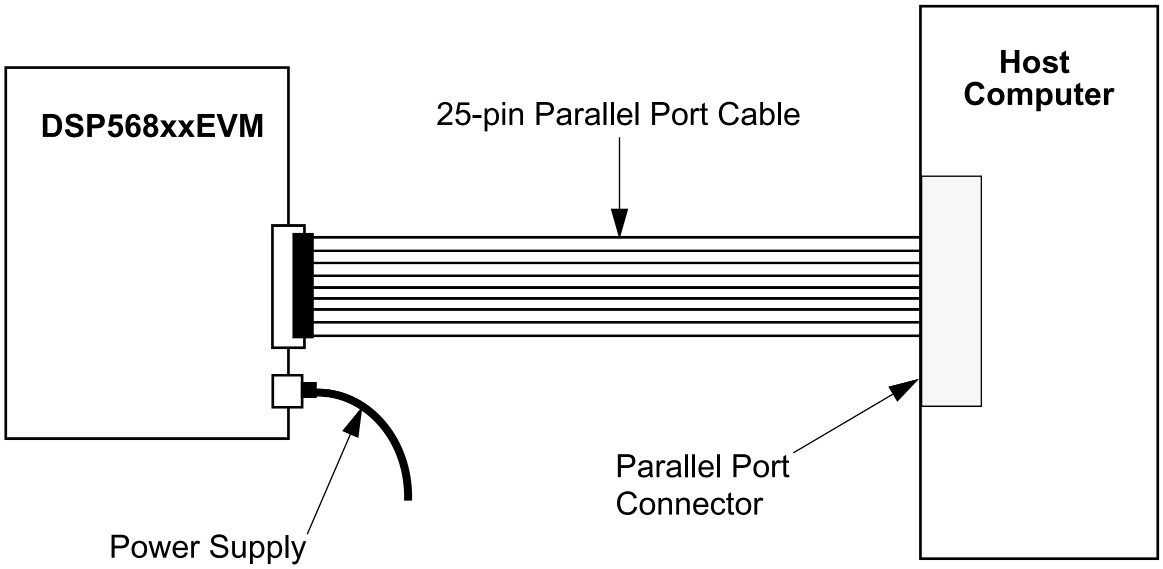
Using Parallel Port

Connect the parallel port cable to your DSP568xxxEVM board as described below.

Connecting the Parallel Port Cable to DSP568xxEVM Board

1. Connect the 25-pin male connector at one end of a parallel port cable to the 25-pin female connector on your computer (Figure 2.1).
2. Connect the 25-pin female connector at the other end of the parallel port cable to the 25-pin male connector on the DSP568xxEVM.

Figure 2.1 Connecting Parallel Port Cable to DSP568xxEVM Board



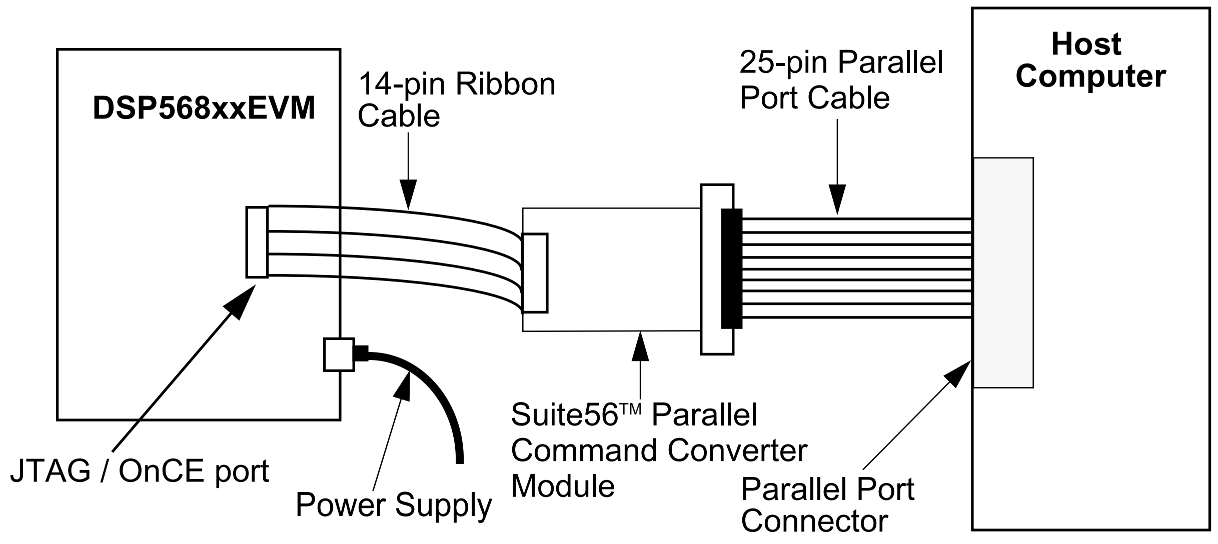
Connecting the Parallel Port Cable to Suite56™ Parallel Port Command Converter Module and DSP568xxEVM Board

1. Enable the JTAG port.

   Table 2.3 shows the jumpers that you need to change from the default configuration for your particular hardware.

2. Connect the 25-pin male connector at one end of a parallel port cable to the 25-pin female connector on your computer (Figure 2.2).

Figure 2.2 Connecting Parallel Port Cable to Suite56™ Parallel Command Converter Module and DSP568xxEVM Board



3. Connect the 25-pin female connector at the other end of the parallel port cable to the 25-pin male connector on the Suite56™ Parallel Port Command Converter module.
4. Locate the 14-pin ribbon cable hanging from the Suite56™ Parallel Port Command Converter module. Connect the 14-pin female connector of the ribbon cable to the 14-pin JTAG male connector on the DSP568xxEVM board.

   Ensure that the red stripe on the ribbon cable corresponds to pin 1 on the DSP568xxEVM card.
5. Plug the power supply into a wall socket.
6. Connect the power supply to the power connector on the DSP568xxEVM board.

   The green LED next to the power connector lights up.

Installing the PCI Command Converter

Connect the PCI Command Converter and your Motorola DSP568xxEVM board to your computer as described below.

Installing the PCI Command Converter

Install the PCI Command Converter hardware:

1. Place your PCI Command Converter card on a static-proof mat.
2. Shut down your computer.

WARNING! Do not touch the components and connectors on the board or inside your computer without first being grounded. Otherwise, you could damage the hardware with static discharge.

3. Locate an empty card slot in your computer.
4. Insert the PCI Command Converter card in the empty card slot.

NOTE One end of the 25-pin cable has a 24-pin female connector. A ground cable is retrofitted to a wire of the 25-pin cable at the same end of the cable. The ground cable is crimped to a female disconnect terminal.

5. Connect the 24-pin female connector at one end of the 25-pin cable to the 24-pin female connector on the PCI Command Converter card (Figure 2.3).
6. Connect the female disconnect terminal of the ground cable to the socket protruding from the PCI Command Converter card in your computer.
7. Connect the 25-pin female connector at the other end of the 25-pin cable to the 25-pin male connector on the OCDemon™ Wiggler.

Procedure for Manual Installation of PCI Command Converter Drivers

Windows® 95

The required files are located in the following directory:

CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win 95 98

1. Install CodeWarrior for DSP56800 Software Development Tools.

2. Shut down your computer.
3. Install the PCI command converter hardware into an empty PCI slot.
4. Turn on your computer.
5. The **Found New Hardware** window appears.
   a. Click the **Driver from Disk Provided from Hardware Manufacturer** box.
   b. Click OK.
6. The **Install from Disk** window appears. Browse to the following directory:

   C:\Program Files\Metrowerks\CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win 95 98

NOTE This is the default installation directory. If you changed this directory during the software installation, you will need to select your custom directory. Then, click the **Next** button.

7. Double-click on the `raptor.inf` file.
8. Click the **Finish** button.
9. Copy `windrvr.sys` file to \Windows\System32\Drivers.
10. Copy `windrvr.vxd` file to \Windows\System\vmm32.
11. From the command prompt, change to the following directory:

    CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win 95 98
12. Type the following:

    wdreg -name "Macraigor_PCI" -file windrvr install

Windows® 98

The required files are located in the following directory:

CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win 95 98

1. Install CodeWarrior for DSP56800 Software Development Tools.
2. Shut down your computer.

3. Install the PCI command converter hardware into an empty PCI slot.
4. Turn on your computer.
5. The **Add New Hardware Wizard** window appears. Click the **Next** button.
6. Check the **Search** button and then click the **Next** button.
7. Click the **Browse** button.
8. Select the following directory:

   C:\Program Files\Metrowerks\CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win 95 98

NOTE This is the default installation directory. If you changed this directory during the software installation, you will need to select your custom directory. Then, click the **Next** button.

   Windows 98 finds the correct driver.

9. Copy the `windrvr.sys` file to \Windows\System32\Drivers
10. Copy the `windrvr.vxd` file to \Windows\System\vmm32.
11. From the command prompt, change to the following directory:

    CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win 95 98
12. Type the following:

    wdreg -name "Macraigor_PCI" -file windrvr install

Windows NT® 4.0

The required files are located in the following directory:

CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win NT

1. Copy the `raptor.inf` file to /winnt/inf.
2. Copy the `windrvr.vxd` file to /winnt/system32/drivers.
3. Copy the `windrvr.sys` file to /winnt/system32/drivers.
4. Install the `raptor.inf` file by right-clicking on this file and selecting the **Install** button.

5. From the command prompt, change to the following directory:

   CodeWarrior\DSP EABI Support\Ads PCI Drivers\Win NT

6. Type the following:

   wdreg -name "Macraigor_PCI" -file windrvr install

7. Shut down your computer.
8. Install the PCI command converter hardware into an empty PCI slot.
9. Turn on your computer.

Connecting the PCI Command Converter to the DSP568xxEVM Board

To connect the PCI Command Converter to your DSP568xxEVM board, follow the steps explained in “Installing the PCI Command Converter” on page 22 before performing the steps in this section.

Connect the PCI Command Converter to your DSP568xxEVM board:

1. Enable the JTAG port.

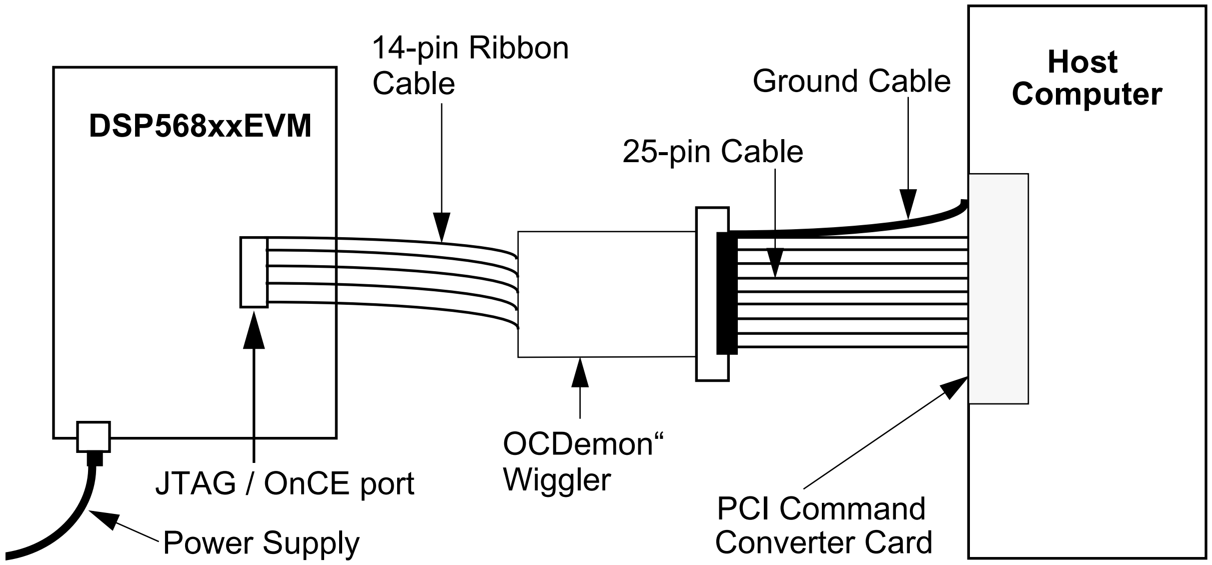
   Table 2.3 shows the jumpers that you need change from the default configuration for your particular hardware. Refer to the *Hardware User Manual* or *Kit Installation Guide* for your particular board for information on default jumper settings.

2. Locate the 14-pin ribbon cable hanging from the OCDemon™ Wiggler. Connect the 14-pin female connector of the ribbon cable to the 14-pin JTAG male connector on the DSP568xxEVM board.

   Ensure that the red stripe on the ribbon cable corresponds to pin 1 on the DSP568xxEVM card.

3. Plug the power supply into a wall socket.
4. Connect the power supply to the power connector on the DSP568xxEVM board.
5. The green LED next to the power connector lights up. The board is now connected.

Figure 2.3 Attaching PCI Command Converter to DSP568xxEVM Board



Installing the Ethernet Command Converter

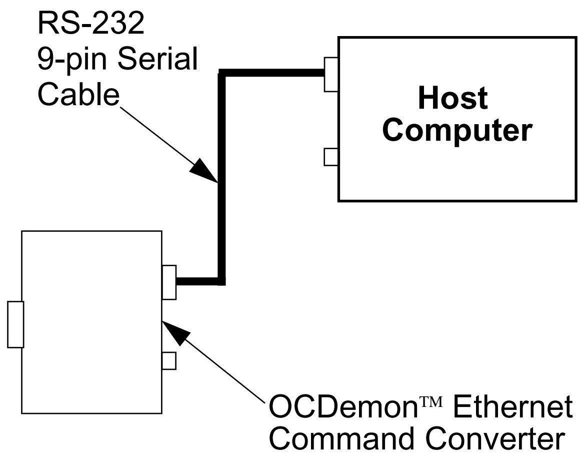
Connect the Ethernet Command Converter and your Motorola DSP568xxEVM board to your computer as described below.

Configuring Network Settings for Ethernet Command Converter

Connect the Ethernet Command Converter hardware to your computer:

1. Shut down your computer.
2. Connect the 9-pin male connector at one end of an RS-232 serial cable to the 9-pin female connector on the Ethernet Command Converter (Figure 2.4).
3. Connect the 9-pin female connector at the other end to of the RS-232 serial cable to the 9-pin male connector on your computer.

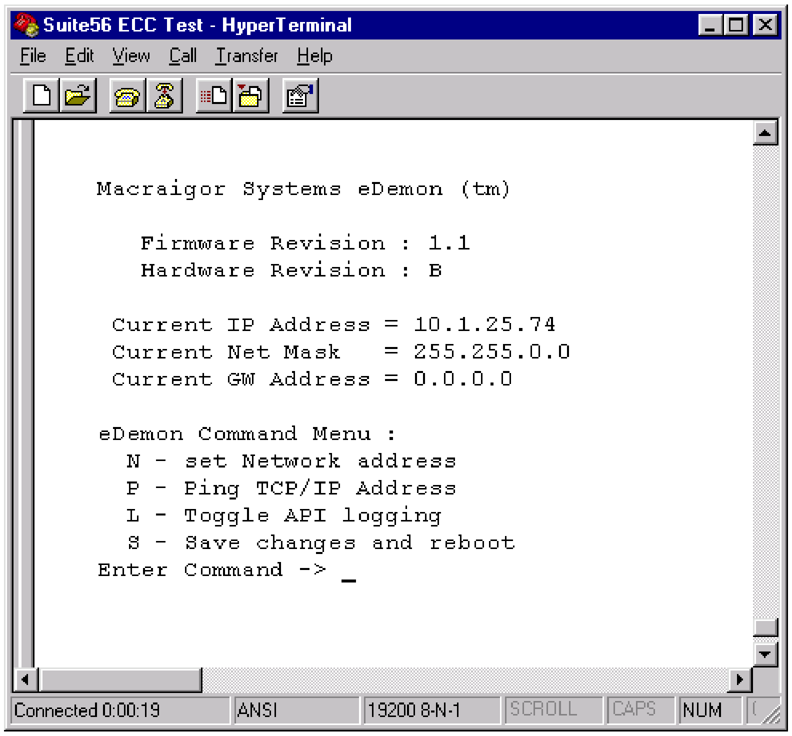
Figure 2.4 Connecting Ethernet Command Converter to Host Computer



4. Open Hyper Terminal or similar program (Figure 2.5) using the procedure appropriate for the operating system you are using:

- For NT workstations, select **Program > Accessories > Hyper Terminal** from the **Start** menu.
- For Windows® 95 and 98, select **Program > Communications > Hyper Terminal** from the **Start** menu.

Figure 2.5 eDemon Command Menu in HyperTerminal


Suite56 ECC Test - HyperTerminal
File Edit View Call Transfer Help
Connected 0:00:19
ANSI
19200 8-N-1
SCROLL
CAPS
NUM

```
Macraigor Systems eDemon (tm)

   Firmware Revision : 1.1
   Hardware Revision : B

 Current IP Address = 10.1.25.74
 Current Net Mask   = 255.255.0.0
 Current GW Address = 0.0.0.0

eDemon Command Menu :
  N - set Network address
  P - Ping TCP/IP Address
  L - Toggle API logging
  S - Save changes and reboot
Enter Command -> _
```

5. Set up the Hyper Terminal with the following COM port settings:

Bits per second:	19200
Data bits: 8	8
Stop bit:	1
Flow control:	Xon/Xoff or None

6. Plug the receptacle portion of detachable power cord into the power supply.
7. Insert the plug portion of the detachable power supply into a wall outlet.
8. Connect the 5V power supply cable to the OCDemon™ Ethernet Command Converter (black box).

After a delay of 15 to 20 seconds, the eDemon Command **Menu** appears. Figure 2.5 shows the eDemon Command **Menu** using HyperTerminal on Windows NT.

9. Follow the instructions from the eDemon Command **Menu** to enter the IP Address and other network settings.

   Refer to the *OCDemon™ Ethernet Command Converter User's Manual* for more information on testing your network connection and firmware upgrades for the Ethernet Command Converter module.

10. After setting up your network settings for the Ethernet Command Converter, disconnect the RS-232 cable from the Command Converter.

Connecting the Ethernet Command Converter to the DSP568xxEVM Board

To connect your DSP568xxEVM with the Ethernet Command Converter, follow the steps explained in "Configuring Network Settings for Ethernet Command Converter" on page 26 before performing the steps in this section.

Connect the Ethernet Command Converter to your DSP568xxEVM board:

1. Enable the JTAG port.

   You must enable the JTAG/OnCE port on your hardware. Table 2.3 shows the jumpers that you need to change from the default configuration for your particular hardware.

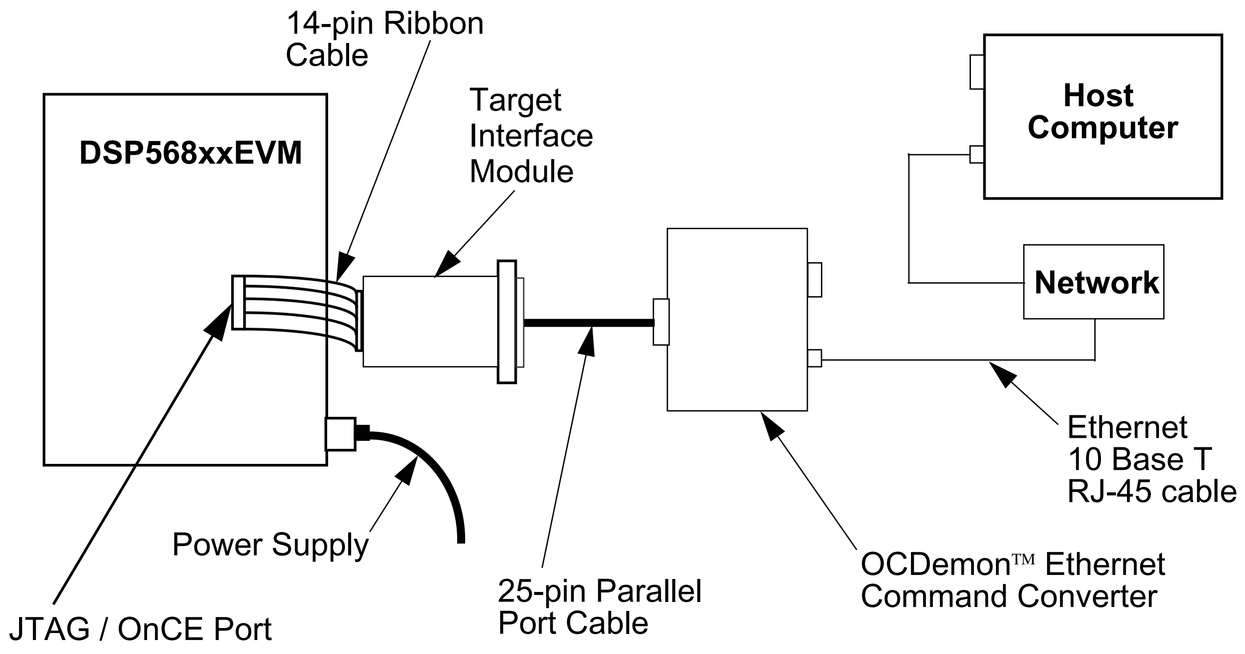
2. Connect the 25-pin male connector at one end of a parallel port cable to the 25-pin female connector on the back panel of the OCDemon™ Ethernet Command Converter (Figure 2.6).
3. Connect the 25-pin female connector at the other end of the 25-pin parallel port cable to the 25-pin male connector on the OCDemon™ target interface module.
4. Locate the 14-pin ribbon cable on the OCDemon™ target interface module. Connect the 14-pin female connector of the ribbon cable to the 14-pin JTAG male connector on the DSP568xxEVM board.

   Ensure that the red stripe on the ribbon cable corresponds to pin 1 on the DSP568xxEVM card.

5. Connect one end of the RJ-45 base T cable to the Ethernet Command Converter (black box).
6. Connect the other end of the RJ-45 base T cable to the network.
7. Apply power to the DSP568xxEVM.
8. Plug the power supply into a wall socket.
9. Connect the power supply to the power connector on the DSP568xxEVM board.

   The green LED next to the power connector lights up. The board is now connected.

Figure 2.6 Connecting Ethernet Command Converter to DSP568xxEVM Board



Installing ADS UCC with ISA Bus Interface

Connect the Application Development System (ADS) Universal Command Converter (UCC) and your computer using the Industry Standard Architecture (ISA) bus interface as described below.

Install the Universal Command Converter and ISA Bus

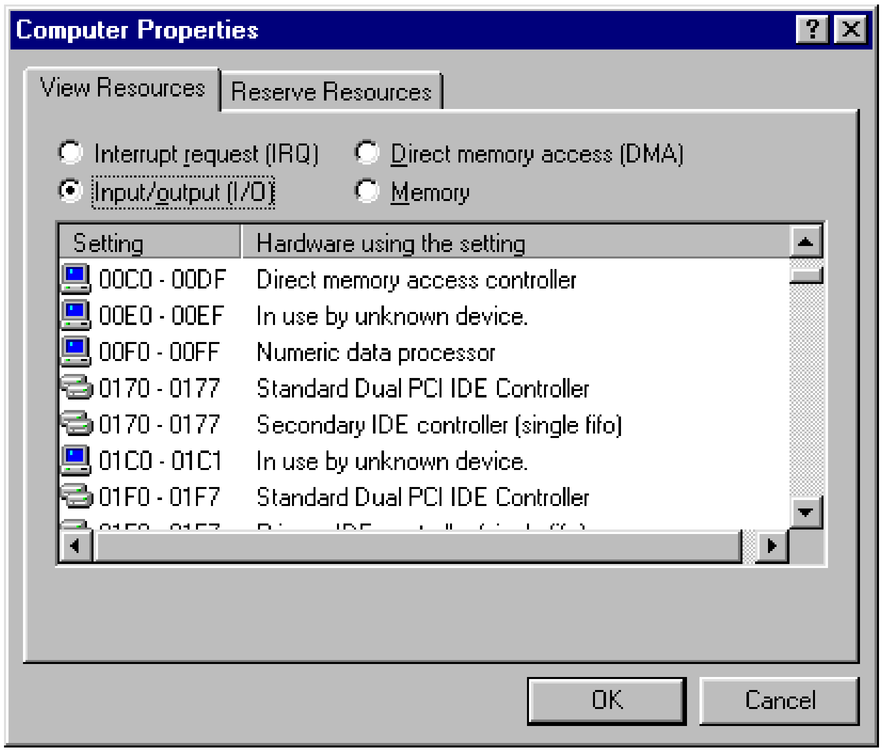
Install the ADS UCC hardware:

1. Place the Motorola Universal Command Converter card on a static-proof mat.
2. Locate an empty card slot in your computer.
3. Insert the Motorola Universal Command Converter card in the empty card slot.
4. Find an open I/O address for the ADS card.
5. Find an open I/O address according to your operating system.

Windows 95 and Windows 98

1. From the Start menu, access the Control Panel. Double-click **Systems.** Select the **Device Manager** tab.
2. Click the **Properties** button. The **Computer Properties** window appears (Figure 2.7).

Figure 2.7 Computer Properties Window



Interrupt request (IRQ) [✓ Input/output (I/O)] Direct memory access (DMA) Memory

Setting	Hardware using the setting
00C0 - 00DF	Direct memory access controller
00E0 - 00EF	In use by unknown device.
00F0 - 00FF	Numeric data processor
0170 - 0177	Standard Dual PCI IDE Controller
0170 - 0177	Secondary IDE controller (single fifo)
01C0 - 01C1	In use by unknown device.
01F0 - 01F7	Standard Dual PCI IDE Controller

3. In the **Computer Properties** window, click the **Input/Output** radio button.
4. In the address list, verify that one of the following addresses is unused:

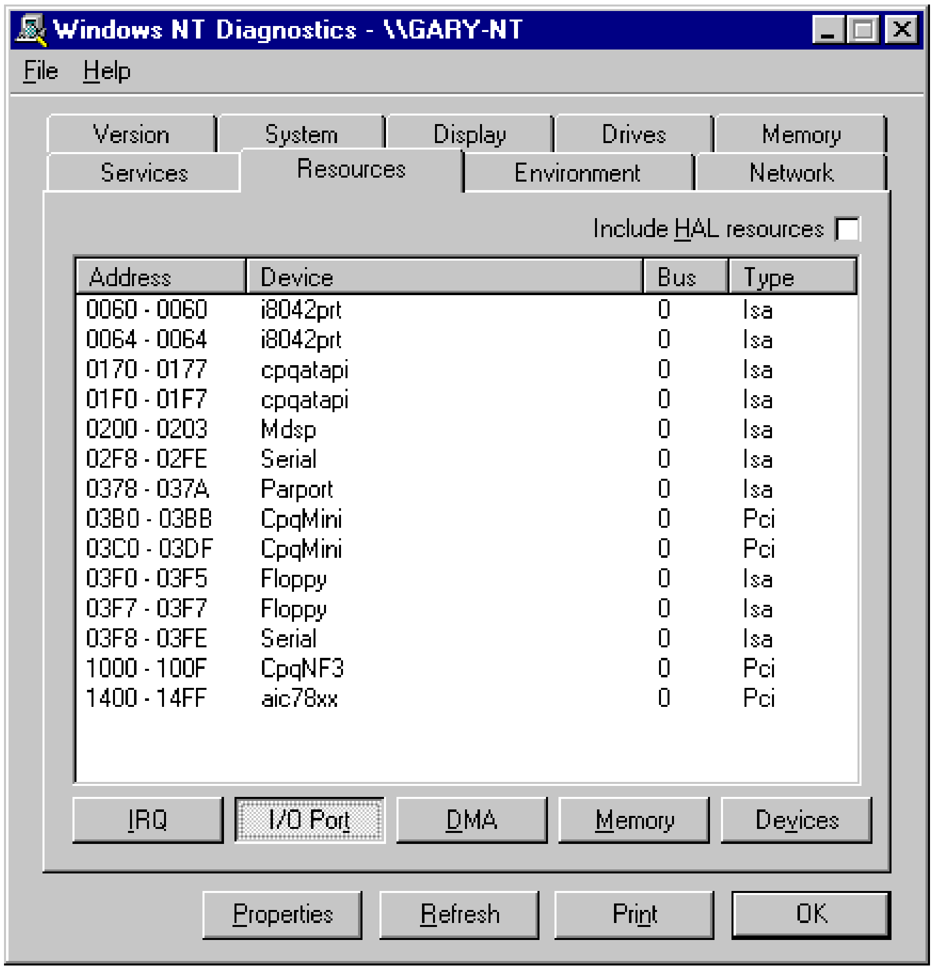
- `0100 - 0102`
- `0200 - 0202`
- `0300 - 0302`

5. If all of these addresses are used, reconfigure your system to accept the ADS card.
6. Close the **Computer Properties** window.

Windows NT

1. Click **Start > Programs > Administrative Tools > Windows NT Diagnostics** to open the Windows NT Diagnostics window.
2. Click the **Resources** tab.
3. Click the **I/O Port** button.

Figure 2.8 Windows NT Diagnostics Resources Panel



Address	Device	Bus	Type
0060 - 0060	i8042prt	0	Isa
0064 - 0064	i8042prt	0	Isa
0170 - 0177	cpqatapi	0	Isa
01F0 - 01F7	cpqatapi	0	Isa
0200 - 0203	Mdsp	0	Isa
02F8 - 02FE	Serial	0	Isa
0378 - 037A	Parport	0	Isa
03B0 - 03BB	CpqMini	0	Pci
03C0 - 03DF	CpqMini	0	Pci
03F0 - 03F5	Floppy	0	Isa
03F7 - 03F7	Floppy	0	Isa
03F8 - 03FE	Serial	0	Isa
1000 - 100F	CpqNF3	0	Pci
1400 - 14FF	aic78xx	0	Pci

4. In the address list (Figure 2.8), verify that one of the following addresses is unused:

- `0100 – 0102`
- `0200 – 0202`
- `0300 – 0302`

If all of these addresses are used, you must reconfigure your system to accept the ADS card as follows:

a. If your Windows NT installation directory is `c:\winnt`, copy the `mdsp.sys` file to the directory:

```
c:\winnt\system32\drivers\
```

The `mdsp.sys` file is in the following path:

```
DSP EABI
Support\AdsDrivers\WinNT\CodeWarrior\
```

b. On a DOS command line, type `regini address`, where `address` reflects the empty address you selected for the card. For example, type `regini 100` to use I/O address `$0100`, which is the default.

5. Shut down your computer.

WARNING! Do not touch the components and connectors on the boards or inside your computer without first being grounded. Otherwise, you could damage the hardware with static discharge.

Adjusting Jumpers and Making Connections

1. Adjust the jumper settings on the ISA card.

   Adjust the jumper group JG2 to match the I/O address you determined in step 4.

   For example, if you want to use `0100 - 0102`, close all jumpers other than jumper A8. If you want to use `0200 - 0202`, close all jumpers other than jumper A9. Refer to Table 2.5.

Table 2.5 ISA Card Jumper Settings

To use this I/O address…	CLOSE all JG2 jumpers except…
`0100 - 0102`	A8
`0200 - 0202`	A9
`0300 - 0302`	A8 and A9

2. Verify that all the IRQ jumpers (JG1) are open.
3. Open your computer and locate an empty card slot in your computer.
4. Insert the Motorola ISA interface card into the empty card slot and close your computer.
5. Connect the 37-pin female connector at one end of a 37-pin ribbon cable to the 37-male connector on the ISA card (Figure 2.9).

6. Connect the 37-pin female connector at the other end of the 37-pin ribbon cable to the 37-pin male connector on the ADS Universal Command Converter card.
7. Arrange the Command Converter jumpers according to Table 2.6.

Table 2.6 ADS Universal Command Converter Jumper Settings

ADS UCC Jumper Location	Settings Known to Work With CodeWarrior IDE for DSP56800
JG1	Use the factory defaults.
JG2	1-2, 3-4, and 5-6 CLOSED
JG3	2-3 CLOSED

8. Turn on your computer.

   The green LED on the ADS Universal Command Converter lights up.

Connect ADS UCC and ISA Bus to DSP568xxEVM Board

To connect your DSP568xxEVM with the ADS Universal Command Converter, follow the steps in "Install the Universal Command Converter and ISA Bus" on page 31 before performing the steps in this section.

Connect the ADS Universal Command Converter to your DSP568xxEVM board (Figure 2.9):

1. Enable the JTAG port.

   You must enable the JTAG/OnCE port on your hardware. Table 2.3 shows the jumpers that you need to change from the default configuration for your particular hardware.
2. Connect 14-pin female connector at one end of a 14-pin ribbon cable to the 14-pin JTAG male connector on the ADS UCC board.

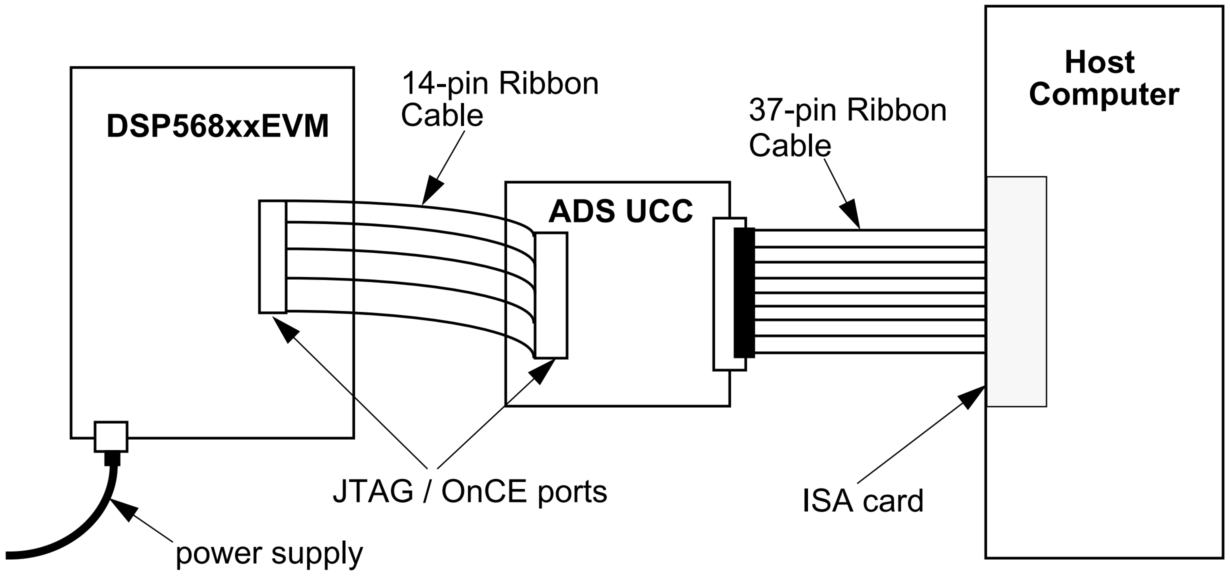
   Ensure that the red stripe on the ribbon cable corresponds to pin 1 on the DSP568xxEVM card.
3. Connect the 14-pin female connector at the other end of the cable to the 14-pin JTAG male connector on the DSP568xxEVM card.

Ensure that the red stripe on the ribbon cable corresponds to pin 1 on the DSP568xxEVM card.

4. Plug in the power supply into a wall socket.
5. Connect the power supply to the power connector on the DSP568xxEVM card.

   The green LED next to the power connector lights up. The board is now connected.

Figure 2.9 Complete Setup for ADS UCC Setup



Using Serial Port to connect DSP568L811 Board

Connect the serial port cable and Motorola DSP568L811 board to your computer as described below.

Connecting the Serial Port Cable to DSP568L811EVM Board

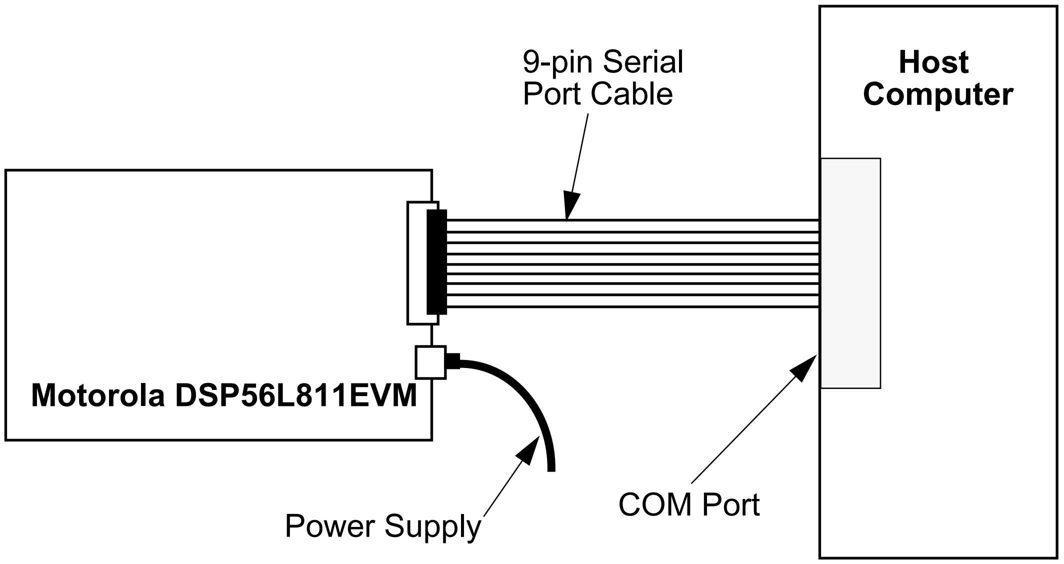
1. Arrange all the jumpers as shown in Table 2.7.

Table 2.7 Motorola DSP56L811EVM Jumper Settings

Jumper location	Settings Known to Work With CodeWarrior IDE for DSP56800
JG1	1-2 CLOSED; 3-4 OPEN
JG2	1-2 CLOSED; 3-4 OPEN
JG3	1-2 OPEN; 3-4 CLOSED
JG4	1-2 CLOSED; 3-4 OPEN
JG5	1-2, 3-4, 5-6, and 7-8 CLOSED
JG6	1-2 OPEN
JG7	1-3, 2-4 CLOSED, 5-6 OPEN
JG8	1-2 OPEN
JG9	2-3 CLOSED
JG10	1-2 OPEN
JG11	1-2 CLOSED
JG12	1-2 OPEN

2. Connect the 9-pin female connector at one end of a 9-pin serial cable to the 9-pin male connector on your computer.
3. Connect the 9-pin male connector at the other end of the serial cable to the 9-pin female connector on the DSP56L811EVM card (Figure 2.10).

Figure 2.10 Connecting the DSP56L811EVM Card to Serial Port



4. Plug in the power supply into a wall socket.
5. Connect the power supply to the power connector on the DSP56L811EVM card.

   The green LED next to the power connector lights up. The board is now connected.

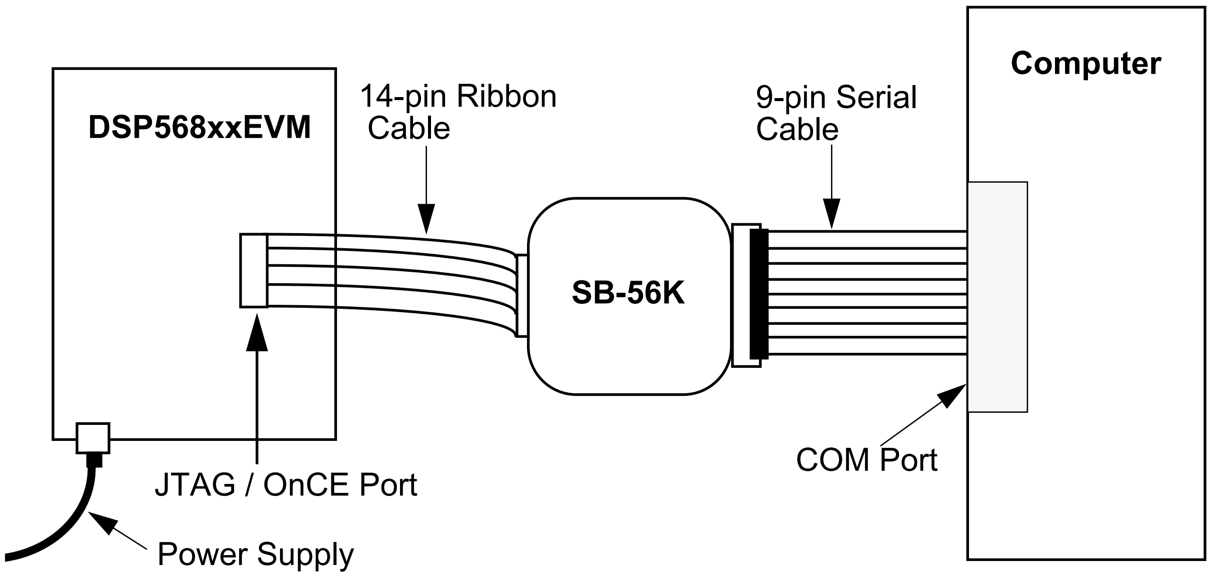
Using the Domain Technologies SB-56K

Connect the Domain Technologies SB-56K Multi-DSP Emulator and your Motorola DSP568xxEVM board to your computer:

Connect the Domain Technologies SB-56K

1. Locate an empty 9-pin COM port on your computer.
2. Connect one end of a 9-pin female serial cable to the 9-pin male connector on your computer (Figure 2.11).

Figure 2.11 Connecting the DSP568xxEVM to SB-56K



3. Connect the 9-pin male connector at the other end of the serial cable to the 9-pin female connector on the SB-56K Emulator.
4. Locate the 14-pin ribbon cable hanging from the SB-56K Emulator. Connect the 14-pin female connector of the ribbon cable to the 14-pin JTAG male connector on the DSP568xxEVM board.

   Ensure that the red stripe on the ribbon cable corresponds to pin 1 on the DSP568xxEVM card.
5. Plug in the power supply into a wall socket.

3

Development Tools

Programming for a DSP56800 board is like programming for any other platform target. If you have never used the CodeWarrior IDE™ before, familiarize yourself with these tools:

- CodeWarrior IDE
- CodeWarrior Compiler Architecture
- CodeWarrior Assembler for DSP56800
- CodeWarrior Linker for DSP56800
- CodeWarrior Debugger for DSP56800

If you are an experienced CodeWarrior IDE user, review the DSP56800 runtime software environment.

Tools Overview

CodeWarrior IDE

The CodeWarrior IDE allows you create software applications. It controls the project manager, the source-code editor, the class browser, the compiler, linker, and the debugger.

In the project manager, you can organize all the files and settings related to your project so that you can see your project at a glance and navigate among your source-code files. The CodeWarrior IDE automatically manages build dependencies.

A project can have multiple "build targets." A build target is a separate build (with its own settings) that uses some or all of the files in the project. For example, you can have both a debug version and a release version of your software as separate build targets within the same project.

The CodeWarrior IDE has an extensible architecture that uses plug-in compilers and linkers to target various operating systems and microprocessors. The CodeWarrior CD includes a C compiler for the DSP56800 family of processors. Other CodeWarrior software packages include C, C++, and Java compilers for Win32, Mac® OS, Linux, and other hardware and software combinations.

CodeWarrior Compiler for DSP56800

The CodeWarrior compiler for DSP56800 is an ANSI-compliant C compiler. This compiler is based on the same compiler architecture used in all CodeWarrior C compilers. When it is used together with the CodeWarrior linker for DSP56800, you can generate DSP56800 applications and libraries.

CodeWarrior Assembler for DSP56800

The CodeWarrior assembler for DSP56800 has an easy-to-use syntax. The CodeWarrior IDE assembles any file with an `.asm` extension in the project. For further information, refer to the *Assembler Reference Manual*.

CodeWarrior Linker for DSP56800

The CodeWarrior linker for Motorola DSP56800 is an Executable and Linker Format (ELF) linker. This linker lets you generate an ELF file (the default output file format) for your application. This linker also lets you generate an S-record output file for your application.

CodeWarrior Debugger for DSP56800

The CodeWarrior debugger controls your program’s execution and lets you see what happens internally as your program runs. You use the debugger to locate problems in your program’s execution.

The debugger can execute your program one statement at a time and suspend execution when control reaches a specified point. When the debugger stops a program, you can view the chain of function calls, examine and change the values of variables, and inspect the contents of the processor’s registers.

For general information about the debugger, including its general features and its visual interface, refer to the *IDE User Guide*.

The Development Process

While working with the CodeWarrior IDE, you proceed through the development stages familiar to all programmers: write code, compile and link code, and debug code. For complete information on performing tasks like editing, compiling, linking, and debugging, refer to the *IDE User Guide*.

The difference between the CodeWarrior IDE and traditional command-line environments is in how the software (in this case the IDE) helps you manage your work more effectively. If you are unfamiliar with an integrated development environment in general, or with the CodeWarrior IDE in particular, you will find the topics in this section helpful.

Read these topics to find out how using the CodeWarrior IDE differs from command-line programming:

- Project Files versus Makefiles
- Editing Code
- Compiling
- Linking
- Debugging
- Viewing Preprocessor Output

Project Files versus Makefiles

The CodeWarrior IDE *project* is analogous to a collection of makefiles because you can have multiple builds in the same project. For example, you can have one project that maintains both a debug version and a release version of your code. You can build either or both of these versions as you wish. Different builds within a single project are called “build targets.”

The IDE uses the project window to list the files in a project. A project can contain various types of files, such as source-code files and libraries.

You can add or remove files from a project. You can assign files to one or more build targets within the same project. These assignments let you manage files common to multiple build targets.

The IDE automatically handles the interdependencies between files, and it tracks which files have changed since the last build. When you rebuild a project, only those files that have changed are recompiled.

The IDE also stores compiler and linker settings for each build target. You can modify these settings by using the IDE or by using `#pragma` statements in your code.

Editing Code

The CodeWarrior IDE features a text editor designed for programmers. It handles text files in MS-DOS®/Windows, UNIX, and Mac OS formats.

To open and edit a source-code file or any other editable file in a project, use either of the following options:

- Double-click the file in the project window.
- Click the file. The file is highlighted. Drag the file to the Metrowerks CodeWarrrior IDE window.

The editor window has excellent navigational features that allow you to switch between related files, locate any particular function, mark any location within a file, or go to a specific line of code.

Compiling

You can compile any source-code file in the current build target. Select the source code file in the project window and then select **Project > Compile** from the menu bar of the Metrowerks CodeWarrior Window.

To compile all the files in the current build target that were modified since they were last compiled, select **Project > Bring Up To Date** from the menu bar of the Metrowerks CodeWarrior Window.

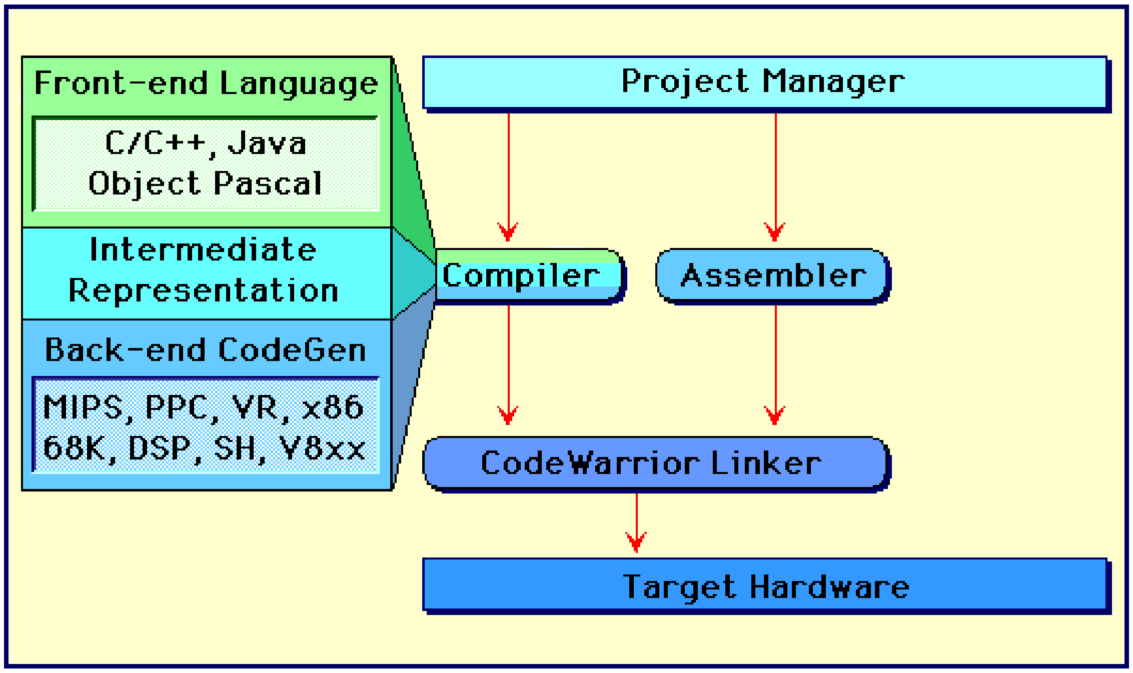
In UNIX and other command-line environments, object code compiled from a source-code file is stored in a binary file (a `.o` or

`.obj` file). On Windows targets, the CodeWarrior IDE stores and manages object files internally in the data folder.

CodeWarrior Compiler Architecture

A proprietary compiler architecture is at the heart of the CodeWarrior IDE. This architecture handles multiple languages and platform targets. Front-end language compilers generate an intermediate representation (IR) of syntactically correct source code. The IR is memory-resident and language-independent. Back-end compilers generate code from the IR for specific platform targets. The CodeWarrior IDE manages the whole process. The CodeWarrior IDE build system is depicted in Figure 3.1.

Figure 3.1 CodeWarrior Build System



As a result of this architecture, the CodeWarrior IDE uses the same front-end compiler to support multiple back-end platform targets. In some cases, the same back-end compiler can generate code from a variety of languages.Users derive significant benefit from this architecture. For example, an advance in the C/C++ front-end compiler means an immediate advance in all code generation. Optimizations in the IR mean that any new code generator is highly optimized. Targeting a new processor does not require compiler-related changes in the source code, so porting is much simpler.

All compilers are built as plug-in modules. The compiler and linker components are modular plug-ins. Metrowerks publishes this API, allowing developers to create custom or proprietary tools. For more information, go to the Metrowerks Support on the World Wide Web at this URL:

```
http://www.metrowerks.com/support
```

Once the compiler generates object code, the plug-in linker generates the final executable file. Multiple linkers are available for some platform targets to support different object-code formats.

Linking

Linking object code into a final binary file is easy: select **Project > Make** from the menu bar of the Metrowerks CodeWarrior Window. The `Make` command brings the active project up to date, then links the resulting object code into a final output file.

The IDE controls the linker through linker command files. There is no need to specify a list of object files; the Project Manager tracks all the object files automatically. You can also use the Project Manager to specify link order. The **M56800 Target** settings panel lets you set the name of the final output file.

Debugging

To debug a project, select **Project > Debug** from the menu bar of the Metrowerks CodeWarrior Window.

Viewing Preprocessor Output

To view preprocessor output, select the file in the project window and click **Project > Preprocess** from the main menu. The CodeWarrior IDE displays a window that shows you what your file looks like after going through the preprocessor.

You can use this feature to track down bugs caused by macro expansion or other subtleties of the preprocessor.

4

Tutorial

This chapter gives you a quick start at learning how to use the CodeWarrior™ IDE for DSP56800.

CodeWarrior IDE for DSP56800 Tutorial

This chapter provides a tour of the software development environment of the CodeWarrior IDE for DSP56800. You will learn how to use the tools to program for DSP56800 boards.

This tutorial introduces you to many important elements of the CodeWarrior IDE that you will use when programming for DSP56800. However, the tutorial does not cover or explain all the features of the IDE.

You will learn how to create, compile, and link code that runs on DSP56800 systems.

If you are already familiar with the CodeWarrior software, read through the steps in this tutorial anyway. You will encounter the DSP56800 compiler and linker for the first time, as well as other features specific to DSP56800 application development.

This tutorial is divided into segments. In each segment, you will perform steps that introduce you to the critical elements of the CodeWarrior IDE programming environment. The segments are:

- Creating a Project
- Working with the Debugger

Creating a Project

In this section of the tutorial, you work with the CodeWarrior IDE to create a project.

You will start using a project stationery. A project stationery file is a template that describes a pre-built project, complete with source-code files, libraries, and all the appropriate compiler and linker settings. When you create a project based on stationery, the stationery is duplicated and becomes the basis of your new project.

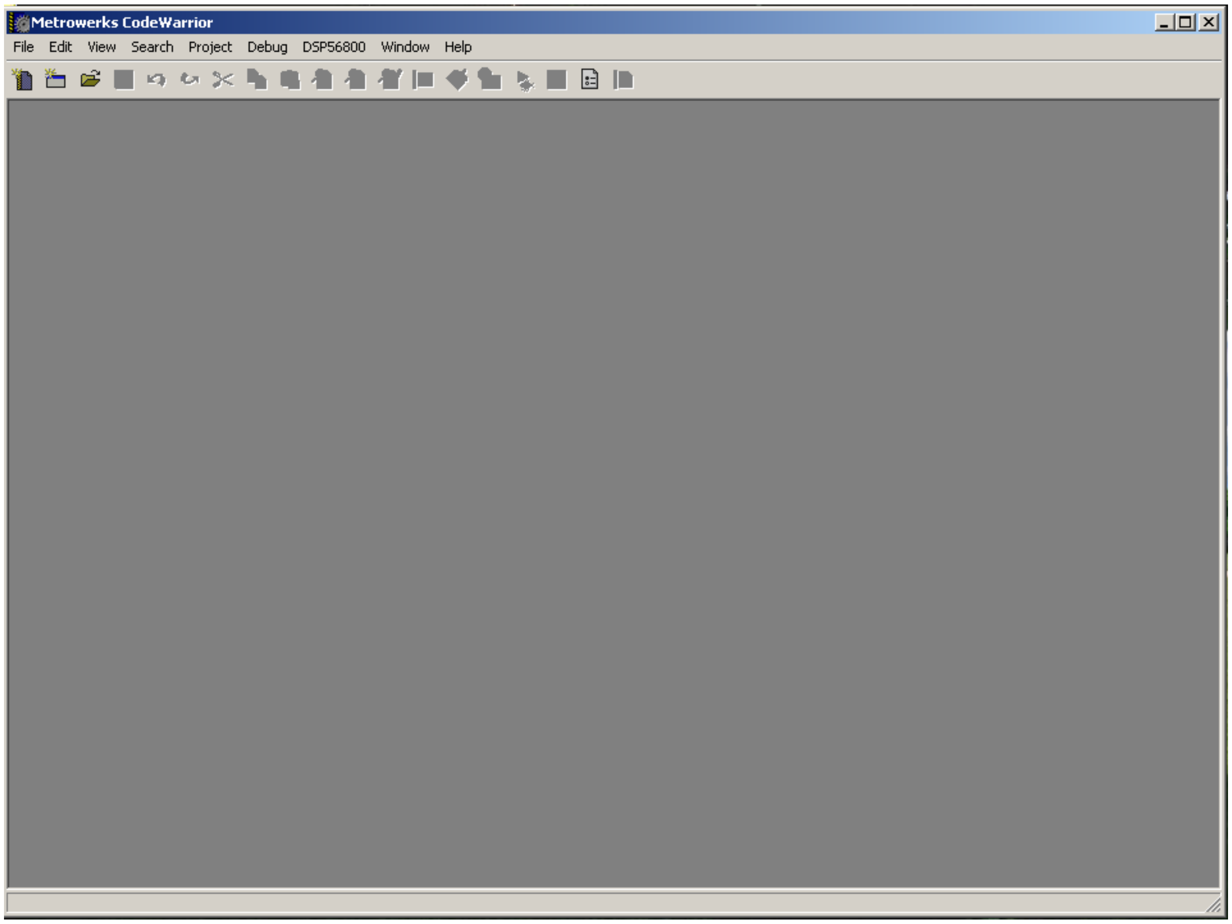
You can create customized project stationery as well. Project stationery is a useful feature of the CodeWarrior IDE.

Practice working with a sample project as follows:

1. Launch the CodeWarrior IDE.

   The Metrowerks CodeWarrior window appears with a menu bar at the top (Figure 4.1).

Figure 4.1 Metrowerks CodeWarrior Window

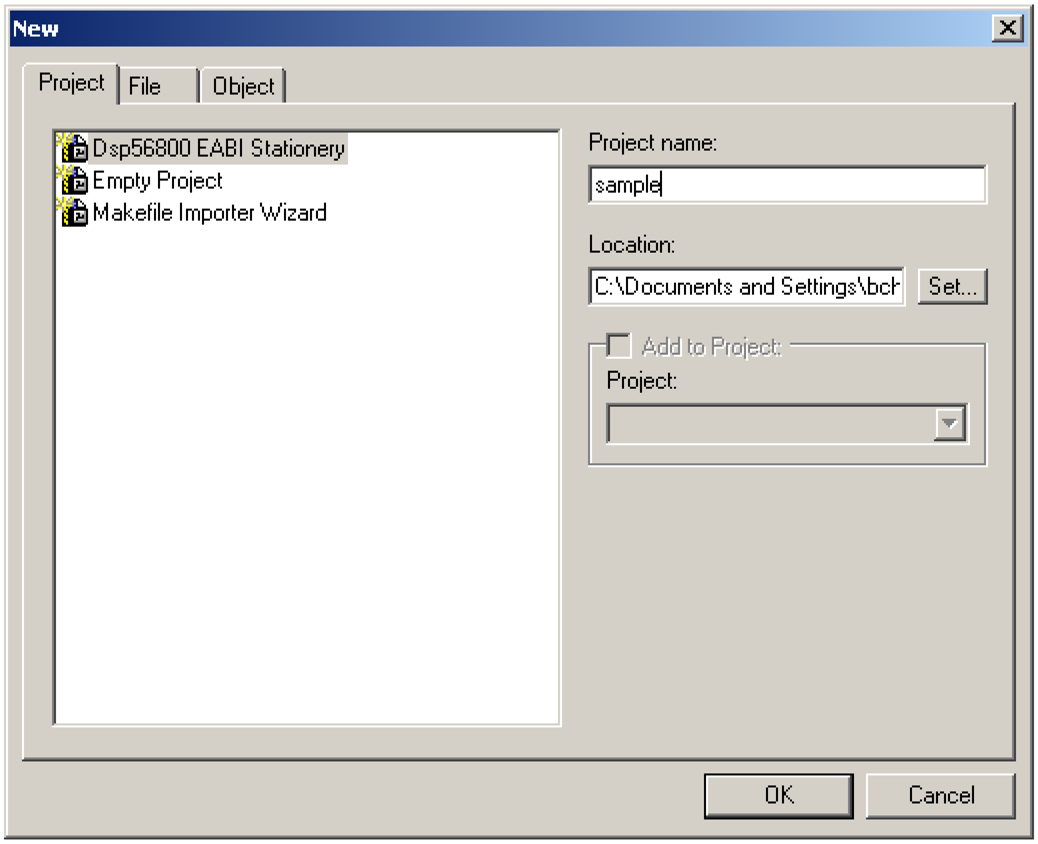


Create a new project from project stationery:

1. From the menu bar of the Metrowerks CodeWarrior window, select **File > New**.

   The **New** window appears with a list of options in the **Project** tab (Figure 4.2).

Figure 4.2 New Window



2. Select **DSP56800 EABI Stationery** in the **Project** tab.

NOTE To create a new project without using stationery, select **Empty Project** in the **New** window. This option lets you create a project from scratch. If you are a beginner, do not use an empty project because of the complexities involved in using the correct libraries and files and selecting the correct build target settings.

3. Type a name in the **Project name** field (in this tutorial use "sample" as the name).

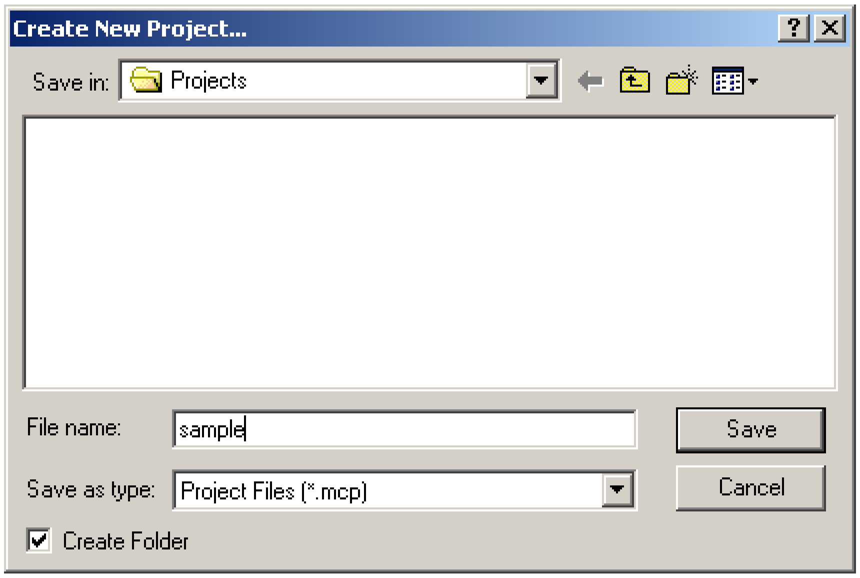
The CodeWarrior IDE adds the `.mcp` extension automatically to your file when the project is saved. The `.mcp` extension allows any user to recognize the file as a Metrowerks CodeWarrior project file. In this tutorial, the file name is `sample.mcp`.

4. Set the location for the project use.

   If you want to change the default location, perform the following steps:

   a. In the **New** window, click the **Set** button. The **Create New Project** dialog box (Figure 4.3) appears:

Figure 4.3 Create New Project Dialog Box



File name: sample
Save as type: Project Files (*.mcp)
☑ Create Folder

   b. Use the standard navigation controls in the **Create New Project** dialog box to specify the path where you want the project file to be saved.

   c. Click the **Save** button. The CodeWarrior IDE closes the **Create New Project** dialog box.

   If you want to use the default location for your project, go to step 5.

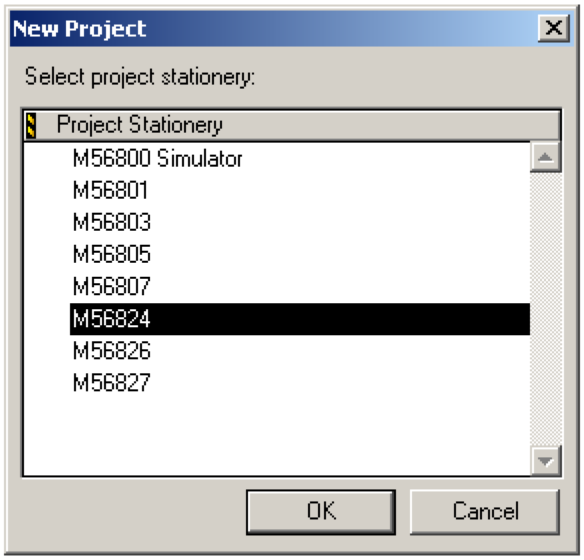
   In either case, the CodeWarrior IDE creates a folder with the same name as your project in the directory you select.

NOTE Enable the **Create Folder** checkbox in the **Create New Project** file dialog box to create a new folder for your project in the selected location.

5. Click **OK** in the **New** window.

   The **New Project** window appears (Figure 4.4) with a list of board-specific project stationeries.

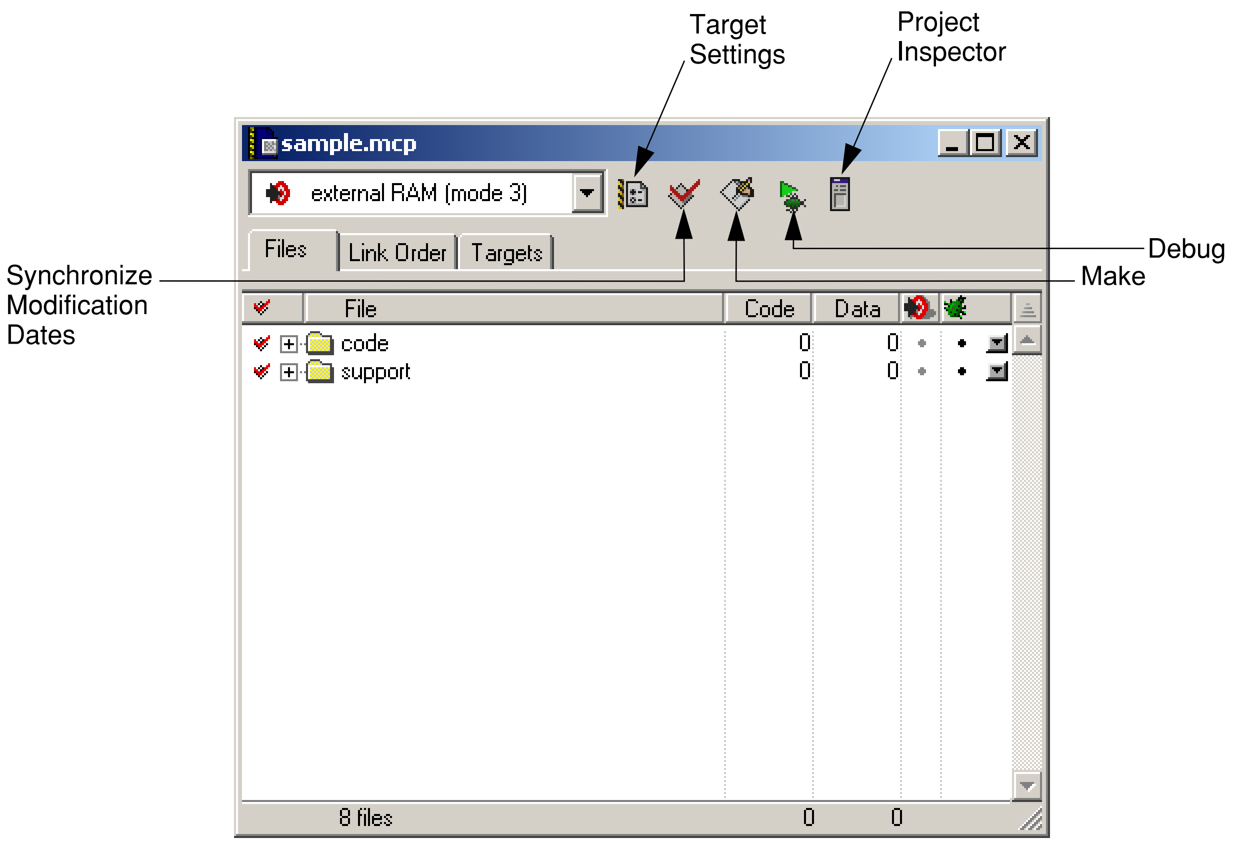
Figure 4.4 New Project Window



6. Select **M56824** as the Project Stationery for your target.
7. Click **OK** in the **New Project** window.

   A project window appears (Figure 4.5). This window displays all the files and libraries that are part of the project stationery.

Figure 4.5 CodeWarrior Project Window



The project window is the central location from which you control development. You can use this window to:

- Add or remove source files
- Add libraries of code
- Compile code
- Generate debugging information and much more

8. View a source file.

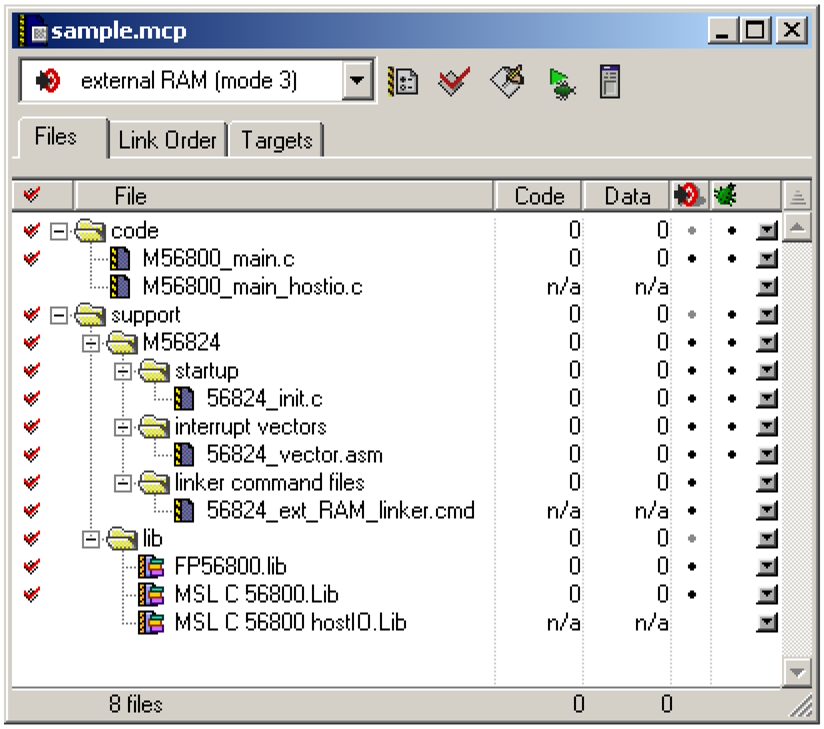
   a. Select the **Files** tab in the project window.

   b. Open source and startup files.

   Hierarchical controls are displayed next to folders (groups) in the project window. You can expand or collapse a view.

Click the hierarchical controls next to `'code'` and `'support'` to expand and view their contents (Figure 4.6).

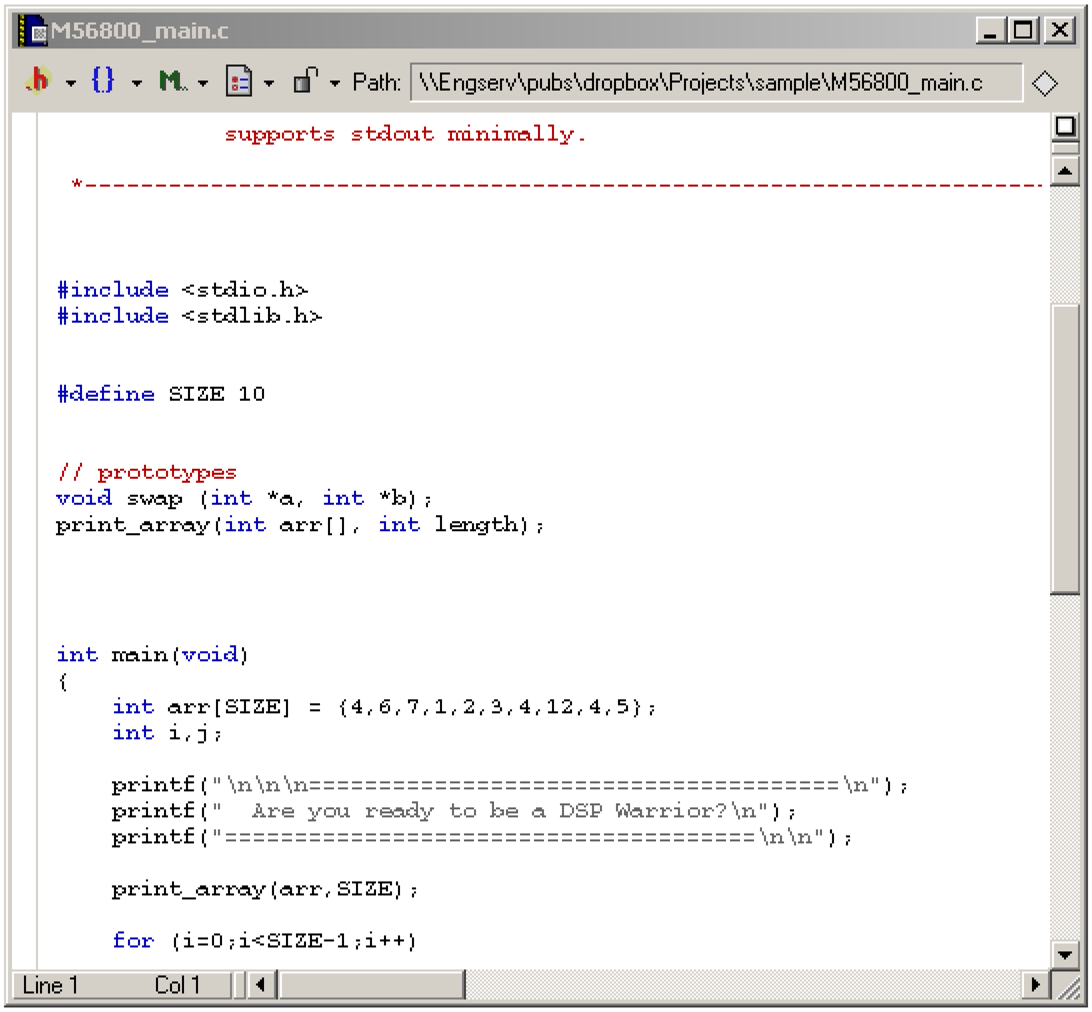
Figure 4.6 CodeWarrior Project Window with Expanded Hierarchical Folders



✓	File	Code	Data			
✓	code	0	0	•	•	
✓	M56800_main.c	0	0	•	•	
	M56800_main_hostio.c	n/a	n/a			
✓	support	0	0	•	•	
✓	M56824	0	0	•	•	
✓	startup	0	0	•	•	
✓	56824_init.c	0	0	•	•	
✓	interrupt vectors	0	0	•	•	
✓	56824_vector.asm	0	0	•	•	
✓	linker command files	0	0	•		
✓	56824_ext_RAM_linker.cmd	n/a	n/a	•		
✓	lib	0	0	•		
✓	FP56800.lib	0	0	•		
✓	MSL C 56800.Lib	0	0	•		
	MSL C 56800 hostIO.Lib	n/a	n/a			
	8 files	0	0			

c. Double-click the **M56800_main.c** file in the project window, the source code in the file is displayed in a CodeWarrior source-code editor window (Figure 4.7).

Figure 4.7 CodeWarrior Editor Window



```
                supports stdout minimally.

  *-----------------------------------------------------------------------



#include <stdio.h>
#include <stdlib.h>


#define SIZE 10


// prototypes
void swap (int *a, int *b);
print_array(int arr[], int length);




int main(void)
{
    int arr[SIZE] = {4,6,7,1,2,3,4,12,4,5};
    int i,j;

    printf("\n\n\n======================================\n");
    printf("  Are you ready to be a DSP Warrior?\n");
    printf("======================================\n\n");

    print_array(arr,SIZE);

    for (i=0;i<SIZE-1;i++)
```

9. Set the build target.

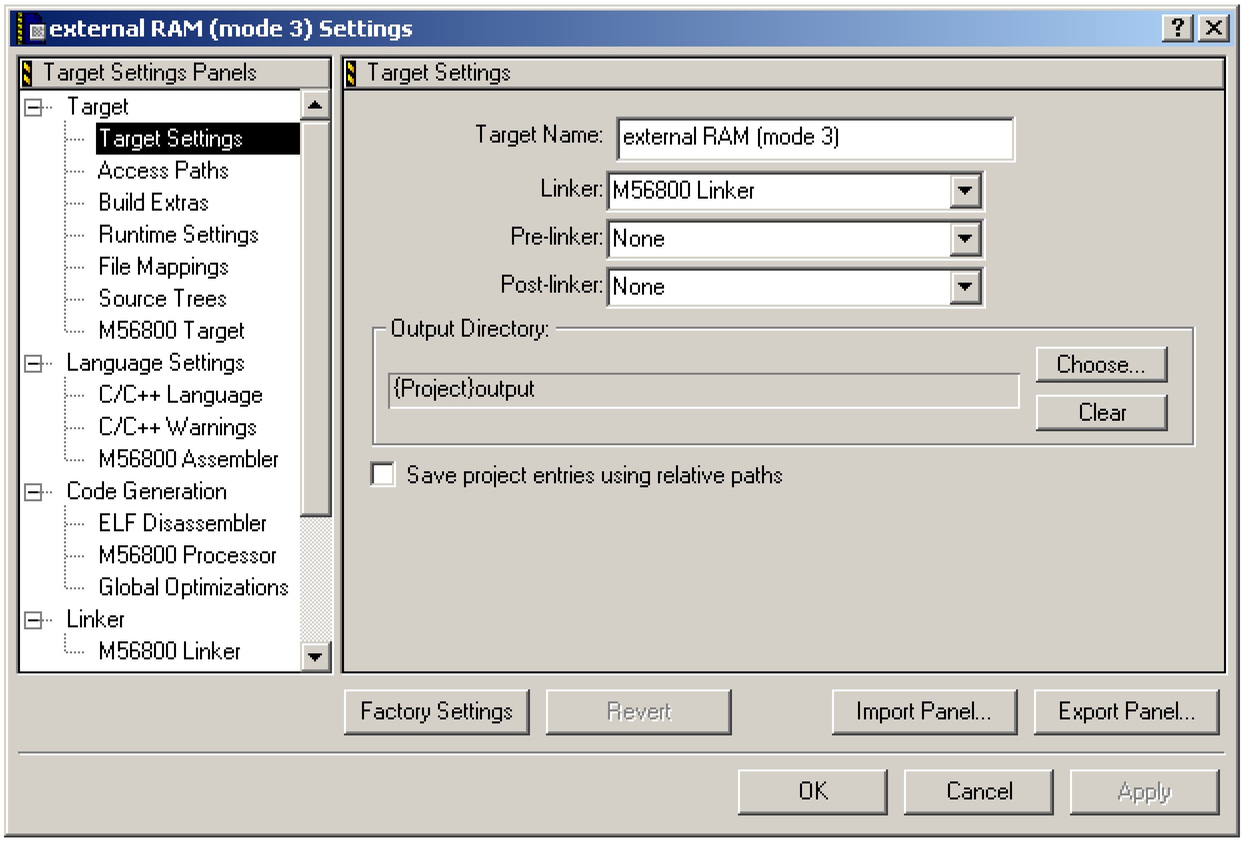
   The CodeWarrior IDE allows you to write code for a variety of microprocessors and operating systems. These are called “build targets.” When you work with a new CodeWarrior project, the first thing you do is specify what your build target is.

   a. To specify a build target, double-click the **Settings** icon in the Project window (see Figure 4.5 for location of icons in the Project window).

      The **Target Settings** window {**external RAM (mode 3) Settings** in sample} appears (Figure 4.8).

This window contains several different panels. In Figure 4.8, the **Target Settings *Panels*** is displayed in the **Target Settings** window.

Figure 4.8 Target Settings Window



Target Name: external RAM (mode 3)
Linker: M56800 Linker
Pre-linker: None
Post-linker: None
Output Directory: {Project}output
[ ] Save project entries using relative paths

b. If it is not already visible, click **Target** from the tree structure in the **Target Settings Panels pane to expand the hierarchical view**.

c. Click **Target Settings** from the hierarchical tree.

The **Target Settings** panel appears which displays all the options related to selecting a build target.

If you select **M56800 Linker** from the **Linker** list box, the CodeWarrior IDE recognizes that the code you are writing is intended for DSP56800 processors.

The **Target Settings** window is the location for all options related to the build target. Every panel and option is explained in the CodeWarrior documentation. Most of the general settings panels are explained in the *IDE User Guide*. DSP56800 target-specific panels are explained in this targeting manual.

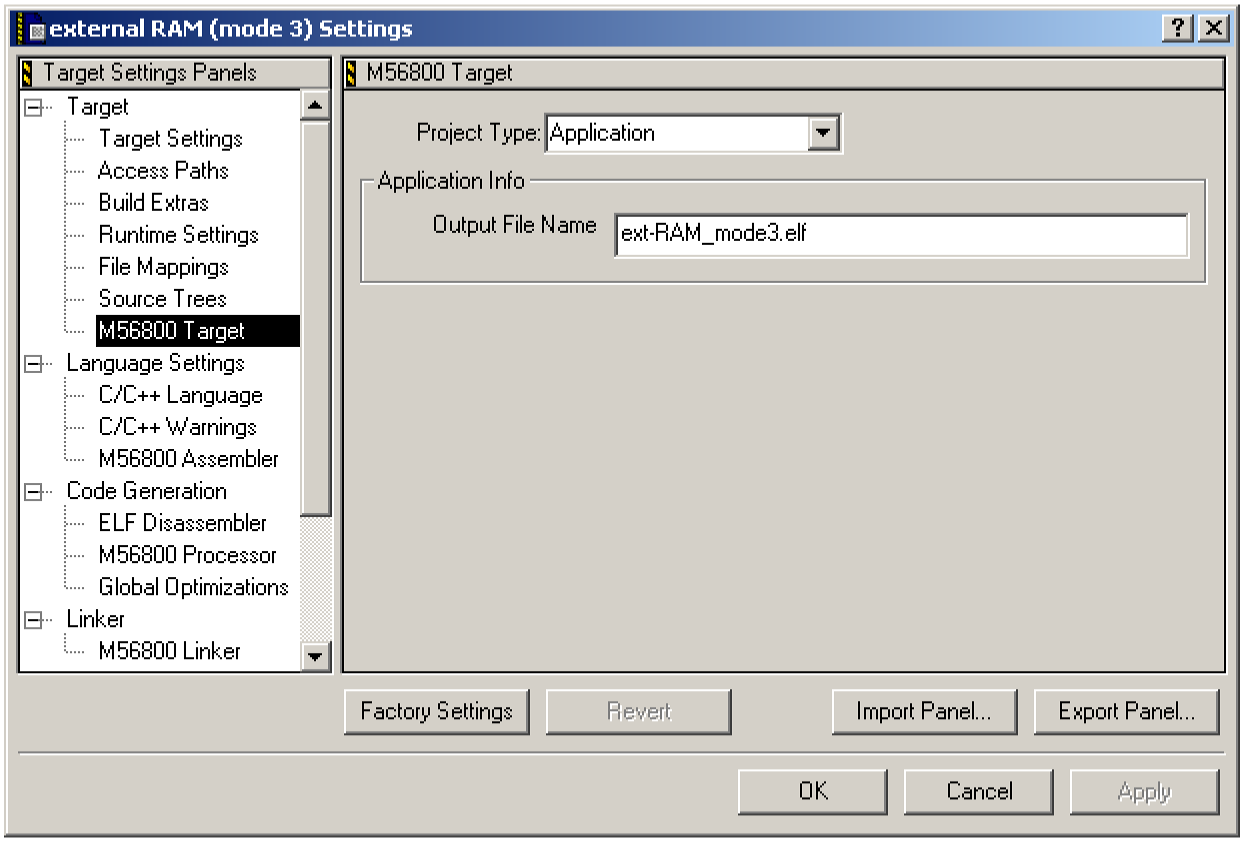
10.Set build target options:

a. In the **Target Settings Panels** panel, click **M56800 Target** in the tree structure to expand the hierarchical view.

b. Click **M56800 Target Settings** from the hierarchical tree.

The **M56800 Target Settings** panel appears (Figure 4.9).

Figure 4.9 M56800 Target Settings Panel



Project Type: Application

Output File Name: ext-RAM_mode3.elf

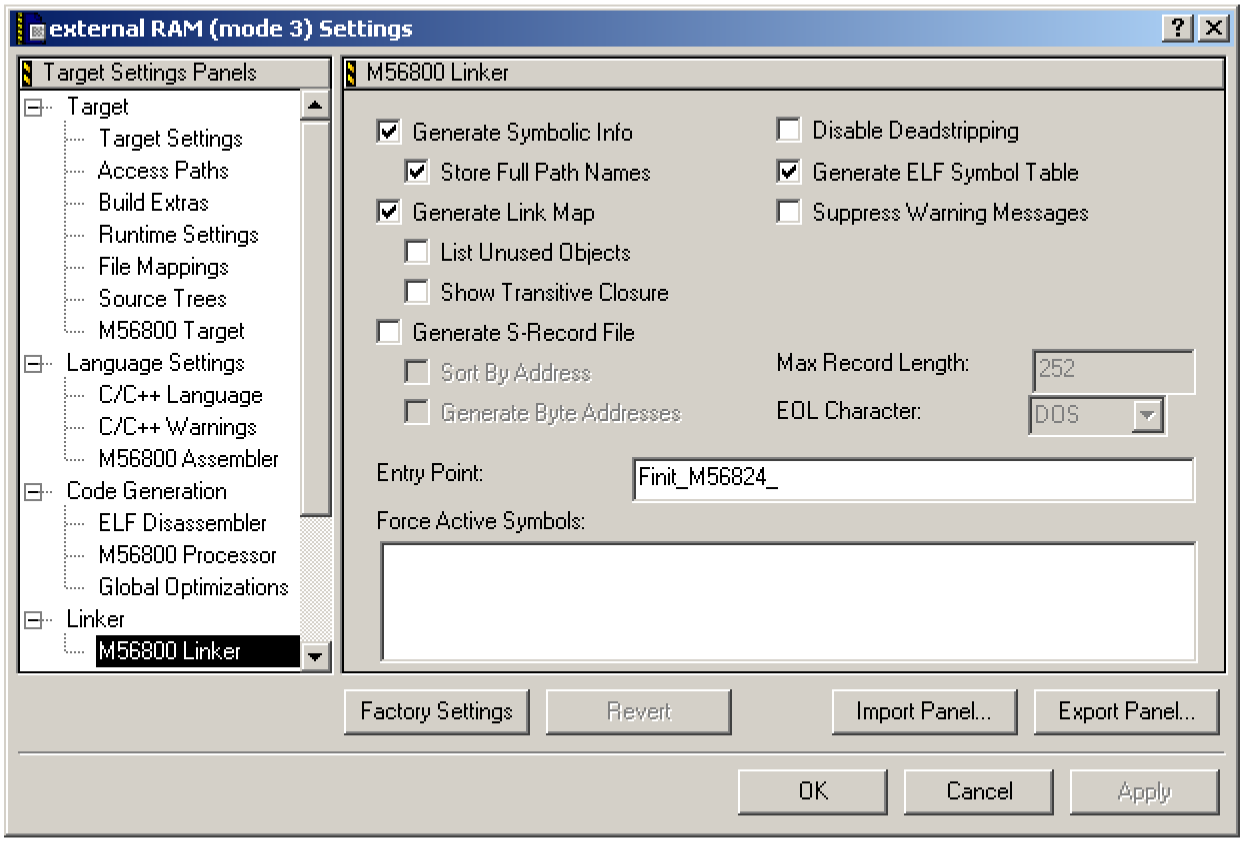
11.Set linker options.

a. In the **Target Settings Panels** pane, click **Linker** in the tree structure to expand the hierarchical view.

b. Click **M56800 Linker** from the hierarchical tree.

The **M56800 Linker** panel appears (Figure 4.10).

Figure 4.10 M56800 Linker Settings



M56800 Linker

- [✓] Generate Symbolic Info
- [✓] Store Full Path Names
- [✓] Generate Link Map
- [ ] List Unused Objects
- [ ] Show Transitive Closure
- [ ] Generate S-Record File
- [ ] Sort By Address
- [ ] Generate Byte Addresses
- [ ] Disable Deadstripping
- [✓] Generate ELF Symbol Table
- [ ] Suppress Warning Messages

Max Record Length: 252
EOL Character: DOS
Entry Point: Finit_M56824_
Force Active Symbols:

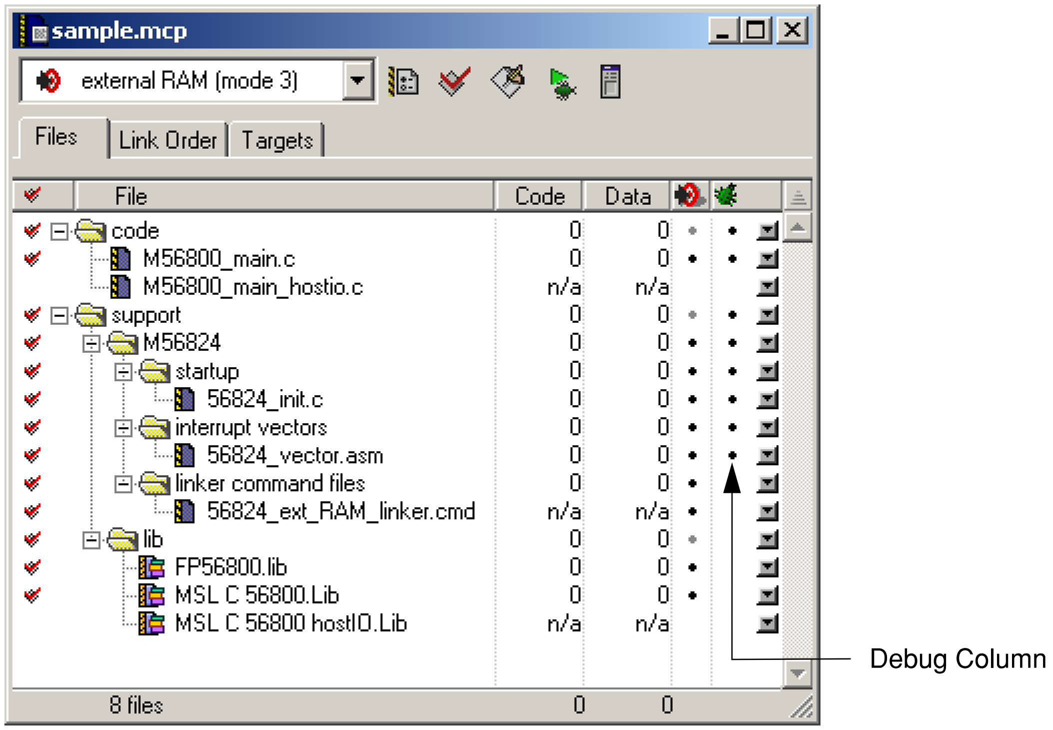
12.Examine the default settings and select the options according to your requirements. Close the **Target Settings** window when you are finished by clicking the **OK** button.

13.Generate debugging information.

For the debugger to work, it needs certain information from the CodeWarrior IDE so that it can connect object code to source code. You must instruct the CodeWarrior IDE to produce this information.

There is a debug-related column in the project window (Figure 4.11). Every file, for which the IDE generates debugging information, has a dot in the Debug column. To enable symbolic information for a file, click the Debug column next to the file. A dot appears confirming that debugging information is generated for that file.

Figure 4.11 Turning on Debugging Per File



✓	File	Code	Data		
✓	code	0	0	·	●
✓	M56800_main.c	0	0	●	●
	M56800_main_hostio.c	n/a	n/a		
✓	support	0	0	·	●
✓	M56824	0	0	●	●
✓	startup	0	0	●	●
✓	56824_init.c	0	0	●	●
✓	interrupt vectors	0	0	●	●
✓	56824_vector.asm	0	0	●	●
✓	linker command files	0	0	●	
✓	56824_ext_RAM_linker.cmd	n/a	n/a	●	
✓	lib	0	0	·	
✓	FP56800.lib	0	0	●	
✓	MSL C 56800.Lib	0	0	●	
	MSL C 56800 hostIO.Lib	n/a	n/a		
	8 files	0	0		

14.Compile the code using either of the following options:

- From the menu bar of the Metrowerks CodeWarrior window, select **Project > Make**.
- In the project window, double-click the **Make** icon.

  The above step updates all files that need to be compiled and re-linked in the project. The IDE tracks these dependencies automatically.

NOTE The **Make** command in the menu bar of the Metrowerks CodeWarrior window compiles selected files, not all changed files. The **Bring Up To Date** command in the menu bar compiles all changed files, but does not link the project into an executable.

When you select the `Make` command, the IDE compiles all of the code. This may take some time as the IDE locates the files, opens them, and generates the object code. When the compiler completes the task, the linker creates an executable from the objects. You can see the compiler's progress in the project window and in the toolbar.

Editing the Contents of a Project

To change the contents of a project:

1. Add source files to the project.

   Most stationery projects contain source files that act as placeholders. Replace these placeholders with your own files.

   To add files, use one of the following options:

- From the menu bar of the Metrowerks CodeWarrior window, select **Project > Add Files**.
- Drag files from the desktop or Windows Explorer to the project window.

  To remove files:

  a. Select the files in the project window that you want to delete.

  b. Press the **Backspace** or **Delete** key.

2. Edit code in the source files.

   Use the IDE's source-code editor to modify the content of a source-code file. To open a file for editing, use either of the following options:

- Double-click the file in the project window.
- Select the file in the project window and press **Enter**.

  Once the file is open, you can use all of the editor's features to work with your code.

You have now been introduced to the major components of CodeWarrior IDE for DSP56800, except for the debugger. You are now familiar with the project manager, source code editor, and settings panels.

Working with the Debugger

In this section, you will explore the CodeWarrior debugger.

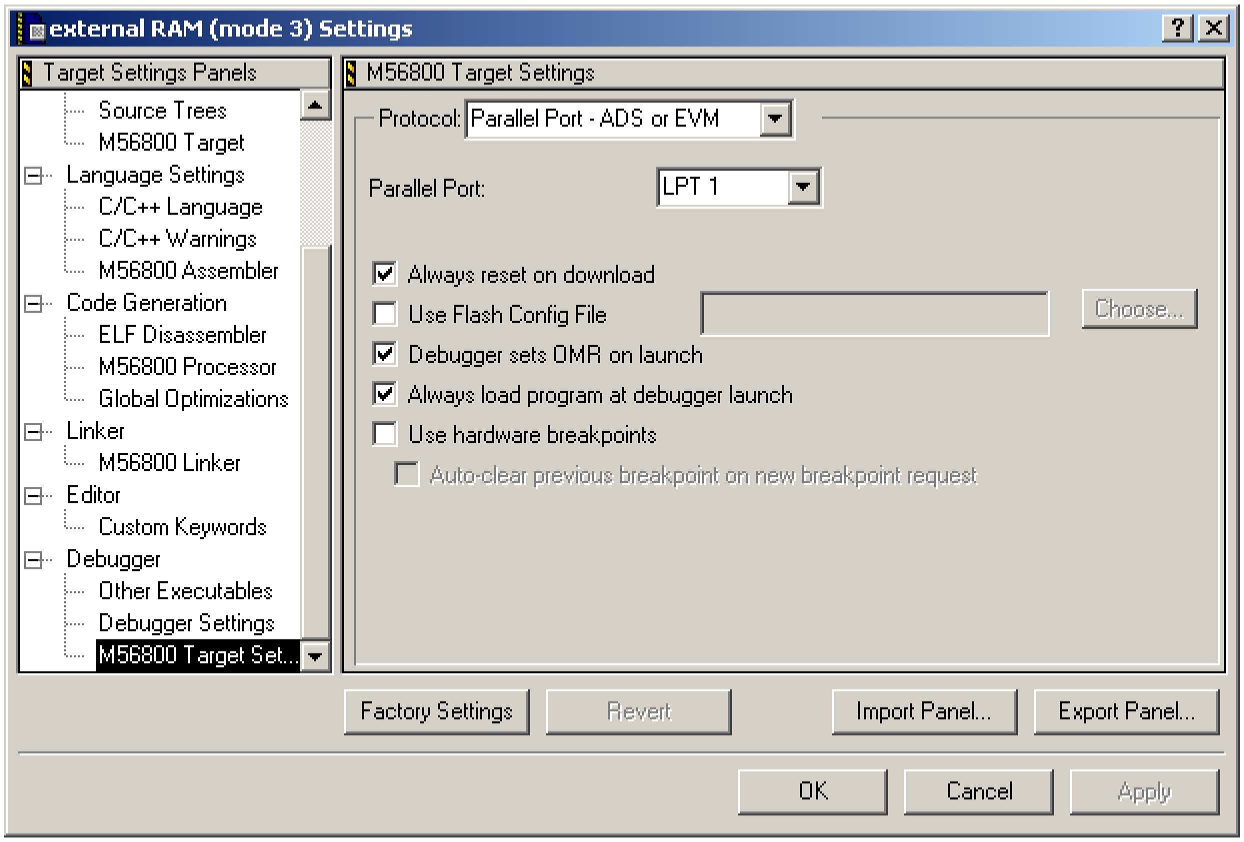
This tutorial assumes that you have already started the CodeWarrior IDE and have opened a sample project.

NOTE CodeWarrior IDE automatically enables the debugger and sets debugger-related settings within the project.

3. Access the **Target Settings** window (Figure 4.9).
4. Set debugger options.
   a. In the **Target Settings Panels** pane, click **Debugger** in the tree structure to expand the hierarchical view.
   b. Click **M56800 Target Settings** from the hierarchical tree

   The **M56800 Target Settings** panel appears (Figure 4.12).

Figure 4.12 Selecting Debugger Settings



external RAM (mode 3) Settings

Target Settings Panels
- Source Trees
- M56800 Target
- Language Settings
  - C/C++ Language
  - C/C++ Warnings
  - M56800 Assembler
- Code Generation
  - ELF Disassembler
  - M56800 Processor
  - Global Optimizations
- Linker
  - M56800 Linker
- Editor
  - Custom Keywords
- Debugger
  - Other Executables
  - Debugger Settings
  - M56800 Target Set...

M56800 Target Settings

Protocol: Parallel Port - ADS or EVM

Parallel Port: LPT 1

- [x] Always reset on download
- [ ] Use Flash Config File
- [x] Debugger sets OMR on launch
- [x] Always load program at debugger launch
- [ ] Use hardware breakpoints
- [ ] Auto-clear previous breakpoint on new breakpoint request

5. Select the correct protocol in the **M56800 Settings Panel**:

- **ADS Command Converter**

Select the **ADS Command Converter** protocol if you are using the ADS Universal Command Converter (UCC).

- **Serial - EVM**

  Select the **Serial - EVM** protocol if you are only using the DSP56L811EVM board with serial interface.

- **Serial - SB56K**

  Select the **Serial - SB56K** protocol if you are using the Domain Technologies SB-56K Multi-DSP Emulator.

- **Parallel Port - ADS or EVM**

  Select the **Parallel Port - ADS or EVM** protocol if **you are using the external** Motorola Suite56™ Parallel Command Converter or the **on-board parallel port interface of the EVM board.**

- **Simulator**

  Select the **Simulator** protocol if you want to run your code on the DSP56800 Simulator instead of downloading the code to actual hardware.

- PCI

  Select the **PCI** protocol if you are using the Motorola Suite56™ PCI Command Converter.

- Ethernet

  Select the **Ethernet** protocol if you are using the Motorola Suite56™ Ethernet Command Converter.

- Command Converter Server

  Select the **Command Converter Server** protocol if you want to debug a target with a complex chain locally or to debug remotely.

6. **Set protocol specific options:**

- **Parallel Port - ADS or EVM**

  Select from LPT1, LPT2, LPT3, or LPT4 depending on which parallel port you have used to connect the DSP568xxEVM card.

- **Serial - EVM or SB56K**

Select from COM 1, COM 2, COM 3, or COM 4, depending on which serial port you used to connect the DSP56L811EVM card or SB-56K Emulator.

- **ADS Command Converter**

  Select the ADS Base Address, which is either `0x100`, `0x200`, or `0x300`, depending on the address of the ISA ADS card.

- **Simulator**

  Select the **Simulator** to simulate the DSP56800 processor. The simulator allows selecting bandwidth for CPU usage. Options are Low, Medium, and High.

- **Always reset on download**

  Select this option to reset the board every time you download code to the board. If unchecked, the board is reset only before the initial download.

NOTE Note that this option is not displayed if you select **Simulator** from the **Protocol** menu.

7. Debug the project by using either of the following options:

- From the Metrowerks CodeWarrior window, select **Project > Debug**.
- Click the **Debug** button in the project window.

  This command instructs the IDE to compile and link the project. An ELF file is created in the process. ELF is the file format created by the CodeWarrior linker for DSP56800. The ELF file contains the information required by the debugger and prepared by the IDE. When you debug the project on DSP hardware, the debugger displays the following message:

  Resetting hardware. Please wait.

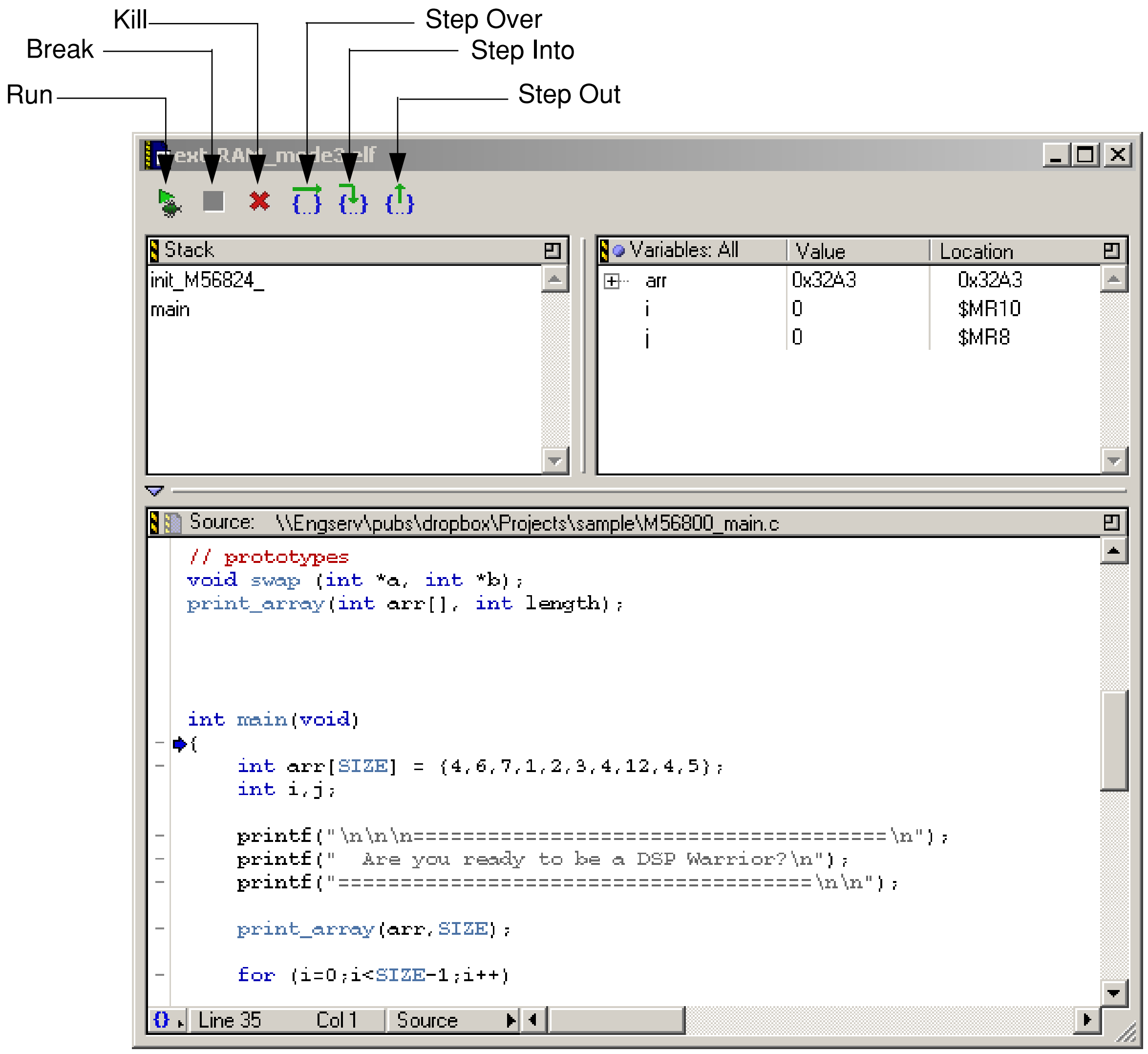
  This reset step occurs automatically only once per debugging session. To reset the boards manually, press the **Reset** button on your board. Next, the debugger displays this message:

  Downloadinging external RAM (mode 3) Settings .elf

  When the download to the board is complete, the IDE displays the **Program** window (**external RAM_mode 3 .elf** in sample) shown in Figure 4.13.

NOTE Source code is shown only for files that are in the project folder or that have been added to the project in the project manager, and for which the IDE has created debug information. You must navigate the file system in order to locate sources that are outside the project folder and not in the project manager, such as library source files.

Figure 4.13 Program Window



```
init_M56824_
main
```

Variables: All	Value	Location
arr	0x32A3	0x32A3
i	0	$MR10
j	0	$MR8

Source: \\Engserv\pubs\dropbox\Projects\sample\M56800_main.c

```
// prototypes
void swap (int *a, int *b);
print_array(int arr[], int length);



int main(void)
{
    int arr[SIZE] = {4,6,7,1,2,3,4,12,4,5};
    int i,j;

    printf("\n\n\n======================================\n");
    printf("  Are you ready to be a DSP Warrior?\n");
    printf("======================================\n\n");

    print_array(arr,SIZE);

    for (i=0;i<SIZE-1;i++)
```

8. Navigate through your code.

   The **Program** window has three panes:

- **Stack pane**

  The **Stack** pane shows the function calling stack.

- **Variables pane**

The **Variables** pane displays local variables.

- **Source pane**

  The **Source** panel displays source or assembly code.

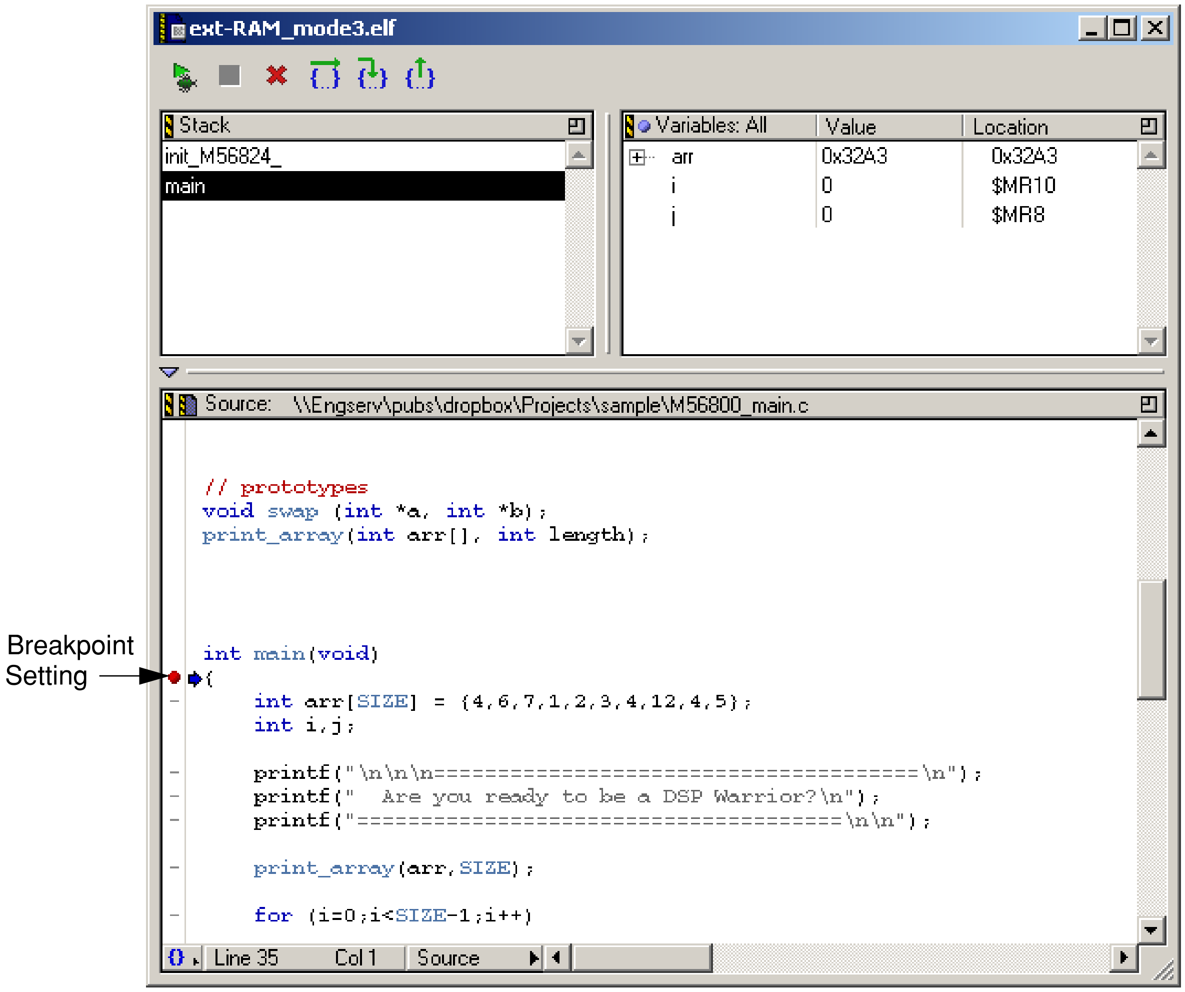
The toolbar at the top of the **Program** window has buttons that allows you access to the execution commands in the **Debug** menu.

9. Set breakpoints.

   a. Scroll through the code in the **Source** pane of the **Program** window until you come across the `main()` function.

   b. Click the gray dash in the far left-hand column of the window, next to the first line of code in the `main()` function. A red dot appears (Figure 4.14), confirming you have set your breakpoint.

Figure 4.14 Breakpoint in the Program Window



Stack
init_M56824_
main

Variables: All	Value	Location
arr	0x32A3	0x32A3
i	0	$MR10
j	0	$MR8

Source: \\Engserv\pubs\dropbox\Projects\sample\M56800_main.c

```
// prototypes
void swap (int *a, int *b);
print_array(int arr[], int length);



int main(void)
{
    int arr[SIZE] = {4,6,7,1,2,3,4,12,4,5};
    int i,j;

    printf("\n\n\n======================================\n");
    printf("  Are you ready to be a DSP Warrior?\n");
    printf("======================================\n\n");

    print_array(arr,SIZE);

    for (i=0;i<SIZE-1;i++)
```

Line 35 Col 1 Source

NOTE To remove the breakpoint, click the red dot. The red dot disappears.

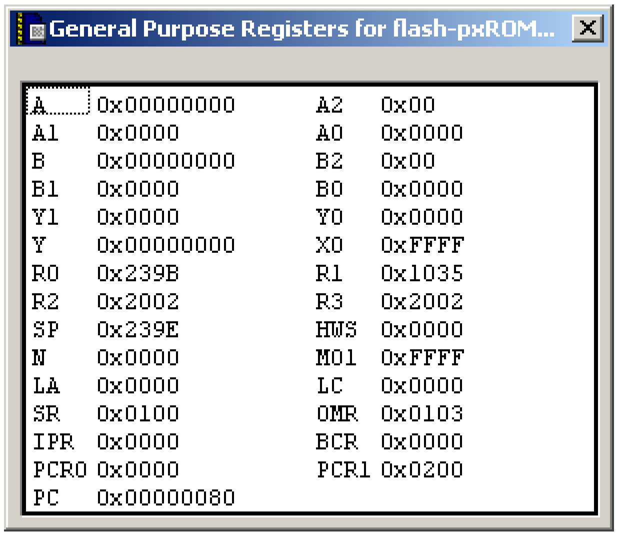
10.View and edit register values.

11.Registers are platform-specific. Different chip architectures have different registers.

a. **From the menu bar of the Metrowerks CodeWarrior window,** select **View > Registers.**

In this tutorial, the **General Purpose Registers** window appears (Figure 4.15).

Figure 4.15 General Purpose Registers for DSP56800



```
A     0x00000000       A2    0x00
A1    0x0000           A0    0x0000
B     0x00000000       B2    0x00
B1    0x0000           B0    0x0000
Y1    0x0000           Y0    0x0000
Y     0x00000000       X0    0xFFFF
R0    0x239B           R1    0x1035
R2    0x2002           R3    0x2002
SP    0x239E           HWS   0x0000
N     0x0000           M01   0xFFFF
LA    0x0000           LC    0x0000
SR    0x0100           OMR   0x0103
IPR   0x0000           BCR   0x0000
PCR0  0x0000           PCR1  0x0200
PC    0x00000080
```

b. To edit values in the register window, double-click a register value. Change the value as you wish.

12. View Data X:Memory.

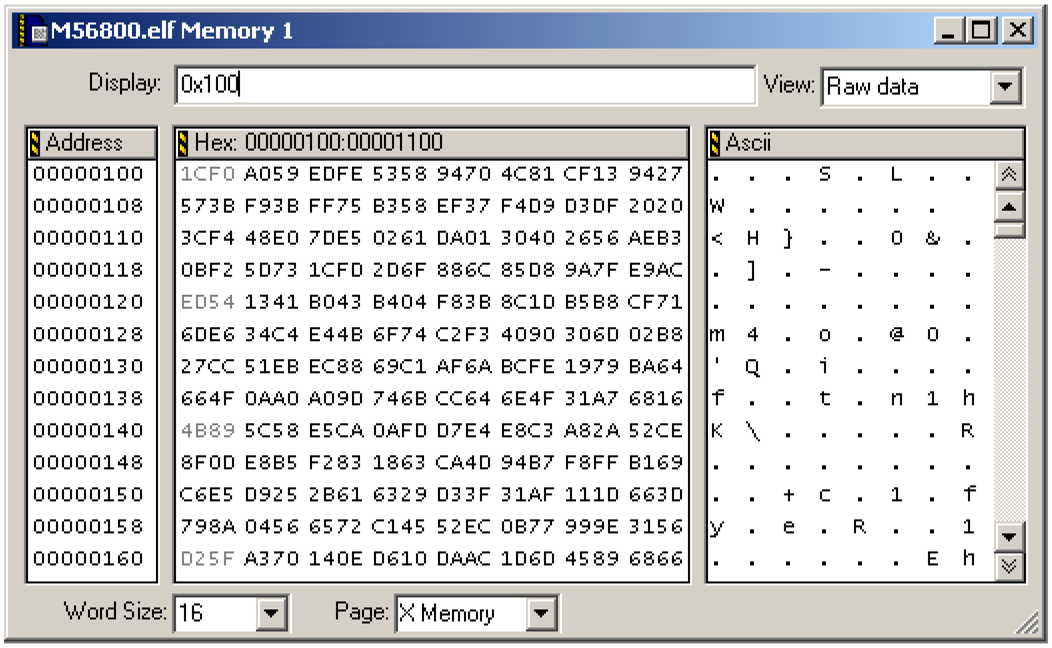
All variables reside at a specific memory address determined at runtime.

a. To view the memory address range of a variable, select **Data > View Memory from the menu bar of the Metrowerks CodeWarrior window**.

The **Memory** window appears (Figure 4.16).

b. Locate the **Page** list box at the bottom of the **View Memory** window. Select **X Memory** from the **Page** list box.

Figure 4.16 View X:Memory Window



```
Display: 0x100                                   View: Raw data

Address    Hex: 00000100:00001100                    Ascii
00000100   1CF0 A059 EDFE 5358 9470 4C81 CF13 9427   . . . S . L . .
00000108   573B F93B FF75 B358 EF37 F4D9 D3DF 2020   W . . . . . .
00000110   3CF4 48E0 7DE5 0261 DA01 3040 2656 AEB3   < H } . . 0 & .
00000118   0BF2 5D73 1CFD 2D6F 886C 85D8 9A7F E9AC   . ] . - . . . .
00000120   ED54 1341 B043 B404 F83B 8C1D B5B8 CF71   . . . . . . . .
00000128   6DE6 34C4 E44B 6F74 C2F3 4090 306D 02B8   m 4 . o . @ 0 .
00000130   27CC 51EB EC88 69C1 AF6A BCFE 1979 BA64   ' Q . i . . . .
00000138   664F 0AA0 A09D 746B CC64 6E4F 31A7 6816   f . . t . n 1 h
00000140   4B89 5C58 E5CA 0AFD D7E4 E8C3 A82A 52CE   K \ . . . . . R
00000148   8F0D E8B5 F283 1863 CA4D 94B7 F8FF B169   . . . . . . . .
00000150   C6E5 D925 2B61 6329 D33F 31AF 111D 663D   . . + c . 1 . f
00000158   798A 0456 6572 C145 52EC 0B77 999E 3156   y . e . R . . 1
00000160   D25F A370 140E D610 DAAC 1D6D 4589 6866   . . . . . . E h

Word Size: 16          Page: X Memory
```

13.Enter the memory address in the **Display** field.

Enter a hexadecimal address in standard C hex notation, for example, 0x100.

The window displays the contents of X: memory.

If you are using the EVM hardware, type the address, `0x2000` in the **Display** text field and press **Enter**. You see the memory starting at that location. This is the `DATA` section in the EVM board's memory. The memory address location for `DATA` (and `CODE`) are set in the Memory Segment and Sections Segment of the linker command file. Note that you see both the hexadecimal and ASCII values for X: memory. The contents of this window are editable as well.

14.View Data P:Memory.

a. To view the memory address range of a variable, select **Data > View Memory from the menu bar of the Metrowerks CodeWarrior window**.

The **Memory** window appears (Figure 4.17).

b. Locate the **Page** list box at the bottom of the **View Memory**. Select **P Memory** from the **Page** list box.

c. Using the **View** list box, you have the option to view four types of P:Memory:

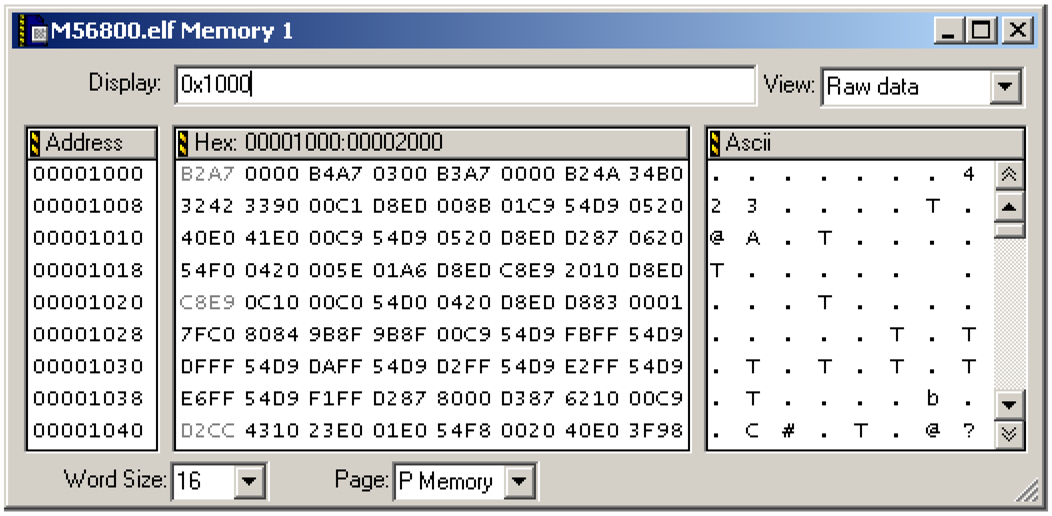
- Raw Data
- Disassembly
- Source
- Mixed

d. Enter the memory address in the **Display** field.

Enter a hexadecimal address in standard C hex notation, for example, 0x1000.

Figure 4.17 shows Raw Data.

Figure 4.17 View P:Memory Window



```
M56800.elf Memory 1

Display: 0x1000                                   View: Raw data

Address    Hex: 00001000:00002000                       Ascii
00001000   B2A7 0000 B4A7 0300 B3A7 0000 B24A 34B0      .  .  .  .  .  .  .  4
00001008   3242 3390 00C1 D8ED 008B 01C9 54D9 0520      2  3  .  .  .  .  T  .
00001010   40E0 41E0 00C9 54D9 0520 D8ED D287 0620      @  A  .  T  .  .  .  .
00001018   54F0 0420 005E 01A6 D8ED C8E9 2010 D8ED      T  .  .  .  .  .     .
00001020   C8E9 0C10 00C0 54D0 0420 D8ED D883 0001      .  .  .  T  .  .  .  .
00001028   7FC0 8084 9B8F 9B8F 00C9 54D9 FBFF 54D9      .  .  .  .  .  T  .  T
00001030   DFFF 54D9 DAFF 54D9 D2FF 54D9 E2FF 54D9      .  T  .  T  .  T  .  T
00001038   E6FF 54D9 F1FF D287 8000 D387 6210 00C9      .  T  .  .  .  .  b  .
00001040   D2CC 4310 23E0 01E0 54F8 0020 40E0 3F98      .  C  #  .  T  .  @  ?

Word Size: 16          Page: P Memory
```

15.Run the debugger.

a. From the menu bar of the Metrowerks CodeWarrior window, select **Project > Run**.

This command executes your code until a breakpoint is reached in the **Program** window.

b. Display local variables by selecting one from the list and clicking the control to the left of that variable in the **Program** window (Figure 4.13).

Local variables are displayed in the top-right pane of the **Program** window.

16.Quit the application.

a. Use either of the following options:

- Select **Project > Run**.
- Click the **Run** icon in the toolbar of the **Program** window.

The code runs to its conclusion. You can now exit the debugger.

b. From the menu bar of the Metrowerks CodeWarrior window, select **Debug > Kill**. This stops the code execution and quits debugging.

References

You have completed the tutorial and used the basic elements of the CodeWarrior IDE for DSP56800.

Refer to the *IDE User Guide* to learn more about the features available to you.

5

Target Settings

Each build target in a CodeWarrior™ project has its own settings. This chapter explains the target settings for DSP56800 software development. These settings affect the CodeWarrior™ DSP56800 compiler, linker, and assembler. Some of the target settings panels are explained in greater detail in the *IDE User Guide*.

This chapter contains the following sections:

Target

Target Settings Overview

These settings control:

- Compiler options
- Linker output
- Assembler options
- Error and warning messages

When you create a project using stationery, the build targets, which are part of the stationery, already include default target settings. You can use those default target settings (if the settings are appropriate), or you can change them.

NOTE Use the DSP56800 project stationery when you create a new project.

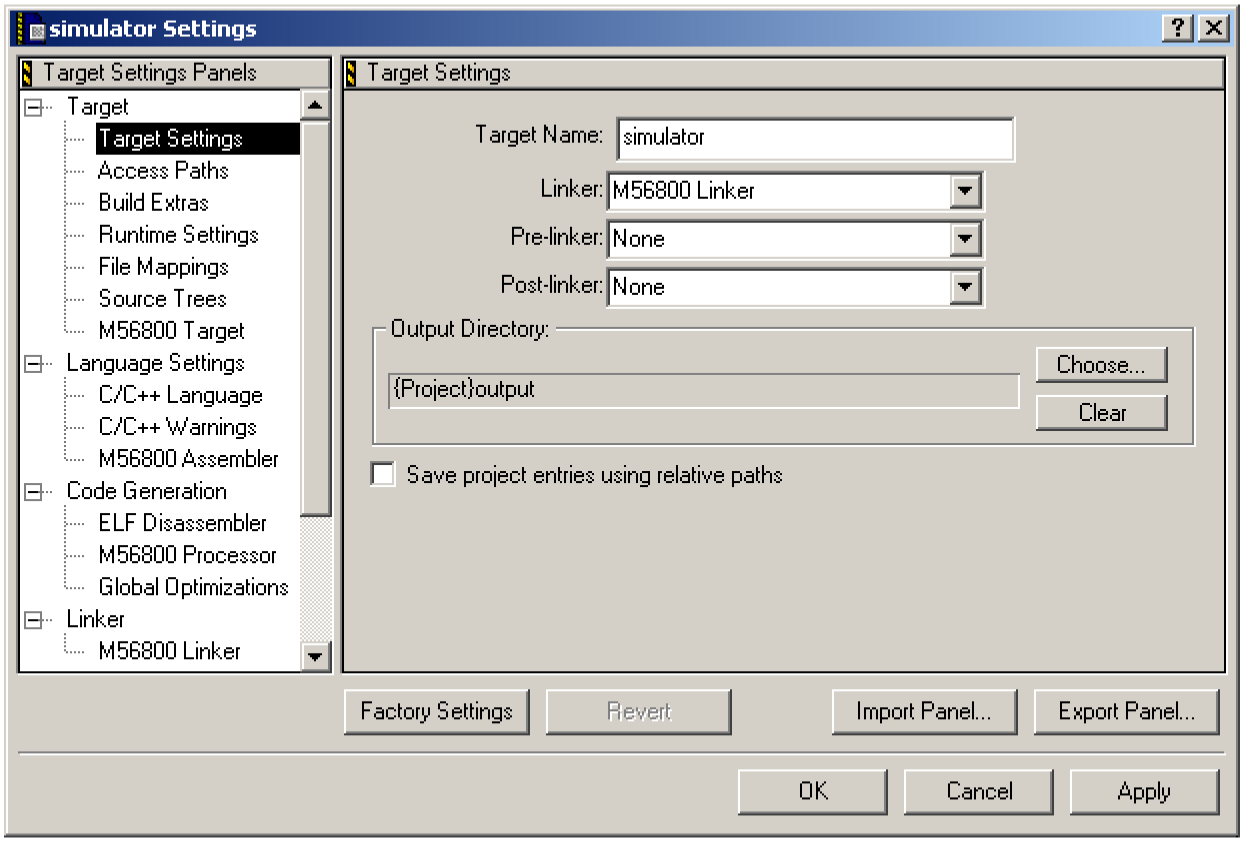
Displaying Target Settings Panel Window

To display any settings panel for an open project, use either of the following options:

- Select **Target Settings** from the **Edit** menu of the Metrowerks CodeWarrior window, where **Target** is the name of the current build target in the CodeWarrior project.
- Click the **Target Settings** icon in the project window.

The **Target Settings** window appears (Figure 5.1).

Figure 5.1 Target Settings Panel Window



Target Name: simulator
Linker: M56800 Linker
Pre-linker: None
Post-linker: None
Output Directory: {Project}output
☐ Save project entries using relative paths

The **Target Settings** panel window is the most important window in the CodeWarrior IDE. This is where your target operating system or microprocessor is selected.

The left side of the **Target Settings** window contains a list of target settings panels that apply to the current build target. Select the preferred target settings panel. The CodeWarrior IDE displays the target settings panel that you selected.

Changing Target Settings

To change target settings:

1. Select **Edit > Target Name Settings.**
2. To view the **Target Settings** panel, click on the name of the **Target Settings** panel in the **Target Settings** panels list on the left side of the **Target Settings** window.

The CodeWarrior IDE displays the target settings panel that you selected.

3. Change the settings in the panel.

Exporting and Importing Panel Options to XML Files

The CodeWarrior IDE can export options for the current settings panel to an Extensible Markup Language (XML) file or import options for the current settings panel from a previously saved XML file.

Exporting Panel Options to XML File

1. Click the **Export Panel** button.
2. Assign a name to the XML file and save the file in the desired location.

Importing Panel Options from XML File

1. Click the **Import Panel** button.
2. Locate the XML file to where you saved the options for the current settings panel.
3. Open the file to import the options.

Restoring Target Settings

After you change settings in an existing project, you can restore previous settings using either of the following methods:

- To restore the previous settings, click the **Revert** button at the bottom of the **Target Settings** window.
- To restore the settings to the factory defaults, click the **Factory Settings** button at the bottom of the window.

Only panels appropriate for the current build target are available. The current build target is displayed in a menu in the toolbar of the project window.

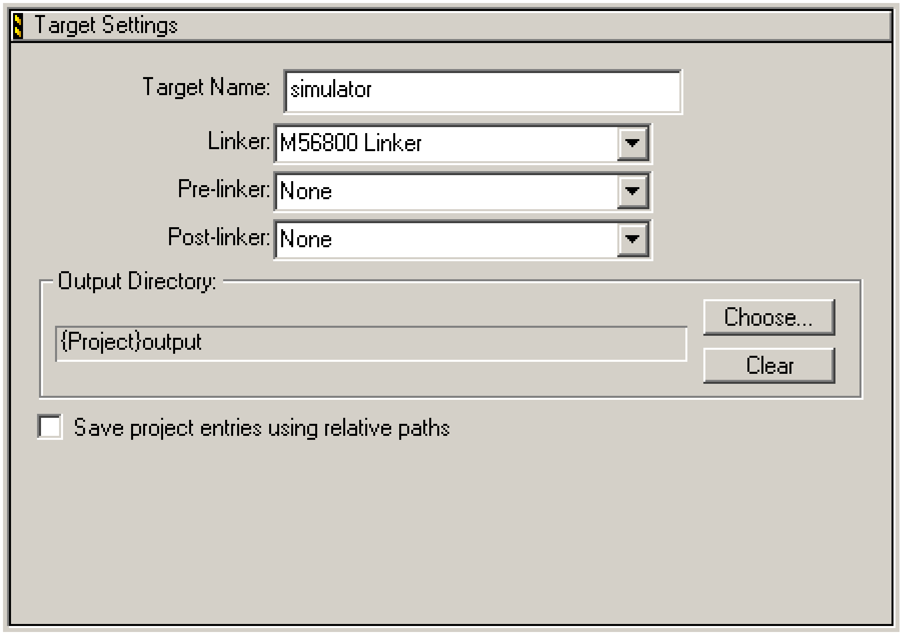
NOTE Use the DSP56800 project stationery to create a new project. The stationery already has reasonable or default values for all of the settings panels. You can also create stationery files with your own preferred settings. Modify a new project to suit your requirements, then save it inside the stationery folder.

Target Settings

The **Target Settings** panel (Figure 5.2), lets you set the name of your build target, as well as the linker and post-linker plug-ins to be used with the build target. By selecting a linker, you are specifying which family of processors to use. The other available panels in the **Target Settings** window change to reflect your choice.

Because the linker choice affects the visibility of other related panels, you must first set your build target before you can specify other options, like compiler and linker settings.

Figure 5.2 Target Settings Panel


Target Settings

Target Name: simulator

Linker: M56800 Linker

Pre-linker: None

Post-linker: None

Output Directory:

{Project}output

☐ Save project entries using relative paths

Target Name

Use the **Target Name** field to set or change the name of a build target. When you use the **Targets** view in the project window, you see the name entered in the **Target Name** field.

The name you specify here is not the name of your final output file. It is instead a name for your personal use that you assign to the build target. You specify the name of the final output file in the **Output File Name** field of the **M56800 Target** panel.

Linker

Select a linker from the items listed in the **Linker** menu.

For DSP56800 projects, you must select the **M56800 Linker**. The selected linker defines the build targets. After you select a linker, only the panels appropriate for your build target (in this case, DSP56800) are available.

Pre-Linker

Some build targets have pre-linkers that perform additional work, such as data-format conversion, before the final executable file is built. CodeWarrior IDE for DSP56800 does not require a pre-linker, so set the **Pre-Linker** menu to **None**.

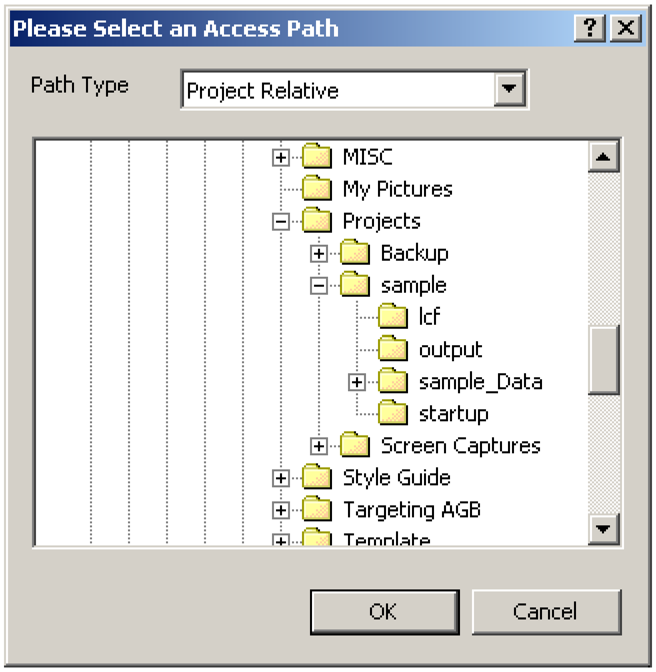
Post-Linker

Some build targets have post-linkers that perform additional work, such as data-format conversion, on the final executable file. CodeWarrior IDE for DSP56800 does not require a post-linker, so set the **Post-Linker** menu set to **None**.

Output Directory

This field shows the directory to which the IDE saves the executable file that is built from the current project. The default output directory is the same directory in which the project file is located. If you want to save the executable file to a different directory, click the **Choose** button. The **Please Select an Access Path** dialog box appears (Figure 5.3).

Figure 5.3 Please Select an Access Path Dialog Box



Use the dialog box to select the directory to which you want the IDE to save the executable file.

You can specify how the CodeWarrior IDE stores an access path by selecting any of the following options in the **Path Type** list box of the **Please select an access path** dialog box:

- Absolute Path

  This option allows the IDE to store the access path from the root level of the startup hard drive to the folder whose access path you want to add, including all folders in between. You must update absolute access paths if you move the project to another system, rename the hard disk, or rename any of the folders along the access path.

- Project Relative

  This option allows the IDE to store the access path from the folder that contains the project to the folder whose access path you want to add. You do not need to update the project relative access paths if you move a project, as long as the hierarchy of the relative path is the same. You cannot create a relative path to a folder on a different hard drive than where your project file resides.

- Compiler Relative

  This options allows the IDE to store the access path that contains the CodeWarrior IDE to the folder whose access path you want to add. You do not need to update the compiler relative access paths if you move a project, as long as the hierarchy of the relative path is the same. You cannot create a relative path to a folder on a different hard drive than where your CodeWarrior IDE resides.

- Systems Relative

  This option allows the IDE to store the access path from the operating system's base folder to the folder whose access path you want to add. You do not need to update the systems relative access paths if you move a project, as long as the hierarchy of the relative path is the same. You cannot create a relative path to a folder on a different hard drive than where your operating system's base folder resides.

4. Click **OK**.

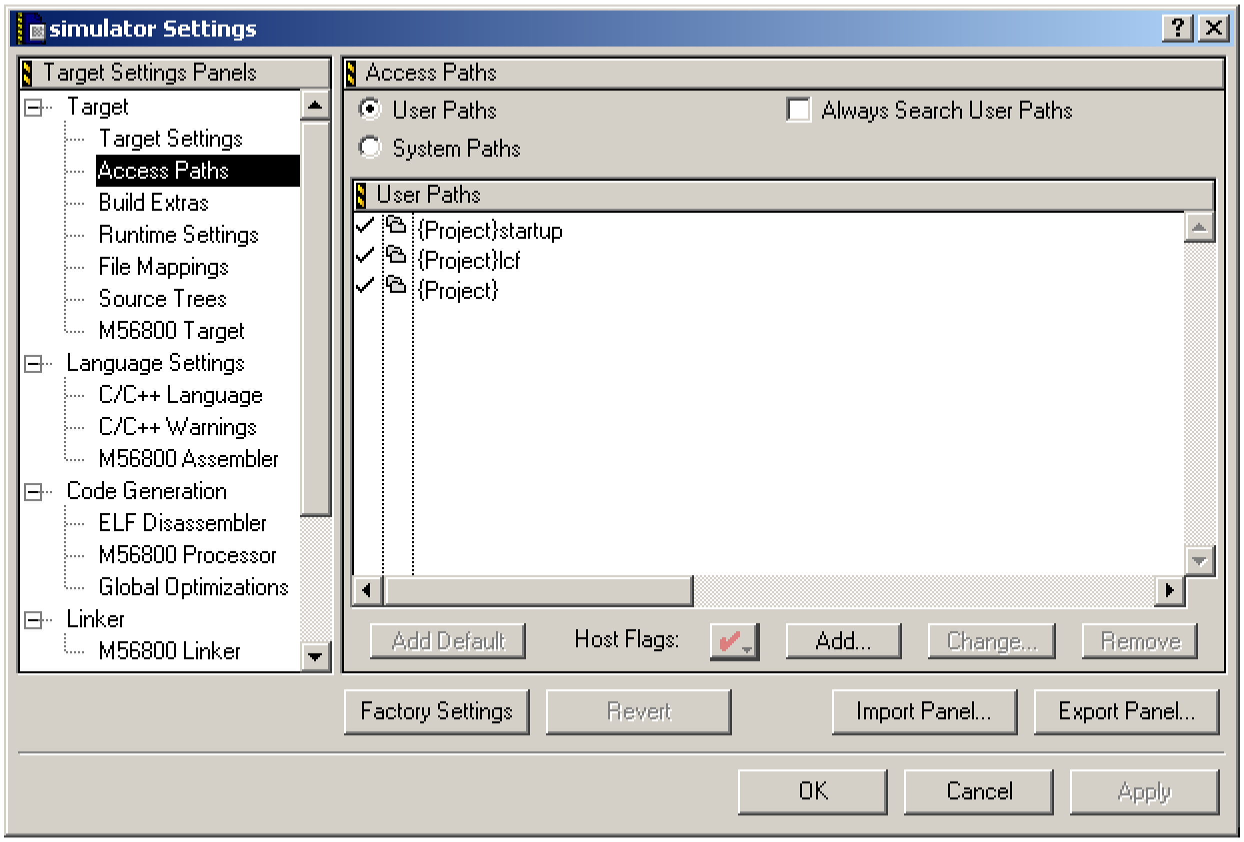
Save Project Entries Using Relative Paths

When you check this check box in the **Target Settings** panel, the IDE uses relative paths to locate the files in your project. Relative paths are useful for distinguishing between two or more files with identical names.

Access Paths

Use the **Access Paths** panel (Figure 5.4) for the CodeWarrior IDE to search for additional access paths while compiling and linking. Search works top-down through the access paths. You can add paths that are Absolute, Project Relative, Compiler Relative, or System Relative. If you cannot change the location of your source and library files, you may need to change your access paths if they do not fall into one of the current locations in the **Access Paths** panel.

Figure 5.4 Access Path Panel



[✓ User Paths] System Paths

☐ Always Search User Paths

User Paths

✓ {Project}startup
✓ {Project}lcf
✓ {Project}

User Paths

Click this radio button to display the User Paths pane in the **Access Paths** panel.

System Paths

Click this radio button to display the System Paths pane in the **Access Paths** panel.

Always Search User Paths

Enable this check box to search for system header files or interface files.

Add Default

Click this button to restore access paths in the User Paths pane or System Paths pane after you delete them. The restored path appears in the active pane.

Host Flags

Select any of the following options:

- All. Allows all host platforms to use the access path.
- None. Prevents any host from using the access path.
- Mac OS. Allows the IDE to search the access path only on a Mac OS computer.
- Windows. Allows the IDE to search the access path only on a Windows PC.
- UNIX. Allows the IDE to search the access path only on a UNIX workstation.

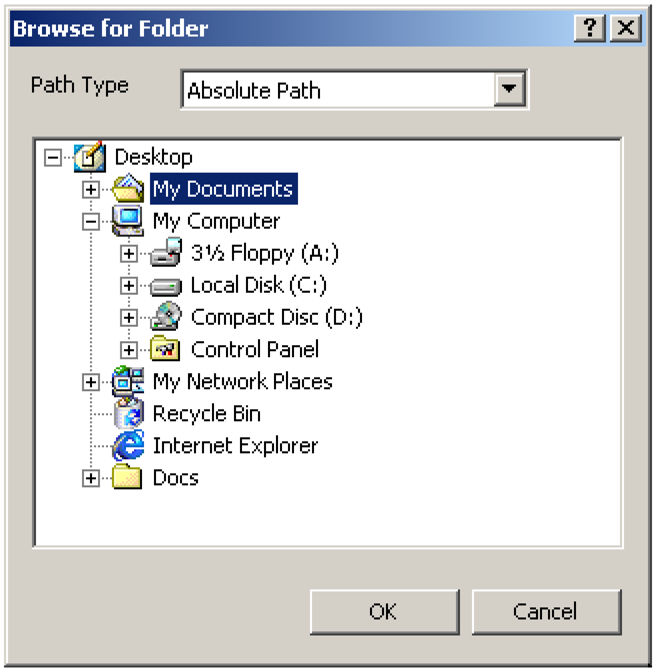
Add Access Path

To add a new access path, perform the following steps:

1. Select the User Paths pane or System Paths pane in the **Access Path** panel.
2. Click the **Add** button.

   The **Browse for Folder** dialog box (Figure 5.5) appears:

Figure 5.5 Browse for Folder



3. Use the dialog box to select the folder to which you want to add an access path.
4. You can specify how the CodeWarrior IDE stores an access path by selecting one of the following options in the **Path Type** list box of the **Browse for Folder** dialog box (Figure 5.5):

- Absolute Path
- Project Relative
- Compiler Relative
- Systems Relative

Change Access Path

If you change the location of your source and library files, you may need to change your access paths if they do not fall into one of the current selections in the **Access Paths** panel.

To change an access path, perform the following steps:

1. Select the path in the User Paths pane or System Paths pane.
2. Click the **Change** button.

   The **Browse for Folder** dialog box (Figure 5.5) appears.

3. Use this dialog box to select a new access path.

Remove Access Path

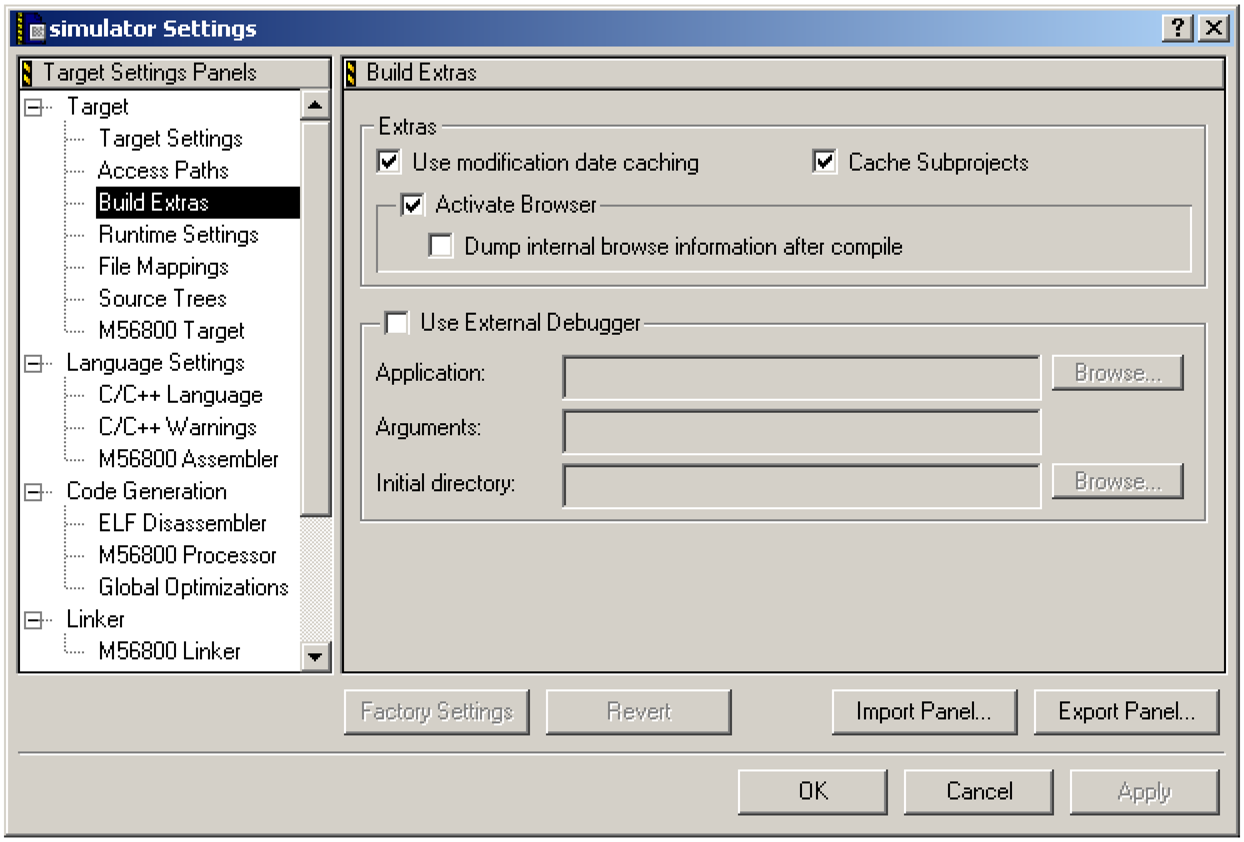
To remove an access path, perform the following steps:

1. Select the path that you want to remove from the User Paths pane or System Paths pane.
2. Click the **Remove** button to delete the path from the pane.

Build Extras

The **Build Extras** panel (Figure 5.6) contains various options that affect the way the IDE builds a project, including the use of a third-party debugger.

Figure 5.6 Build Extras Panel


simulator Settings

Target Settings Panels

- Target
  - Target Settings
  - Access Paths
  - Build Extras
  - Runtime Settings
  - File Mappings
  - Source Trees
  - M56800 Target
- Language Settings
  - C/C++ Language
  - C/C++ Warnings
  - M56800 Assembler
- Code Generation
  - ELF Disassembler
  - M56800 Processor
  - Global Optimizations
- Linker
  - M56800 Linker

Build Extras

Extras
- [✓] Use modification date caching
- [✓] Cache Subprojects
- [✓] Activate Browser
  - [ ] Dump internal browse information after compile

[ ] Use External Debugger
- Application:
- Arguments:
- Initial directory:

Extras

Use modification date caching

Check this check box to enable the IDE to check the modification date of each project prior to making the project. Checking the check box causes the IDE to cache the modification dates of the files in a project.

Cache Subprojects

Check this check box to improve multi-project updating and linking. The option also allows the IDE to generate symbolics information for both the build targets and the subprojects within each build target. Disable this check box to reduce the amount of memory required by the CodeWarrior IDE.

Activate Browser

Check the check box to allow the IDE to generate symbolics information for the project during each build. The symbolics information is required for opening browser windows.

Dump internal browse information after compile

Check this check box to review the raw browser information that a plug-in compiler or linker provides for the IDE.

Use External Debugger

Check the check box to use an external debugger in place of the CodeWarrior debugger.

Application

Click the **Browse** button for the Application box. The **Open** dialog box appears. Locate and select the debugger application from the dialog box.

You must check the check box for **Use External Debugger** to enable the **Browse** button.

Arguments

Type command-line arguments to pass to the project at the beginning of a debugging session.

Initial Directory

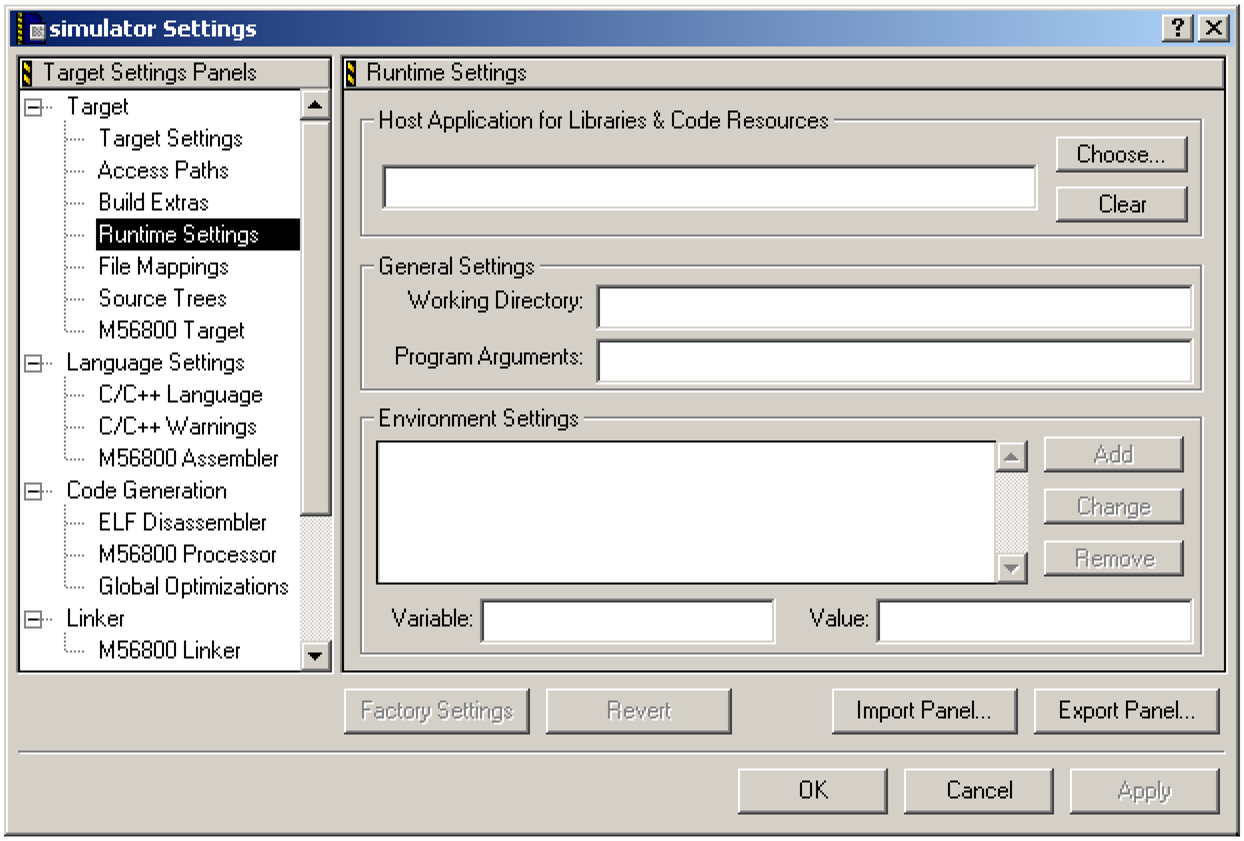
Click the **Browse** button. The **Please Select an Access Path** dialog box appears. Locate and select the path to the external debugger from the dialog box.

You must check the check box for **Use External Debugger** to enable the **Browse** button.

Runtime Settings

The **Runtime Settings** panel (Figure 5.7) includes options for specifying a debugging application for non-executable files, defining a working directory, listing program arguments, and creating environment variables.

Figure 5.7 Runtime Settings Panel



Host Application for Libraries & Code Services

Use the text box for Host Application for Libraries & Code Services specify a host application when debugging a non-executable field, such as shared library, dynamic link library (DLL), or code resource. The application that you specify is not the debugger application, but rather the application with which the non-executable file interacts.

General Settings

Working Directory

Use this text box to specify the default directory to which the current project has access. Debugging occurs in this location. If you do not specify a directory, debugging occurs in the same field as the executable file.

Program Arguments

Use this text box to type command-line arguments to pass to the project at the beginning of a debugging session. The program receives these arguments after you select **Project > Run** from the menu bar of the Metrowerks CodeWarrior window.

Environment Settings

This section allows you to specify environment variables to pass to your program as part of the environment parameter in your program's `main()` function, or as part of environment calls. These variables are only available to the target program. When your program terminates, the settings are no longer available.

To enable the **Environment Settings** text, you must make entries in the **Variable** and **Value** text boxes at the same time.

Variable

Type a name for the environment variable.

Value

Type a value for the environment variable.

Add an Environment Variable

To add an environment variable, perform the following steps:

1. Type a name in the **Variable** text box.
2. Type a value in the **Variable** text box.
3. Click the **Add** button.

The new environment variable appears in the **Environment Settings** text box.

Change an Environment Variable

To change an environment variable, perform the following steps:

1. Select an environment variable that you want to change from the **Environment Settings** text box.
2. Change the name in the **Variable** text box.
3. Change the value in the **Value** text boxes.
4. Click the **Change** button.

The changes appear in the **Environment** text box.

Delete an Environment Variable

Select an environment variable that you want to remove from the **Environment** text box.

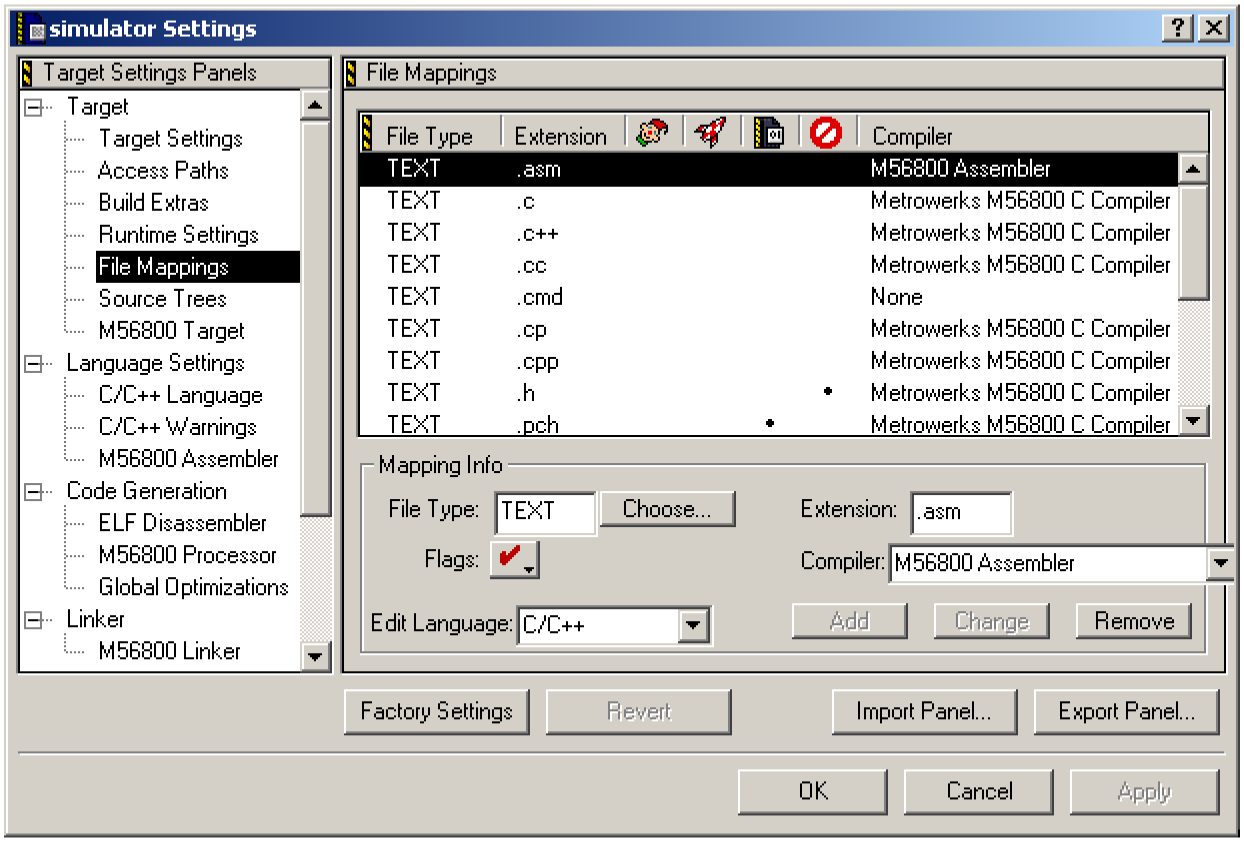
To delete an environment variable, perform the following steps:

1. Select an environment variable that you want to remove from the **Environment Settings** text box.
2. Change the name in the **Variable** text box.
3. Click the **Remove** button. The environment variable is removed from the **Environment Settings** text box.

File Mappings

The **File Mappings** panel (Figure 5.8) is used to associate a file name extension, such as ".c" or "p" with a plug-in compiler. The CodeWarrior IDE assigns a compiler to process files with matching file-name extensions.

Figure 5.8 File Mappings Panel



File Type	Extension					Compiler
TEXT	.asm					M56800 Assembler
TEXT	.c					Metrowerks M56800 C Compiler
TEXT	.c++					Metrowerks M56800 C Compiler
TEXT	.cc					Metrowerks M56800 C Compiler
TEXT	.cmd					None
TEXT	.cp					Metrowerks M56800 C Compiler
TEXT	.cpp					Metrowerks M56800 C Compiler
TEXT	.h				•	Metrowerks M56800 C Compiler
TEXT	.pch			•		Metrowerks M56800 C Compiler

File Type: TEXT
Extension: .asm
Flags: ✓
Compiler: M56800 Assembler
Edit Language: C/C++

Mapping Info

File Type

Use this text box to type the file type for the selected file mapping in the File Mappings list.

Extension

Use this text box to enter a file-name extension, such as the ".c" or ".h" extensions, for a selected file type in the File Mapping list.

Refer to a list of default file-name extensions in Appendix A.

Compiler

Use this list box to select a compiler for the selected **File Type** in the File Mapping list.

Edit Language

Select any of the following from the Edit Language list box:

- None
- C/C++
- Disassembly
- Java
- Pascal
- PEF Export List
- Rez
- XML

Flags

Resource File

Select this file to cause the IDE to include in your finished product the resources from the files with the selected file mapping.

Launchable

Select this file to cause the IDE to open the source-code file with the application that created it after you double-click the file in the **Project** window.

Precompiled

Select this file to cause the IDE to compile files with the selected mapping before compiling other files.

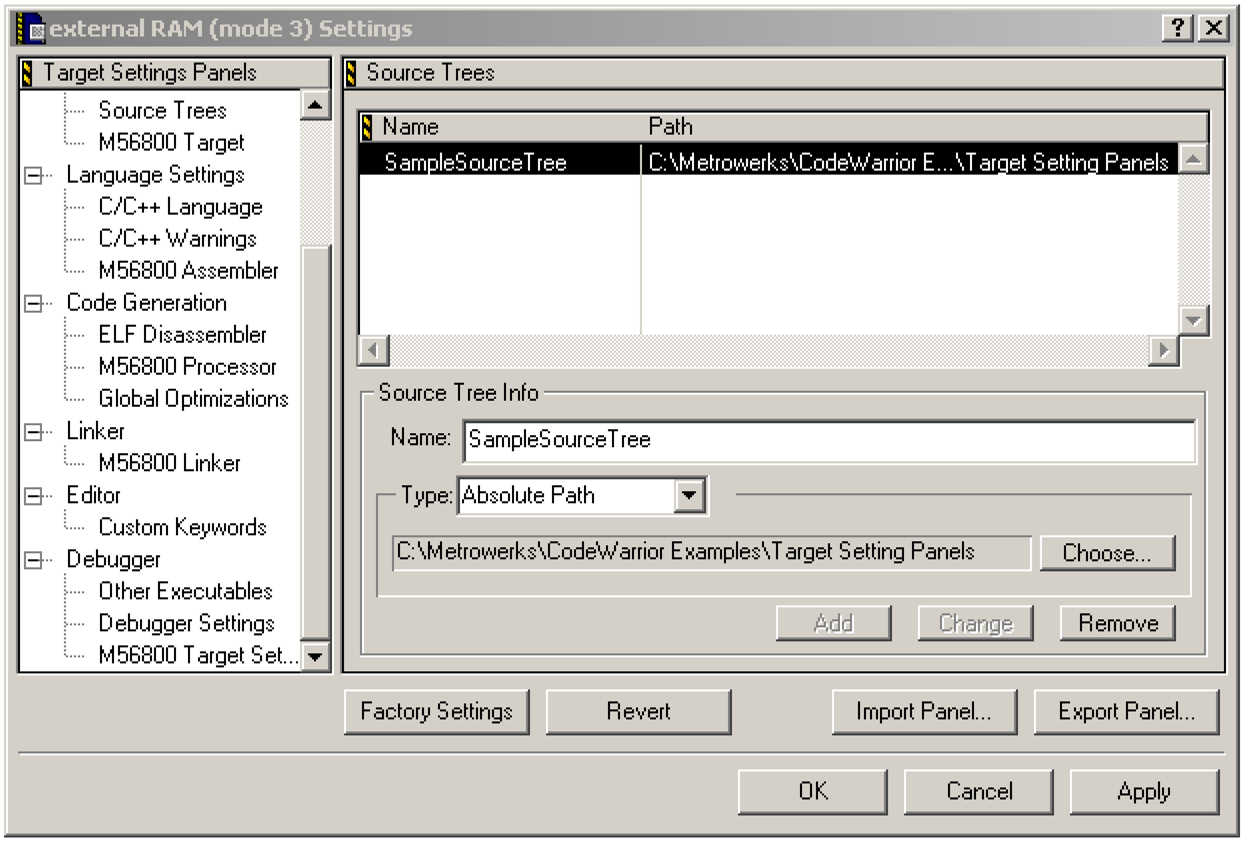
Ignored by Make

Select this file to cause the IDE to ignore files with the selected file mapping when compiling or linking the project.

Source Trees

The Source Trees settings panel (Figure 5.9) allows you to define project-specific source trees (root paths). You can define your project’s access paths and build-target output in terms of source trees. Using this approach, you can share projects across various hosts.

Figure 5.9 Source Trees Settings Panel



external RAM (mode 3) Settings

Target Settings Panels
- Source Trees
- M56800 Target
- Language Settings
  - C/C++ Language
  - C/C++ Warnings
  - M56800 Assembler
- Code Generation
  - ELF Disassembler
  - M56800 Processor
  - Global Optimizations
- Linker
  - M56800 Linker
- Editor
  - Custom Keywords
- Debugger
  - Other Executables
  - Debugger Settings
  - M56800 Target Set...

Source Trees

Name	Path
SampleSourceTree	C:\Metrowerks\CodeWarrior E...\Target Setting Panels

Source Tree Info

Name: SampleSourceTree

Type: Absolute Path

C:\Metrowerks\CodeWarrior Examples\Target Setting Panels

Source Trees List

Name

This column shows the name of each source tree. When you define access paths in terms of source trees, you use this name in your access path's definition.

Path

This column shows the path to each source tree. You might need to modify the paths of the source trees when you transfer your project to a new host.

Source Tree Info

Name Source Tree

Type a name for a new source tree in the text box, or to change the name of an existing source tree.

Type

Use the list box to select the type of source tree:

- Absolute Path

  This type defines a path from the root level of the hard drive to a desired folder, including all intermediate folders.

- Environment Variable

  This type defines an environment variable in the operating environment (Windows, Solaris, and Linux).

- Registry Key

  This type defines a key entry in the operating-environment registry.

Add Source Tree

To add a new source tree, perform the following steps:

1. Select the type of source tree from the **Type** menu.
2. Enter a name for the new source tree in the **Name** text box.
3. If you select **Absolute Path** in the **Type** list box, the **Choose** button is enabled.
   a. Click the **Choose** button to select a path using a standard dialog box (Figure 5.5).
   b. Click the **Add** button. The new source tree appears in the **Source Trees** list.
4. Click **Save** in the **Target Settings** window to save your changes.

Change Source Tree

To change a source tree, perform the following steps:

1. Select the source tree that you want to change from the **Source Trees** list.
2. Click the **Change** button.

3. Change the name in the **Name** text box.
4. Change the type of source tree in the **Type** text boxes.

   The modified source tree name and path for the source tree are displayed in the **Source Trees** list.
5. Click **Save** in the **Target Settings** window to save your changes.

Remove Source Tree

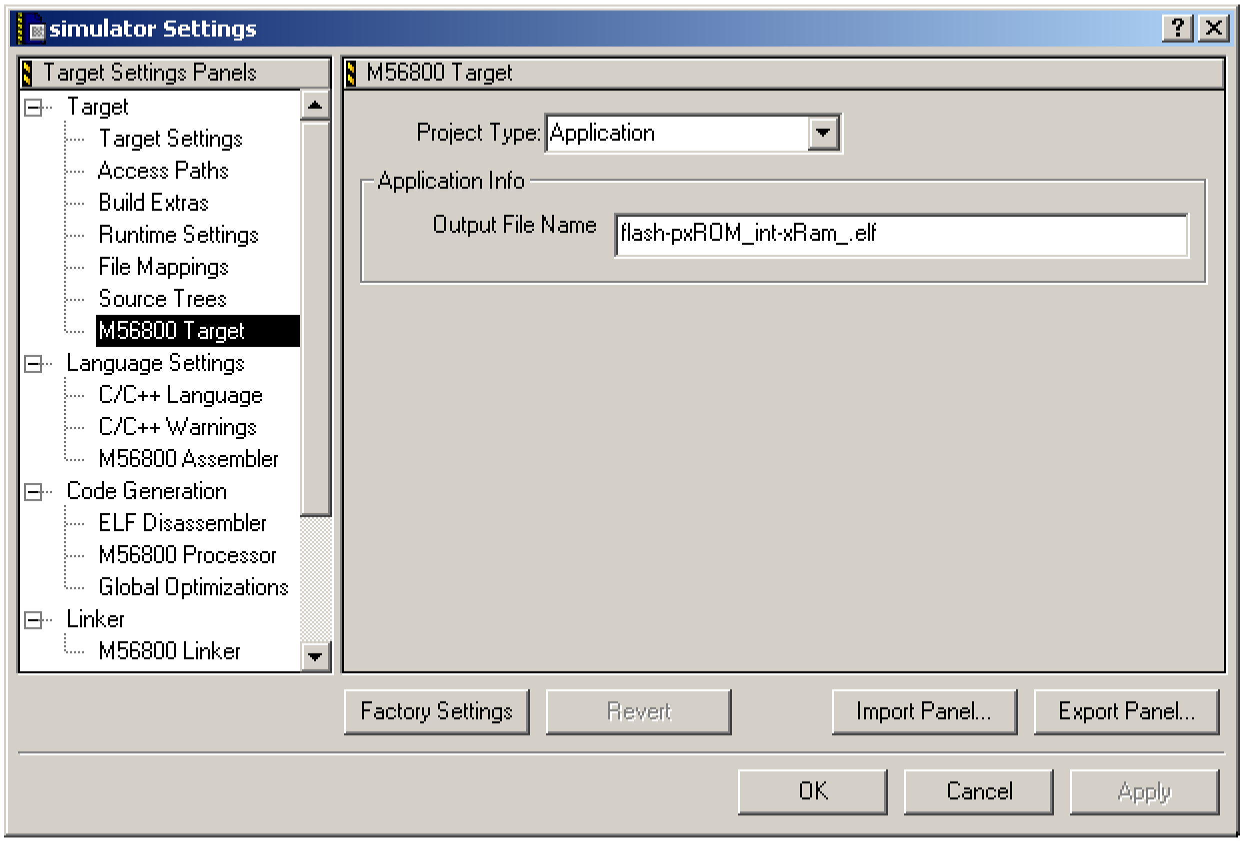
To remove a source tree, perform the following steps:

1. Select the source tree that you want to remove from the **Source Trees** list.
2. Click the **Remove** button to delete the source tree.
3. Click **Save** in the **Target Settings** window to save your changes.

M56800 Target

The **M56800 Target** panel (Figure 5.10) instructs the compiler and linker about the environment in which they are working, such as available memory and stack size. This panel is only available when the current build target uses the M56800 Linker.

Figure 5.10 M56800 Target Panel



Project Type: Application

Output File Name: flash-pxROM_int-xRam_.elf

The items in the **M56800 Target** panel are:

Project Type

The **Project Type** menu determines the kind of project you are creating. The available project types are **Application** and **Library**.

Use this menu to select the project type that reflects the kind of project you are building (Figure 5.10).

Output File Name

The **Output File Name** field specifies the name of the executable file or library to create. This file is also used by the CodeWarrior debugger. By convention, application names must end with the extension “`.elf`” (without the quotes), and library names must end with the extension “`.lib`” (without the quotes).

NOTE When building a library, ensure that use the extension "`.lib`," as this is the default file-mapping entry for libraries.

If you wish to change an extension, you must add a file-mapping entry in the **File Mappings** settings panel.

Language

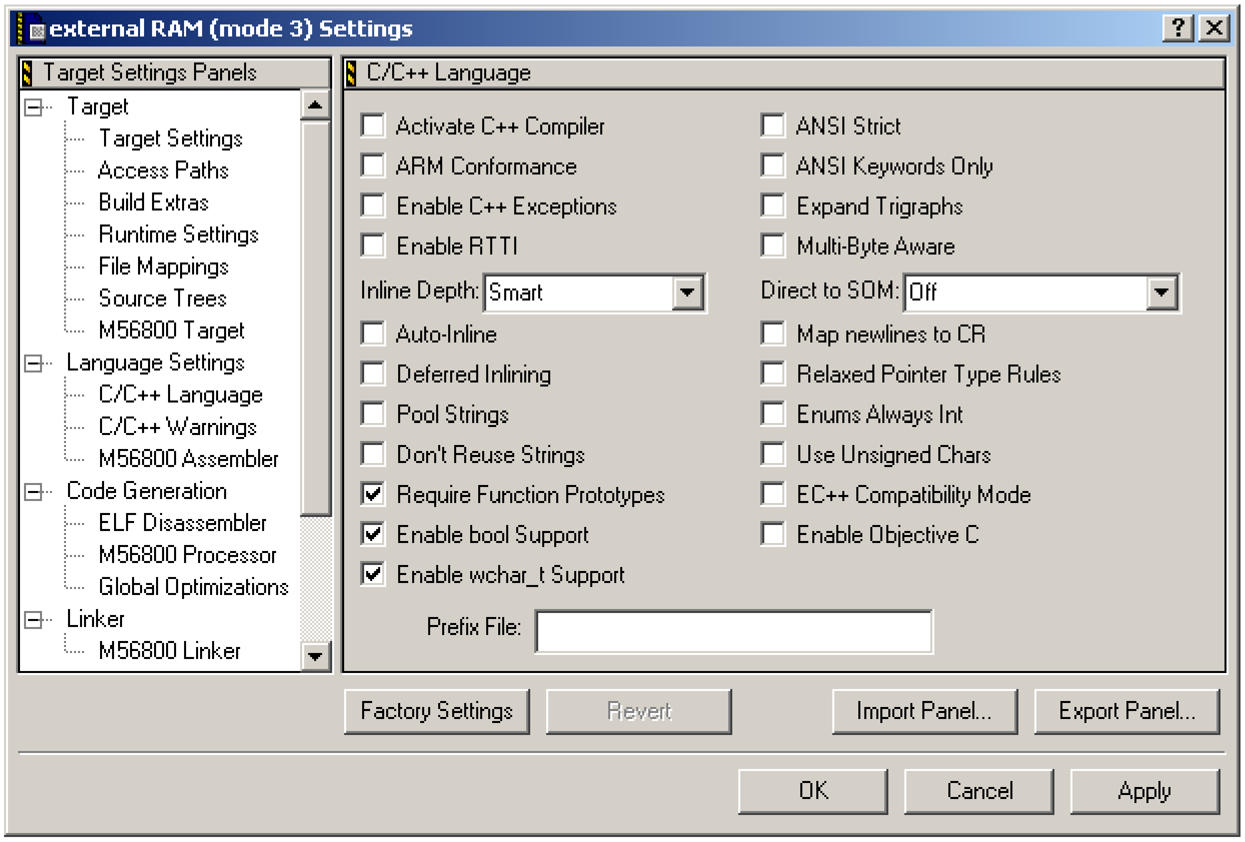
C/C++ Language

Settings in the **C/C++ Language** panel (Figure 5.11), only affect C language features implemented for the DSP56800.

The following options are not applicable to the DSP56800 compiler. Disable the options at all times:

- Activate C++ Compiler
- ARM Conformance
- Enable C++ Exceptions
- Enable RTTI
- Pool Strings
- Enable bool support
- Enable wchar_t Support
- Multi-Byte Aware
- EC++ Compatibility Mode
- Enable Objective C

Figure 5.11 C/C++ Language Panel



- [ ] Activate C++ Compiler
- [ ] ARM Conformance
- [ ] Enable C++ Exceptions
- [ ] Enable RTTI
- Inline Depth: Smart
- [ ] Auto-Inline
- [ ] Deferred Inlining
- [ ] Pool Strings
- [ ] Don't Reuse Strings
- [✓] Require Function Prototypes
- [✓] Enable bool Support
- [✓] Enable wchar_t Support
- [ ] ANSI Strict
- [ ] ANSI Keywords Only
- [ ] Expand Trigraphs
- [ ] Multi-Byte Aware
- Direct to SOM: Off
- [ ] Map newlines to CR
- [ ] Relaxed Pointer Type Rules
- [ ] Enums Always Int
- [ ] Use Unsigned Chars
- [ ] EC++ Compatibility Mode
- [ ] Enable Objective C
- Prefix File:

The **C/C++ Language** panel options are:

- Inline Depth

  Select this function if you want the compiler to determine whether to inline a function based on the settings of **ANSI Keywords Only** and the **Inline Depth** and **Auto-inline** options.

NOTE When you call an inline function, the compiler inserts the function's code instead of issuing instructions to call that function. Inline functions makes your programs faster because you execute the function's code immediately without a function call, but possibly larger because the function's code may be repeated in several different places.

If you do not select **ANSI Keywords Only** option, you can declare C functions to be `inline`. The list box for the

Inlining options allows you to select inline no functions, only functions declared inline, or all small functions as shown in Table 5.1.

Table 5.1 Options for Inline Depth Menu

Options	Inline
Don't Inline	Does not inline functions, not even C or C++ declared `inline`.
Smart	Inline small functions to a depth of 2 to 4 inline functions deep.
1 to 8	Always inlines functions to the depth specified by the numerical selection.
Always Inline	Always inlines functions, no matter the depth.

- Auto-Inline

  Select this option to allow the compiler to choose which functions to inline.

- Deferred Inlining

  Select this option if you want the compiler to allow inlining of inline and auto-inline functions that are called before these functions are declared.

  The compiler requires more memory for this option.

- Don't Reuse Strings

  Select this option if you want the compiler to store each string literal separately.

  When you do not select this option, the compiler stores only one copy of identical string literals. This option helps you save memory if your program contains identical string literals that you would not modify.

  If you do not select this option and if you change one of the strings, all the strings will be changed.

- Require Function Prototypes

  Select this option if you want the compiler to generates an error if you use a function that is defined after it is referenced and does not have a prototype. If the function is implicitly defined, that is, defined before it is referenced, and does not have a prototype, then the compiler will issue a warning when this option is on. This option helps you to prevent errors that occur when you call a function before you declare or define it. For example, without a function prototype, you may pass data of the wrong type. As a result, your code may not work as you expect even though it compiles without error.

- ANSI Strict

  This option affects several extensions to the C language supported by the CodeWarrior compiler. The extensions are:

  – C++ style comments

  – Unnamed arguments in functions definitions

  – A # not followed by argument in a macro

  – Using an identifier after #endif

  – Using typecasted pointers as 1values

  – Converting pointers to types of the same size

  – Arrays of zero length in structures

  – The "D" constant suffix

  In each case the extension is available only if the option is not selected. If the option is selected, then these extensions to the ANSI C standard are disabled.

- ANSI Keywords Only

  Select this option if you want the compiler to generate an error if it encounters any of the CodeWarrior C additional keywords. Use this option if you are writing code that must strictly follow the ANSI/ISO standard.

  When this option is not selected, the following additional keywords are available to you:

  – asm

    This keyword allows you to use the compiler's built-in inline assembler.

  – inline

    This keyword allows you to declare a C function as inline.

- Expand Trigraphs

  Select this option if you want the C compiler to ignore trigraph characters. Many common character constants look like trigraph sequences (specially on Mac OS), and this extension allows you to use them without including escape characters.

If you are writing code that must follow the ANSI/ISO standard strictly, select this option.

NOTE If this option is on, exercise caution when you initialize strings or multi-character constants that contain questions marks.

- Map newlines to CR

  When you select this option, the C compiler allows you to choose how to interpret the newline (‘\n’) and return (‘\r’) characters.

  In most compilers, ‘\r’ is translated to the value `0x0D`, the standard value for carriage return, and ‘\n’ is translated to `0x0A`, the standard value for linefeed.

  However, the C compiler in the Macintosh Programmers Workshop, known as MPW C, ‘\r’ is translated to `0x0A` and ‘\n’ is translated to `0x0D` - the opposite of the typical behavior.

  If you select this option, the compiler uses the MPW C conventions for ‘\n’ and ‘\r’ characters.

  If you do not select this option, the compiler uses the CodeWarrior C and C++ conventions for the ‘\n’ and ‘\r’ characters.

- Relaxed Pointer Type Rules

  When you select this option, the compiler treats `char*` and `unsigned char*` as the same type. While prototypes are checked for compatible pointer types, direct pointer assignments are allowed.

  This option is useful for if you are using code written before the ANSI/ISO standard. Old source code frequently uses these types interchangeably.

- Enum Always Int

  When you select this option, the underlying type is always `signed int`. All enumerators must be no larger than a `signed int`. If an enumerated constant is larger than an `int`, the compiler generates an error.‘

However, if you do not select this option, enumerators that can be represented as an `unsigned int` are implicitly converted to `signed int`. The compiler chooses the integral data type that supports the largest enumerated constant. The type could be as small as a `char` or as large as `long int`.

- Use Unsigned Chars

  Select this option to allow the C compiler to treat a `char` declaration as an `unsigned char` declaration.

  To check whether this option is on, use `_option` (`unsigned char`). By default, this option is off.

NOTE If you select this option, your code may not be compatible with libraries that were compiled with this option turned off.

C/C++ Warnings

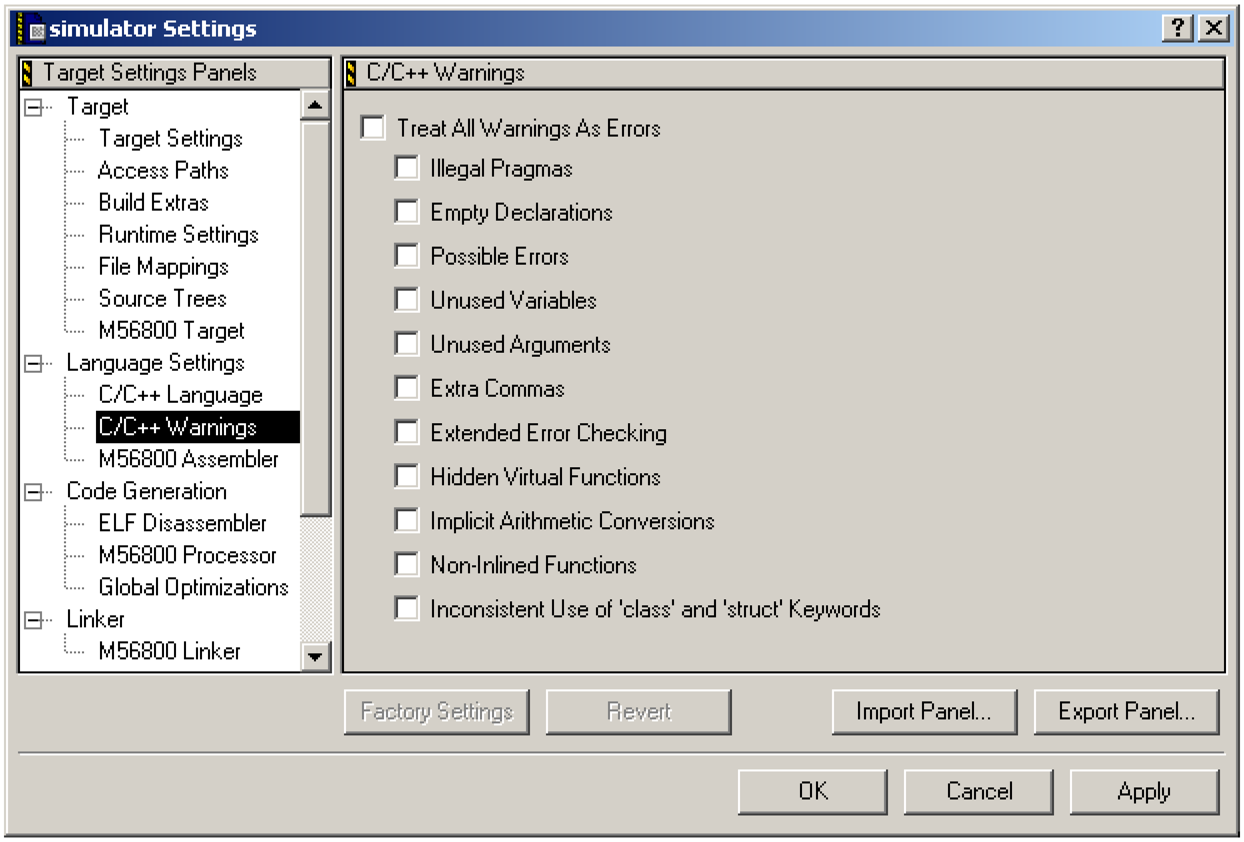
Settings in the **C/C++ Warnings** panel (Figure 5.12), affect only C language features implemented for DSP56800.

There are no C++ warning features applicable to DSP56800 development.

The following options are not applicable to the DSP56800E compiler. Disable the options at all times:

- Hidden Virtual Functions
- Inconsistent use of ‘class’ and ‘struct’ Keywords

Figure 5.12 C/C++ Warnings Panel



C/C++ Warnings

- [ ] Treat All Warnings As Errors
- [ ] Illegal Pragmas
- [ ] Empty Declarations
- [ ] Possible Errors
- [ ] Unused Variables
- [ ] Unused Arguments
- [ ] Extra Commas
- [ ] Extended Error Checking
- [ ] Hidden Virtual Functions
- [ ] Implicit Arithmetic Conversions
- [ ] Non-Inlined Functions
- [ ] Inconsistent Use of 'class' and 'struct' Keywords

The **C/C++ Language** panel options are:

- Illegal Pragmas

  When you select this option, the compiler displays a warning if it encounters an illegal pragma.

Listing 5.1 Example of Pragma Statements that generate Warnings

```
#pragma near_data off      // WARNING: near data is not a pragma
```

- Empty Declarations

  When you select this option, the compiler declares a warning if it encounters a declaration with no variable name.

Listing 5.2 Example of Empty Declarations that generate Warnings

```
int ;          // WARNING
int i;         // OK
```

- Possible Errors

  Select this option if you want the compiler check to for some common typographical mistakes that are legal C syntax, but that may have unwanted side effects, such as putting in unintended semicolons or confusing = and ==. The compiler generates a warning if it encounters one of these:

  – An assignment in a logical expression or the condition in a `while`, `if`, or `for` expression. This check is useful if you frequently use = when you meant to use ==.

  – An equal comparison in a statement that contains a single expression. This check is useful if you frequently use == when you meant to use =.

  – A semicolon (;) directly after a `while`, `if`, or `for` statement.

- Unused Variables

  When you select this option, compiler generates a warning when it encounters a variable that you declare, but do not use. This check helps you find misspelled variable names and variables you have written out of your program.

  If you want to use this warning, but need to declare a variable that you do not use, use the pragma `unused` statement.

- Unused Arguments

  When you select this option, the compiler generates a warning when it encounters an argument you declare but do not use. This check helps you find misspelled argument names and arguments you have written out of your program.

  There are two ways to avoid this warning:

  – Use the pragma `unused` statement.

  – You can turn off the **ANSI Strict** option in the **C/C++ Language Panel** and not assign a name to the unused argument.

- Extra Commas

When you select this option, the compiler generates a warning when it encounters an extra comma. For example, this statement is legal in C, but it causes a warning when this option is on:

Listing 5.3 Example of Extra Comma that generate a Warning

```
int a[] = {1, 2, 3, 4, }; // ^ WARNING: Extra comma after 4
```

- Extended Error Checking

  When you select this option, the compiler generates a warning (not an error) if it encounters one of the following syntax problems:

  – A non-void function that does not contain a `return` statement.

  – An integer or floating-point value assigned to an `enum` type.

  – An empty `return` statement (`return;`) in a function that is not declared `void`.

- I**mplicit Arithmetic Conversions**

  When you select this option, the compiler issues a warning if the destination of an operation is not large enough to hold all possible results. For example, assigning the value of a variable type `long` to a variable of type `char` results in a warning if this option is on.

- Non-Inlined Functions

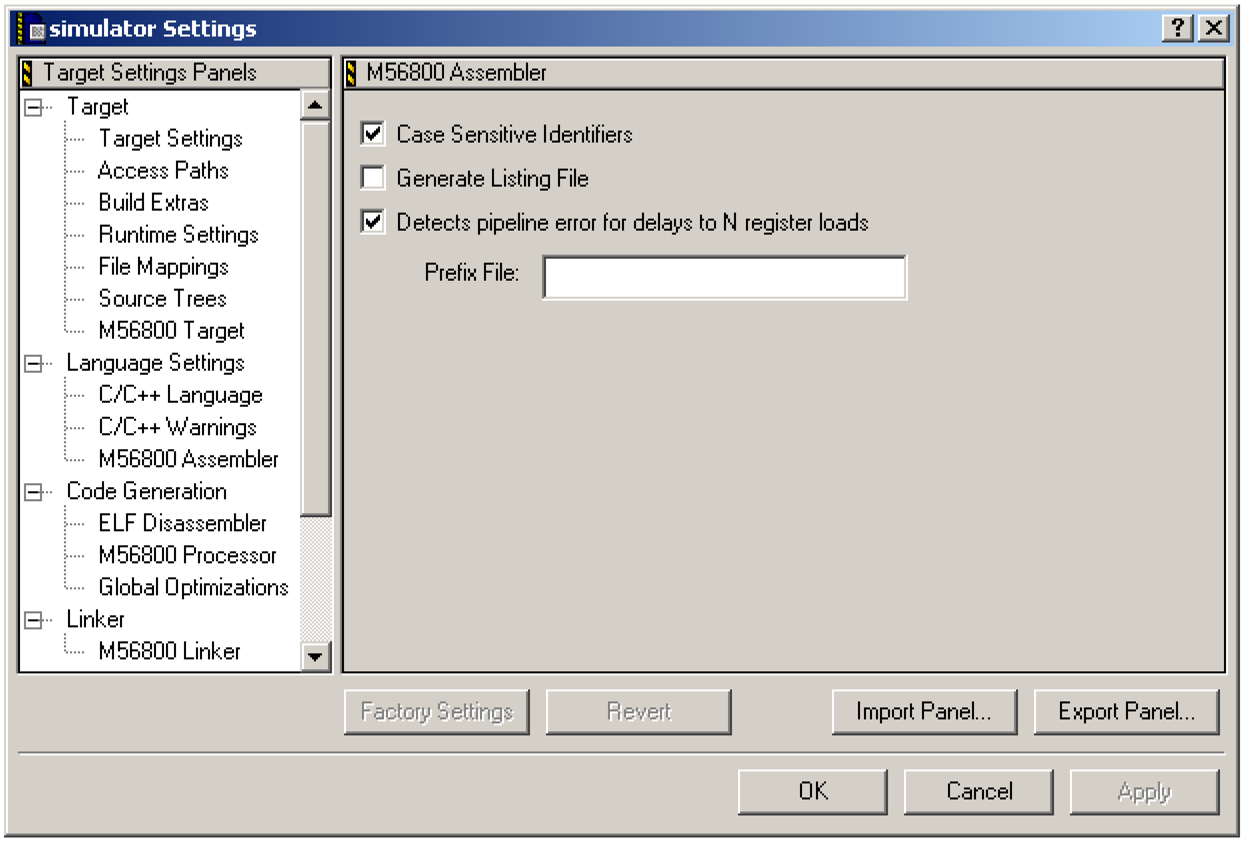
  Select this option if you want the compiler to issue a warning when it is unable to inline a function.

  If you want to check if the option is on, use `_option`.

M56800 Assembler

The **M56800 Assembler** panel (Figure 5.13) determines the format used for the assembly source files and the code generated by the DSP56800 assembler.

Figure 5.13 M56800 Assembler Settings Panel



[✓] Case Sensitive Identifiers
[ ] Generate Listing File
[✓] Detects pipeline error for delays to N register loads
Prefix File:

The items in this panel are:

Case Sensitive Identifiers

When this option is enabled, the assembler distinguishes lowercase characters from uppercase characters for symbols. For example, the identifier `flag` is the not the same as `Flag` when the option is enabled.

NOTE This option must be enabled when mixing assembler and C code.

Generate Listing File

The **Generate Listing File** option determines whether or not a listing file is generated when the CodeWarrior IDE assembles the source files in the project. The assembler creates a listing file that contains file source along with line numbers, relocation information, and macro expansions when the option is enabled. When the option is disabled, the assembler does not generate the listing file.

When a listing file is output, the file is created in the same directory as the assembly file it is listing with an `.lst` extension appended to the end of the file name.

Detects pipeline errors for delays to N register loads

Checking this option enables the assembler to generate error messages.

In move X:(Rntoffset),N, N is not available in the instruction following immediately. This option allows the assembler to insert NOP instructions to resolve the restrictions in pipeline dependencies.

Prefix File

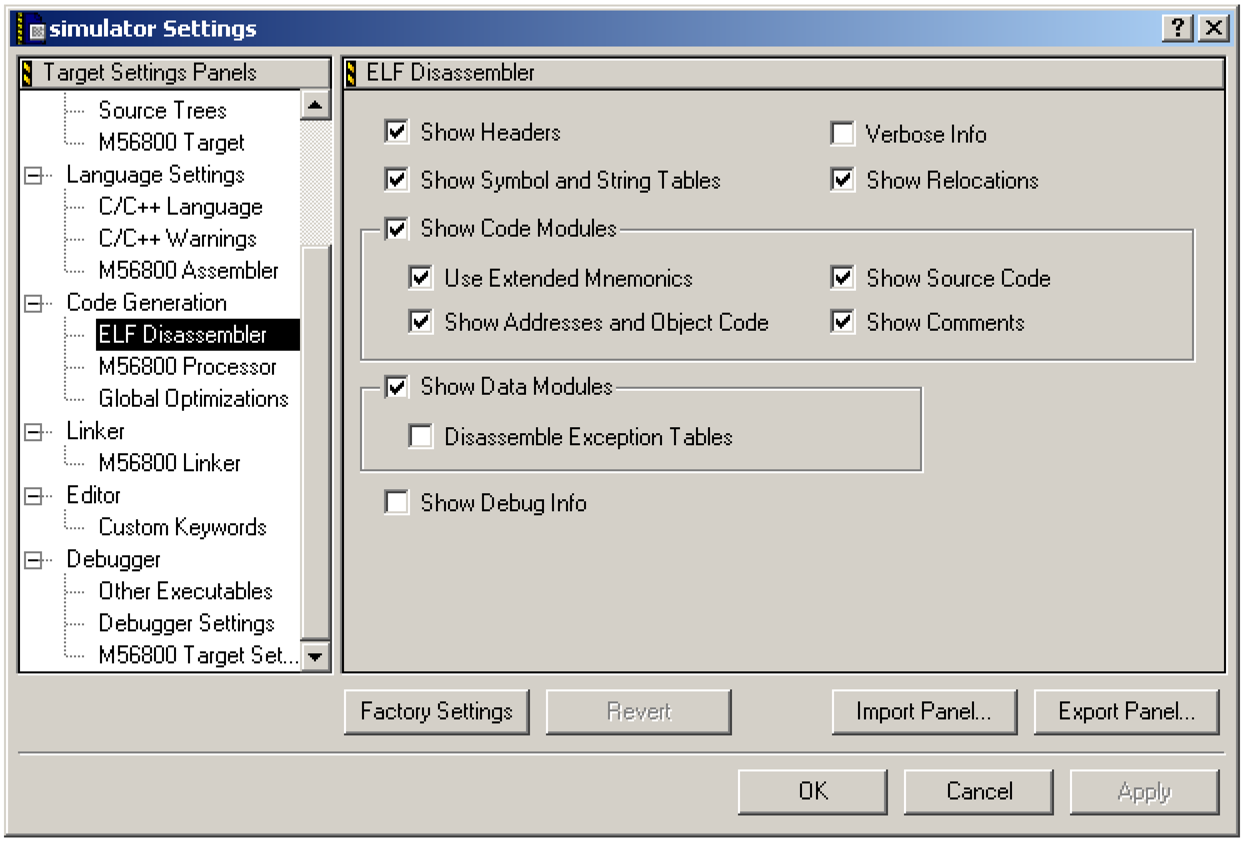
The **Prefix File** field contains the name of a file to be included automatically at the beginning of every assembly file in the project. This field lets you include common definitions without using an `include` directive in every file.

Code Generation

ELF Disassembler

The **ELF Disassembler** panel (Figure 5.14) controls settings related to the disassembly view, which appear when you when you disassemble object files. To view the disassembly of a module, select **Project > Disassemble from the menu bar of the Metrowerks CodeWarrior window**.

Figure 5.14 ELF Disassembler Panel



simulator Settings

Target Settings Panels
- Source Trees
- M56800 Target
- Language Settings
  - C/C++ Language
  - C/C++ Warnings
  - M56800 Assembler
- Code Generation
  - ELF Disassembler
  - M56800 Processor
  - Global Optimizations
- Linker
  - M56800 Linker
- Editor
  - Custom Keywords
- Debugger
  - Other Executables
  - Debugger Settings
  - M56800 Target Set...

ELF Disassembler

- [✓] Show Headers
- [ ] Verbose Info
- [✓] Show Symbol and String Tables
- [✓] Show Relocations
- [✓] Show Code Modules
  - [✓] Use Extended Mnemonics
  - [✓] Show Source Code
  - [✓] Show Addresses and Object Code
  - [✓] Show Comments
- [✓] Show Data Modules
  - [ ] Disassemble Exception Tables
- [ ] Show Debug Info

The items in this panel are:

Information on ELF Files

Show Headers

The **Show Headers** option determines whether or not the assembled file lists any ELF header information in the disassembled output.

Show Symbol and String Tables

The **Show Symbol and String Tables** option determines whether the disassembler lists the symbol table for the disassembled module.

Verbose Info

The **Verbose Info** option instructs the disassembler to show additional information about certain types of information in the ELF file. For the `.symtab` section some of the descriptive constants are shown with their numeric equivalents. The sections `.line`, `.debug`, `extab` and `extabindex` are also shown with an unstructured hex dump.

Show Relocations

The **Show Relocations** option shows relocation information for the corresponding text (.reala.text) or data (.reala.data) section.

Show Code Modules

The **Show Code Modules** option determines whether the disassembler outputs the ELF code sections for the disassembled module.

When enabled, the **Use Extended Mnemonics, Show Source Code, Show Addresses and Object Code, and Show Comments options** become available.

Use Extended Mnemonics

The **Use Extended Mnemonics** option determines whether the disassembler lists the extended mnemonics for each instruction for the disassembled module.

This option is displayed only if **Show Code Modules** is enabled.

Show Addresses and Object Code

The **Show Addresses and Object Code** option determines whether the disassembler lists the address and object code for the disassembled module.

This option is available only if **Show Code Modules** is enabled.

Show Source Code

The **Show Source Code** option determines whether the disassembler lists the source code for the module presented. Source code is displayed in mixed mode with line number information from the original C source.

This option is available only if the **Show Code Modules** option is enabled.

Show Comments

The **Show Comments** option displays comments produced by the disassembler in sections where comment columns are provided.

This option is available only if **Show Code Modules** is enabled.

Show Data Modules

The **Show Data Modules** option determines whether the disassembler outputs any ELF data sections (such as `.rodata` and `.bss`) for the module that was disassembled.

Disassemble Exception Tables

The **Disassemble Exception Tables** option determines whether or not the disassembler outputs any C++ exception tables for the disassembled module. This option is not enabled for DSP56800 because exception tables are not supported.

This option is available when you enable **Show Data Modules**.

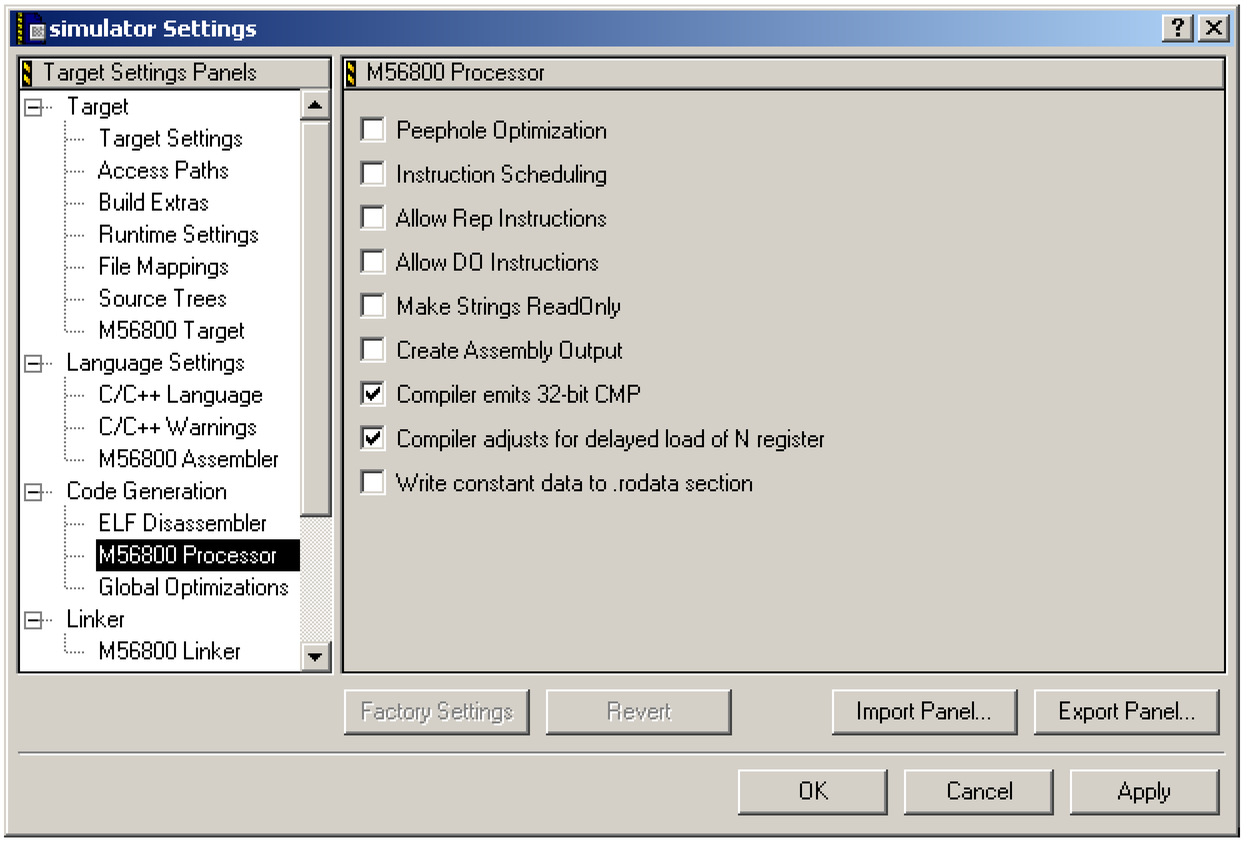
Show Debug Info

The **Show Debug Info** option informs the disassembler to include DWARF symbol information in the disassembled output.

M56800 Processor

The **M56800 Processor** settings panel (Figure 5.15) determines the kind of code the compiler creates. This panel is available only when the current build target uses the M56800 Linker.

Figure 5.15 M56800 Processor Settings Panel



- [ ] Peephole Optimization
- [ ] Instruction Scheduling
- [ ] Allow Rep Instructions
- [ ] Allow DO Instructions
- [ ] Make Strings ReadOnly
- [ ] Create Assembly Output
- [✓] Compiler emits 32-bit CMP
- [✓] Compiler adjusts for delayed load of N register
- [ ] Write constant data to .rodata section

The items in this panel are:

Peephole Optimization

This option controls the use of peephole optimizations. The peephole optimizations are small local optimizations that eliminate some compare instructions and optimize some address register updates for more efficient sequences.

Instruction Scheduling

This option determines whether the compiler rearranges instructions to take advantage of the M56800's scheduling architecture. This option results in faster execution speed, but is often difficult to debug.

NOTE Instruction Scheduling can make source-level debugging difficult because the source code might not correspond exactly to the underlying instructions. Disable this option when debugging code.

Allow REP Instructions

This option controls `REP` instruction usage. Such instructions are generally more efficient, but they prevent you from servicing any incoming interrupts inside a `REP` construct. If you are using interrupts or writing a time-critical real-time application, avoid using `REP` instructions.

Allow DO Instructions

This option controls the compiler's support for the `DO` instruction. Since the compiler never nests `DO` instructions, interrupt routines are always free to use those instructions.

Make Strings ReadOnly

This option determines whether you can specify a location to store string constants. If this option is disabled, the compiler stores string constants in the data section of the ELF file. If this option is enabled, the compiler stores string constants in the read-only `.rodata` section.

Create Assembly Output

This option allows the compiler to produce a `.asm` assembler-compatible file for each C source file in the project. The `.asm` file is located in the same path as the Project/Debug file and has the same name as the .c file containing `main`.

For example, `MyProgram.c` would produce the assembly output `MyProgram.asm`.

Compiler Emits 32-bit CMP

This option allows the compiler to use a 32-bit compare instruction. Enable this option for all target CPUs except for the DSP56811.

Compiler adjusts for delayed load of N-registers

When N-register (offset registers) are used consecutively, this option allows the compiler to send NOP instruction to resolve the restrictions in pipeline dependencies.

Write const data to .rodata section

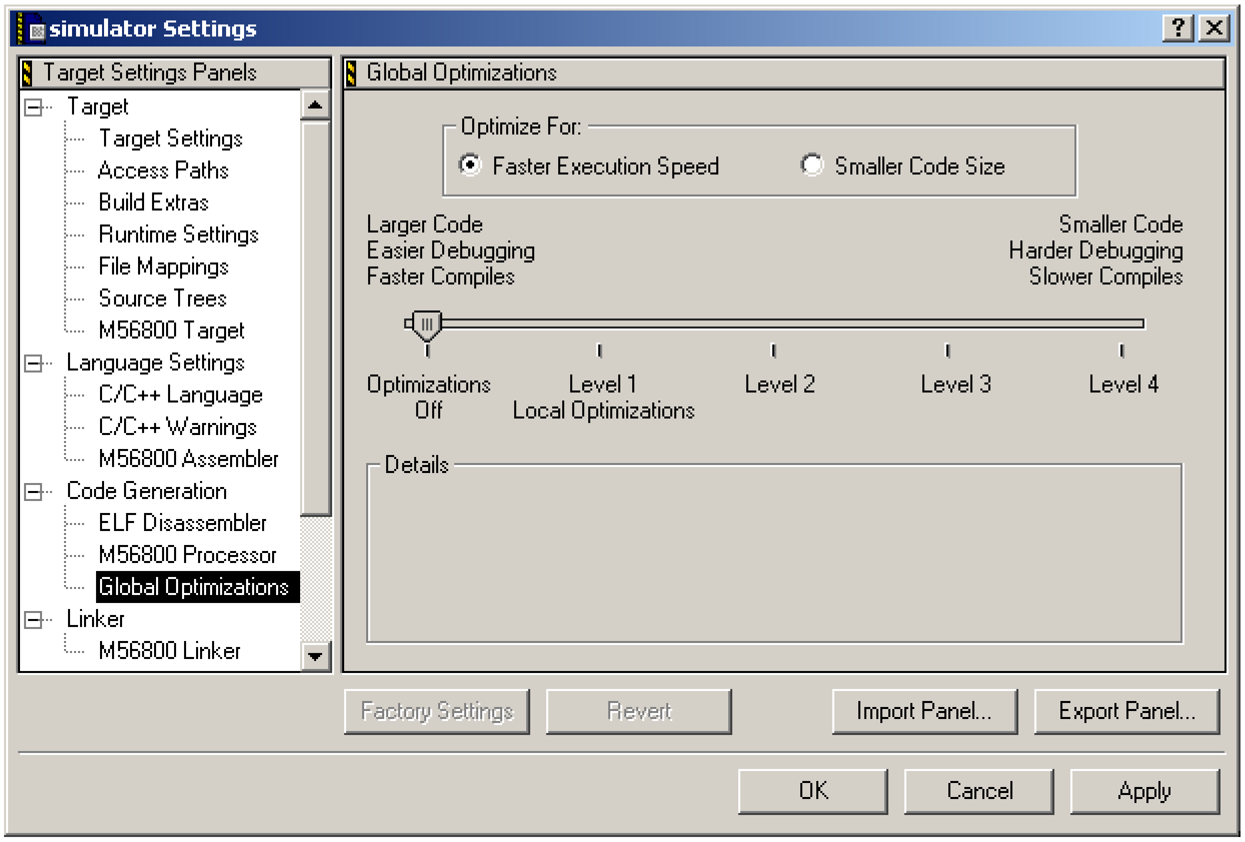
This option allows the compiler to write all constant data to a read-only memory section (.rodata). You must add .rodata section in the linker command file. This option is overridden by the use_rodata pragma.

Global Optimizations

Use the **Global Optimizations** panel (Figure 5.16), to configure how the compiler rearranges its object code to produce smaller and faster object-code. Some optimizations remove redundant operations in a program, while other optimizations analyze an item’s use in a program. The goal of these optimizations is to improve performance.

NOTE Use compiler optimizations only after you have debugged your software. Optimizing may break the one-to-one relationship between source and object code.

Figure 5.16 Global Optimizations Panel


simulator Settings

Target Settings Panels
- Target
  - Target Settings
  - Access Paths
  - Build Extras
  - Runtime Settings
  - File Mappings
  - Source Trees
  - M56800 Target
- Language Settings
  - C/C++ Language
  - C/C++ Warnings
  - M56800 Assembler
- Code Generation
  - ELF Disassembler
  - M56800 Processor
  - Global Optimizations
- Linker
  - M56800 Linker

Global Optimizations

Optimize For: [✓ Faster Execution Speed] Smaller Code Size

Larger Code / Easier Debugging / Faster Compiles — Smaller Code / Harder Debugging / Slower Compiles

[✓ Optimizations Off] Level 1 Local Optimizations, Level 2, Level 3, Level 4

Details

Optimizing for Space or Speed

You can optimize for space (size of the code in memory) or speed. Although some code optimizations can reduce both size and execution time, there is often a trade-off between these two factors. The **Smaller Code Size** and **Faster Execution Speed** settings allow you to control these trade-offs.

For example, if you click the **Faster Execution Speed** radio button, then the compiler optimizes code for speed even if it adversely affects the code size.

Faster Execution Speed

This option improves the execution speed of object code. With this option on, object code is faster but may be larger. Click the **Smaller Code Size** radio button to reduce the effect that this option has on a size of a program.

Smaller Code Size

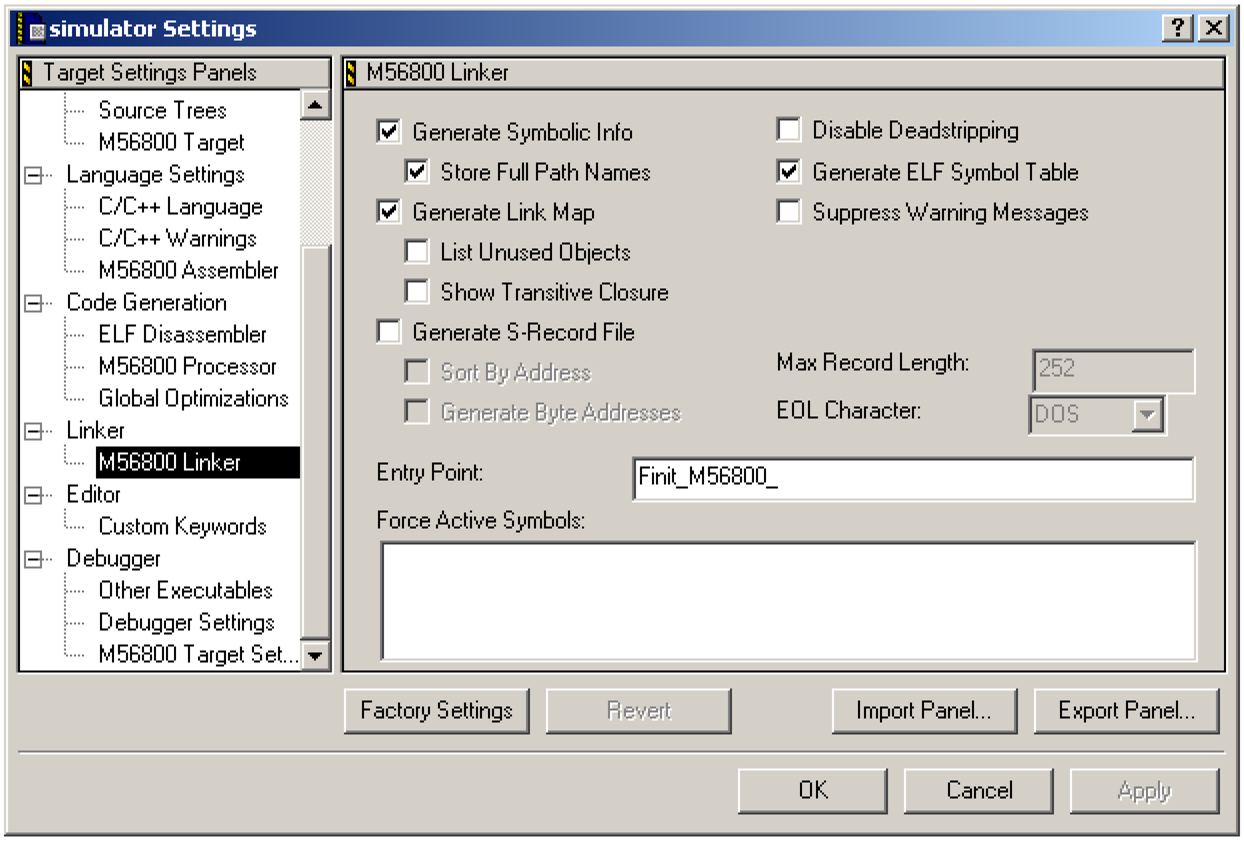
This setting reduces the size of object code that the compiler produces. If you select this radio button, object code is smaller but may be slower.

Linker

M56800 Linker

The **M56800 Linker** panel (Figure 5.17), controls the behavior of the linker. This panel is available only when the current build target uses the M56800 Linker.

Figure 5.17 M56800 Linker Settings Panel



M56800 Linker

- [✓] Generate Symbolic Info
  - [✓] Store Full Path Names
- [✓] Generate Link Map
  - [ ] List Unused Objects
  - [ ] Show Transitive Closure
- [ ] Generate S-Record File
  - [ ] Sort By Address
  - [ ] Generate Byte Addresses
- [ ] Disable Deadstripping
- [✓] Generate ELF Symbol Table
- [ ] Suppress Warning Messages

Max Record Length: 252

EOL Character: DOS

Entry Point: Finit_M56800_

Force Active Symbols:

Generate Symbolic Info

The **Generate Symbolic Info** option controls whether the linker generates debugging information.

When you enable this option, the linker generates debugging information included in the linked ELF file. This setting does not generate a separate file.

If the **Generate Symbolic Info** option is not enabled, the **Store Full Path Names** option is not available.

NOTE If you disable the **Generate Symbolic Info** option, you cannot debug your project using the CodeWarrior debugger. For this reason, the option is enabled by default.

Store Full Path Names

The **Store Full Path Names** option controls how the linker includes path information for source files when generating debugging information.

When the option is enabled, the linker includes full path names to the source files. When the option is disabled, the linker uses only the file names. In typical usage, this option is enabled.

This option is available only if you enable **Generate Symbolic Info**.

Generate Link Map

The **Generate Link Map** option controls whether the linker generates a link map. The file name for the link map adds the extension **xMAP** to the generated file name. The IDE places the link map in the Debug subdirectory.

For each object and function in the output file, the link map shows which file provided the definition. The link map also shows the address given to each object and function, a memory map of where each section resides in memory, and the value of each linker-generated symbol.

Although the linker aggressively strips unused code and data when the CodeWarrior IDE compiles the relocatable file, it never deadstrips assembler relocatable files or relocatable files built with other compilers. If a relocatable file was not built with the CodeWarrior C compiler, the link map lists all of the unused but unstripped symbols. You can use that information to remove the symbols from the source manually and rebuild the relocatable file in order to make your final process image smaller.

List Unused Objects

The **List Unused Objects** option controls whether the linker includes unused objects in the link map.

Enable this option to let the linker include unused objects in the link map. The linker does not link unused code in the program.

Usually, this option is disabled. However, you might want to enable it in certain cases. For example, you might discover that an object you expect to be used is not actually used.

Show Transitive Closure

The **Show Transitive Closure** option recursively lists in the link map file all of the objects referenced by `main()`. Listing 6.1 shows some sample code. To show the effect of the **Show Transitive Closure** option, you must compile the code.

Listing 5.4 Sample Code to Show Transitive Closure

```
void foot( void ){  int a = 100; }
void pad( void ){  int b = 101; }

int main( void ){
 foot();
 pad();
 return 1;
}
```

After you compile the source, the linker generates a link map file as shown in Listing 6.2.

Listing 5.5 Effects of Show Transitive Closure in Link Map File

```
# Link map of FSTART_
  1] FSTART_ (func,global) found in MSL C 56800.Lib FSTART.c
   2] FIntVec (notype,global) found in MSL C 56800.Lib 
Init56811.asm
   2] F_stack_addr (object,global) found in dsp568_heap_stack.c
   2] FInt_Addr (notype,global) found in MSL C 56800.Lib 
Init56811.asm
   2] Fmain (func,global) found in M56800_main.c
    3] Ffoot (func,global) found in M56800_main.c
    3] Fpad (func,global) found in M56800_main.c
   2] Ffflush (notype,global) found in MSL C 56800.Lib console.asm
    3] F__stdout_ready (object,global) found in MSL C 56800.Lib 
console.c
    3] rtlib.bss.lo (section,local) found in MSL C 56800.Lib 
console.asm
    3] rtlib.data (section,local) found in MSL C 56800.Lib 
console.asm
```

Disable Deadstripping

The **Disable Deadstripping** option prevents the linker from removing unused code and data.

Generate ELF Symbol Table

The **Generate ELF Symbol Table** option generates an ELF symbol table, as well as a list of relocations in the ELF executable file.

Suppress Warning Messages

The **Suppress Warning Messages** option controls whether the linker displays warnings.

When this option is disabled, the linker displays warnings in the **Message** window. When this option is disabled, the linker does not display warnings.

In typical usage, this option is disabled.

Generate S-Record File

This option controls whether the linker generates an S-Record file based on the application object image.

The file name for the S-Record adds the **.s** extension to the generated file name. The linker generates S3 type S-Records.

Sort By Address

This option enables the compiler to sort S-records generated by the linker using byte address.

Generate Byte Address

This option enables the linker to generate S-records in bytes.

Max Record Length

The **Max Record Length** field specifies the maximum length of the S-record generated by the linker. This field is available only if you enable **Generate S-Record File**. The maximum value allowed for an S-Record length is 256 bytes.

NOTE Most programs that load applications onto embedded systems have a maximum allowable length for the S-Records. The CodeWarrior debugger can handle S-Records that are 256 bytes long. If you are using something other than the CodeWarrior debugger to load your embedded application, you need to determine the maximum allowable length.

EOL Character

The **EOL Character** menu defines the end-of-line character for the S-record file. This field is available only if you enable **Generate S-Record File**. The end-of-line characters are:

- <cr> <lf> for DOS
- <cr> for Mac OS
- <lf> for Unix

Entry Point

The **Entry Point** field specifies the function that the linker first uses when the program runs. This function is the program's starting point.

The default `FSTART_` function is the IDE's bootstrap or glue code that sets up the DSP56800 environment before your code executes. This function is in the `FSTART.asm` file, which is part of the Metrowerks Standard Library for DSP56800. The `FSTART function` performs other tasks, such as clearing the hardware stack, creating an interrupt table, and fetching the stack start and exception handler addresses.

The final task performed by `FSTART_` is to call your `main()` function.

For the DSP56800 development environment, the `FSTART.asm` file is located in the following path:

\M56800 Support\Msl\Msl_c\DSP_56800\Src\`FSTART.asm`

Force Active Symbols

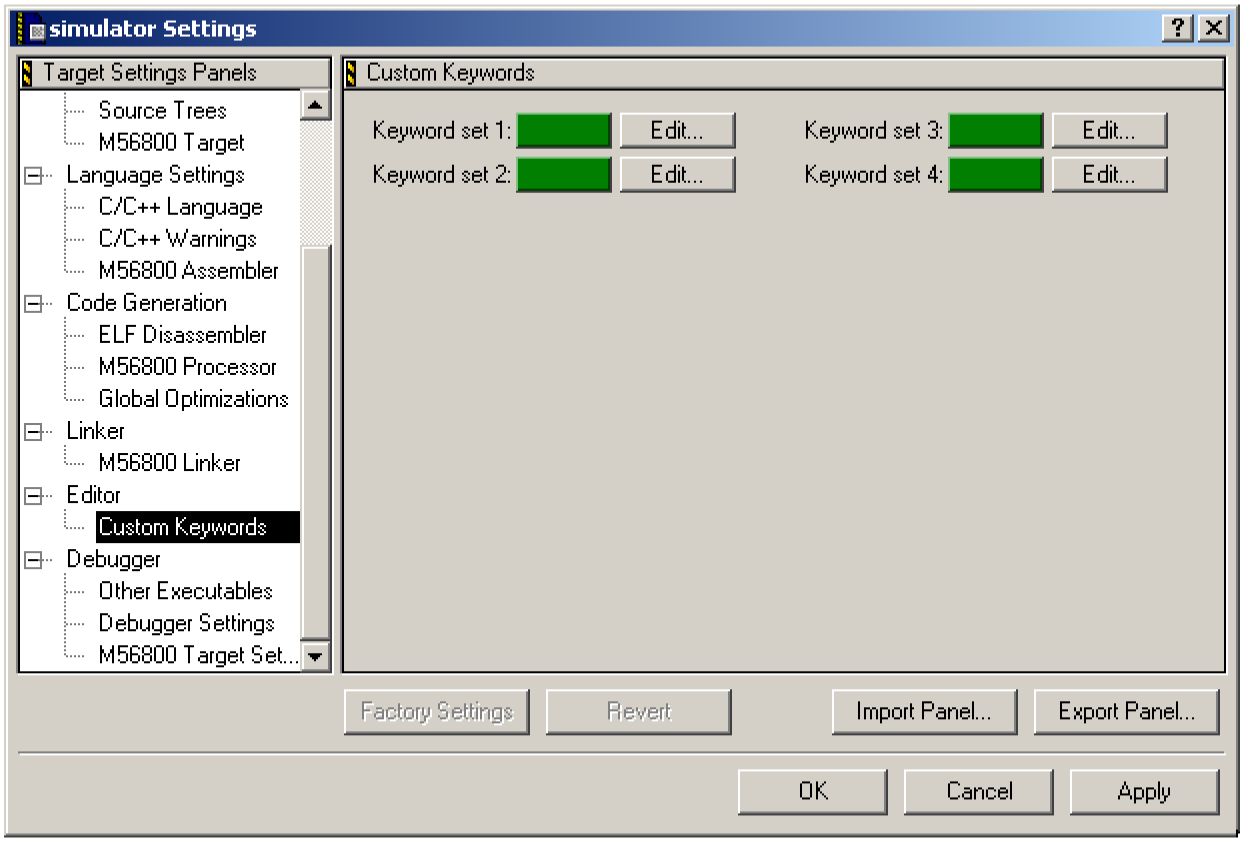
The **Force Active Symbols** text field allows the linker to include symbols in the link even if the symbols are not referenced. In essence, it is a way to make symbols immune to deadstripping. When listing multiple symbols, use a single space between them as a separator.

Editor

Custom Keywords Panel

The CodeWarrior IDE can use different colors for each type of text. To change these colors, select the **Custom Keywords** panel (Figure 5.18). This can configure as many as four keyword sets, each with a list of keywords, and syntax coloring for a project.

Figure 5.18 Custom Keywords Panel



Keyword Set

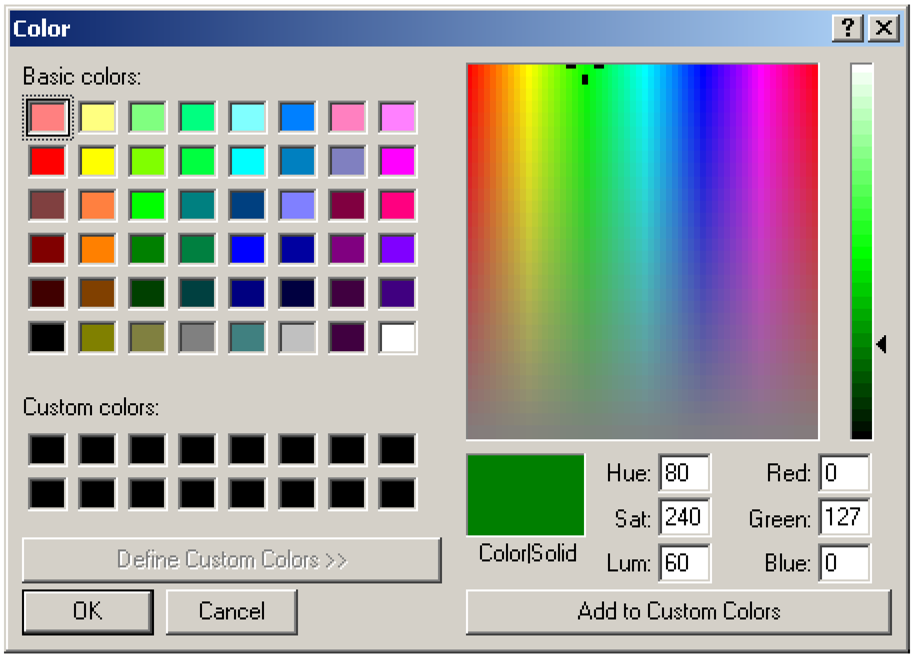
You have two options to select the color:

- **Color** dialog box
- Custom Keywords dialog box

Color Dialog Box

Click the color swatch. The **Color** dialog box appears (Figure 5.19):

Figure 5.19 Color Dialog Box



Hue: 80
Sat: 240
Lum: 60
Red: 0
Green: 127
Blue: 0

Basic Colors

Select the color by clicking the rectangular box in the **Color** dialog box.

Color/Solid

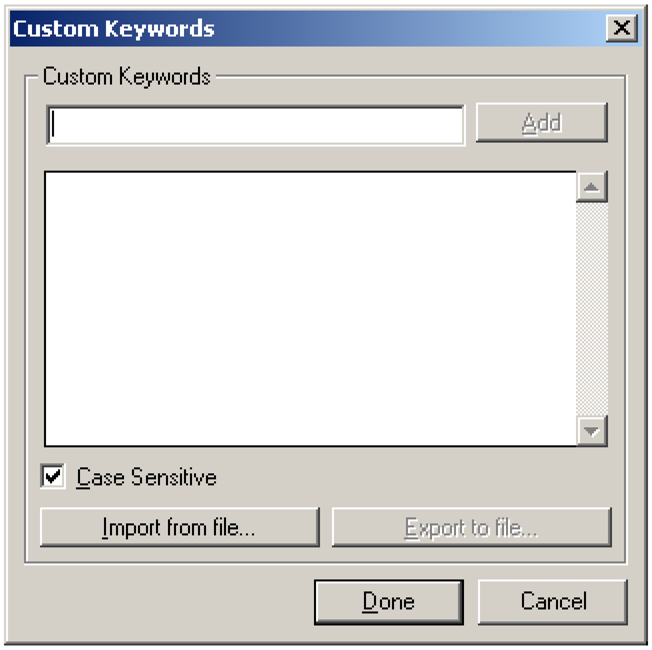
When you select a color, the selected color appears in the color strip adjacent to the right side of the dialog box. Drag the arrow located on the right of the color strip to change the color shade. Click the **Add to Custom Color** button to save the chosen color shade. The new shade of color appears in one of the rectangle under **Custom Colors**.

Custom Keywords Dialog Box

You can define a collection of keywords to which you can assign a unique color. This custom keyword set can include functions, types, and other names that you want to highlight with a particular color. You can enter four sets as shown in the **Custom Keywords** panel (Figure 5.18). Use the **Custom Keywords** dialog box to define, modify, export, and import the sets for use within the IDE.

Click the **Edit** button adjacent to the swatch. The **Custom Keywords** dialog box dialog box appears (Figure 5.20).

Figure 5.20 Custom Keywords Dialog Box



Custom Keywords

Add

1. Type the custom keyword in the text box at the top of the **Custom Keywords** dialog box. The **Add** button is enabled.
2. Click the **Add** button. The custom keyword appears in the dialog box. You can enter up to four sets.
3. Click **Done** to save the sets and close the dialog box.

Import from file

Using the **Import from file** option, you can import existing custom keyword sets for use in the IDE.

Export to file

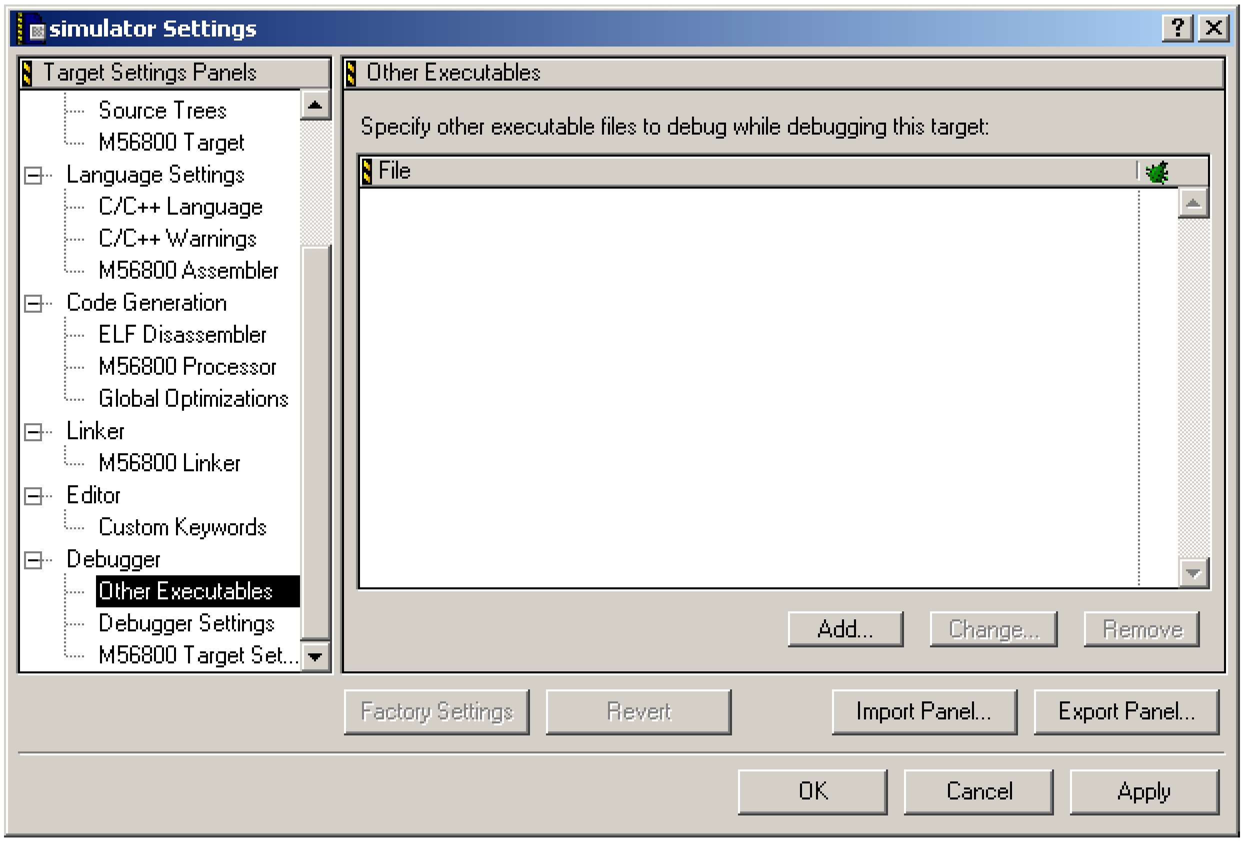
Using the **Export to file** option, you can export your custom keyword sets for use on another IDE host.

Debugger

Other Executables Panel

The Other Executables panel (Figure 5.21) does not apply to the DSP56800 chip.

Figure 5.21 Other Executables Settings Panel

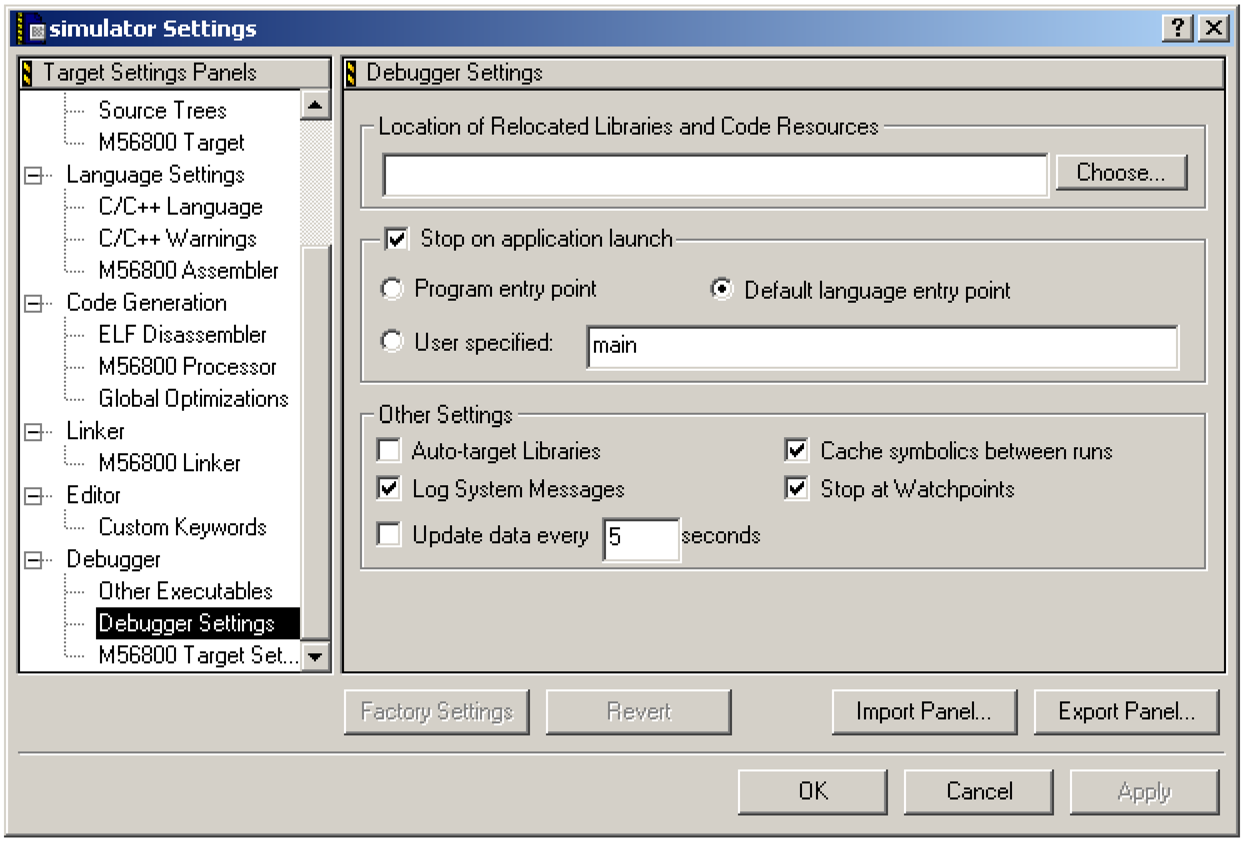


Specify other executable files to debug while debugging this target:

Debugger Settings

The **Debugger Settings** panel (Figure 5.22) includes options to log activities, change data-update intervals, and set other related options.

Figure 5.22 Debugger Settings Panel



Debugger Settings

Location of Relocated Libraries and Code Resources

[✓] Stop on application launch

( ) Program entry point [● Default language entry point]

( ) User specified: main

Other Settings

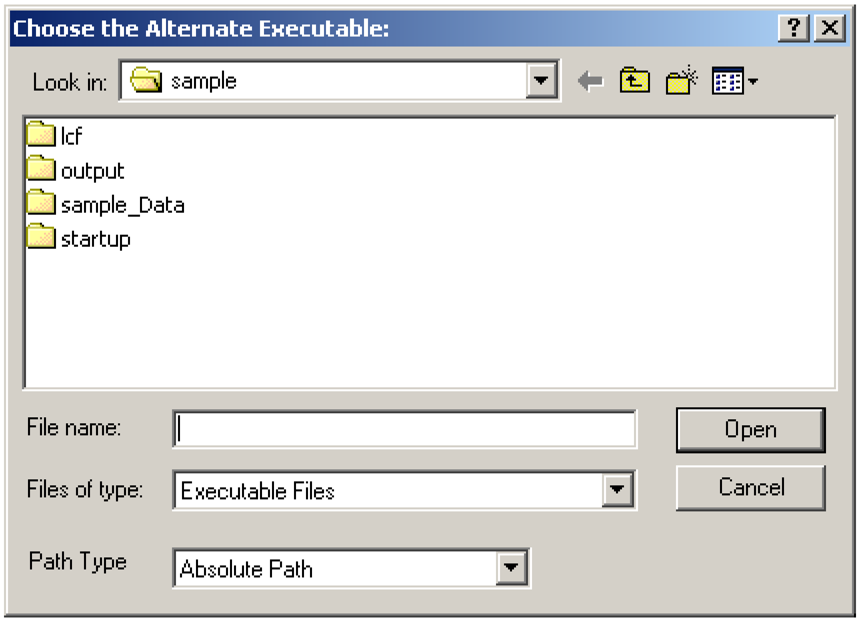
[ ] Auto-target Libraries
[✓] Cache symbolics between runs
[✓] Log System Messages
[✓] Stop at Watchpoints
[ ] Update data every 5 seconds

Location of Relocated Libraries and Code Resources

Use any of the following options to enter a path in the **Location of Relocated Libraries and Code Resources** text box.

- Type the path name in the **Location of Relocated Libraries and Code Resources** text box.
- Click the **Choose** button to display a standard dialog box (Figure 5.23) and use the dialog box to select the path.

Figure 5.23 Choose the Alternate Executable Dialog Box



The path to the selected executable field then appears in the **Location of Relocated Libraries and Code Resources** text box.

Stop on application launch

Check this check box to stop program execution at a specified temporary breakpoint at the beginning of a debugging session.

Select any of the following three options to stop program execution:

- Click the **Program entry point** radio button to halt program execution upon entering the program.
- Click the **Default language entry point** radio button to always stop at the `main()` function.
- Click the **User specified** radio button and type the field at which you want to stop.

Other Settings

Auto-target Libraries

This check box applies to the current project when you debug a non-project file. For example, this situation can occur when you attach a running process.

Check the **Auto Target Libraries** check box to allow the IDE to attempt to debug dynamically linked libraries (DLL) loaded by the target application. The IDE attempts to automatically debug the loaded DLLs for which symbolics information is available.

Cache symbolics between runs

Check this check box to allow the debugger to cache a project's symbolics information and refer to that cached information during subsequent debugging sessions. Leave the check box unchecked to force the debugger to discard the project's symbolics information after each debugging session. Enabling the symbolics cache is useful for improving the performance of successive debugging sessions.

Log System Messages

Check this check box to log all system messages to a file. Leave the check box unchecked if you do not wish to create a log file.

Stop at Watchpoints

Check this check box to halt a program's execution when the debugger encounters a watchpoint, regardless of whether the watched value changes. Leave the check box unchecked to halt execution only when the watched value changes.

NOTE Watchpoints always stop regardless of the settings.

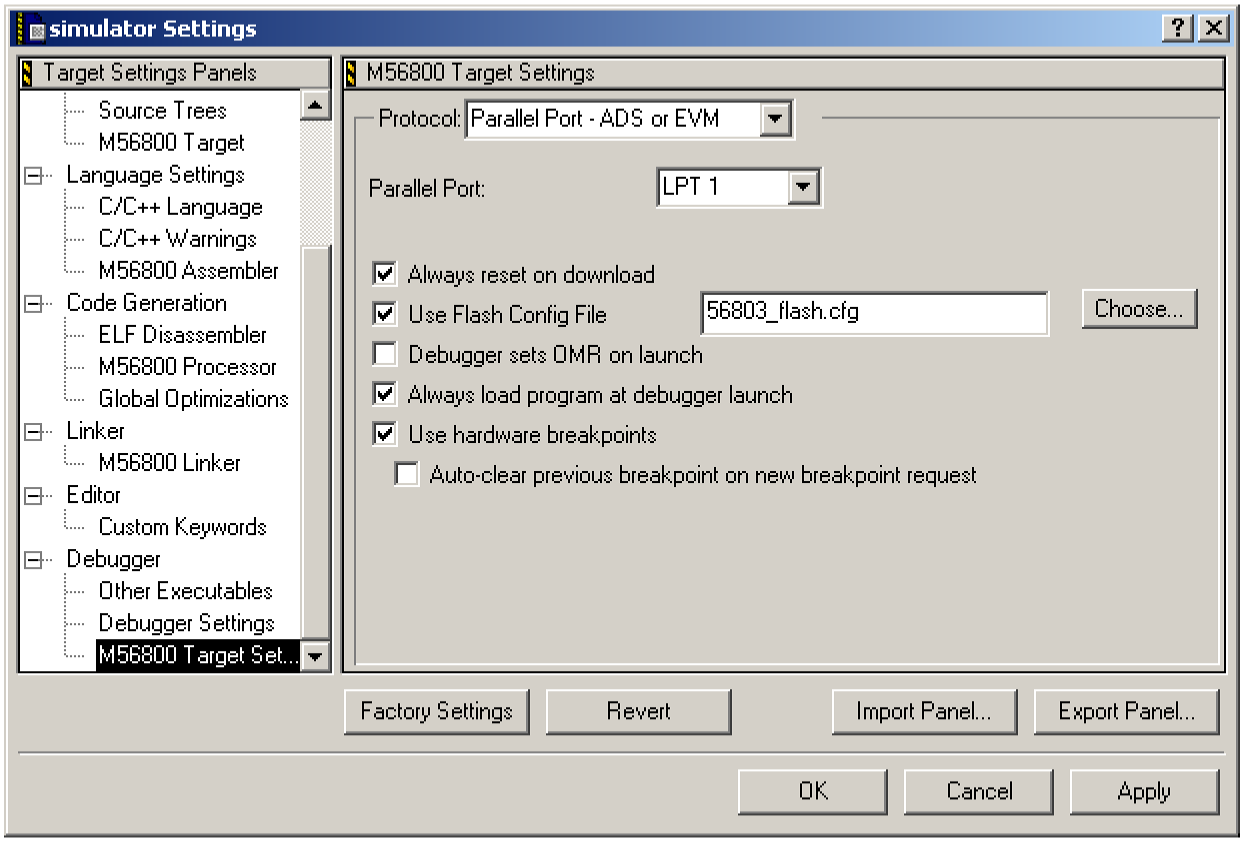
Update Data every x seconds

Check this check box to update the information in debugging windows while the target is running after a specified time interval. Type in an interval in the **Update Data every x seconds** text box, where x represents the number of seconds you wish to elapse before the next update. Leave the check box unchecked if you do not wish to update the debugging information. In this case, debugging-window information stays the same throughout the debugging session.

M56800 Target Settings

The **M56800 Target Settings** panel lets you set communication protocols for interaction between the DSP56800 board and the CodeWarrior debugger.

Figure 5.24 M56800 Target Settings Panel



Protocol: Parallel Port - ADS or EVM

Parallel Port: LPT 1

☑ Always reset on download
☑ Use Flash Config File: 56803_flash.cfg
☐ Debugger sets OMR on launch
☑ Always load program at debugger launch
☑ Use hardware breakpoints
☐ Auto-clear previous breakpoint on new breakpoint request

Protocol

- **ADS Command Converter**

  Select the **ADS Command Converter** protocol if you are using the ADS Universal Command Converter (UCC).

- **Serial - EVM**

  If you are only using the DSP56L811EVM card with serial interface.

- **Serial - SB56K**

  If you are using the Domain Technologies SB-56K Multi-DSP Emulator.

- **Parallel Port - ADS or EVM**

  Select the **Parallel Port - ADS or EVM** protocol if **you are using the external** Motorola Suite56™ Parallel Command Converter or the **on-board parallel port interface of the EVM board.**

- **Simulator**

  If you want to run your code on the DSP56800 Simulator instead of downloading the code to actual hardware.

- PCI

  If you are using the Motorola Suite56™ PCI Command Converter with parallel port interface.

- Ethernet

  If you are using the Motorola Suite56™ Ethernet Command Converter.

- Command Converter Server

  Select the **Command Converter Server** protocol if you want to debug a target with a complex chain locally or to debug remotely.

- **Simulator**

  Select the **Simulator** to simulate the DSP56800 processor. The simulator allows selection of bandwidth for CPU usage. Options are Low, Medium, and High.

Always Reset on Download

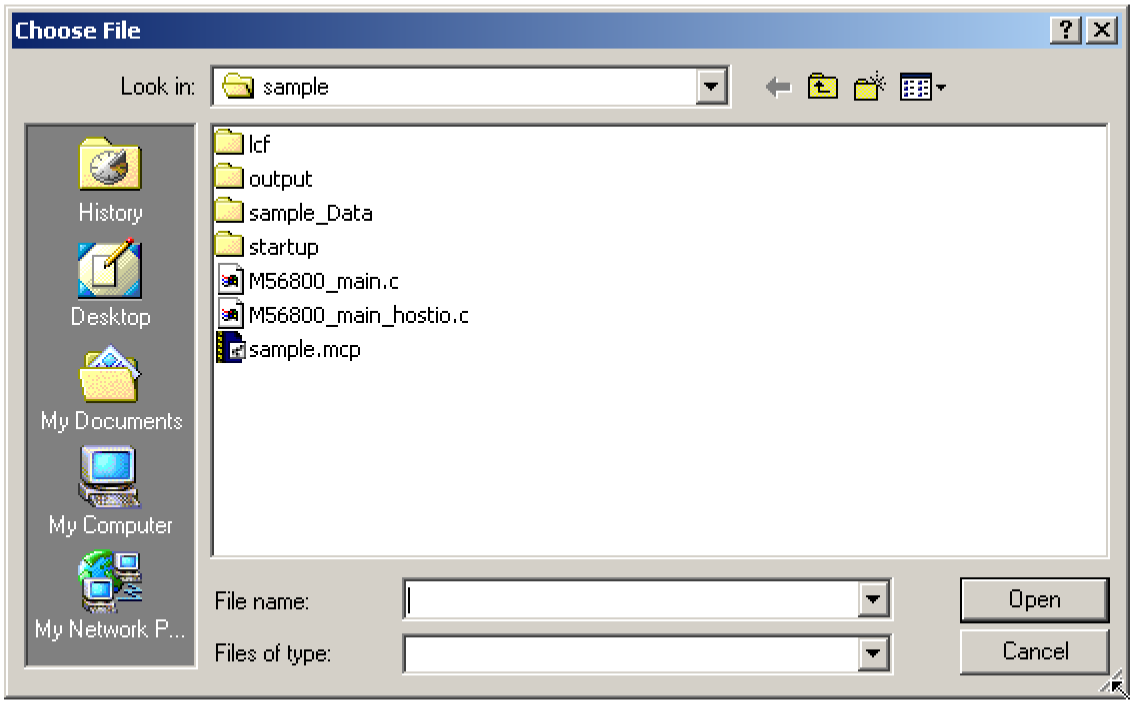
Always reset on download determines whether the debugger always resets the DSP hardware before starting a debugging session. If enabled, the debugger automatically resets the hardware before each session. If disabled, the debugger does not reset the hardware.

Use Flash Config File

When the **Use Flash Config File** option is enabled, you can specify the use of a flash configuration file (Listing 6.3) in the text box. If the full path and file name are not specified, the default location is the same as the project file.

You can click the **Choose** button to specify the file. The **Choose File** dialog box appears (Figure 5.25).

Figure 5.25 Choose File Dialog Box



Listing 5.6 Flash Configuration File Format in Column Major

```
base   AddrstartAddr   endAddr   progMem   regBaseAddr   Terase   Tme
Tnvs   Tpgs   Tprog   Tnvh    Tnvh1   Trcv
```

Where:

`baseAddr`	address where row 0 (zero) starts
`startAddr`	first flash memory address
`endAddr`	last flash memory address
`progMem`	0 = data (X:), 1 = program memory (P:)
`regBaseAddr`	location in data memory map where the control registers are mapped
Terase	erase time
TME	mass erase time
Tnvs	PROG/ERASE to NVSTR set up time

Tpgs	NVSTR to program set up time
Tprog	program time
Tnvh	NVSTR hold time
Tnvh1	NVSTR hold time(mass erase)
Trcv	recovery time

A sample flash configuration file for DSP56F803 and DSP56F805 is in Listing 6.4. Do not change the contents of this file.

Listing 5.7 Sample Flash Configuration File for DSP56F803/5

```
0  0x0004   0x7dff   1  0x0f40   0x0002   0x0006   0x001A   0x0033   0x0066   0x001A   0x019A   0x0006

0  0x8000   0x87ff   1  0x0f80   0x0002   0x0006   0x001A   0x0033   0x0066   0x001A   0x019A   0x0006

0  0x1000   0x1fff   0  0x0f60   0x0002   0x0006   0x001A   0x0033   0x0066   0x001A   0x019A   0x0006
```

NOTE You cannot use Flash ROM with the board set in development mode. Ensure the **Debugger sets OMR on launch** is not enabled if you are using this feature.

Debugger sets OMR on launch

Enable **Debugger sets OMR on launch** to put the board into development mode (setting the OMR register to 0x103). Otherwise, the OMR value is 0x100. This is necessary for boards that do not have jumpers to set the development mode.

NOTE If you are using Flash ROM, do not enable **Debugger sets OMR on launch.**

Always Load Program at Debugger Launch

When the **Always load program at debugger launch** option is enabled, the debugger downloads your object code to the target hardware when you select **Project > Debug** from the menu bar of the Metrowerks CodeWarrior window. Disable this option when you want to debug a target that is already loaded.

Use Hardware Breakpoints

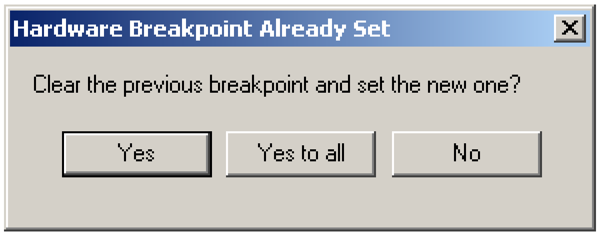
Enabling the **Use hardware breakpoints** option lets you set a hardware breakpoint in your C source code at one location. To set a hardware breakpoint, enable the **Use hardware breakpoints** option and set a breakpoint in the same manner as setting a software breakpoint.

Use hardware breakpoints only for flash debugging. Using a hardware breakpoint halts execution after an instruction goes into the pipeline. This causes the execution point to "skid" a few instructions past the breakpoint.

NOTE Enabling **Use hardware breakpoints** disables all previously set break-points.

Auto-clear previous breakpoint on new breakpoint request

This option is only available when you enable the **Use hardware breakpoints** option. When you also enable the **Auto-clear previous breakpoint on new breakpoint request** and set a breakpoint, the original breakpoint is automatically cleared and the new breakpoint is immediately set. If you disable the **Auto-clear previous breakpoint on new breakpoint request** option and attempt to set another breakpoint, you will be prompted the following message:


Hardware Breakpoint Already Set

Clear the previous breakpoint and set the new one?

If you click the **Yes** button, the previous breakpoint is cleared and the new breakpoint is set.

If you click the **Yes to all** button, the **Auto-clear previous breakpoint on new breakpoint request** option is enabled and the previously set breakpoint is cleared out without prompting for every subsequent occurrence.

If you click the **No** button, the previous breakpoint is kept and the new breakpoint request is ignored.

6

C for DSP56800

This chapter explains the CodeWarrior™ compiler and linker for DSP56800.

This chapter contains the following sections:

General Notes on C

Note the following on the DSP56800 processors:

- C^{++} language is not supported.
- Floating-point functions (for example, sin, cos, and sqrt) are not supported.
- The sizeof function in C is not the same as the SIZEOF function in the linker. In C, the sizeof function returns a number of type SIZE_T, which the complier declares to be of type `unsigned long int`. The sizeof function in C returns the number of words, whereas the SIZEOF function in the linker returns the number of bytes.

Number Formats

This section explains how the CodeWarrior compilers implement integer and floating-point types for DSP56800 processors. Look at `limits.h` for more information on integer types and `float.h` for more information on floating-point types. Both `limits.h` and `float.h` are in the Metrowerks Standard Library (MSL) folder for DSP.

DSP56800 Integer Formats

Table 6.1 shows the sizes and ranges of the data types for the DSP56800 compiler.

Table 6.1 Data Type Ranges

Type	Option Setting	Size (bits)	Range
`bool`	n/a	16	`true` or `false`
`char`	**Use Unsigned Chars** is disabled in the **C/C++ Language** settings panel	16	`-32,768 to 32,767`
	Use Unsigned Chars is enabled	16	`0 to 65,535`
`signed char`	n/a	16	`-32,768 to 32,767`
`unsigned char`	n/a	16	`0 to 65,535`
`short`	n/a	16	`-32,768` to `32,767`
`unsigned short`	n/a	16	`0` to `65,535`
`int`	n/a	16	`-32,768` to `32,767`
`unsigned int`	n/a	16	`0` to `65,535`
`long`	n/a	32	`-2,147,483,648` to `2,147,483,647`
`unsigned long`	n/a	32	`0` to `4,294,967,295`

Type	Option Setting	Size (bits)	Range
`pointer`	small-model enabled	16	`0` to `65,535`
	small-model disabled (not available)	32	`0` to `4,294,967,295`

DSP56800 Floating-Point Formats

Table 6.2 shows the sizes and ranges of the floating-point types for the DSP56800 compiler.

Table 6.2 DSP56800 Floating-Point Types

Type	Size (bits)	Range
`float`	32	`1.17549e-38` to `3.40282e+38`
`short double`	32	`1.17549e-38` to `3.40282e+38`
`double`	32	`1.17549e-38` to `3.40282e+38`
`long double`	32	`1.17549e-38` to `3.40282e+38`

DSP56800 Fixed-Point Formats

Table 6.3 shows the sizes and ranges of the fixed-point types for the DSP56800 compiler.

Table 6.3 DSP56800 Fixed-Point Types

Type	Declared As	Size (bits)	Range
fixed	`__fixed__`	16	`(-1.0 <= x < 1.0)`

Type	Declared As	Size (bits)	Range
short fixed	`__shortfixed__`	16	`(-1.0 <= x < 1.0)`
long fixed	`__longfixed__`	32	`(-1.0 <= x < 1.0)`

NOTE For compatibility reasons, preferably use DSP intrinsics instead of fixed-point types in Table 6.3 for fractional arithmetic.

Calling Conventions, Stack Frames

The CodeWarrior IDE for Motorola DSP56800 stores data and calls functions in ways that might be different from other target platforms.

Calling Conventions

The registers `A`, `R2`, `R3`, `Y0`, and `Y1` pass parameters to functions. When a function is called, the parameter list is scanned from left to right. The parameters are passed in this way:

1. The first long fixed-point value is placed in `A`.
2. The first two 16-bit fixed-point values are placed in `Y0` and `Y1`.
3. The first two 16-bit addresses are placed in `R2` and `R3`.
4. If there are no long fixed-point parameters, the first non-fixed-point 32-bit value or 19-bit address is placed in `A`.
5. If there are no 16-bit fixed-point parameters, the first two 16-bit non-fixed-point, non-address values are placed in `Y0` and `Y1` (and `Y0` receives the single value when only one is passed).

   All remaining parameters are pushed onto the stack, beginning with the rightmost parameter. Multiple-word parameters (19- and 32-bit values) have their least significant word pushed onto the stack first.

When calling a routine that returns a structure, the caller passes an address in `R0` which specifies where to copy the structure.

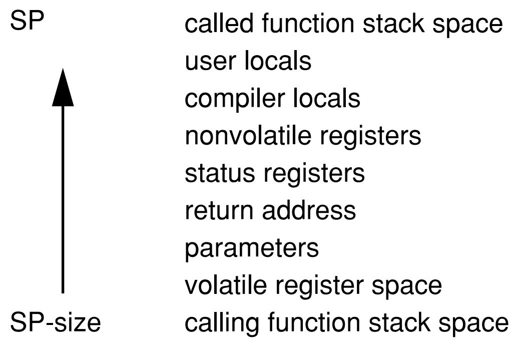
The registers `A`, `R0`, `R2`, and `Y0` are used to return function results as follows:

- Long fixed-point values are returned in `A`.
- All 19-bit addresses and 32-bit values are returned in `A`.
- 16-bit addresses are returned in `R2`.
- All 16-bit non-address values are returned in `Y0`.

Stack Frame

The stack frame is generated as shown in Figure 6.1. The stack grows upward, meaning that pushing data onto the stack increments the address in the stack pointer.

Figure 6.1 The Stack Frame



The stack pointer register (`SP`) is a 16-bit register used implicitly in all `PUSH` and `POP` instructions. The software stack supports structured programming, such as parameter passing to subroutines and local variables. If you are programming in both assembly-language and high-level language programming, use stack techniques. Note that it is possible to support passed parameters and local variables for a subroutine at the same time within the stack frame.

Code and Data Storage

There are two memory sections for the DSP56800: CODE (P memory) and DATA (X memory) (Table 6.4). The compiler places code and data in the appropriate sections. You may need to specify how the program-defined sections map to real memory by using the ELF Linker and Command Language and the **M56800 Linker** settings panel.

Table 6.4 Code and Data Memory

Section	Size	Range (Hexadecimal)
`CODE`	64K x 16 bit	`0000 - FFFF`
`DATA`	64K x 16 bit	`0000 - FFFF`

Optimizing Code

Optimizations that are specific to DSP56800 development with the CodeWarrior IDE are:

Page 0 Register Assignment

The compiler uses page 0 address locations `0x30` - `0x40` as *register variables*. Frequently accessed local variables are assigned to the page 0 *registers* instead of to stack locations so that load and store instructions are shortened. Addresses `0x30 - 0x37` (page 0 registers `MR0-MR7`) are volatile registers and can be overwritten. The remaining registers (page 0 registers `MR8-MR15`) are treated as non-volatile and, if used by a routine, must be saved on entry and restored on exit.

Register Coloring

The C compiler performs an optimization called *register coloring*. In this optimization, the compiler may assign two or more register variables to the same register. The compiler does this optimization if the code is not using the two variables at the same time. In this example, the compiler could place `i` and `j` in the same register.

Listing 6.1 Register Coloring Example

```
short i;
int j;

for (i=0; i<100; i++) { MyFunc(i); }
for (j=0; j<100; j++) { MyFunc(j); }
```

However, if a line of code like the one below is placed anywhere in the function, the compiler would realize that you are using `i` and `j` at the same time, and would place the variables in different registers.

```
MyFunc (i + j);
```

Register coloring reduces code size and has no effect on execution time.

Using the DSP56800 development tools, you can instruct the compiler to:

1. Store all local variables on the stack.

   The compiler loads and stores local variables when you read and write to them. This behavior is standard for the compiler.

   If desired, set the optimization level to Off, level 1, or level 2 in the **Global Optimizations** settings panel.

2. Place as many local variables as possible in registers.

   In this case, two or more variables whose lifetimes do not overlap can be placed in the same register.

   If desired, set the optimization level to 3 or 4 in the **Global Optimizations** settings panel.

NOTE At optimization level 3 or 4, you can assign local variables to different registers in different sections of your code. This behavior could produce unexpected results if you compile your code at optimization level 3 or 4 and then attempt to debug your code.

Variables that are declared `volatile` (or those that have the address taken) are not kept in registers.

Array Optimizations

Array indexing operations are optimized when optimizations are turned on in the **Global Optimizations** settings panel.

In Listing 6.2, the `i` index is optimized out and the operation performs with address registers.

Listing 6.2 C Code Example for Array Optimizations

```
void main( void ) {
  short a[100], b[100];int i;

  // ... other code

  for ( i = 0; i < 100; i++ ) {
    ArrayA[i] = ArrayB[i]; }
  // ... other code
}
```

It is easier to understand the optimization process by viewing the assembler code mixed with C code, created both before (Listing 6.3) and after (Listing 6.4) optimizations are turned on.

Listing 6.3 Array Example Before Optimizations - Mixed View

```
for (i = 0;i < 100; i++ )
00001004: A7B20000  moves    #0,X:0x0032
00001006: A90B      bra      main+0x18 (0x1018)      ; 0x000812
 {
  a[i] = b[i];
00001007: 880F      move     SP,R0
00001008: DE40FF9D  lea      (R0+-99)
0000100A: BC32      moves    X:0x0032,N
0000100B: F044      move     X:(R0+N),X0
0000100C: 880F      move     SP,R0
0000100D: DE40FF39  lea      (R0+-199)
0000100F: BC32      moves    X:0x0032,N
00001010: D044      move     X0,X:(R0+N)
 }
```

The optimization level has been set to 3 (Listing 6.4). Note that `i` is optimized out and the operation is now performed with address registers.

Listing 6.4 Array Example After Optimizations - Mixed View

```
for ( i = 0; i < 100; i++ )
00001008: A7B20000  moves    #0,X:0x0032
0000100A: A905      bra      START_+0x3 (0x101a)     ; 0x000810
 {
  a[i] = b[i];
0000100B: F016      move     X:(R2),X0
0000100C: D017      move     X0,X:(R3)
0000100D: DE02      lea      (R2)+
0000100E: DE03      lea      (R3)+
 }
```

Multiply and Accumulate (MAC) Optimizations

Multiply and Accumulate optimizations use address register calculations and perform arithmetic operations with a `MACR` instruction. The effect of these optimizations reflects in the source code examples in Listing 6.5 and Listing 6.6.

Listing 6.5 Sample Multiply and Accumulate Operation

```
void main( void )
{
  __fixed__ a[100], b[100];
  __fixed__ sum = 0;

  int i=0;

  for ( i = 0; i < 100; i++ ){
    sum += a[i] * b[i];
  }
}
```

The mixed view without optimizations is as follows:

Listing 6.6 Assembly Output for Multiply and Accumulate Operation

```
for ( i = 0; i < 100; i++ )
00001006: A7B20000  moves    #0,X:0x0032
00001008: A90E      bra      START_ (0x101f)         ; 0x000817
 {
  sum += a[i] * b[i];
00001009: 880F      move     SP,R0
0000100A: DE40FF39  lea      (R0+-199)
0000100C: BC32      moves    X:0x0032,N
0000100D: F344      move     X:(R0+N),Y1
0000100E: 880F      move     SP,R0
0000100F: DE40FF9D  lea      (R0+-99)
00001011: BC32      moves    X:0x0032,N
00001012: F144      move     X:(R0+N),Y0
00001013: B033      moves    X:0x0033,X0
00001014: 7C79      macr     +Y1,Y0,X0
00001015: 9033      moves    X0,X:0x0033
 }
```

The optimized version with level 3 optimizations (Listing 6.7):

Listing 6.7 Assembly Output for Optimized Multiply and Accumulate Operation

```
for ( i = 0; i < 100; i++ )
0000100A: A7B20000  moves    #0,X:0x0032
0000100C: A908      bra      START_+0x5 (0x1021)     ; 0x000815
 {
  sum += a[i] * b[i];
0000100D: F316      move     X:(R2),Y1
0000100E: F117      move     X:(R3),Y0
0000100F: B033      moves    X:0x0033,X0
00001010: 7C79      macr     +Y1,Y0,X0
00001011: 9033      moves    X0,X:0x0033
00001012: DE02      lea      (R2)+
00001013: DE03      lea      (R3)+
 }
```

Pragma Directives

A pragma is a method for modifying compiler settings from the source code rather than the preference panels. Typically, you would use the settings panels to set global options and use pragmas for special cases.

Description of Pragma Interrupt

The pragma interrupt directive controls the compilation of object code for interrupt routines. The compiler generates a special prologue and epilogue for functions so that they may be used to handle interrupts. The contents of the epilogue and prologue vary depending on the mode selected.

The compiler also emits an RTI or RTS for the return statement depending upon the mode selected. The SA, R, and CC bits of the OMR register are set to system default.

To use the interrupt pragma, place the pragma interrupt inside your interrupt handler as shown in Listing 6.8. This causes the function to return with an RTI instruction instead of an RTS.

Listing 6.8 Syntax and Examples

```
void myIntHandler(){
#pragma interrupt
//code...}
```

There are several ways to use this pragma as described below.

`pragma interrupt saveall|called[warn]`

The compiler performs the following using the `pragma interrupt [warn]` option:

- Sets M01 to –1 if M01 is used by ISR.
- Sets OMR to system default:
  – Convergent rounding
  – No saturation mode
  – 32-bit compares

- Saves/restores only registers used by ISR.
- Generates an RTI to return from interrupt.
- If [`warn}` is present, then emits warnings if this ISR makes calls to functions that have not been defined with pragma called.

NOTE You must use the `[warn]` argument only within the scope of function body.

```
pragma interrupt saveall [warn]
```

The compiler performs the following using the `pragma interrupt saveall[warn]` argument:

- Always sets M01 to –1.
- Sets OMR to system default 0x103:
  - Convergent rounding
  - No saturation mode
  - 32-bit compares
- Saves/restores hardware stack via a runtime call.
- Generates an RTI to return from interrupt
- If [`warn]` is present, then emits warnings if this ISR makes calls to functions that have not been defined with pragma called.

NOTE You must use the `saveall[warn]` argument only within the scope of function body.

```
pragma interrupt called
```

The compiler performs the following using the `pragma interrupt called` argument:

- Saves/restores only registers used by routine.
- Generates an RTS to return from function.

Note the following for the `called` argument:

- You can use the argument on function declarations or within scope of function body.
- You must use this argument before interrupt body is compiled.

- Use this pragma for all functions called by an interrupt routine.

Listing 6.9 Sample Code - #pragma interrupt saveall|called [warn]

```
#pragma interrupt called
void calledfunction();

int irq1( void )
{
#pragma interrupt warn
...irq1 code
} /* end of ISR--pragma interrupt state is turned off
automatically */

int irq2( void )
{
#pragma interrupt saveall warn
...irq2 code
calledfunction();
} /* end of ISR--pragma interrupt state is turned off
automatically */

void calledfunction()
{
…code
}

int main ( void )
{
irq1();
irq2();
}
```

NOTE The end of a function always turns off the pragma interrupt directive.

Pragma Optimization

Listing 6.10 Synopsis - Pragma Optimization

```
#pragma optimization_level [<level> | reset]
<level> is an integer number between 0 and 4 inclusive
```

The optimization_level pragma controls the global optimization level programmatically through the #pragma preprocessor statement. The optimization level may be set to any legal value (0-4) using this method. The 'reset' option resets the optimization level to its prior value before the #pragma is encountered. This pragma does not affect the interactive preference panel settings for global optimization levels. If this pragma occurs in the middle of a function definition, the entire function is compiled as if the pragma had occurred before the function definition since the actual compilation of the function is deferred until the function is parsed entirely.

Listing 6.11 Sample Code - Pragma Optimization

```
// Function definition
int afunc ( void )
{

// Function statements...
#pragma optimization_level 0
// Remaining function statements...
}

// Restore optimization level to its previous value
#pragma optimization_level reset
```

The entire function 'afunc' is compiled under optimization level 0.

Constant Data Section

By default, the compiler emits const defined data to the .data section. There are two ways to cause the compiler to emit const defined data to the .rodata section:

1. Setting the “write const data to .rodata section” option in the M56800 Processor Settings panel.

   This method emits all const-defined data to the .rodata section.

2. Using #pragma use_rodata [on | off | reset].

on	Write const data to .rodata section.
off	Write const data to .data section.
reset	Toggle pragma state.

   To use this pragma, place the pragma before the const data that you wish the compiler to emit to the .rodata section. This method overrides the target setting and allows a subset of constant data to be emitted to or excluded from the .rodata section.

Listing 6.12 Synopsis - Pragma use_rodata

```
#pragma use_rodata on|off|reset
```

By default, the compiler emits const defined data to the .data section. There are two ways to cause the compiler to emit const defined data to the .rodata section:

1. Setting the “write const data to .rodata section” option in the M56800 Processor Settings panel.

   This method emits all const-defined data to the .rodata section.

2. Using #pragma use_rodata [on | off | reset].

on	Write const data to .rodata section.
off	Write const data to .data section.
reset	Toggle pragma state.

To use this pragma, place the pragma before the const data that you wish the compiler to emit to the .rodata section. This method

overrides the target setting and allows a subset of constant data to be emitted to or excluded from the .rodata section.

Listing 6.13 Sample Code _ Pragma use_rodata

```
const UInt16 len_l_mult_ls_data = sizeof(l_mult_ls_data) /
sizeof(Frac32) ;
const Int16 g = a+b+c;

#pragma use_rodata on
const Int16    d[]={0xdddd};
const Int16    e[]={0xeeee};
const Int16    f[]={0xffff};
#pragma use_rodata off

main()
{
           // ... code
}
```

You must add .rodata section information to the linker command file.

Listing 6.14 Sample Linker Command FIle - Pragma use_rodata

```
MEMORY {
    .text   (RWX) : ORIGIN = 0x2000, LENGTH = 0x00000000
    .data   (RW)  : ORIGIN = 0x3000, LENGTH = 0x00000000
    .rodata (R)   : ORIGIN = 0x5000, LENGTH = 0x00000000
}
SECTIONS {
.main_application :
    {
           # .text sections
    } > .text

    .main_application_data :
    {
           # .data sections
           # .bss sections
    } > .data
    .main_application_data:
    {
           # .data sections
           * (.rodata)
    } > .rodata
}
```

Linker Issues

This section explains background information on the DSP56800 linker and its operation.

Deadstripping Unused Code and Data

The DSP56800 linker deadstrips unused code and data only from files compiled by the CodeWarrior C compiler. Assembler relocatable files and C object files built by other compilers are never deadstripped. Libraries built with the CodeWarrior C compiler only contribute the used objects to the linked program. If a library has assembly or other C compiler-built files, only those files that have at least one referenced object contribute to the linked program. Completely unreferenced object files are always ignored when deadstripping is enabled.

Link Order

The DSP56800 linker always processes C and assembly source files, as well as archive files (`.a` and `.lib`) in the order specified under the **Link Order** tab in the project window. Therefore, if a symbol is defined in a source-code file and a library, the linker uses the definition which appears first in the link order.

If you want to change the link order, select the **Link Order** tab in the project window and drag your source or library file to the preferred location in the link order list. Files that appear at the top of the list are linked first.

7

Inline Assembly Language and Intrinsic Functions

This chapter explains the support for inline assembly language and intrinsic functions that is built into the CodeWarrior™ compiler. This chapter only covers the CodeWarrior IDE implementation of Motorola assembly language.

Working With DSP56800 Inline Assembly Language

This section explains how to use the CodeWarrior compiler's for inline assembly language programming, including assembly language syntax.

This chapter contains the following sections:

Inline Assembly Language Syntax for DSP56800

This section explains the inline assembly language syntax specific to DSP56800 development with the CodeWarrior IDE.

Function-level Inline Assembly Language

To specify that a block of code in your file should be interpreted as assembly language, use the `asm` keyword and standard DSP56800 instruction mnemonics.

To ensure that the C compiler recognizes the `asm` keyword, you must disable the **ANSI Keywords Only** option in the **C/C++ Language** panel.

You can use the M56800 inline assembly language to specify that an *entire function* is in assembly language by using the syntax displayed in Listing 7.1.

Listing 7.1 Function-level Syntax

```
asm  <function header>
{
    <local declarations>
 <assembly instructions>
}
```

The function header is any valid C function header, and the local declarations are any valid C local declarations.

Statement-level Inline Assembly Language

The M56800 inline assembly language supports single assembly instructions as well as `asm` blocks, *within* a function using the syntax in Listing 7.2. The inline assembly language statement is any valid assembly language statement.

Listing 7.2 Statement-level Syntax

```
asm  {  inline assembly statement
        inline assembly statement
        ...
}
asm  (  inline assembly statement ;
        inline assembly statement ;
        ...
)
```

There are two different ways to represent statement-level assembly. In the first way, you use braces "{}" to contain the block. Within this type of block, the semicolon that separates statements is optional. In the second way, you use parenthesis "()" to contain the block and the the semicolon between statements is mandatory.

Adding Assembly Language to C Source Code

There are two ways to add assembly language statements in a C source code file. You can define a function with the `asm` qualifier, or you can use the inline assembly language.

The first method uses the `asm` keyword to specify that *all* statements in the function are in assembly language, as shown in Listing 7.3 and Listing 7.7. Note that if you are using this method, you must define local variables within the function.

Listing 7.3 Defining a Function with `asm`

```
asm long MyAsmFunction(void)
{
   /* Local variable definitions */
   /* Assembly language instructions */
}
```

The second method uses the `asm` qualifier as a statement to provide inline assembly language instructions, as shown in Listing 7.4. Note that if you are using this method, you must *not* define local variables within the inline `asm` statement.

Listing 7.4 Inline Assembly with asm

```
long MyInlineAsmFunction(void)
{
    asm { move   x:(r0)+,x0 }
}
```

Assembly Language Quick Guide

Keep these points in mind as you write assembly language functions:

- All statements must either be a label:

  `[`*`LocalLabel`*`:]`

  Or an instruction:

  `( (`*`instruction`*`) [`*`operands`*`] )`

- Each statement must end with a new line
- Assembly language directives, instructions, and registers are not case-sensitive:

```
    add   x0,y0
    ADD   X0,Y0
```

Creating Labels for M56800 Assembly

A label can be any identifier that you have not already declared as a local variable. A label must end with a colon.

Listing 7.5 Labels in M56800 Assembly

```
x1:  add  x0,y1,a
x2:  add  x0,y1,a
x3   add  x0,y1,a  //ERROR, MISSING COLON
```

Using Comments in M56800 Assembly

Comments in inline assembly language can only be in the form of C and C++ comments. You cannot begin the inline assembly language comments with a semicolon (;) nor with a pound sign (#) - the preprocessor uses the pound sign. You can use the semicolon for comments in `.asm` sources. The proper comment format is shown in Listing 7.6.

Listing 7.6 Comments Allowed in M56800 In-line Assembly Language

```
    move     x:(r3),y0      #  ERROR
    add      x0,y0          // OK
    move     r2,x:(sp)      ; ERROR
    adda     r0,r1,n        /* OK */
```

Calling Assembly Language Functions from C Code

You can call assembly language functions from C just like you would call any standard C function. You need to use standard C syntax for calling inline assembly language functions and pure assembly language functions in `.asm` files.

Calling Inline Assembly Language Functions

You can call inline assembly language functions just like you would call any standard C function. Listing 7.7 demonstrates how to create an inline assembly language function in a C source file. This example adds two 16-bit integers and returns the result.

Notice that you are passing two 16-bit addresses to the add_int function. You pick up those addresses in R3 and R2, and in Y0 pass back the result of the addition.

Listing 7.7 Sample Code - Creating an Inline Assembly Language Function

```
asm int add_int( int * i, int * j )
{
 move    x:(r2),y0
 move    x:(r3),x0
 add   x0,y0
 // int result returned in y0
 rts
}
```

Now you can call your inline assembly language function with standard C notation, as in Listing 7.8.

Listing 7.8 Sample Code - Calling an Inline Assembly Language Function

```
int x = 4, y = 2;

y = add_int( &x, &y ); /* Returns 6 */
```

Calling Pure Assembly Language Functions

In order for your assembly language files to be called from C code, you need to specify a `SECTION` mapping for your code so that it is linked appropriately. You must also specify a memory space location. Code is usually specified to program memory (P) space with the ORG directive.

When defining an assembly language function, use the GLOBAL directive to specify the list of symbols within the current section. You can then define the assembly language function.

An example of a complete assembly language function is shown in Listing 7.9. In this function, two 16-bit integers are written to program memory. A separate function is needed to write to P: memory because C pointer variables cannot be employed. C pointer values only allow access to X: data memory.

The first parameter is a short value and the second parameter is the 16-bit address where the first parameter is written.

Listing 7.9 Sample Code - Creating an Assembly Language Function

```
                              ;"my_assym.asm"
  SECTION user               ;map to user defined section in CODE
  ORG P:                    ;put the following program in P
                              ;memory

  GLOBALF pmemwrite         ;This symbol is defined within the
                            ;current section and should be
                              ;accessible by all sections

Fpmemwrite:
  MOVE   Y1,R0                ;Set up pointer to address
  NOP                         ;Pipeline delay for R0
  MOVE   Y0,P:(R0)+        ;Write 16-bit value to address
                           ;pointed to by R0 in P: memory and
                               ;post-increment R0
  rts                          ;return to calling function

  ENDSEC                       ;End of section
  END                          ;End of source program
```

NOTE The compiler prepends the letter 'F' to every function label name.

You can now call your assembly language function from C, as shown in Listing 7.10.

Listing 7.10 Sample Code - Calling an Assembly Language Function from C

```
void pmemwrite( short, short ); /* Write a value into P: memory */

void main( void )
{
  // ...other code

 // Write the value given in the first parameter to the address
  // of the second parameter in P: memory
  pmemwrite( (short)0xE9C8, (short)0x0010 );

  // other code...
}
```

Calling Functions from Assembly Language

Assembly programs can call C function or Assembly language functions. This section explains the compiler convention for:

- Calling C Functions from Assembly Language

  Functions written in C can be called from within assembly language instructions. For example, if you defined your C program function as:

  ```
  void foot( void ) {
      /* Do something */
  ```

```
}
```

You could then call your C function from assembly language as:

```
  jsr  Ffoot
```

- Calling Assembly Language Functions from Assembly Language

  To call an assembly language function from assembly language, use the `jsr` instruction with the function name as defined in your assembly language source. For example, you can call your function in Listing 7.9 on page 152 as:

```
  jsr  Fpmemwrite
```

Intrinsic Functions for DSP56800

This section explains issues related to DSP56800 intrinsic functions and using them with DSP56800 projects.

- An Overview of Intrinsic Functions
- Fractional Arithmetic
- Macros Used with Intrinsics

An Overview of Intrinsic Functions

CodeWarrior C for DSP56800 has intrinsic functions to generate inline assembly language instructions.

Intrinsic functions are used to target specific processor instructions. They can be helpful in accomplishing a few different things:

- Intrinsic functions let you pass in data to perform specific optimized computations. For example, some calculations may be inefficient if coded in C because the compiler has to follow ANSI C rules to represent data, and this may cause the program to jump to runtime math routines for certain computations. In such cases, it probably is better to code these calculations using assembly language instructions and intrinsic functions.
- Intrinsic functions can control small tasks. For example, with intrinsic functions you can set a bit in the operating mode register to enable saturation. This is more convenient than using

inline assembly language syntax and specifying the operation in an `asm` block, every time that the operation is required.

NOTE Support for intrinsic functions is not part of the ANSI C standard. They are an extension provided by the CodeWarrior compiler.

Fractional Arithmetic

Many of the intrinsic functions for Motorola DSP56800 use fractional arithmetic with implied fractional values. An implied fractional value is a symbol, which has been declared as an integer type, but is to be calculated as a fractional type. Data in a memory location or register can be interpreted as fractional or integer, depending on the needs of a user's program.

All intrinsic functions that generate multiply and divide instructions (DIV, MPY, MAC, MPYR, and MACR) perform fractional arithmetic on implied fractional values. The following equation shows the relationship between a 16-bit integer and a fractional value:

$$\text{Fractional Value} = \text{Integer Value} / (2^{15})$$

Similarly, the equation for converting a 32-bit integer to a fractional value is as follows:

$$\text{Fractional Value} = \text{Long Integer Value} / (2^{31})$$

Table 7.1 shows how both 16 and 32-bit values can be interpreted as either fractional or integer values.

Table 7.1 Interpretation of 16- and 32-bit Values

Type	Hex	Integer Value	Fixed-point Value
short int	0x2000	8192	0.25
short int	0xE000	-8192	-0.25
long int	0x20000000	536870912	0.25
long int	0xE0000000	-536870912	-0.25

Macros Used with Intrinsics

These macros are used in intrinsic functions:

- Word16. A macro for signed short.
- Word32. A macro for signed long.

List of Intrinsic Functions: Definitions and Examples

The intrinsic functions supported by the DSP56800 are shown in Table 7.2. However, please refer to `intrinsics_56800.h` for any last minute changes.

Table 7.2 Intrinsic Functions for DSP56800

Category	Function	Category	Function
Absolute/ Negate	__abs	Multiplication/ MAC	__mac_r
	__negate		__msu_r
	_L_negate		__mult
Addition/ Subtraction	__add		__mult_r
	__sub		_L_mac
	_L_add		_L_msu
	_L_sub		_L_mult
Control	__stop		_L_mult_ls

Conversion	__fixed2int	Normalization	__norm_l
	__fixed2long		__norm_s
	__fixed2short	Rounding	__round
	__int2fixed	Shifting	__shl
	__labs		__shr
	__long2fixed		__shr_r
	__short2fixed		_L_shl
Copy	__memcpy		_L_shr
	__strcpy		_L_shr_r
Deposit/ Extract	__extract_h		
	__extract_l		
	_L_deposit_h		
	_L_deposit_I		
Division	__div		
	__div_ls		

Absolute/Negate

- __abs
- __negate
- _L_negate

__abs

Definition Computes and returns the absolute value of a 16-bit integer. Generates an `ABS` instruction.

Assumption

Prototype `int __abs( int );`

Example

```
int i = -2;
i = __abs( i );
```

__negate

Definition

Negates a 16-bit integer or fractional value returning a 16-bit result. Returns 0x7FFF for an input of 0x8000.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __negate(Word16 svar1)
```

Example

```
int result, s1 = 0xE000;/*  - 0.25 */
result = __negate(s1);
// Expected value of result: 0x2000 = 0.25
```

_L_negate

Definition

Negates a 32-bit integer or fractional value returning a 32-bit result. Returns 0x7FFFFFFF for an input of 0x80000000.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word32 _L_negate(Word32 lvar1)
```

Example

```
long result, s1 = 0xE0000000;  /*  - 0.25 */
result = _L_negate(s1);
// Expected value of result: 0x20000000 = 0.25
```

Addition/Subtraction

- __add
- __sub
- _L_add
- _L_sub

__add

Definition

Addition of two 16-bit integer or fractional values, returning a 16-bit result.

Assumptions

OMR’s SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __add(Word16 src_dst, Word16 src2)
```

Example

```
short s1 = 0x4000;/* 0.5   */
short s2 = 0x2000;/* 0.25 */
short result;

result = __add(s1,s2);
// Expected value of result: 0x6000 = 0.75
```

__sub

Definition

Subtraction of two 16-bit integer or fractional values, returning a 16-bit result.

Assumptions

OMR’s SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __sub(Word16 src_dst, Word16 src2)
```

Example

```
short s1 = 0x4000;/* 0.5   */
short s2 = 0xE000;/* -0.25 */
short result;

result = __sub(s1,s2);
// Expected value of result: 0x6000 = 0.75
```

_L_add

Definition: Addition of two 32-bit integer or fractional values, returning a 32-bit result.

Assumptions: OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype:
```
Word32 _L_add(Word32 src_dst, Word32 src2)
```

Example:
```
long la = 0x40000000;/* 0.5  */
long lb = 0x20000000;/* 0.25 */
long result;

result = _L_add(la,lb);
// Expected value of result: 0x60000000 = 0.75
```

_L_sub

Definition: Subtraction of two 32-bit integer or fractional values, returning a 32-bit result.

Assumptions: OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype:
```
Word32 _L_sub(Word32 src_dst, Word32 src2)
```

Example:
```
long la = 0x40000000;/* 0.5   */
long lb = 0xE0000000;/* -0.25 */
long result;

result = _L_sub(la,lb);
// Expected value of result: 0x60000000 = 0.75
```

Control

__stop

__stop

Definition: Generates a STOP instruction which places the processor in the low power STOP mode.

Prototype:
```
void  __stop(void)
```

Usage:
```
__stop();
```

Conversion

- __fixed2int
- __fixed2long
- __fixed2short
- __int2fixed
- __labs
- __long2fixed
- __short2fixed

__fixed2int

Definition: Converts a 16-bit __fixed__ value to a 16-bit integer.

Prototype:
```
int  __fixed2int ( __fixed__ );
```

Example:
```
int  i;
__fixed__   i_fix = 0.645;

i = __fixed2int(  i_fix ); /* Returns 21135 */
```

__fixed2long

Definition: Converts a 32-bit __longfixed__ value to a 32-bit long integer.

Prototype:
```
long __fixed2long ( __longfixed__ );
```

Example

```
long l;
__longfixed__  lfix = 0.645;

l = __fixed2long( lfix ); /* Returns 1385126952 */
```

__fixed2short

Definition Converts a 16-bit __shortfixed__ value to a 16-bit short integer.

Prototype

```
short __fixed2short ( __shortfixed__ );
```

Example

```
short  s;
__shortfixed__  sfix = 0.645;

s = __fixed2short( sfix ); /* Returns 21135 */
```

__int2fixed

Definition Converts a 16-bit integer value to a 16-bit __fixed__ value.

Prototype

```
__fixed__  __int2fixed ( int );
```

Example

```
int i = 2; __fixed__ ifix;

/* Returns 0.0000610 (2^-14)*/
ifix = __int2fixed( i );
```

__labs

Definition Computes and returns the absolute value of a 32-bit long integer. Generates an `ABS` instruction.

Prototype

```
long __labs ( long );
```

Example

```
long l = -2;
l = __labs( l );       /* Returns 2 */
```

__long2fixed

Definition Converts a 32-bit long integer to a 32-bit __longfixed__ type.

Prototype

```
__longfixed__     __long2fixed ( long );
```

Example

```
long l = 2;
__longfixed__ lfix;

/* Returns 9.31e-10  (2^-30)*/
lfix = __long2fixed( l );
```

__short2fixed

Definition Converts a 16-bit short integer to a 16-bit __shortfixed__ type.

Prototype

```
__shortfixed__   __short2fixed ( short );
```

Example

```
short  s = 2;
__shortfixed__  sfix;

/* Returns 0.0000610 (2^-14)*/
sfix = __short2fixed( s );
```

Copy

- __memcpy
- __strcpy

__memcpy

Definition Copy a contiguous block of memory of n characters from the item pointed to by `source` to the item pointed to by `dest.` The behavior of `__memcpy( )` is undefined if the areas pointed to by `dest` and `source` overlap.

Prototype
```
void * __memcpy ( void *dest,
                  const void *source,
                  size_t n );
```

Example
```
const int len =  9;
char a1[len] = “Socrates\0”;
char a2[len] = null;

/* Now copy contents of a1 to a2 */
__memcpy( (char *)a2, (char *)a1, len );
```

__strcpy

Definition

Copies the character array pointed to by `source` to the character array pointed to by `dest`. The `source` argument must be a constant string. The function will not be inlined if `source` is defined outside of the function call. The resulting character array at `dest` is null terminated as well.

Prototype
```
char * __strcpy  ( char *dest,

                   const char *source );
```

Example
```
char d[11];

__strcpy( d, “Metrowerks\0” );
/* d array now contains the string “Metrowerks” */
```

Deposit/ Extract

- __extract_h
- __extract_l
- _L_deposit_h
- _L_deposit_I

__extract_h

Definition

Extracts the 16 MSBs of a 32-bit integer or fractional value. Returns a 16-bit value. Does not perform saturation. When an accumulator is the destination, zeroes out the LSP portion. Corresponds to "truncation" when applied to fractional values.

Prototype

```
Word16 __extract_h(Word32 lsrc)
```

Example

```
long l = 0x87654321;
short result;

result = __extract_h(l);
// Expected value of result: 0x8765
```

__extract_l

Definition

Extracts the 16 LSBs of a 32-bit integer or fractional value. Returns a 16-bit value. Does not perform saturation. When an accumulator is the destination, zeroes out the LSP portion.

Prototype

```
Word16 __extract_l(Word32 lsrc)
```

Example

```
long l = 0x87654321;
short result;

result = __extract_l(l);
// Expected value of result: 0x4321
```

_L_deposit_h

Definition

Deposits the 16-bit integer or fractional value into the upper 16 bits of a 32-bit value, and zeroes out the lower 16 bits of a 32-bit value.

Prototype

```
Word32 _L_deposit_h(Word16 ssrc)
```

Example

```
short s1 = 0x3FFF;
```

```
long result;

result = _L_deposit_h(s1);
// Expected value of result: 0x3fff0000
```

_L_deposit_l

Definition

Deposits the 16-bit integer or fractional value into the lower 16 bits of a 32- bit value, and sign extends the upper 16 bits of a 32-bit value.

Prototype

```
Word32 _L_deposit_l(Word16 ssrc)
```

Example

```
short s1 = 0x7FFF;
long result;

result = _L_deposit_l(s1);
// Expected value of result: 0x00007FFF
```

Division

- __div
- __div_ls

__div

Definition

Divides two 16-bit short integers as a fractional operation and returns the result as a 16-bit short integer. Generates a `DIV` instruction.

Prototype

```
short __div( short, short );
```

Example

```
short i = 0x2000; /* Assign 0.25 to i */
short j = 0x4000; /* Assign 0.50 to j */
__fixed__ f;

i = __div( i, j );      /* Returns 16384 */
f = __short2fixed( i ); /* Returns 0.50 */
```

__div_ls

Definition Single quadrant division, that is, both operands positive of two 16-bit fractional values, returning a 16-bit result. If both operands are equal, returns 0x7FFF (occurs naturally).

Note Does not check for division overflow cases.

Does not check for divide by zero cases.

Prototype
```
Word16 __div_s(Word16 s_denominator, Word16
s_numerator)
```

Example
```
short s1=0x2000;/*  0.25 */
short s2=0x4000;/*  0.5  */
short result;

result = __div_s(s2,s1);
// Expected value of result: 0.25/0.5 = 0.5 =
0x4000
```

Multiplication/ MAC

- __mac_r
- __msu_r
- __mult
- __mult_r
- _L_mac
- _L_msu
- _L_mult
- _L_mult_ls

__mac_r

Definition Multiply two 16-bit fractional values and add to 32-bit fractional value. Round into a 16-bit result, saturating if necessary. When an accumulator is the destination, zeroes out the LSP portion.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

OMR's R bit was set to 1 at least 3 cycles before this code, that is, 2's complement rounding, not convergent rounding.

Prototype

```
Word16 __mac_r(Word32 laccum,  Word16 sinp1,
Word16 sinp2)
```

Example

```
short s1 = 0xC000;/* - 0.5 */
short s2 = 0x4000;/*   0.5 */
short result;
long Acc = 0x0x0000FFFF;

result = __mac_r(Acc,s1,s2);
// Expected value of result: 0xE001
```

__msu_r

Definition

Multiply two 16-bit fractional values and subtract this product from a 32-bit fractional value. Round into a 16-bit result, saturating if necessary. When an accumulator is the destination, zeroes out the LSP portion.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

OMR's R bit was set to 1 at least 3 cycles before this code, that is, 2's complement rounding, not convergent rounding.

Prototype

```
Word16 __msu_r(Word32 laccum,  Word16 sinp1,
Word16 sinp2)
```

Example

```
short s1 = 0xC000;/* - 0.5 */
short s2 = 0x4000;/*   0.5 */
short result;
long Acc = 0x20000000;

result = __msu_r(Acc,s1,s2);
// Expected value of result: 0x4000
```

__mult

Definition

Multiply two 16-bit fractional values and truncate into a 16-bit fractional result. Saturates only for the case of 0x8000 x 0x8000. When an accumulator is the destination, zeroes out the LSP portion.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __mult(Word16 sinp1, Word16 sinp2)
```

Example

```
short s1 = 0x2000;/*  0.25 */
short s2 = 0x2000;/*  0.25 */
short result;

result = __mult(s1,s2);
// Expected value of result: 0.625 = 0x0800
```

__mult_r

Definition

Multiply two 16-bit fractional values, round into a 16-bit fractional result.   Saturates only for the case of 0x8000 x 0x8000. When an accumulator is the destination, zeroes out the LSP portion.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

OMR's R bit was set to 1 at least 3 cycles before this code, that is, 2's complement rounding, not convergent rounding.

Prototype

```
Word16 __mult_r(Word16 sinp1, Word16 sinp2)
```

Example

```
short s1 = 0x2000;/*  0.25 */
short s2 = 0x2000;/*  0.25 */
short result;

result = __mult_r(s1,s2);
// Expected value of result: 0.625 = 0x0800
```

_L_mac

Definition

Multiply two 16-bit fractional values and add to 32-bit fractional value, generating a 32-bit result, saturating if necessary.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word32 _L_mac(Word32 laccum, Word16 sinp1, Word16
sinp2)
```

Example

```
short s1 = 0xC000;/* - 0.5 */
short s2 = 0x4000;/*   0.5 */
long result, Acc = 0x20000000;/*  0.25 */

result = _L_mac(Acc,s1,s2);
// Expected value of result: 0
```

_L_msu

Definition

Multiply two 16-bit fractional values and subtract this product from a 32-bit fractional value, saturating if necessary. Generates a 32-bit result.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word32 _L_msu(Word32 laccum, Word16 sinp1, Word16
sinp2)
```

Example

```
short s1 = 0xC000;/* - 0.5 */
short s2 = 0xC000;/* - 0.5 */
long result, Acc = 0;

result = _L_msu(Acc,s1,s2);
// Expected value of result: -0.25
```

_L_mult

Definition
Multiply two 16-bit fractional values generating a signed 32-bit fractional result. Saturates only for the case of 0x8000 x 0x8000.

Assumptions
OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype
```
Word32 _L_mult(Word16 sinp1, Word16 sinp2)
```

Example
```
short s1 = 0x2000;/*  0.25 */
short s2 = 0x2000;/*  0.25 */
long result;

result = _L_mult(s1,s2);
// Expected value of result: 0.625 = 0x08000000
```

_L_mult_ls

Definition
Multiply one 32-bit and one-16-bit fractional value, generating a signed 32-bit fractional result. Saturates only for the case of 0x80000000 x 0x8000.

Assumptions
OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype
```
Word32 _L_mult_ls(Word32 linp1, Word16 sinp2)
```

Example
```
long l1 = 0x20000000;/* 0.25 */
short s2 = 0x2000;/* 0.25 */
long result;

result = _L_mult(l1,s2);
// Expected value of result: 0.625 = 0x08000000
```

Normalization

- __norm_l

- __norm_s

__norm_l

Definition Computes the number of left shifts required to normalize a 32-bit value, returning a 16-bit result. Returns a shift count of 0 for an input of 0x00000000.

Note Does not actually normalize the value!

This operation is NOT optimal on the DSP56800 because of the case of returning 0 for an input of 0x00000000.

Prototype
```
Word16 __norm_l(Word32 lsrc)
```

Example
```
long ll = 0x20000000;/* .25 */
short result;

result = __norm_l(ll);
// Expected value of result: 1
```

__norm_s

Definition Computes the number of left shifts required to normalize a 16-bit value, returning a 16-bit result. Returns a shift count of 0 for an input of 0x0000.

Note Does not actually normalize the value!

This operation is NOT optimal on the DSP56800 because of the case of returning 0 for an input of 0x0000. See the intrinsic __norm_s which is more optimal but generates a different value for the case where the input == 0x0000.

Prototype
```
Word16 __norm_s(Word16 ssrc)
```

Example
```
short s1 = 0x2000;/* .25 */
short result;

result = __norm_s(s1);
// Expected value of result: 1
```

Rounding

__round

__round

Definition
Rounds a 32-bit fractional value into a 16-bit result. When an accumulator is the destination, zeroes out the LSP portion.

Assumptions
OMR's R bit was set to 1 at least 3 cycles before this code, that is, 2's complement rounding, not convergent rounding.

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype
```
Word16 __round(Word32 lvar1)
```

Example
```
long l = 0x12348002;/*if low 16bit = 0xFFFF >
0x8000 then add 1 */
short result;

result = __round(l);
// Expected value of result: 0x1235
```

Shifting

- __shl
- __shr
- __shr_r
- _L_shl
- _L_shr
- _L_shr_r

__shl

Definition

Arithmetic shift of 16-bit value by a specified shift amount. If the shift count is positive, a left shift is performed. Otherwise, a right shift is performed. Saturation may occur during a left shift. When an accumulator is the destination, zeroes out the LSP portion.

Note

This operation is not optimal on the DSP56800 because of the saturation requirements and the bidirectional capability.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __shl(Word16 sval2shft, Word16
s_shftamount)
```

Example

```
short result;
short s1 = 0x1234;
short s2= 1;

result = __shl(s1,s2);
// Expected value of result: 0x2468
```

__shr

Definition

Arithmetic shift of 16-bit value by a specified shift amount. If the shift count is positive, a right shift is performed. Otherwise, a left shift is performed. Saturation may occur during a left shift. When an accumulator is the destination, zeroes out the LSP portion.

Note

This operation is not optimal on the DSP56800 because of the saturation requirements and the bidirectional capability.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __shr(Word16 sval2shft, Word16
s_shftamount)
```

Example

```
short result;
short s1 = 0x2468;
short s2= 1;

result = __shr(s1,s2);
// Expected value of result: 0x1234
```

__shr_r

Definition

Arithmetic shift of 16-bit value by a specified shift amount. If the shift count is positive, a right shift is performed. Otherwise, a left shift is performed. If a right shift is performed, then rounding performed on result. Saturation may occur during a left shift. When an accumulator is the destination, zeroes out the LSP portion.

Note

This operation is not optimal on the DSP56800 because of the saturation requirements and the bidirectional capability.

Assumptions

OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype

```
Word16 __shr_r(Word16 s_val2shft, Word16
s_shftamount)
```

Example

```
short result;
short s1 = 0x2468;
short s2= 1;

result = __shr(s1,s2);
// Expected value of result: 0x1234
```

_L_shl

Definition

Arithmetic shift of 32-bit value by a specified shift amount. If the shift count is positive, a left shift is performed. Otherwise, a right shift is performed. Saturation may occur during a left shift. When an accumulator is the destination, zeroes out the LSP portion.

Note — This operation is not optimal on the DSP56800 because of the saturation requirements and the bidirectional capability. See the intrinsic _L_shl or result = shlfts(l, s1); which are more optimal.

Assumptions — OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype
```
Word32 _L_shl(Word32 lval2shft, Word16
s_shftamount)
```

Example
```
long result, l = 0x12345678;
short s2= 1;

result = _L_shl(l,s2);
// Expected value of result: 0x2468ACF0
result = shlfts(l, s1);
// Expected value of result: 0x91A259E0
```

_L_shr

Definition — Arithmetic shift of 32-bit value by a specified shift amount. If the shift count is positive, a right shift is performed. Otherwise, a left shift is performed. Saturation may occur during a left shift. When an accumulator is the destination, zeroes out the LSP portion.

Note — This operation is not optimal on the DSP56800 because of the saturation requirements and the bidirectional capability.

Assumptions — OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.

Prototype
```
Word32 _L_shr(Word32 lval2shft, Word16
s_shftamount)
```

Example
```
long result, l = 0x24680000;
short s2= 1;

result = _L_shr(l,s2);
// Expected value of result: 0x12340000
```

_L_shr_r

Definition	Arithmetic shift of 32-bit value by a specified shift amount. If the shift count is positive, a right shift is performed. Otherwise, a left shift is performed. If a right shift is performed, then rounding performed on result. Saturation may occur during a left shift.
Assumptions	OMR's SA bit was set to 1 at least 3 cycles before this code, that is, saturation on data ALU results enabled.
Prototype	`Word32 _L_shr_r(Word32 lval2shft, Word16 s_shftamount)`

Example

```
long l1 = 0x41111111;
short s2 = 1;
long result;

result = _L_shr_r(l1,s2);
// Expected value of result: 0x20888889
```

Pipeline Restrictions

This section gives an overview of how the pipeline restrictions are handled by the DSP56800 compiler.

The following list contains pipeline restrictions that are detected and handled. If any of these cases are detected by the compiler's inline assembler, the compiler generates a warning and inserts a NOP instruction to correct the violation of the pipeline restriction.

1. A NORM instruction cannot be immediately followed by an instruction that accesses X memory using the R0 pointer. The following example shows a warning is generated:

```
NORM   R0,A
MOVE   X:(R0)+,A     ;Cannot reference R0 after NORM
```

2. Any jump, branch, or branch on bit field may not specify the instruction at LA or LA-1 of a hardware DO loop as their target addresses.

```
DO #7,LABEL
BCC LABEL ;Cannot branch to LA
;instruction
LABEL:
```

3. Any jump, branch, or branch on bit field instructions may not be located in the last two locations of a hardware DO loop (that is, at LA or at LA-1).

```
DO #7,LABEL
   BCC ULABEL ;Cannot branch in LA
   ;instruction
LABEL:
```

NOTE A warning will be emitted when pipeline conflicts are detected.

4. If a MOVE instruction changes the value in one of the address registers (R0–R3), then the contents of the register are not available for use until the second following instruction, that is, the instruction immediately following the MOVE instruction does not use the modified register to access X memory or update an address. This also applies to the SP register and M01 register.

```
MOVE    X:(SP-2),R1
MOVE    X:(R1)+,A;    ; R1 is not available
```

In addition, it applies if a 16-bit immediate value is moved to the N register, and the option for **Compiler adjusts for delayed load of N register** in the M56800 Processor target settings panel is enabled.

```
MOVE    #3,N
MOVE    X:(SP+N),Y0   ; N is not available
```

5. If a bit-field instruction changes the value in one of the address registers (R0–R3), then the contents of the register are not available for use until the second following instruction that is, the instruction immediately following the MOVE instruction does not use the modified register to access X memory or update an address. This applies to the SP and M01 registers.

```
BFCLR   #1,R1
MOVE    X:(R1)+,A;   ; R1 is not available
```

In addition, it applies to the N register when the **Compiler adjusts for delayed load of N register** option in the M56800 Processor target settings panel is enabled.

```
BFCLR   #1,N
MOVE    X:(R0+N),Y0   ;N is not available
```

6. For the case of nested hardware DO loops, it is required that there be at least two instructions after the pop of the LA and LC registers before the instruction at the last address of the outer loop.

```
DO #3,OLABEL ; Beginning of outer loop
PUSH LC
PUSH LA
DO X0,ILABEL ; Beginning of inner loop
; (instructions)
REP Y0 ; Skips ASL if y0 = 0
ASL A
; (instructions)
ILABEL:  ; End of inner loop
      POP LA
      POP LC
      NOP; 3 instructions required after POP
      NOP; 3 instructions required after POP
      NOP; 3 instructions required after POP
OLABEL: ; End of outer loop
```

7. If the CLR instruction changes the value in one of the address registers (R0-R3), then the contents of the register are not available for use until the second following instruction, that is, the instruction immediately following the CLR instruction does not use the modified register to acccess X memory or update an address. This also applies to the SP register and the M01 register.

```
CLR R0
MOVE X:(R0)+,A;Cannot reference R0 after NORM
```

In addition, it applies if the 16-bit immediate value is moved to the N register and the option for **Compiler adjusts for delayed load of N register** in the M56800 Processor target settings panel is enabled.

```
clr N
MOVE X:(SP)+N,Y0  ;N is not available
```

8

Debugging

This chapter explains the generic features of the CodeWarrior™ debugger and additional features specific to DSP56800 debugging.

This chapter contains the following sections:

Target Settings for Debugging

This section explains how to control the debugger's behavior by modifying the appropriate settings panels.

To properly debug DSP56800 software, you must set certain preferences in the **Target Settings** window.

The **M56800 Target** settings panel, which is described below, is specific to DSP56800 development. The remaining settings panels are generic to all build targets. In addition, other settings panels can affect debugging. Table 8.1 lists these panels.

Table 8.1 Settings Panels That Can Affect Debugging

This panel…	Affects this…	See…
M56800 Linker	Symbolics, linker warnings	"M56800 Linker,"
M56800 Processor	Optimizations	"M56800 Processor,"
Debugger Settings	Debugging options	"Debugger Settings"

M56800 Target Settings

The **M56800 Target** settings panel is unique to DSP56800 debugging. The options available in this panel depend on the communications protocol you use.

The **Protocol** menu determines the communications protocol the debugger uses when downloading your application into memory. The options available depend on the protocol you are using.

Table 8.2 lists the protocols supported by the CodeWarrior debugger for DSP56800. Refer to a section for settings specific to your chosen protocol.

Table 8.2 Debugging Protocols Supported

Debug protocol option	Comment
ADS Command Converter	Select this option if you are communicating through the JTAG interface with the UCC. The **Target Settings** window presents the options shown in Figure 8.1.
Serial - EVM	Select this option if you use the DSP56L811EVM board. The **Target Settings** window presents the options shown in Figure 8.2.
Serial - SB56K	Select this option if you are using the Domain Technologies SB-56K Multi-DSP Emulator. The **Target Settings** window presents the options shown in Figure 8.3.
Simulator	Select this option if you want to use the DSP56800 Simulator. The **Target Settings** window presents the options shown in Figure 8.4.
Parallel Port - ADS or EVM	Select this option if you are using either the Motorola Parallel Port Command Converter or a direct parallel port connection. The **Target Settings** window presents the options shown in Figure 8.5.
PCI Command Converter	Select this option if you are using the PCI Command Converter. The **Target Settings** window presents the options shown in Figure 8.6

Debug protocol option	Comment
Ethernet Command Converter	Select this option if you are using the Ethernet Command Converter. The **Target Settings** window presents the options shown in Figure 8.7
Command Converter Server	Select this option if you are using the Command Converter Server. The **Target Settings** window presents the options shown in Figure 8.8

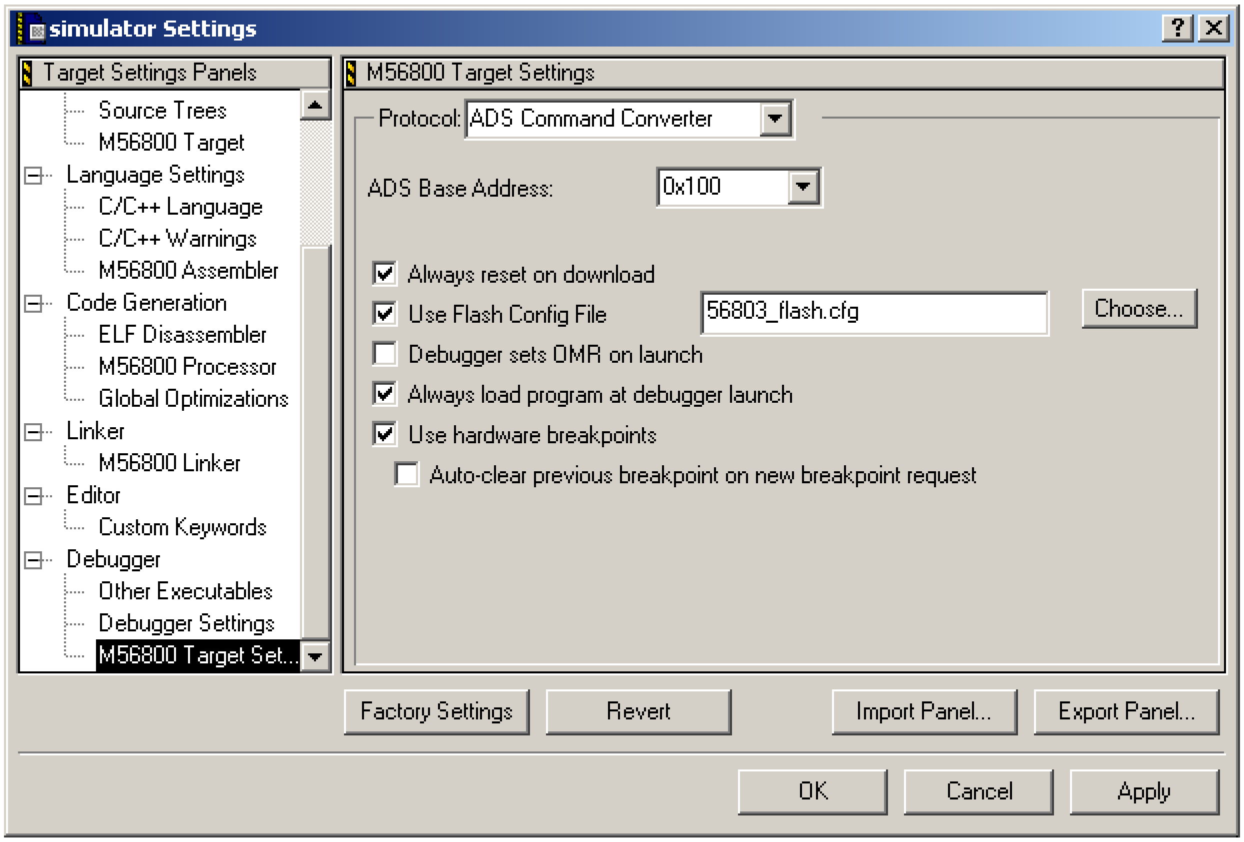
NOTE Refer to section on "Debugger Settings," for detail description of options common to all the protocol boards.

ADS Command Converter

Figure 8.1 shows the **M56800 Target Settings** panel after you select **ADS Command Converter** from the **Protocol** menu.

The **ADS Base Address** menu lets you select an I/O address for the ISA card. This address can be `0x100`, `0x200`, or `0x300`, depending on the address you selected when installing the card.

Figure 8.1 M56800 Target Settings Panel - ADS Command Converter



Protocol: ADS Command Converter

ADS Base Address: 0x100

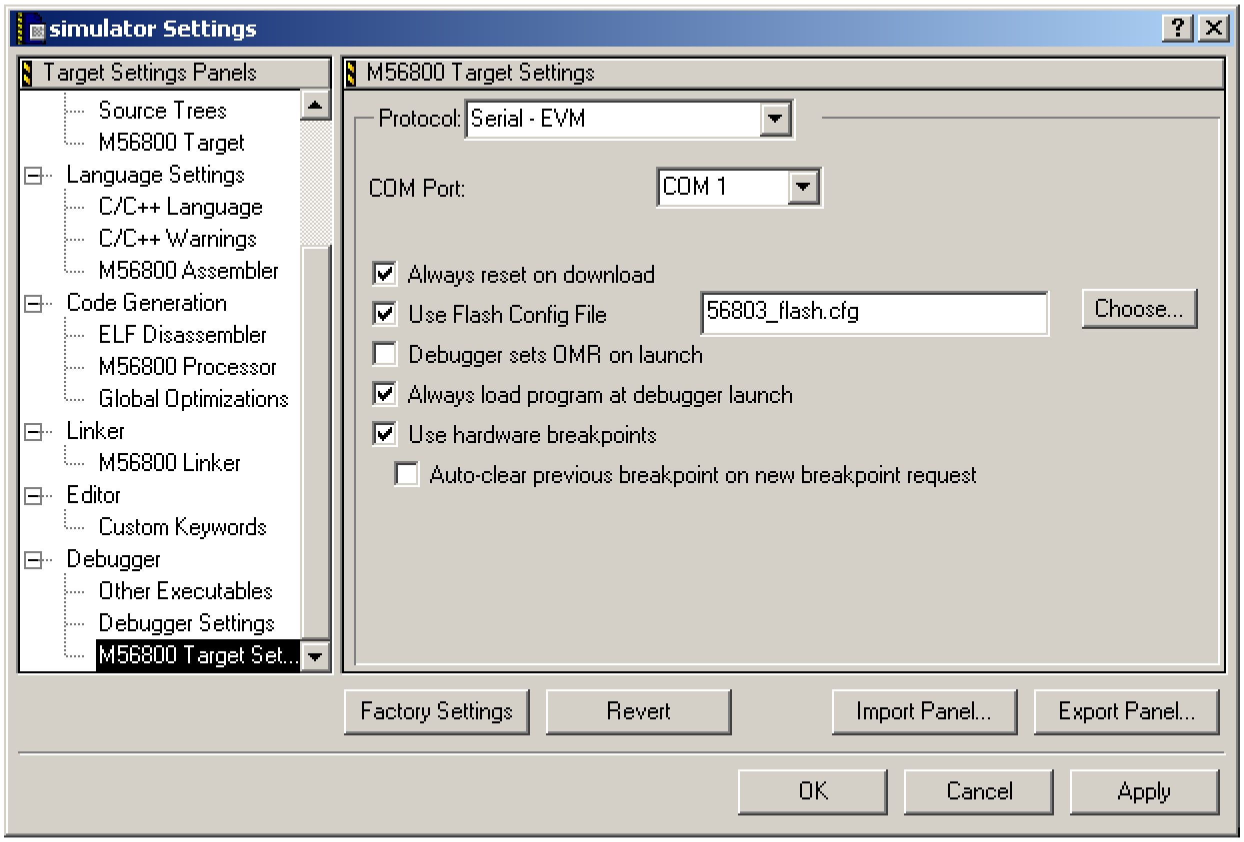
- [✓] Always reset on download
- [✓] Use Flash Config File 56803_flash.cfg
- [ ] Debugger sets OMR on launch
- [✓] Always load program at debugger launch
- [✓] Use hardware breakpoints
  - [ ] Auto-clear previous breakpoint on new breakpoint request

Serial - EVM

Figure 8.2 shows the **M56800 Target Settings** panel when you select **Serial - EVM from the Protocol menu**. This panel provides the same options when you select **Serial - SB56K**.

The **COM Port** menu lets you select the serial port for the DSP568xx card or the Domain Technologies SB-56K Emulator. This port can be COM 1, COM 2, COM 3, or COM 4, depending on the port you selected when installing the hardware.

Figure 8.2 M56800 Target Settings Panel - Serial - EVM Connections



Protocol: Serial - EVM

COM Port: COM 1

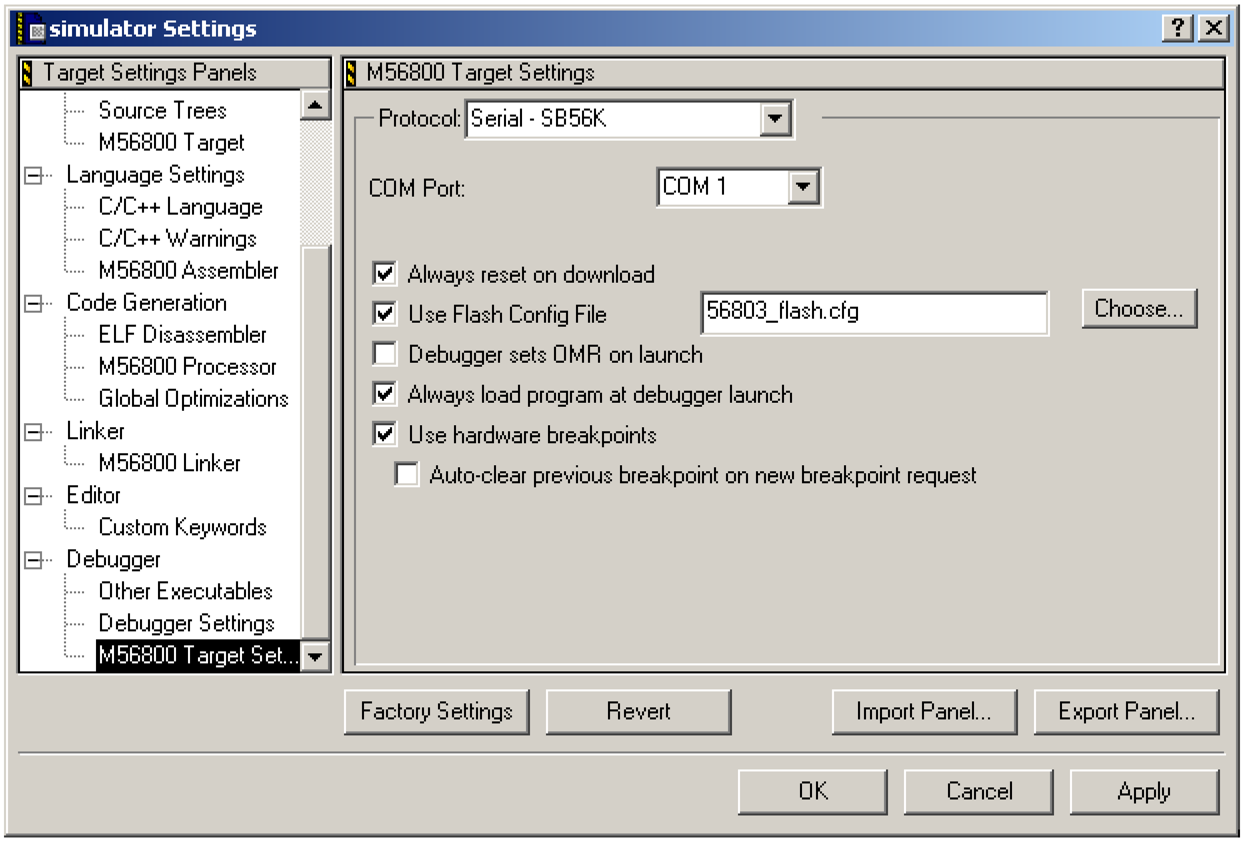
- [✓] Always reset on download
- [✓] Use Flash Config File: 56803_flash.cfg
- [ ] Debugger sets OMR on launch
- [✓] Always load program at debugger launch
- [✓] Use hardware breakpoints
- [ ] Auto-clear previous breakpoint on new breakpoint request

Serial - SB56K

Figure 8.3 shows the **M56800 Target Settings** panel when you select **Serial - SB56K from the Protocol menu**. This panel provides the same options when you select **Serial - EVM**.

The **COM Port** menu lets you select the serial port for the DSP568xx card or the Domain Technologies SB-56K Emulator. This port can be COM 1, COM 2, COM 3, or COM 4, depending on the port you selected when installing the hardware.

Figure 8.3 M56800 Target Settings Panel - Serial SB - 56K Connections

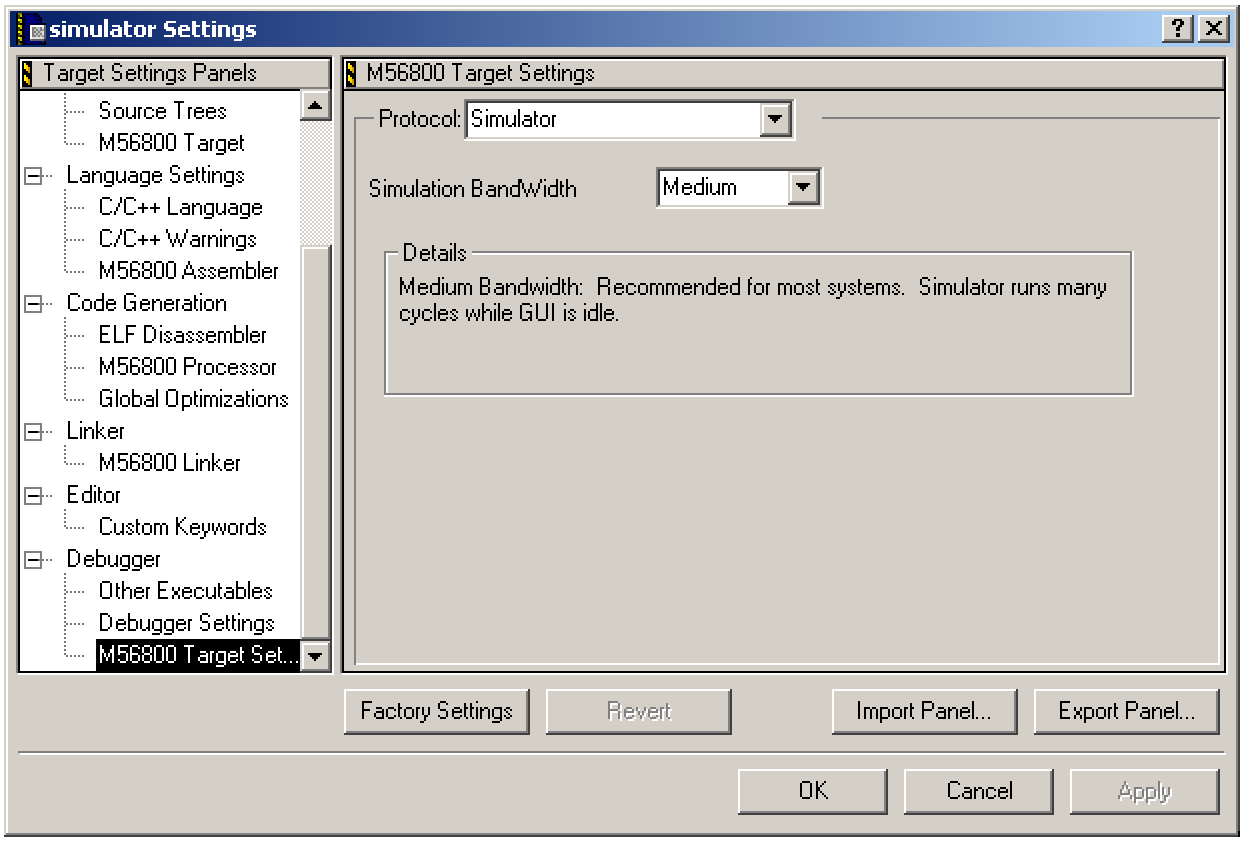


Protocol: Serial - SB56K
COM Port: COM 1
[✓] Always reset on download
[✓] Use Flash Config File: 56803_flash.cfg
[ ] Debugger sets OMR on launch
[✓] Always load program at debugger launch
[✓] Use hardware breakpoints
[ ] Auto-clear previous breakpoint on new breakpoint request

Simulator

Figure 8.4 shows the **M56800 Target Settings** panel when you select **Simulator** from the **Protocol** menu.

Figure 8.4 M56800 Target Settings Panel - Simulator



Protocol: Simulator

Simulation BandWidth: Medium

Details

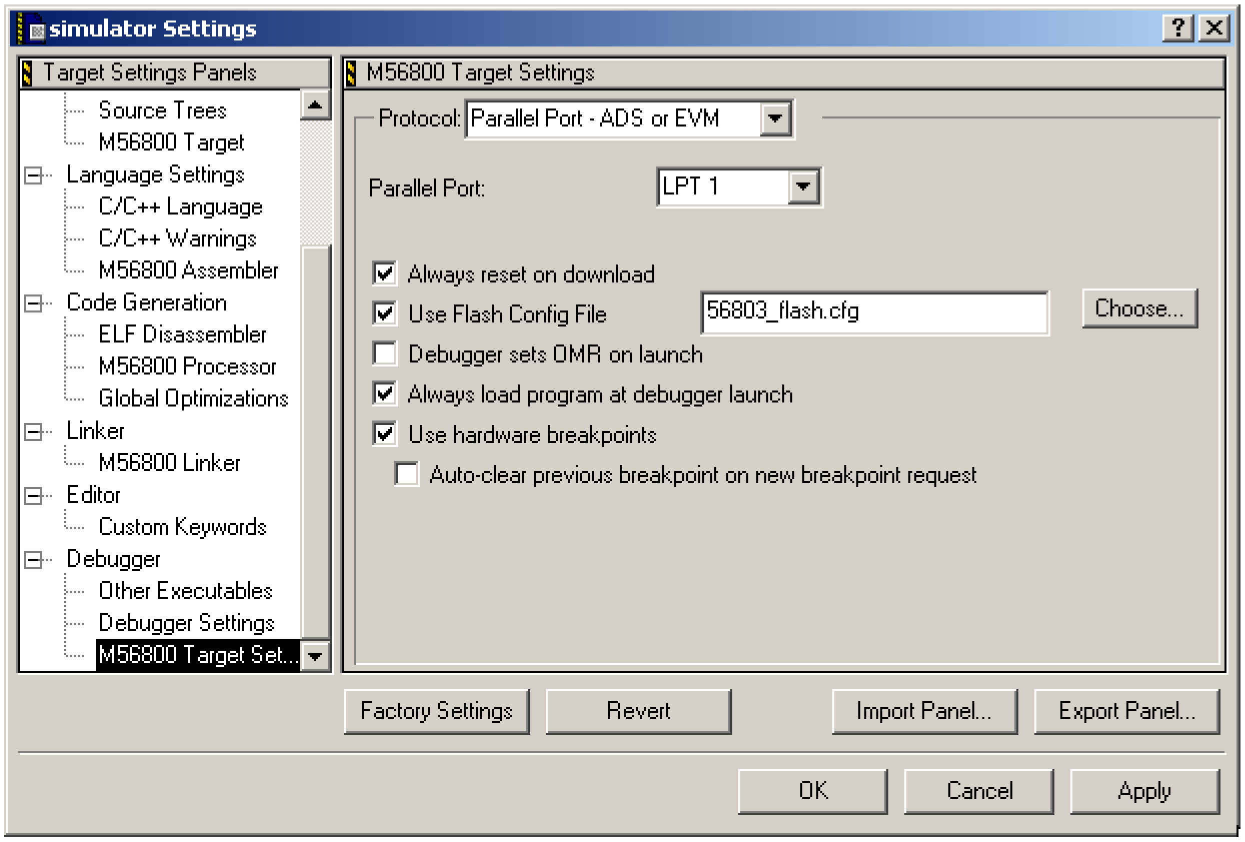
Medium Bandwidth: Recommended for most systems. Simulator runs many cycles while GUI is idle.

Parallel Port - ADS or EVM

Figure 8.5 shows the **M56800 Target Settings** panel when you select **Parallel Port - ADS or EVM** from the **Protocol** menu.

The **Parallel Port** menu lets you select the port for the Motorola Parallel Port Command Converter. This port can be LPT 1, LPT 2, LPT 3, or LPT 4, depending on the port you selected when installing the hardware.

Figure 8.5 M56800 Target Settings Panel - Parallel Port - ADS or EVM



Protocol: Parallel Port - ADS or EVM

Parallel Port: LPT 1

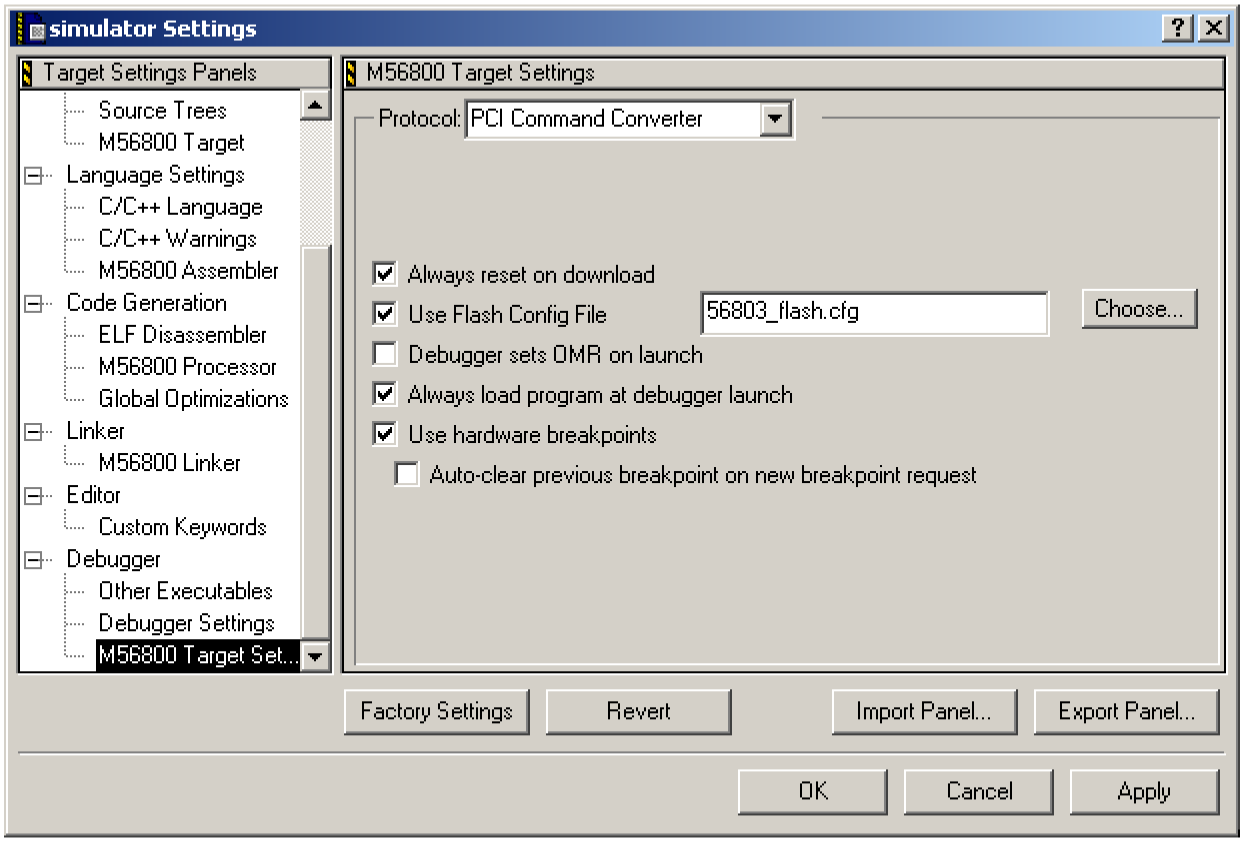
- [✓] Always reset on download
- [✓] Use Flash Config File: 56803_flash.cfg
- [ ] Debugger sets OMR on launch
- [✓] Always load program at debugger launch
- [✓] Use hardware breakpoints
- [ ] Auto-clear previous breakpoint on new breakpoint request

PCI Command Converter

Figure 8.6 shows the **M56800 Target Settings** panel when you select **PCI Command Converter** from the **Protocol** menu.

When using the PCI Command Converter, no additional selections need to be made as the CodeWarrior debugger automatically detects this device when this protocol is chosen.

Figure 8.6 M56800 Target Settings Panel - PCI Command Converter



Protocol: PCI Command Converter

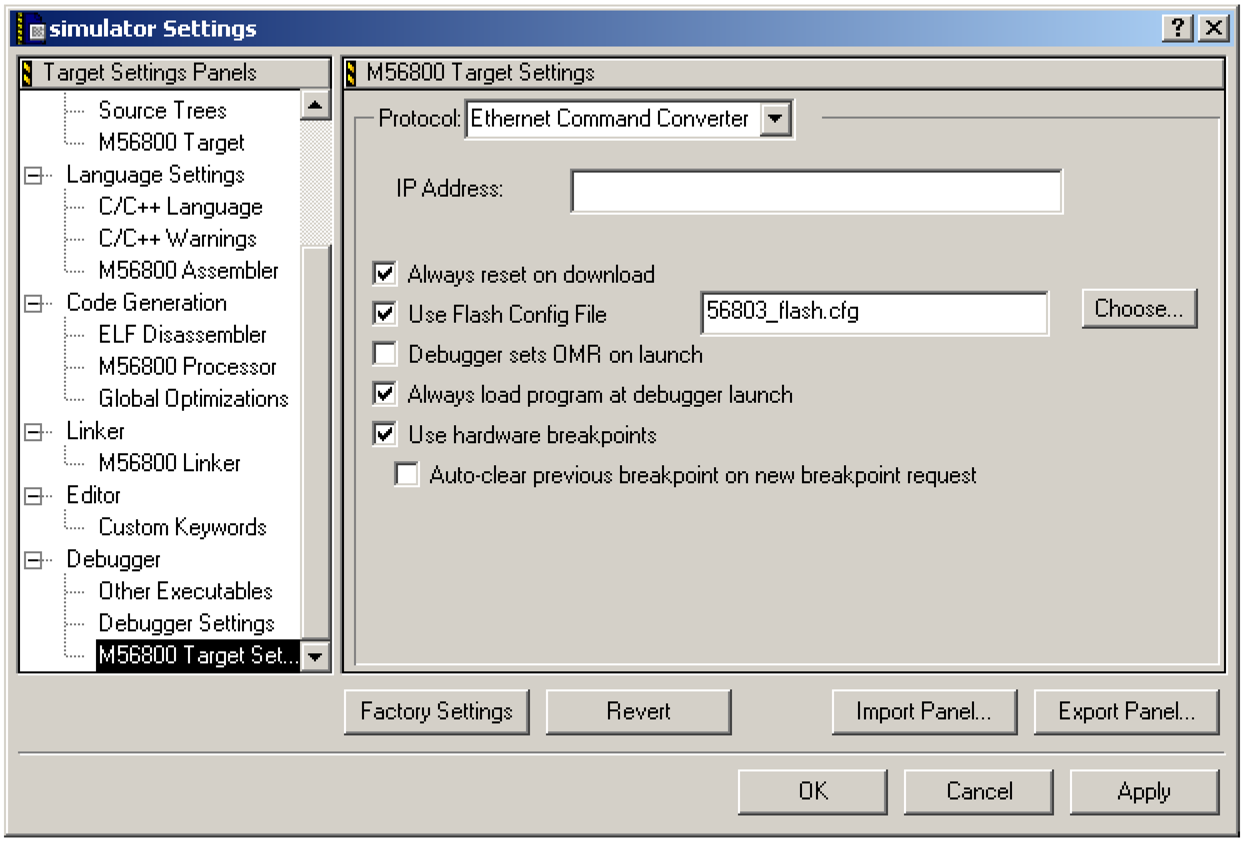
- [✓] Always reset on download
- [✓] Use Flash Config File: 56803_flash.cfg
- [ ] Debugger sets OMR on launch
- [✓] Always load program at debugger launch
- [✓] Use hardware breakpoints
  - [ ] Auto-clear previous breakpoint on new breakpoint request

Ethernet Command Converter

Figure 8.7 shows the **M56800 Target Settings** panel when you select **Ethernet Command Converter** from the **Protocol** menu.

Once you have Flashed an IP address into the Ethernet Command Converter, you can specify that address in the **IP Address** text box. Any valid local or remote IP address is acceptable.

Figure 8.7 M56800 Target Settings Panel - Ethernet Command Converter



Protocol: Ethernet Command Converter

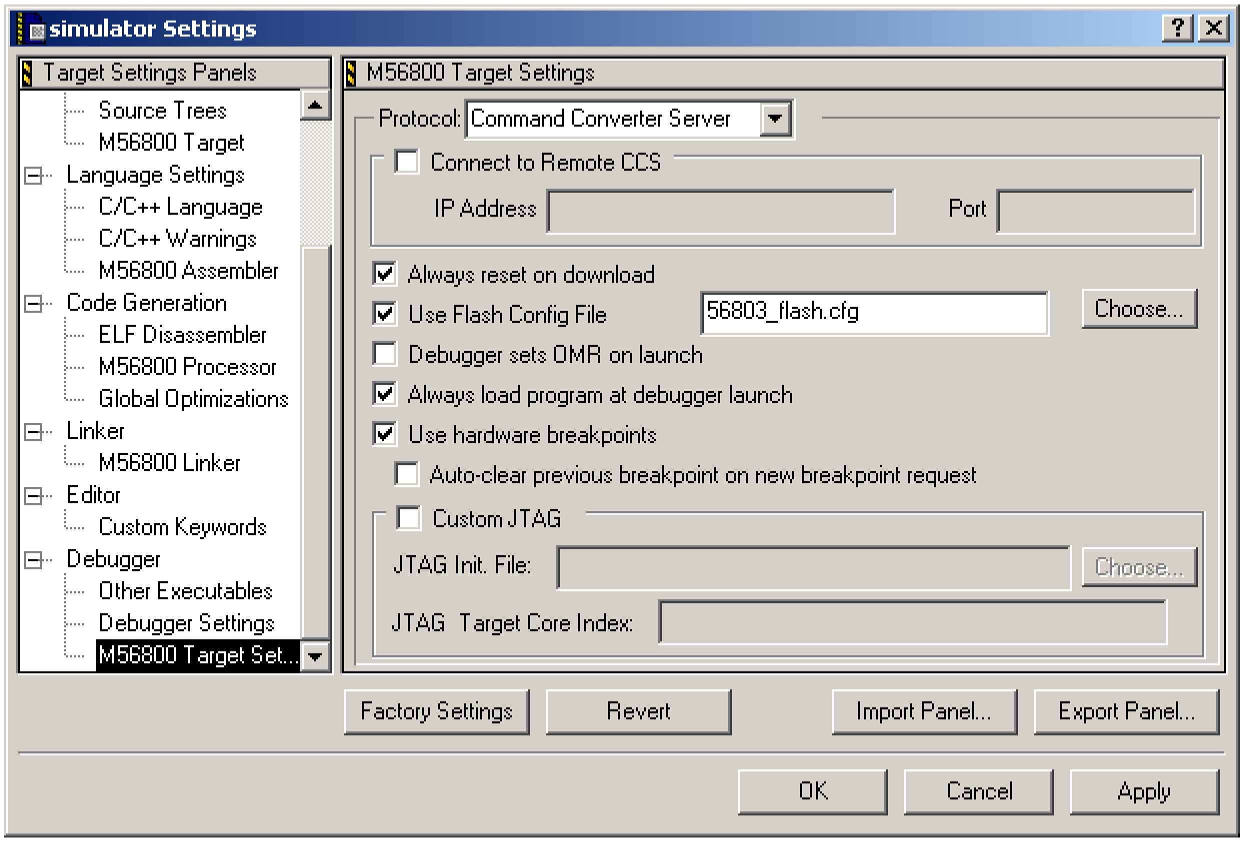
IP Address:

- [✓] Always reset on download
- [✓] Use Flash Config File: 56803_flash.cfg
- [ ] Debugger sets OMR on launch
- [✓] Always load program at debugger launch
- [✓] Use hardware breakpoints
- [ ] Auto-clear previous breakpoint on new breakpoint request

Command Converter Server

Figure 8.8 shows the **M56800 Target Settings** panel when you select **Command Converter Server** from the **Protocol** menu.

Figure 8.8 M56800 Target Settings Panel - Command Converter Server


simulator Settings

Target Settings Panels: Source Trees, M56800 Target, Language Settings, C/C++ Language, C/C++ Warnings, M56800 Assembler, Code Generation, ELF Disassembler, M56800 Processor, Global Optimizations, Linker, M56800 Linker, Editor, Custom Keywords, Debugger, Other Executables, Debugger Settings, M56800 Target Set...

M56800 Target Settings

Protocol: Command Converter Server

☐ Connect to Remote CCS
IP Address:
Port:

☑ Always reset on download
☑ Use Flash Config File: 56803_flash.cfg
☐ Debugger sets OMR on launch
☑ Always load program at debugger launch
☑ Use hardware breakpoints
☐ Auto-clear previous breakpoint on new breakpoint request

☐ Custom JTAG
JTAG Init. File:
JTAG Target Core Index:

Connect to Remote CCS

Select this checkbox to specify that the CodeWarrior IDE should connect to a remote command converter server. Otherwise, the IDE starts the command converter server locally.

- IP Address

  Use this text box to specify the IP address where the command converter server resides when running the command converter server from a remote location on the network.

- Port

  The port to which the command converter server listens. This field defaults to port 41475.

If you check the **Custom JTAG** checkbox, the following options appear:

- JTAG Init. File

  A JTAG initialization file specifies the name and order of the boards you are debugging.

- JTAG Target Core Index

  This value specifies the location of your target processor in the JTAG chain. The first board in the chain has an index value of 0, the second board has an index value of 1, and so on.

Command Converter Server

The command converter server (CCS) handles communication between the CodeWarrior debugger and the target board. An icon in the status bar indicates the CCS is running. The CCS is automatically launched by your project when you start a CCS debug session if you are debugging a target board using a local machine. However, if you wish to start CCS without launching a debug session, you may do so by selecting **Command Converter Server** from the **Protocol** text box in the **M56800 Target Settings** panel.

NOTE Projects are set to debug locally by default. The protocol the debugger uses to communicate with the target board, for example, PCI, is determined by how you installed the CodeWarrior software. To modify the protocol, make changes in the **Metrowerks Command Converter Server** window (Figure 8.11).

Essential Target Settings for Command Converter Server

Before you can download programs to a target board for debugging, you must specify the target settings for the command converter server:

- Local Settings

  If you specify that the CodeWarrior IDE start the command converter server locally, the command converter server uses the connection port (for example, LPT1) that you specified when you installed CodeWarrior IDE for DSP56800.

- Remote Settings

If you specify that the CodeWarrior IDE start the command converter server on a remote machine, specify the IP address of the remote machine on your network.

- Default Settings

  By default, the command converter server listens on port 41475. You can specify a different port number in the **M56800 Target** panel for the debugger to connect to if needed. This is necessary if the CCS is configured to a port other than 41475.

After you have specified the correct settings for the command converter server (or verified that the default settings are correct), you can download programs to a target board for debugging.

The CodeWarrior IDE starts the command converter server at the appropriate time if you are debugging on a local target.

Before debugging on a board connected to a remote machine, ensure the following:

- The command converter server is running on the remote host machine.
- No user is debugging the board connected to the remote host machine.

Changing the Command Converter Server Protocol to Parallel Port

If you specified the wrong parallel port for the command converter server when you installed CodeWarrior IDE for DSP56800, you can change the port.

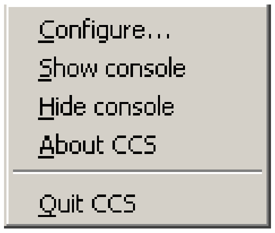
Change the parallel port:

1. While the command converter server is running, locate the command converter server icon on the status bar. Right-click on the command converter server icon (Figure 8.9):

Figure 8.9 Command Converter Server Icon

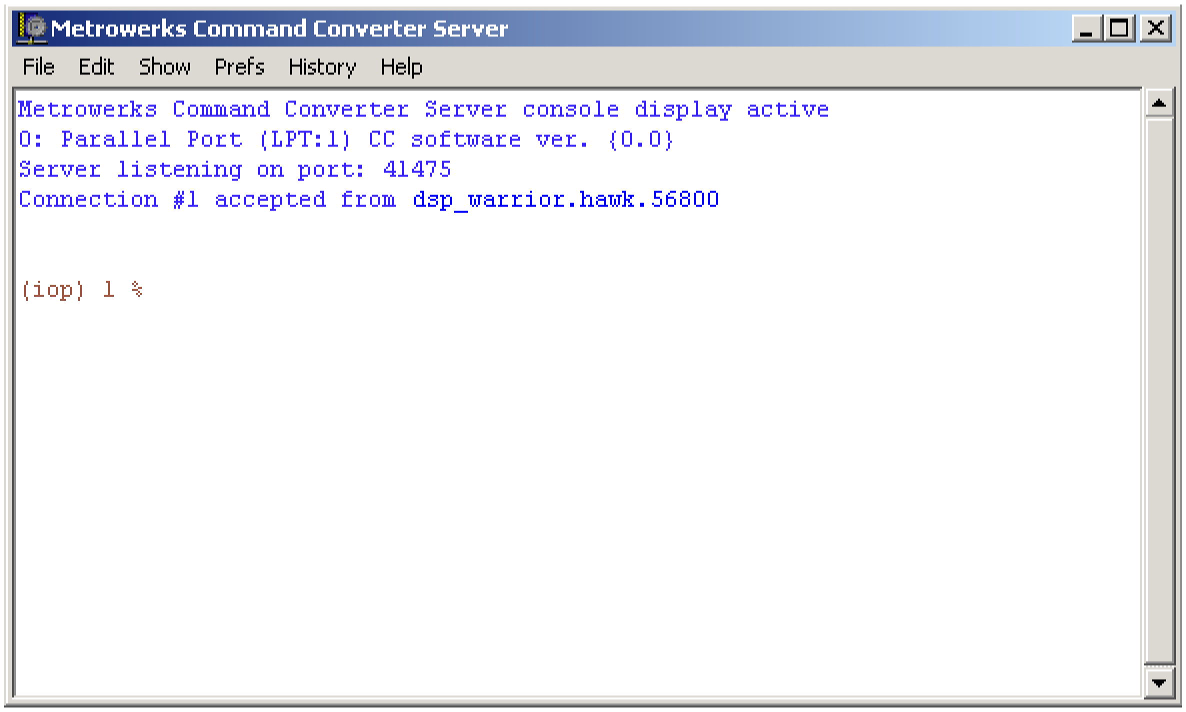
A menu appears (Figure 8.10):

Figure 8.10 Command Converter Server Menu



2. Select **Show console** from the menu.
3. The **Metrowerks Command Converter Server** window appears (Figure 8.11):

Figure 8.11 Metrowerks Command Converter Server Window


Metrowerks Command Converter Server
File Edit Show Prefs History Help

```
Metrowerks Command Converter Server console display active
0: Parallel Port (LPT:1) CC software ver. {0.0}
Server listening on port: 41475
Connection #1 accepted from dsp_warrior.hawk.56800


(iop) 1 %
```

4. On the console command line, type the following command:

   ```
   delete all
   ```

5. Press **Enter**.
6. Type the following command, substituting the number of the parallel port to use (for example, 1 for LPT1):

   ```
   config cc parallel:1
   ```

7. Press **Enter**.

Changing the Command Converter Server Protocol to PCI

To change the command converter server to a PCI Connection:

1. While the command converter server is running, right-click on the command converter server icon shown in Figure 8.9.
2. From the menu shown Figure 8.10, select **Show Console**.
3. At the console command line in the **Metrowerks Command Converter Server** window shown in Figure 8.11, type the following command:

   ```
   delete all
   ```

4. Press **Enter**.
5. Type the following command:

   ```
   config cc pci
   ```

6. Press **Enter**.

Debugging a Remote Target Board

For debugging a target board connected to a remote machine with Code Warrior IDE installed, perform the following steps:

1. Connect the target board to the remote machine.
2. Launch the command converter server (CCS) on the remote machine with the proper protocol configuration using instructions described in the section Essential Target Settings for Command Converter Server.
3. In the **M56800 Target Settings** panel for the debugger, do the following:
   a. Check the **Connect to Remote CCS** checkbox.

      The text boxes for **IP Address** and **Port** are now enabled.

   b. In the **IP Address** text box, type the IP address or machine name if on the network. If you leave the text box for the IP address blank, it will default to the local host machine.

   c. In the **Port** text box, type the port address. If you leave the text box blank, the CCS uses the default value.

NOTE The default port number is 41475.

4. Ensure that the debugger is enabled on your computer.
5. Launch the debugger.

DSP56800 Menu

The **DSP56800** menu offers these selections:

Load Default Target

From the menu bar of the Metrowerks CodeWarrior window, select **DSP56800 > Load default target** to load the target program without launching the debugger.

This feature performs the following:

- Retrieves the settings for the default target (as set in the IDE in the Project menu)
- Connects to the target machine
- Loads the target program from file to the target machine
- Disconnects

This feature is a subset of the debugger launch process. Use **Load Default Target** primarily for loading programs into flash ROM to allow a speedier turn-around time for stand-alone testing.

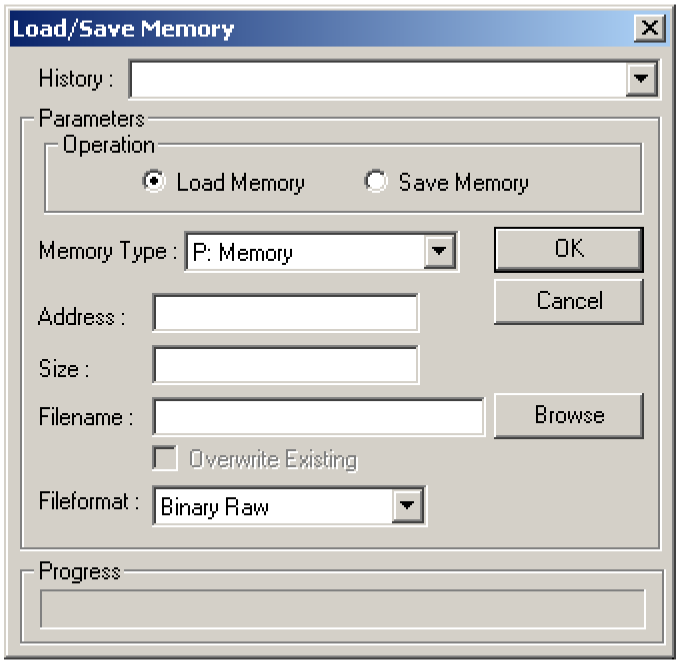
If the default target is not a DSP56800 target, Code Warrior generates an error message and aborts the process. While loading, the software displays a progress bar.

You can abort the load by clicking the **Cancel** button on the progress bar. **Load Default Target** is not available while you are debugging a DSP56800 target.

Load/Save Memory

From the menu bar of the Metrowerks CodeWarrior window, select **DSP56800 > Load/Save memory** to display the **Load/Save Memory** dialog (Figure 8.12).

Figure 8.12 Load/Save Memory Dialog Box



Use this dialog box to load and save memory at a specified location and size with a user-specified file. You can associate a key binding with this dialog box for quick access. Press the `Tab` key to cycle through the dialog displays, which lets you quickly make changes without using the mouse.

History Combo Box

The **History** combo box displays a list of recent loads and saves. If this is the first time you load or save, the **History** combo box is empty. If you load/save more than once, the combo box fills with the memory address of the start of the load or save and the size of the fill, to a maximum of ten sessions.

If you enter information for an item that already exists in the history list, that item moves up to the top of the list. If you perform another operation, that item appears first.

Radio Buttons

The Load/Save Memory dialog box has two radio buttons for you to use:

- Load Memory
- Save Memory

The default is load.

Memory Type Combo Box

The memory types that appear in the **Memory Type** Combo box are:

- P: Memory (Program Memory)
- X: Memory (Data Memory)

Address Text Field

Use this field to specify the address you want to write the memory to. If you want your entry to be interpreted as hex, prefix it with `0x`; otherwise, it is interpreted as decimal.

Size Text Field

Use this field to specify the number of words to write to the target. If you want your entry to be interpreted as hex, prefix it with `0x`; otherwise, it is interpreted as decimal.

Dialog Controls

Cancel, Esc, and OK

In Load and Save operations, all controls are disabled except **Cancel** for the duration of the load or save. The status field is updated with the current progress of the operation. Clicking **Cancel** halts the operation, and re-enables the controls on the dialog. Clicking **Cancel** again closes the dialog box. Pressing the **Esc** key is same as clicking the **Cancel** button.

With the **Load Memory** radio button selected, clicking **OK** reads the memory from the specified file and writes it to memory until the end of the file or the size specified is reached. If the file does not exist, an error message appears.

With the **Save Memory** radio button selected, clicking **OK** reads the memory from the target piece by piece and writes it to the specified file. The status field is updated with the current progress of the operation.

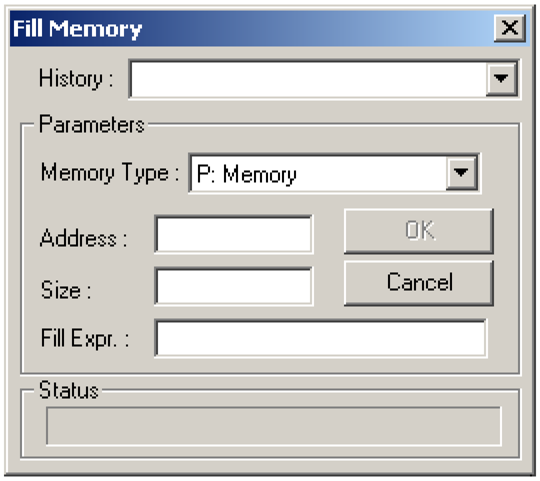
Browse Button

Clicking the **Browse** button displays an OPENFILENAME or a SAVEFILENAME dialog, depending on whether you selected the **Load Memory** or **Save Memory** radio button.

Fill Memory

From the menu bar of the Metrowerks CodeWarrior window, select **DSP56800 > Fill memory** to display the **Fill Memory** dialog box (Figure 8.13).

Figure 8.13 Fill Memory Dialog Box



Use this dialog box to fill memory at a specified location and size with user- specified raw memory data. You can associate a key binding with this dialog box for quick access. Press the **Tab** key to cycle through the dialog display, which lets you quickly make changes without using the mouse.

History Combo Box

The **History** combo box displays a list of recent fill operations. If this is the first time you perform a fill operation, the **History** combo box is empty. If you do more than one fill, then the combo box populates with the memory address of that fill, to a maximum of ten sessions.

If you enter information for an item that already exists in the history list, that item moves up to the top of the list. If you do another fill, then this item is the first one that appears.

Memory Type Combo Box

The memory types that can appear in the **Memory Type** Combo box are:

- P:Memory (Program Memory)
- X:Memory (Data Memory)

Address Text Field

Use this field to specify the address you want to write the memory to. If you want it to be interpreted as hex, prefix it with `0x`; otherwise, it is interpreted as decimal.

Size Text Field

Use this field to specify the number of bytes to write to the target. If you want it to be interpreted as hex, prefix your entry with `0x`; otherwise, it is interpreted as decimal.

Fill Expression Text Field

Fill writes a set of characters to a location on the target, repeatedly copying the characters until the user-supplied fill size has been reached. **Size** is the total words written, not the number of times to write the string.

Interpretation of the Fill Expression

The fill string is interpreted differently depending on how it is entered in the Fill String field. Any words prefixed with `0x` is interpreted as hex bytes. Thus, `0xBE 0xEF` would actually write `0xBEEF` on the target. Optionally, the string could have been set to `0xBEEF` and this would do the same thing. Integers are interpreted so that the equivalent signed integer is written to the target.

ASCII Strings

ASCII strings can be quoted to have literal interpretation of spaces inside the quotes. Otherwise, spaces in the string are ignored. Note that if the ASCII strings are not quoted and they are numbers, it is possible to create illegal numbers. If the number is illegal, an error message is displayed.

Dialog Controls

OK, Cancel, and Esc

Clicking **OK** writes the memory piece by piece until the target memory is filled in. The **Status** field is updated with the current progress of the operation. When this is in progress, the entire dialog grays out except the **Cancel** button, so the user cannot change any information. Clicking the **Cancel** button halts the fill operation, and re-enables the controls on the dialog. Clicking the **Cancel** button again closes the dialog. Pressing the **Esc** key is same as pressing the **Cancel** button.

Default Information

The dialog is empty when you first display it. However, if default information is to appear, ship the text file containing default information. The dialog loads default information when it first appears.

Using DSP56800 Simulator

The CodeWarrior IDE for DSP56800E includes the Motorola DSP56800 Simulator. This software lets you run and debug code on a simulated DSP56800 architecture without installing any additional hardware.

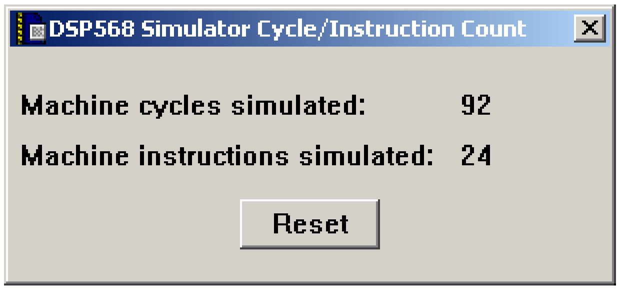
The simulator does not simulate interrupts, it only simulates core instructions. In order to use the simulator, you must select it as your debugging protocol from the **M56800 Target Settings** panel (Target Settings Window).

NOTE The simulator also enables the DSP56800 menu to retrieve the machine cycle count and machine instruction count when debugging.

Cycle/Instruction Count

From the menu bar of the Metrowerks CodeWarrior window, select **DSP56800 > Cycle/Instruction count**. The following window appears (Figure 8.14):

Figure 8.14 Simulator Cycle/Instruction Count


DSP568 Simulator Cycle/Instruction Count

Machine cycles simulated: 92

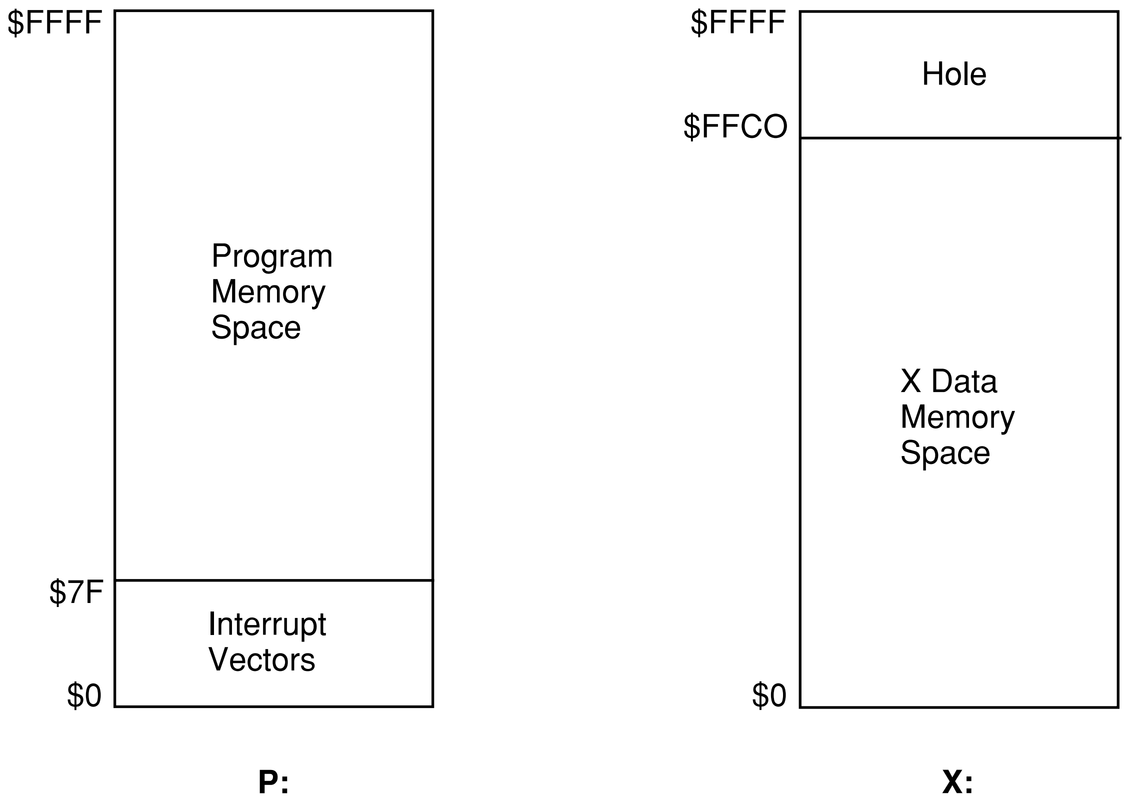
Machine instructions simulated: 24

NOTE Cycle counting is not accurate while single stepping through source code in the debugger. It is only accurate while running. Thus, the cycle counter is more of a profiling tool than an interactive tool.

Press the **Reset** button to zero out the current machine-cycle and machine-instruction readings.

Memory Map

Figure 8.15 Simulator Memory Map



Watchpoints and Breakpoints

The CodeWarrior DSP56800 debugger allows you to monitor the status of a watchpoint. Since the OnCE™ port only supports either a hardware breakpoint or a watchpoint, you cannot have both active at the same time.

Watchpoints are useful for monitoring memory and processes where software breakpoints cannot be set, such as in Flash ROM, or a data or address bus. If the watchpoint status is used as a trace counter, it can also be helpful to debug sections of code that do not have a normal flow or are hung up in infinite loops.

Watchpoints are available regardless of whether you have checked "Use Hardware Breakpoints." The watchpoint status window does not report the status of hardware breakpoints. OnCE™ hardware only supports one hardware breakpoint or watchpoint at a time. If a watchpoint is in place, you cannot use a breakpoint and vice versa.

The CodeWarrior watchpoint debugger can monitor:

- Program memory addresses
- Data memory addresses
- The value on the Core Global Data Bus
- The value on the Program Address Bus
- Specified number of occurrences

NOTE If you are debugging Flash ROM, enable the Use Hardware breakpoints option in the M56800 Target Settings panel. However, you can use the Watchpoint status window debugging RAM as well.

Opening the Watchpoint Status Window

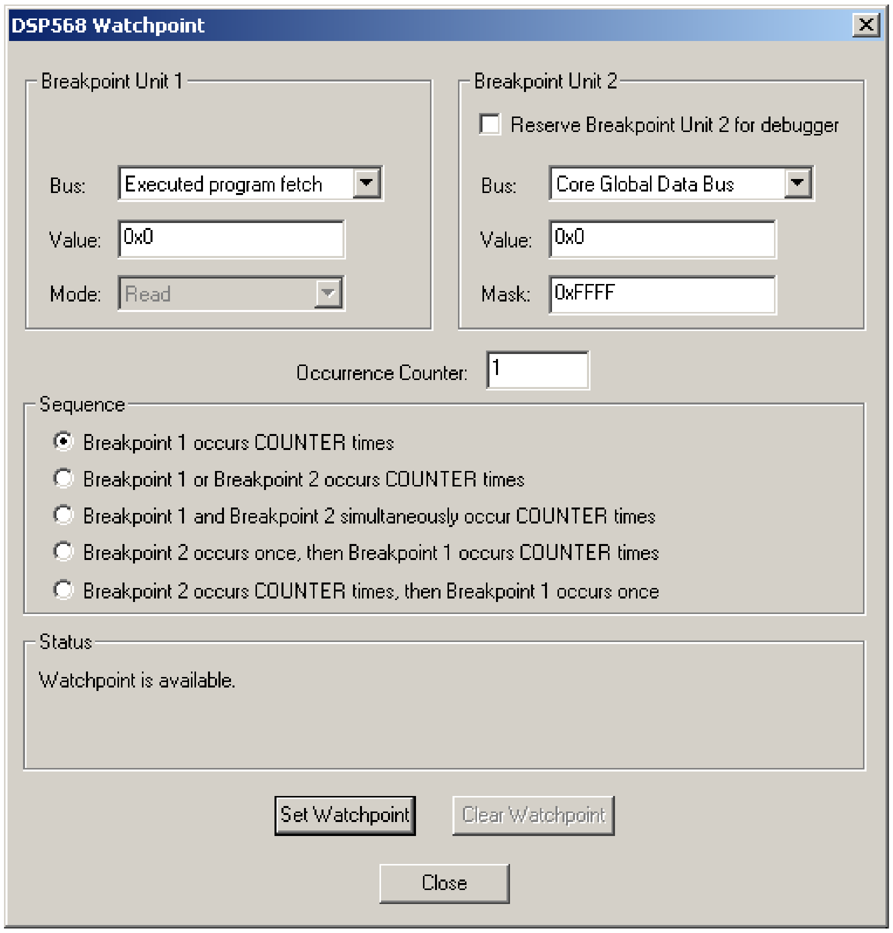
To select a new watchpoint status:

1. Start a debugging session.
2. From the menu bar of the Metrowerks CodeWarrior window, select **DSP56800 > Watchpoint status**.

   The **Watchpoint Status** window appears (Figure 8.16).

NOTE The **Watchpoint Status** menu item is disabled when you use the Simulator or during a system-level connect.

Figure 8.16 Watchpoint Status Window


DSP568 Watchpoint

Breakpoint Unit 1

Bus: Executed program fetch

Value: 0x0

Mode: Read

Breakpoint Unit 2

[ ] Reserve Breakpoint Unit 2 for debugger

Bus: Core Global Data Bus

Value: 0x0

Mask: 0xFFFF

Occurrence Counter: 1

Sequence

- [● Breakpoint 1 occurs COUNTER times]
- ○ Breakpoint 1 or Breakpoint 2 occurs COUNTER times
- ○ Breakpoint 1 and Breakpoint 2 simultaneously occur COUNTER times
- ○ Breakpoint 2 occurs once, then Breakpoint 1 occurs COUNTER times
- ○ Breakpoint 2 occurs COUNTER times, then Breakpoint 1 occurs once

Status

Watchpoint is available.

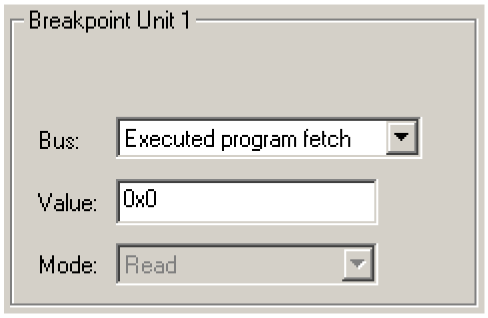
NOTE When you clear a custom watchpoint, the settings you last used are now selected instead of the previous default values. These settings do not carry over from previous debugging sessions.

Breakpoint Unit 1

Breakpoint unit 1 (BPU1) of the watchpoint status window allows you to monitor address values and access type for any X or P memory location.

Options for setting BPU1 are in the Breakpoint Unit 1 group box shown in Figure 8.17 and listed in Table 8.3.

Figure 8.17 Breakpoint Unit 1 Options



Bus: Executed program fetch
Value: 0x0
Mode: Read

Table 8.3 Options for Breakpoint Unit 1

Setting	Value	Comment
Bus	Execute program fetch	When a P memory instruction is executed. **Mode** defaults to **Read**. Useful when only interest is opcode instructions.
	Any P memory access	Any time a P memory address is accessed, depending on the value of **Mode**. Useful when writing or reading data from P memory.
	X Address Bus 1	Access for all X address values through XAB1 (internal or external memory) depending on the **Mode** you select.
Value	C hexadecimal or decimal notation	Range: `0x0` to `0xFFFF`
Mode	Read	
	Write	
	Read and Write	

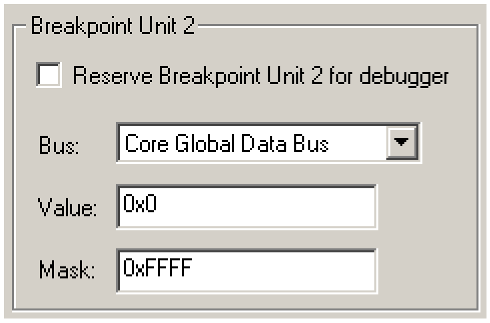
NOTE If Breakpoint Unit 2 is disabled (in use by the debugger), then the occurrence counter is set to 1 as the default.

Breakpoint Unit 2

Breakpoint unit 2 (BPU2) of the watchpoint status window allows you to monitor values (and their masks) in either the Core Global Data Bus (CGDB) or Program Address Bus (PAB). When you use BPU2 in conjunction with BPU1 and the occurrence counter, you can monitor the status of a watchpoint to a resolution as fine as 1 bit at single memory location.

Options for setting BPU2 are in the Breakpoint Unit 2 group box are in Figure 8.18 and listed in Table 8.4.

Figure 8.18 Breakpoint Unit 2 Options



Breakpoint Unit 2

☐ Reserve Breakpoint Unit 2 for debugger

Bus: Core Global Data Bus

Value: 0x0

Mask: 0xFFFF

NOTE If you are using Breakpoint Unit 2, ensure that one of the radio buttons is set to use Breakpoint 2 in the **Sequence** group box.

Table 8.4 Options for Breakpoint Unit 2

Setting	Value	Comment
Reserve Breakpoint Unit 2 for Debugger	Enabled	Breakpoint unit 2 cannot be user defined and the occurrence counter defaults to 1 for BPU1.
	Disabled	Breakpoint unit 2 is user-defined and occurrence counter is available for both BPU1 and BPU2. Single stepping, stepping over, and stepping out of functions cannot be done when hardware breakpoints are enabled.
Bus	**Core Global Data Bus** (CGDB)	Data transfer between the data ALU and X data memory for one memory access.
	Program Address Bus (PAB)	19-bit program memory address bus.
Value	The hexadecimal value read from the specified **Bus**.	To read full value, set **Mask** to `0xFFFF`.
Mask	Mask value in C hex notation from `0x0` to `0xFFFF`.	Specify a value of `0xFFFF` for full value specified by **Value**. Specify other hex value to exclude bits. For example, if you wanted to stop at any value where bit 15 is set, you would specify `0x8000` in both the **Mask** and **Value** fields

Occurrence Counter and Sequence Options

This section explains how the debugger uses the Occurrence Counter (hardware breakpoint counter) and Sequence Options when halting the debugger.

Occurrence Counter

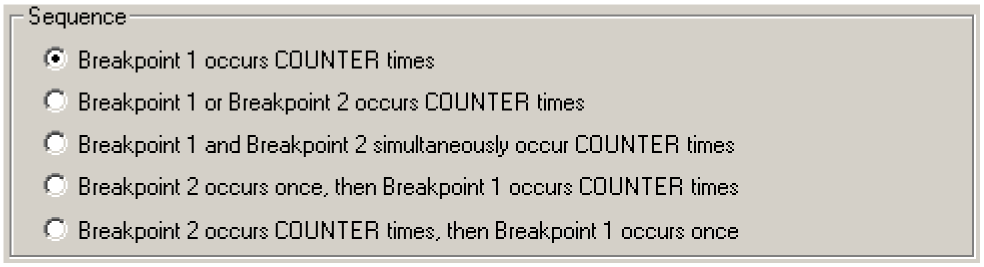
The **Occurrence Counter** uses the OnCE breakpoint counter (OCNTR) for stopping on the *n*th iteration of a program loop or when the *n*th occurrence of a data memory access occurs. When you specify a value from 1 to 256 in the **Occurrence Counter** text box, it sets ONCTR to that value minus 1. Refer to *OnCE Breakpoint Counter (OCNTR)* in the *DSP56800 Family Manual* for more information.

NOTE Once the **Occurrence Counter** is decremented and a breakpoint is reached, the counter is not reset. Hence, the **Occurrence Counter** remains at one and stops at every specified breakpoint.

Sequence Options

To define the criteria for how often the debugger stops on a watchpoint, use the **Sequence** group box (Figure 8.19). The value you set in the **Occurrence Counter** text box determines the value of COUNTER.

Figure 8.19 Sequence Counter Options in the Watchpoint Status Window



Sequence

- [✓ Breakpoint 1 occurs COUNTER times]
- Breakpoint 1 or Breakpoint 2 occurs COUNTER times
- Breakpoint 1 and Breakpoint 2 simultaneously occur COUNTER times
- Breakpoint 2 occurs once, then Breakpoint 1 occurs COUNTER times
- Breakpoint 2 occurs COUNTER times, then Breakpoint 1 occurs once

Table 8.5 explains the options available in the **Sequence** group box.

Table 8.5 Options for the Occurrence Counter

Option	Comment
Breakpoint 1 occurs COUNTER times	If **Reserve Breakpoint Unit 2 for Debugger** is enabled, this is the default options and COUNTER is 1.
Breakpoint 1 or Breakpoint 2 occurs COUNTER times	BPU1 and BPU2 work independently. If you are only interested in using BPU2, set BPU1 to a value you know will not be reached during program execution.
Breakpoint 1 and Breakpoint 2 simultaneously occur COUNTER times	BPU1 and BPU2 work together. This is useful for monitoring bit status with a defined mask.
Breakpoint 2 occurs once, then Breakpoint 1 occurs COUNTER times	Useful for monitoring the status of recursive or nested algorithms.
Breakpoint 2 occurs COUNTER times, then Breakpoint 1 occurs once	Useful for monitoring the status of recursive or nested algorithms

Setting and Clearing Watchpoint Status

You can set and clear watchpoint only through the **Watchpoint Status** window. Use the following commands:

- **Set Watchpoint**

  Enables a watchpoint for the values specified by BPU1 and BPU2. Hardware breakpoints are not available when a watchpoint is set.
- **Clear Watchpoint**

  Disables the current watchpoint and returns all values in the **Watchpoint Status** window to their default values.

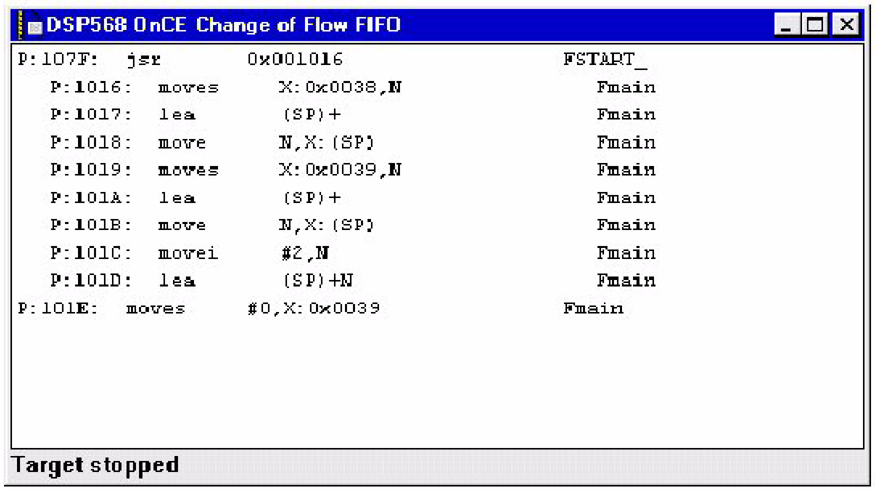
Change of Flow FIFO Dump

From the menu bar of the Metrowerks CodeWarrior window, select **DSP56800 > Change-of-flow FIFO Dump** to see the most recent changes in the program flow and a reconstructed program trace (Figure 8.20).

Use this feature to query the FIFO History Buffer, located in the On-Chip Emulation module of a hardware target. This buffer stores the eight most recent changes in the program flow. The debugger retrieves these addresses and attempts to reconstruct a trace of the program flow. This occurs both when the window is opened and whenever debugging stops while the window is open.

The **Change-of-flow FIFO Dump** menu item is enabled when the IDE is debugging a hardware target and debugging has stopped.

Figure 8.20 Change-of-Flow History Window



```
P:107F:  jsr       0x001016                FSTART_
   P:1016:  moves     X:0x0038,N              Fmain
   P:1017:  lea       (SP)+                   Fmain
   P:1018:  move      N,X:(SP)                Fmain
   P:1019:  moves     X:0x0039,N              Fmain
   P:101A:  lea       (SP)+                   Fmain
   P:101B:  move      N,X:(SP)                Fmain
   P:101C:  movei     #2,N                    Fmain
   P:101D:  lea       (SP)+N                  Fmain
P:101E:  moves     #0,X:0x0039             Fmain
```

Target stopped

Status Line

The status line at the bottom of the window explains the state of the target as either running or stopped. This alerts the user to the validity of the data. The data is updated each time the target stops. The `Target running` status indicates that the current data was valid at the most recent debugger halt, but is not currently valid.

Data Display

The data display uses a tree control object. Initially, the tree is collapsed. The top most tree items are the addresses at which a flow change occurred, followed by the current Program Counter address. By double-clicking each top item, the item expands, showing the program flow between the selected address and the next change-of-flow address. Each line displays the address and, if available, the disassembly and function name for that instruction. Double-clicking an expanded line collapses it.

Trace Reconstruction

There are situations when the trace cannot be reconstructed due to inconclusive evidence. These situations include occasional returns from subroutines and returns from interrupts. When an interrupt occurs immediately after a flow change, the trace cannot always be reconstructed, due to the fact that the interrupt is not always apparent. However, most of these problems are solved when symbolic information is available to the debugger.

The window is modeless and resides in the CodeWarrior IDE workspace. It can be resized, minimized, and maximized. It can be closed directly, by standard Windows methods, or indirectly, by killing the debugger.

Global Variable Watchpoints

You can monitor a single global variable as a watchpoint during a debugging session. This section explains how to set and clear a watchpoint.

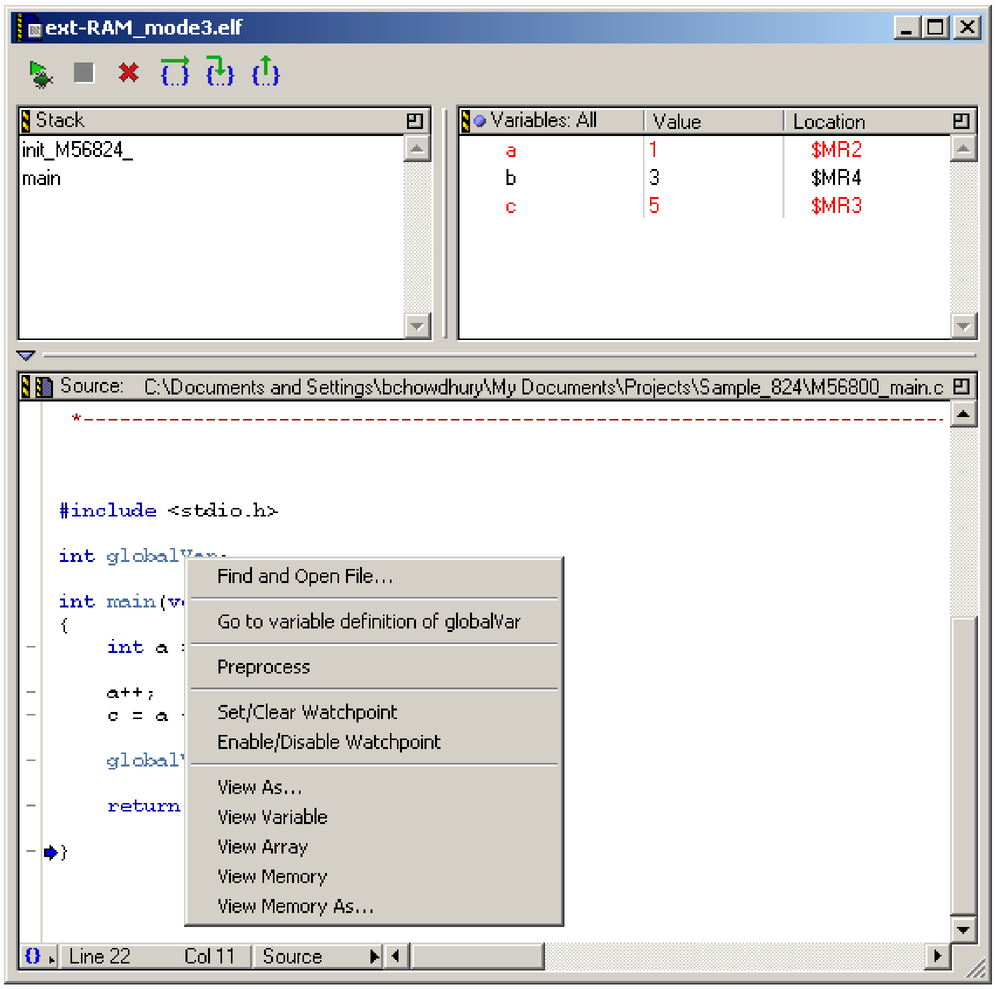
Setting a watchpoint

1. Set a watchpoint:
   a. In the program window, right-click on a variable name.

      A menu appears in the program window.

   b. Select **Set/Clear Watchpoint** from the menu (Figure 8.21).

Figure 8.21 Setting a Watchpoint in the Program Window



Stack
init_M56824_
main

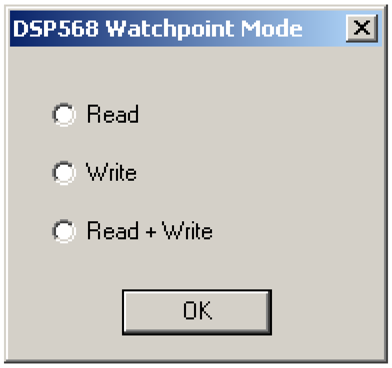
Variables: All	Value	Location
a	1	$MR2
b	3	$MR4
c	5	$MR3

```
*---------------------------------------------------------------------------


#include <stdio.h>

int globalVar;

int main(v
{
    int a =

    a++;
    c = a

    globalV

    return
}
```

2. Set watchpoint mode:

    a. From the menu bar of the Metrowerks CodeWarrior window, select **Debug > Set/Clear Watchpoint**. The **DSP568 Watchpoint Mode Dialog** box appears (Figure 8.22):

Figure 8.22 DSP568 Watchpoint Mode Dialog



b. **Select Read, Write,** or **Read + Write** from the **DSP568 Watchpoint Mode** dialog box (Figure 8.22).

c. Click **OK**.

You have now set a global watchpoint.

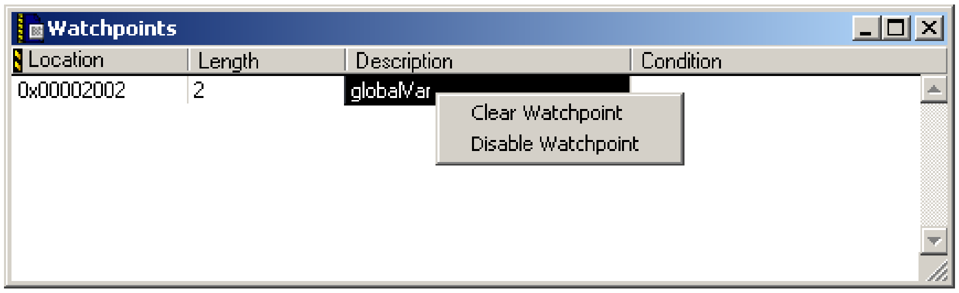
Clearing a Watchpoint

Use either of the following methods for clearing a watchpoint:

- Right-click the variable name in the program window during debugging. Select **Set/Clear Watchpoint**. The watchpoint is cleared.
- Select **View > Watchpoints**. Right-click the variable name set as a global watchpoint. The **Watchpoints** window appears (Figure 8.23). Select the variable in the Description column of the **Watchpoints** window. A menu appears. Select **Clear Watchpoint**. The watchpoint is cleared.

NOTE Conditions are not enabled for watchpoints.

Figure 8.23 Clearing a Global Watchpoint

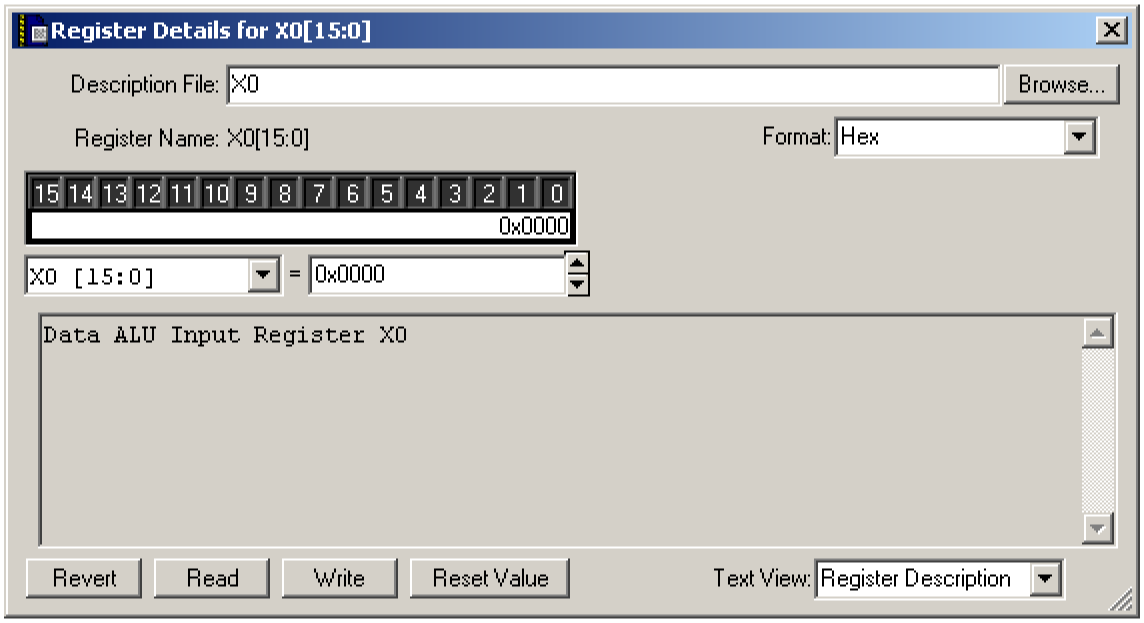


Location	Length	Description	Condition
0x00002002	2	globalVar	

Register Details Window

From the menu bar of Metrowerks CodeWarrior window, select **View > Register Details.** The **Register Details** window (Figure 8.24) appears.

Figure 8.24 Register Details Window


Register Details for X0[15:0]

Description File: X0

Register Name: X0[15:0]

Format: Hex

0x0000

X0 [15:0] = 0x0000

```
Data ALU Input Register X0
```

Text View: Register Description

You can use the **Register Details** window to view different DSP568xx registers. The most accurate and up-to-date listing of XML register descriptions files is in the following path:

```
\bin\Plugins\support\Registers\Dsp568\Generic
```

NOTE The **Register Details** window can show both all-purpose DSP56800 registers as well as memory-mapped registers. You can create your own register views with XML files.

In the **Register Details** window, type the name of the register you want to view in the **Description File** field to display the applicable register and its values.

By default, the IDE looks in the following path when searching for a register description file:

`bin\Plugins\support\Registers\Dsp568\`

Register description files must end with the `.xml` extension. Alternatively, you can use the **Browse** button to locate the register description files.

Using the **Format** list box in the **Register Details** window, you can change the format in which the CodeWarrior IDE displays the registers.

Using the **Text View** list box in the **Register Details** window, you can change the text information the CodeWarrior IDE displays.

Viewing Memory

Viewing X: Memory

You can view X memory space values as hexadecimal values with ASCII equivalents. You can edit theses values at debug time.

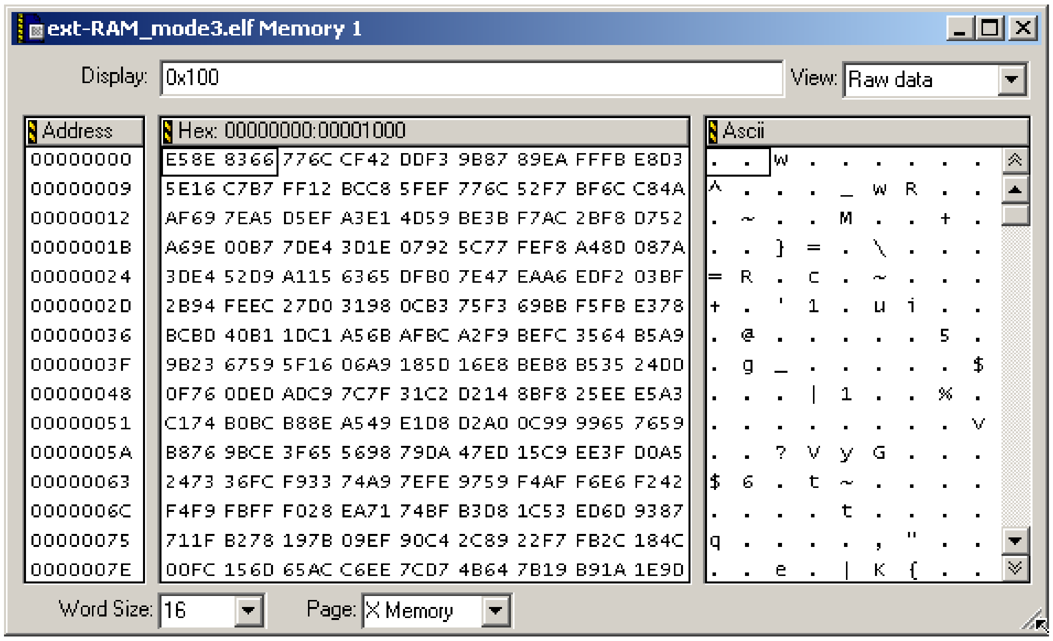
On targets that have Flash ROM, you cannot edit those values in the memory window that reside in Flash memory.

---

1. To view the memory address range of a variable, select **Data > View Memory from the menu bar of the Metrowerks CodeWarrior window**.

   The **Memory** window appears (Figure 8.25).

Figure 8.25 View X:Memory Window



```
Display: 0x100                                        View: Raw data

Address    Hex: 00000000:00001000                          Ascii
00000000   E58E 8366 776C CF42 DDF3 9B87 89EA FFFB E8D3    . . w . . . . . .
00000009   5E16 C7B7 FF12 BCC8 5FEF 776C 52F7 BF6C C84A    ^ . . . _ w R . .
00000012   AF69 7EA5 D5EF A3E1 4D59 BE3B F7AC 2BF8 D752    . ~ . . M . . + .
0000001B   A69E 00B7 7DE4 3D1E 0792 5C77 FEF8 A48D 087A    . . } = . \ . . .
00000024   3DE4 52D9 A115 6365 DFB0 7E47 EAA6 EDF2 03BF    = R . c . ~ . . .
0000002D   2B94 FEEC 27D0 3198 0CB3 75F3 69BB F5FB E378    + . ' 1 . u i . .
00000036   BCBD 40B1 1DC1 A56B AFBC A2F9 BEFC 3564 B5A9    . @ . . . . . 5 .
0000003F   9B23 6759 5F16 06A9 185D 16E8 BEB8 B535 24DD    . g _ . . . . . $
00000048   0F76 0DED ADC9 7C7F 31C2 D214 8BF8 25EE E5A3    . . . | 1 . . % .
00000051   C174 B0BC B88E A549 E1D8 D2A0 0C99 9965 7659    . . . . . . . . v
0000005A   B876 9BCE 3F65 5698 79DA 47ED 15C9 EE3F D0A5    . . ? V y G . . .
00000063   2473 36FC F933 74A9 7EFE 9759 F4AF F6E6 F242    $ 6 . t ~ . . . .
0000006C   F4F9 FBFF F028 EA71 74BF B3D8 1C53 ED6D 9387    . . . . t . . . .
00000075   711F B278 197B 09EF 90C4 2C89 22F7 FB2C 184C    q . . . . , " . .
0000007E   00FC 156D 65AC C6EE 7CD7 4B64 7B19 B91A 1E9D    . . e . | K { . .

Word Size: 16          Page: X Memory
```

2. Locate the **Page** list box at the bottom of the **View Memory** window. Select **X Memory**.
3. Enter the memory address in the **Display** field.

   To enter a hexadecimal address use standard C hex notation, for example, 0x100.

NOTE You also can enter the symbolic name whose value you want to view by typing its name in the **Display** field of the **Memory** window.

The window displays the contents of X: memory.

If you are using the EVM hardware, type the address, `0x2000` in the **Display** text field and press **Enter**. You see the memory starting at that location. This is the `DATA` section in the EVM board’s memory. The memory address location for `DATA` (and `CODE`) are set in the Memory Segment and Sections Segment of the linker command file. Note that you see both the hexadecimal and ASCII values for X: memory. The contents of this window are editable as well.

Viewing P: Memory

You can view P memory space and edit the opcode hexadecimal values at debug time.

NOTE On targets that have Flash ROM, you cannot edit those values in the memory window that reside in Flash memory.

1. To view the memory address range of a variable, select **Data > View Memory from the menu bar of the Metrowerks CodeWarrior window**.

   The **Memory** window appears (Figure 8.25).

2. In the **Page** list box located at the bottom of the **View Memory** window, select **P Memory**.

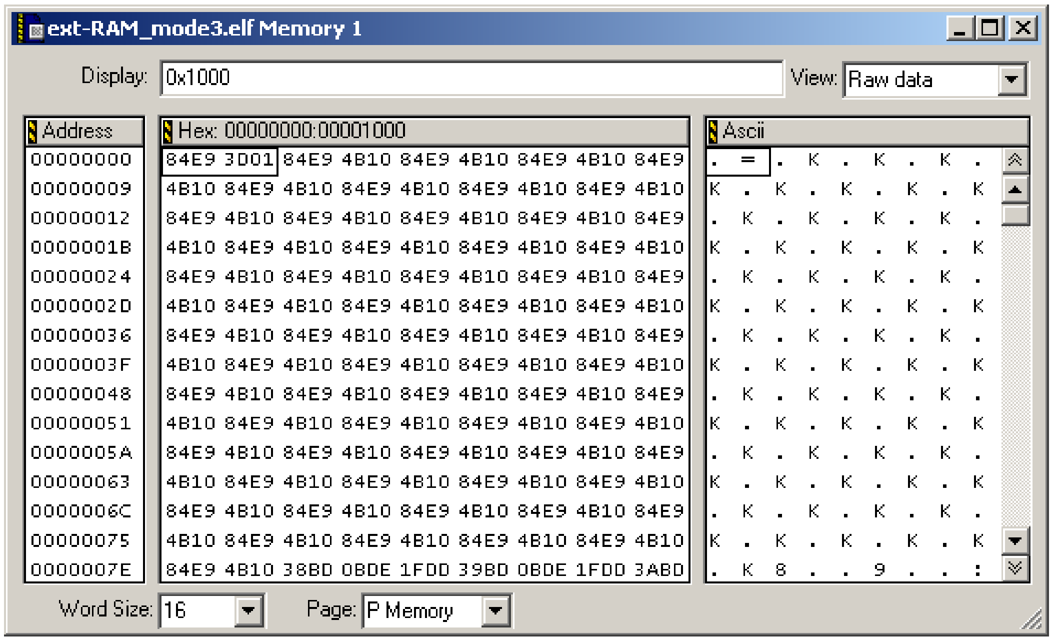
3. Enter the memory address in the **Display** field.

   To enter a hexadecimal address use standard C hex notation, for example: `0x1000`.

4. Using the View list box, you have the option to view four types of P:Memory:

- **Raw Data** (Figure 8.26).

Figure 8.26 View P:Memory (Raw Data) Window



ext-RAM_mode3.elf Memory 1

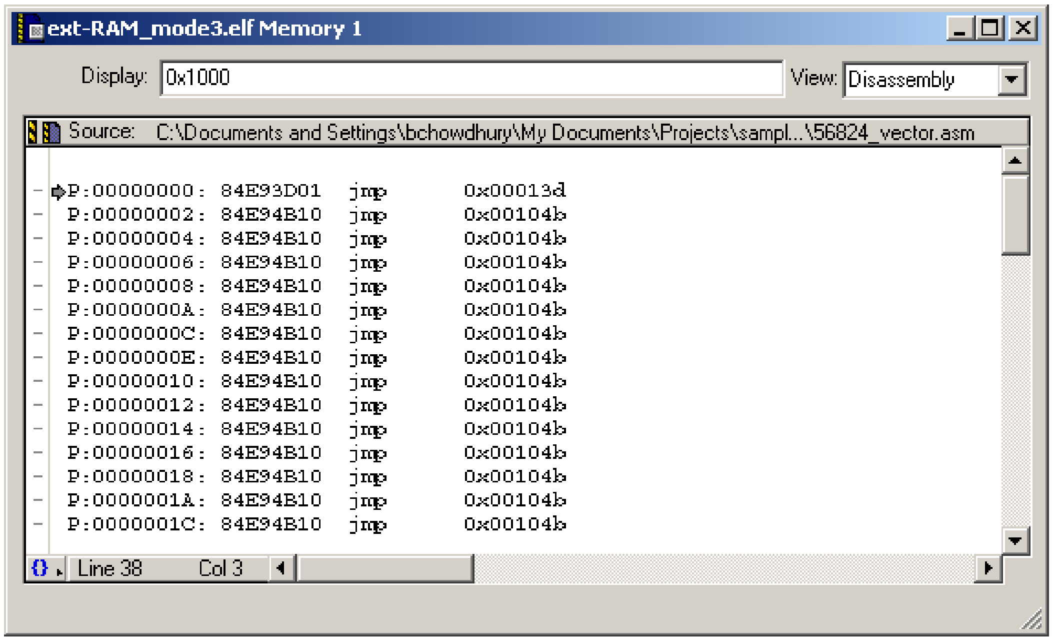
Display: 0x1000 View: Raw data

```
Address   Hex: 00000000:00001000                          Ascii
00000000  84E9 3D01 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . = . K . K . K .
00000009  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
00000012  84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . K . K . K . K .
0000001B  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
00000024  84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . K . K . K . K .
0000002D  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
00000036  84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . K . K . K . K .
0000003F  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
00000048  84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . K . K . K . K .
00000051  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
0000005A  84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . K . K . K . K .
00000063  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
0000006C  84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9    . K . K . K . K .
00000075  4B10 84E9 4B10 84E9 4B10 84E9 4B10 84E9 4B10    K . K . K . K . K
0000007E  84E9 4B10 38BD 0BDE 1FDD 39BD 0BDE 1FDD 3ABD    . K 8 . . 9 . . :
```

Word Size: 16 Page: P Memory

- **Disassembly** (Figure 8.27).

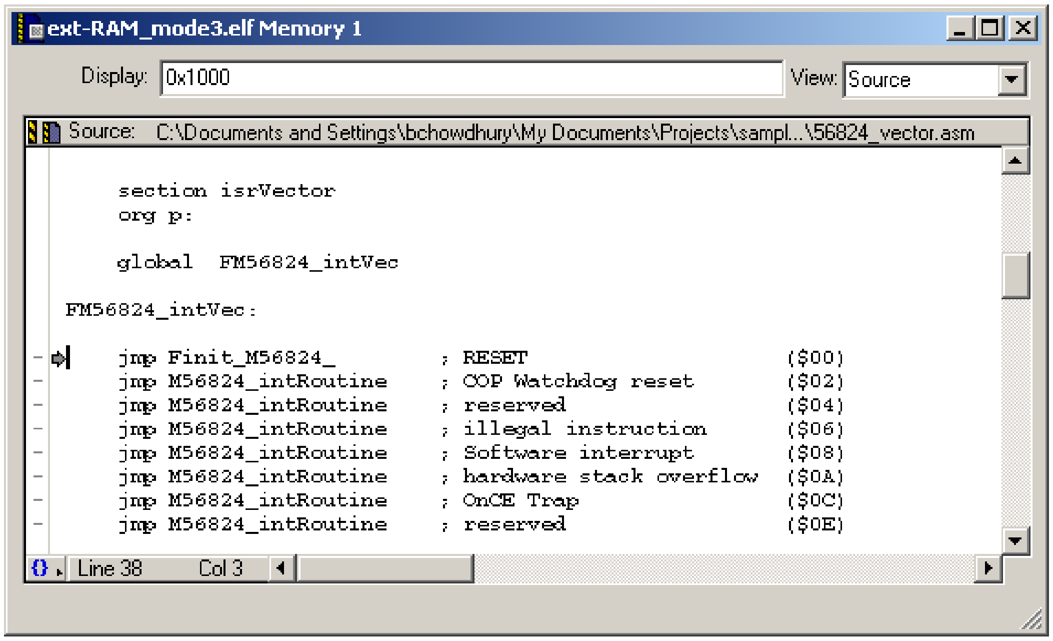
Figure 8.27 View P:Memory (Disassembly) Window


ext-RAM_mode3.elf Memory 1
Display: 0x1000
View: Disassembly
Source: C:\Documents and Settings\bchowdhury\My Documents\Projects\sampl...\56824_vector.asm
Line 38
Col 3

```
P:00000000: 84E93D01  jmp     0x00013d
P:00000002: 84E94B10  jmp     0x00104b
P:00000004: 84E94B10  jmp     0x00104b
P:00000006: 84E94B10  jmp     0x00104b
P:00000008: 84E94B10  jmp     0x00104b
P:0000000A: 84E94B10  jmp     0x00104b
P:0000000C: 84E94B10  jmp     0x00104b
P:0000000E: 84E94B10  jmp     0x00104b
P:00000010: 84E94B10  jmp     0x00104b
P:00000012: 84E94B10  jmp     0x00104b
P:00000014: 84E94B10  jmp     0x00104b
P:00000016: 84E94B10  jmp     0x00104b
P:00000018: 84E94B10  jmp     0x00104b
P:0000001A: 84E94B10  jmp     0x00104b
P:0000001C: 84E94B10  jmp     0x00104b
```

- **Source** (Figure 8.28).

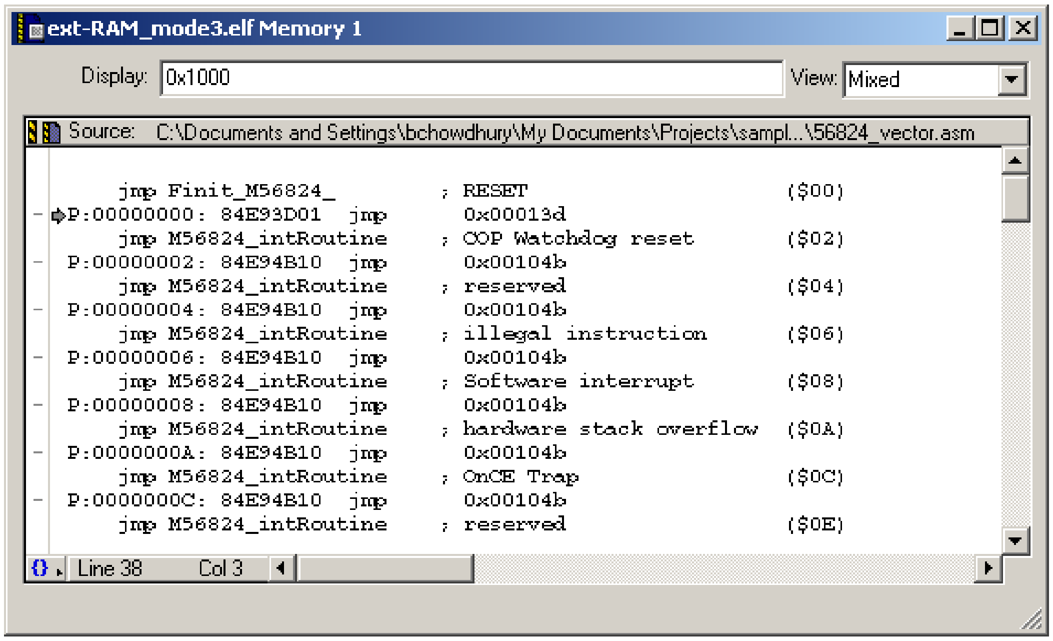
Figure 8.28 View P:Memory (Source) Window


ext-RAM_mode3.elf Memory 1
Display: 0x1000
View: Source
Source: C:\Documents and Settings\bchowdhury\My Documents\Projects\sampl...\56824_vector.asm
Line 38
Col 3

```
    section isrVector
    org p:

    global  FM56824_intVec

FM56824_intVec:

    jmp Finit_M56824_        ; RESET                  ($00)
    jmp M56824_intRoutine    ; COP Watchdog reset     ($02)
    jmp M56824_intRoutine    ; reserved               ($04)
    jmp M56824_intRoutine    ; illegal instruction    ($06)
    jmp M56824_intRoutine    ; Software interrupt     ($08)
    jmp M56824_intRoutine    ; hardware stack overflow ($0A)
    jmp M56824_intRoutine    ; OnCE Trap              ($0C)
    jmp M56824_intRoutine    ; reserved               ($0E)
```

- **Mixed** (Figure 8.29).

Figure 8.29 View P:Memory (Mixed) Window


ext-RAM_mode3.elf Memory 1
Display: 0x1000
View: Mixed
Source: C:\Documents and Settings\bchowdhury\My Documents\Projects\sampl...\56824_vector.asm
Line 38
Col 3

```
     jmp Finit_M56824_        ; RESET                  ($00)
- P:00000000: 84E93D01  jmp     0x00013d
     jmp M56824_intRoutine    ; COP Watchdog reset     ($02)
- P:00000002: 84E94B10  jmp     0x00104b
     jmp M56824_intRoutine    ; reserved               ($04)
- P:00000004: 84E94B10  jmp     0x00104b
     jmp M56824_intRoutine    ; illegal instruction    ($06)
- P:00000006: 84E94B10  jmp     0x00104b
     jmp M56824_intRoutine    ; Software interrupt     ($08)
- P:00000008: 84E94B10  jmp     0x00104b
     jmp M56824_intRoutine    ; hardware stack overflow ($0A)
- P:0000000A: 84E94B10  jmp     0x00104b
     jmp M56824_intRoutine    ; OnCE Trap              ($0C)
- P:0000000C: 84E94B10  jmp     0x00104b
     jmp M56824_intRoutine    ; reserved               ($0E)
```

Debugging on a Complex Scan Chain

This section describes the procedure for debugging a chip connected on a complex JTAG chain.

Setting Up

The general steps for debugging a DSP56800 chip connected on a complex scan chain are:

1. Set up and connect your JTAG chain of target boards.
2. Write a JTAG initialization file that describes the items on the JTAG chain.
3. Open a project to debug.
4. In the project you are debugging, select the **Custom JTAG** checkbox in the M56800 Target Settings panel.
5. Specify the name of the JTAG initialization file in the **JTAG Init. File** text field.

6. Specify the index of the core to debug in the **JTAG Target Core Index** text field (the index numbering sequence starts with 0).
7. Select **Project > Run**.

   The IDE downloads the program to the specified core. You can begin debugging.

JTAG Initialization File

Although you may debug only one single chip at a time, you must create a JTAG initialization file that specifies the type and order of all the chips in the chain.

To specify DSP56800 chips, you must specify DSP56800 as the name of a the chip you are debugging. For example, Listing 8.1 shows a JTAG initialization file for three 56800 chips in a JTAG chain.

Listing 8.1 Example JTAG Initialization File for DSP56800 Boards

```
# JTAG Initilaization File

# Has an index value of 0 in the JTAG chain
DSP56800
# Has an index value of 1 in the JTAG chain
DSP56800
# Has an index value of 2 in the JTAG chain
DSP56800
```

NOTE See the sample configuration file in the `DSP EABI Support\JTAG` folder.

Debugging a Loaded Target

If you have already downloaded an application file to hardware, you can kill the debug process and start over without having to reset the hardware and download your application again.

To debug a loaded target:

1. Disable the **Always Reset on Download** and **Always Load Program at Debugger Launch** options in the **M56800 Target Settings** panel.
2. Form the menu bar of the Metrowerks CodeWarrior window, select **Project > Debug**.

   Your application begins at the entry point specified in the entry point in the **M56800 Linker Settings** panel without resetting the hardware.

System-Level Connect

The CodeWarrior IDE DSP56800 debugger lets you connect to a loaded target board and view system registers and memory. A system-level connect does not let you view symbolic information during a connection.

NOTE The following procedure explains how to connect in the context of developing and debugging code on a target board. However, you can select the **Debug > Connect** command anytime you have a project window open, even if you have not yet downloaded a file to your target board.

To perform a system-level connect:

1. Select the **Project** window for the program you downloaded.
2. From the menu bar, select **Debug > Connect**.

   The debugger connects to the board. You can now examine registers and the contents of memory on the board.

9

ELF Linker and Command Language

The CodeWarrior™ Executable and Linking Format (ELF) Linker makes a program file out of the object files of your project. The linker also allows you to manipulate code in different ways. You can define variables during linking, control the link order to the granularity of a single function, change the alignment, and even compress code and data segments so that they occupy less space in the output file.

All of these functions are accessed through commands in the linker command file (LCF). The linker command file has its own language complete with keywords, directives, and expressions, that are used to create the specifications for your output code. The syntax and structure of the linker command file is similar to that of a programming language.

This chapter contains the following sections:

- Structure of Linker Command Files
- Linker Command File Syntax
- Linker Command File Keyword Listing
- Sample M56800 Linker Command File

Structure of Linker Command Files

Linker command files contain three main segments:

- Memory Segment
- Closure Blocks
- Sections Segment

A command file must contain a memory segment and a sections segment. Closure segments are optional.

Memory Segment

In the memory segment, available memory is divided into segments. Listing 9.1 shows a sample memory-segment format.

Listing 9.1 Sample MEMORY Segment

```
MEMORY {
    segment_1 (RWX): ORIGIN = 0x1000, LENGTH = 0x1000
    segment_2 (RWX): ORIGIN = AFTER(segment_1), LENGTH = 0
    data      (RW) : ORIGIN = 0x2000, LENGTH = 0x0000
    #segment_name (RW) : ORIGIN = memory address, LENGTH = segment length
    #and so on...
}
```

The (`RWX`) portion consists of ELF access permission flags, **r**ead, **w**rite, and e**x**ecute where:

- `ORIGIN` represents the start address of the memory segment.
- `LENGTH` represents the maximum size allowed for the memory segment.

Memory segments with `RWX` attributes are placed in to P memory while `RW` attributes are placed into X memory.

You can put a segment immediately after the previous one using the AFTER command.

If you cannot predict how much space a segment will occupy, you can use the command `LENGTH = 0` (unlimited length) and let the linker figure out the size of the segment.

Closure Blocks

The linker is very good at deadstripping unused code and data. Sometimes, however, symbols need to be kept in the output file even if they are never directly referenced. Interrupt handlers, for example, are usually linked at special addresses, without any explicit jumps to transfer control to these places.

Closure blocks provide a way to make symbols immune from deadstripping. The closure is transitive, meaning that symbols referenced by the symbol being closed are also forced into closure, as are any symbols referenced by those symbols, and so on.

NOTE The closure blocks need to be in place before the SECTIONS definition in the linker command file.

The two types of closure blocks available are:

- Symbol-level

  Use `FORCE_ACTIVE` to include a symbol into the link that would not be otherwise included. An example is in Listing 9.2.

Listing 9.2 Sample Symbol-level Closure Block

```
FORCE_ACTIVE {break_handler, interrupt_handler, my_function}
```

- Section-level

  Use `KEEP_SECTION` when you want to keep a section (usually a user-defined section) in the link. Listing 9.3 is an example.

Listing 9.3 Sample Section-level Closure Block

```
KEEP_SECTION {.interrupt1, .interrupt2}
```

A variant is `REF_INCLUDE`. It keeps a section in the link, but only if the file where it is coming from is referenced. This is very useful to include version numbers. Listing 9.4 is an example.

Listing 9.4 Sample Section-level Closure Block With File Dependency

```
REF_INCLUDE {.version}
```

Sections Segment

In the Sections segment, you define the contents of memory segments and any global symbols to be used in the output file.

The format of a typical sections block is in Listing 10.2.

Listing 9.5 Sample SECTIONS Segment

```
SECTIONS {
   .section_name : #the section name is for your reference
   {               #the section name must begin with a '.'
      filename.c  (.text) #put the .text section from filename.c
      filename2.c (.text) #then the .text section from filename2.c
      filename.c  (.data)
      filename2.c (.data)
      filename.c  (.bss)
      filename2.c (.bss)
      . = ALIGN (0x10);   #align next section on 16-byte boundary.
   } > segment_1     #this means "map these contents to segment_1"

   .next_section_name:
   {
      more content descriptions
   } > segment_x      # end of .next_section_name definition
}                     # end of the sections block
```

Linker Command File Syntax

This section explains some practical ways in which to use the commands of the linker command file to perform common tasks.

Alignment

To align data on a specific byte-boundary, you use the ALIGN and ALIGNALL commands to bump the location counter to the preferred boundary. For example, the following fragment uses `ALIGN` to bump the location counter to the next 16-byte boundary. A sample is in Listing 9.6.

Listing 9.6 Sample ALIGN Command Usage

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

You can also align data on a specific byte-boundary with `ALIGNALL as shown in` (Listing 10.7).

Listing 9.7 Sample ALIGNALL Command Usage

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

Arithmetic Operations

Standard C arithmetic and logical operations may be used to define and use symbols in the linker command file. Table 9.1 shows the order of precedence for each operator. All operators are left-associative. To learn more about C operators, refer to the *C Compiler Reference.*

Table 9.1 Arithmetic Operators

Precedence	Operators
1 (highest)	`-  ~  !`
2	`*  /  %`
3	`+  -`
4	`>>  <<`
5	`==  !=  >  <  <=  >=`
6	`&`
7	`|`
8	`&&`
9	`||`

Comments

Add comments by using the pound character (#) or C++ style double-slashes (//). C-style comments are not accepted by the LCF parser. Listing 9.8 shows examples of valid comments.

Listing 9.8 Example Comments

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

Deadstrip Prevention

The M56800 linker removes unused code and data from the output file. This process is called deadstripping. To prevent the linker from deadstripping unreferenced code and data, use the `FORCE_ACTIVE`, `KEEP_SECTION, and REF_INCLUDE` directives to preserve them in the output file.

Variables, Expressions and Integral Types

This section explains variables, expressions, and integral types.

Variables and Symbols

All symbol names within a Linker Command File (LCF) start with the underscore character (_), followed by letters, digits, or underscore characters. Listing 9.9 shows examples of valid lines for a command file:

Listing 9.9 Valid Command File Lines

```
_dec_num = 99999999;
_hex_num_ = 0x9011276;
```

Variables that are defined within a `SECTIONS` section can only be used within a `SECTIONS` section in a linker command file.

Global Variables

Global variables are accessed in a linker command file with an ‘F’ prepended to the symbol name. This is because the compiler adds an ‘F’ prefix to externally defined symbols.

Listing 9.10 shows an example of using a global variable in a linker command file. This example sets the global variable `_foot`, declared in C with the `extern` keyword, to the location of the address location current counter.

Listing 9.10 Using a Global Variable in the LCF

```
F_foot = .;
```

If you use a global symbol in an LCF, as in Listing 9.10, it can be accessed from C program sources as shown in Listing 9.11.

Listing 9.11 Accessing a Global Symbol From C Program Sources

```
extern unsigned long _foot;
void main( void ) {
  unsigned long i;
  // ...
  i = _foot;   // _foot value determined in LCF
  // ...
}
```

Expressions and Assignments

You can create symbols and assign addresses to those symbols by using the standard assignment operator. An assignment may only be used at the start of an expression, and a semicolon is required at the end of an assignment statement. An example of standard assignment operator usage is shown in Listing 9.12.

Listing 9.12 Standard Assignment Operator Usage

```
_symbolicname = some_expression; # Legal
_sym1 + _sym2 =  sym3;           # ILLEGAL!
```

When an expression is evaluated and assigned to a variable, it is given either an absolute or a relocatable type. An absolute expression type is one in which the symbol contains the value that it will have in the output file. A relocatable expression is one in which the value is expressed as a fixed offset from the base of a section.

Integral Types

The syntax for linker command file expressions is very similar to the syntax of the C programming language. All integer types are `long` or `unsigned long`.

Octal integers (commonly know as base eight integers) are specified with a leading zero, followed by numeral in the range of zero through seven. Listing 10.13 shows valid octal patterns you could put into your linker command file.

Listing 9.13 Sample Octal Patterns

```
_octal_number  = 012;
_octal_number2 = 03245;
```

Decimal integers are specified as a non-zero numeral, followed by numerals in the range of zero through nine. To create a negative integer, use the minus sign (-) in front of the number. Listing 10.14 shows examples of valid decimal integers that you could write into your linker command file.

Listing 9.14 Sample Decimal Integers

```
_dec_num       = 9999;
_decimalNumber = -1234;
```

Hexadecimal (base sixteen) integers are specified as `0x` or `0X` (a zero with an X), followed by numerals in the range of zero through nine, and/or characters `A` through `F`. Examples of valid hexadecimal integers you could put in your linker command file appear in Listing 9.15.

Listing 9.15 Example Hexadecimal Integers

```
_somenumber       = 0x0F21;
_fudgefactorspace = 0XF00D;
_hexonyou         = 0xcafe;
```

File Selection

When defining the contents of a `SECTION` block, specify the source files that are contributing to their sections. The standard method of doing this is to list the files, as shown in Listing 10.16.

In a large project, the list can grow to become very long. For this reason, use the asterix (`*`) keyword. The asterix (`*`) keyword represents the filenames of every file in your project. Note that since you have already added the `.text` sections from the files `main.c`, `file2.c`, and `file3.c`, the '`*`' keyword does not addition of the `.text` sections from those files again.

Sometimes you may only want to include the files from a particular file group. The `GROUP` keyword allows you to specify all the files of a named file group.

Listing 9.16 Sample file listing

```
SECTIONS {
  .example_section :
    {
       main.c  (.text)
       file2.c (.text)
       file3.c (.text)
       *  (.text)
       GROUP(fileGroup1) (.text)
       GROUP(fileGroup1) (.data)
     } > MYSEGMENT
}
```

Function Selection

The OBJECT keyword allows precise control over how functions are placed within a section. For example, if the functions `pad` and `foot` are to be placed before anything else in a section, use code like the example in Listing 10.17.

Listing 9.17 Sample Function Selection Using the Object Keyword

```
SECTIONS {
  .program_section :
    {
      OBJECT (Fpad, main.c)
      OBJECT (Ffoot, main.c)
      * (.text)
     } > ROOT
```

NOTE If an object is written once using the **Object** function selection keyword, you can prevent the same object from being written again using the '`*`' file selection keyword.

ROM to RAM Copying

In embedded programming, it is common to copy a portion of a program resident in ROM into RAM at runtime. For example, program variables cannot be accessed until they are copied to RAM.

To indicate data or code that is meant to be copied from ROM to RAM, the data or code is given two addresses. One address is its resident location in ROM (defined by the linker command file). The other is its intended location in RAM (defined in C code where you do the actual copying).

To create a section with the resident location in ROM and an intended location in RAM, you define the two addresses in the linker command file. Use the `MEMORY` segment to specify the intended RAM location, and the `AT(`*`address`*`)` parameter to specify the resident ROM address.

NOTE This method only works for copying from data ROM to data RAM.

For example, you have a program and you want to copy all your initialized data into RAM at runtime. Listing 10.18 shows you the LCF used to set up for writing initialized data to ROM.

NOTE If you want to write initialized data to program ROM, use the `WRITE` commands in the LCF. Also, write your own P to X memory copy routine in assembly to copy data from program ROM to data RAM at runtime.

Listing 9.18 LCF File to Prepare Data Copy From ROM to RAM

```
MEMORY {
  .text (RWX) : ORIGIN = 0x8000, LENGTH = 0x0    # code (P)
  .data (RW)  : ORIGIN = 0x3000, LENGTH = 0x0    # data (X)-> RAM
}

SECTIONS{

  F__ROM_Address = 0x1000;        # ROM Starting Address

  .main_application :
  {
    # .text sections

    *(.text)
    *(.rtlib.text)
    *(.fp_engine.txt)
    *(user.text)
  } > .text

  .data : AT( F__ROM_Address )  # Start data at 0x1000 -> ROM
  {
    # .data sections
    F_Begin_Data = .;           # Get start location for RAM
    *(.data)                    # Write data to the section (ROM)
    *(fp_state.data);
    *(rtlib.data);
    F_End_Data = .;             # Get end location for RAM

    # .bss sections
    * (rtlib.bss.lo)
    * (.bss)

  } > .data
}
```

To make the runtime copy the section from ROM to RAM, you need to know where the data start in ROM (`__ROM_Address`) and the size of the block in ROM you want to copy to RAM. In Listing 9.19, all variables in the data section from ROM to RAM in C code are copied.

Listing 9.19 ROM to RAM Copy From C After Data-Flash Write

```
#include <stdio.h>
#include <string.h>

int GlobalFlash = 6;

// From linker command file
extern __Begin_Data, __ROMAddress, __End_Data;

void main( void )
{
  unsigned short a = 0, b = 0, c = 0;
  unsigned long dataLen  = 0x0;
  unsigned short __myArray[] = { 0xdead, 0xbeef, 0xcafe };

  // Calculate the data length of the X memory written to Flash
  dataLen = (unsigned long)&__End_Data -
             (unsigned long)&__Begin_Data;

  // Block move from ROM to RAM
  memcpy( (unsigned long *)&__Begin_Data,
           (const unsigned long *)&__ROMAddress,
           dataLen );

  a = GlobalFlash;

  return;
}
```

NOTE For this example to work, you must be writing to Flash with the CodeWarrior debugger and have your board jumpered to mode 0.

Stack and Heap

To reserve space for the stack and heap, arithmetic operations are performed to set the values of the symbols used by the runtime. Listing 9.20 shows a code fragment from a section definition that illustrates this arithmetic.

You do not need to set up your heap and stack in the linker, as this is done by the run-time initialization of the MSL.

Listing 9.20 Setting Up Some Heap

```
_HEAP_ADDR = .;
_HEAP_SIZE = 0x2000;  // this is the size of the heap
_HEAP_END  = _HEAP_ADDR + _heap_size;
. = _HEAP_END         // reserve the space
```

The same thing is done for the stack using the ending address of the heap as the start of the stack (Listing 9.21).

Listing 9.21 Setting Up the Stack

```
_stack_size = 0x2000; // this is the size of the stack
_stack_addr = heap_end + _stack_size;
. = _stack_addr;
```

Writing Data Directly to Memory

You can write directly to memory using the `WRITEx` command in the linker command file. The `WRITEB` command writes a byte, the `WRITEH` command writes two bytes, and the `WRITEW` command writes four bytes. You insert the data at the section's current address.

Listing 9.22 Embedding Data Directly Into the Output

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

Linker Command File Keyword Listing

This sections explains the keywords available for use when creating CodeWarrior IDE for DSP56800E applications with the linker command file. Valid linker command file functions, keywords, directives, and commands are described:

- . (location counter)
- ADDR
- ALIGN
- ALIGNALL
- FORCE_ACTIVE
- GROUP
- INCLUDE
- KEEP_SECTION
- MEMORY
- OBJECT
- REF_INCLUDE
- SECTIONS
- SIZEOF
- SIZEOFW
- WRITEB
- WRITEH
- WRITES
- WRITEW

. (location counter)

Definition The period character (`.`) always maintains the current position of the output location. Since the period always refers to a location in a `SECTIONS` block, it can not be used outside a section definition.

A period may appear anywhere a symbol is allowed. Assigning a value to period that is greater than its current value causes the location counter to move, but the location counter can never be decremented.

This effect can be used to create empty space in an output section. In the example below, the location counter is moved to a position that is 0x1000 bytes past the symbol `FSTART_`.

Example

```
.data :
{
     *(.data)
     *(.bss)
     FSTART_ = .;
     . = FSTART_ + 0x1000;
     __end = .;
} > DATA
```

ADDR

Definition The `ADDR` function returns the address of the named section or memory segment.

Prototype

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

In the example below, `ADDR` is used to assign the address of `ROOT` to the symbol `__rootbasecode`.

Example

```
MEMORY{
    ROOT  (RWX) : ORIGIN = 0x8000, LENGTH = 0
}

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

ALIGN

Definition

The `ALIGN` function returns the value of the location counter aligned on a boundary specified by the value of `alignValue`. The `alignValue` must be a power of two.

Prototype

`ALIGN(alignValue)`

Please note that `ALIGN` does not update the location counter; it only performs arithmetic. To update the location counter, use an assignment such as the following:

Example

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

ALIGNALL

Definition

`ALIGNALL` is the command version of the ALIGN function. It forces the minimum alignment for all the objects in the current segment to the value of `alignValue`. The `alignValue` must be a power of two.

Prototype

`ALIGNALL(alignValue);`

Unlike its counterpart ALIGN, ALIGNALL is an actual command. It updates the location counter as each object is written to the output.

Example

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

```
            *    (.text)

           ALIGNALL(16);  //align data on 16 byte boundary
            *    (.rodata)
         } > .text
```

FORCE_ACTIVE

Definition The `FORCE_ACTIVE` directive allows you to specify symbols that you do not want the linker to deadstrip. You must specify the symbol(s) you want to keep before you use the `SECTIONS` keyword.

Prototype `FORCE_ACTIVE{ symbol[ , symbol] }`

GROUP

Definition The `GROUP` keyword allows you to selectively include files and sections from certain file groups.

Prototype `GROUP (fileGroup) (sectionType)`

In the example, all the .bss sections of the files in the file group named `PAD` are specified.

Example `GROUP (PAD) (.bss)`

INCLUDE

Definition The `INCLUDE` command allows you to include a binary file in the output file.

Prototype `INCLUDE filename`

KEEP_SECTION

Definition

The `KEEP_SECTION` directive allows you to specify sections that you do not want the linker to deadstrip. You must specify the section(s) you want to keep before you use the `SECTION` keyword.

Prototype

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

MEMORY

Definition

The `MEMORY` directive allows you to describe the location and size of memory segment blocks in the target. This directive specifies the linker the memory areas to avoid, and the memory areas into which it links the code and date.

The linker command file may only contain one `MEMORY` directive. However, within the confines of the `MEMORY` directive, you may define as many memory segments as you wish.

Prototype

```
MEMORY { memory_spec }
```

The `memory_spec` is:

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

`segmentName` can include alphanumeric characters and underscore '_' characters.

`accessFlags` are passed into the output ELF file (`Phdr.p_flags`). The `accessFlags` can be:

- R-read
- W-write
- X-executable (for P memory placement)

`address origin` is one of the following:

- **Memory address**

Specify a hex address, such as `0x8000`.

- **AFTER command**

  Use the `AFTER(`*`name [,name]`*`)` command to instruct the linker to place the memory segment after the specified segment. In the example below, `overlay1` and `overlay2` are placed after the code segment. When multiple memory segments are specified as parameters for `AFTER`, the highest memory address is used.

Example

```
MEMORY{
code     (RWX)  : ORIGIN = 0x8000,      LENGTH = 0
overlay1 (RWX)  : ORIGIN = AFTER(code), LENGTH = 0
overlay2 (RWX)  : ORIGIN = AFTER(code), LENGTH = 0
data     (RW)   : ORIGIN = 0x1000,      LENGTH = 0
}
```

`ORIGIN` is the assigned address.

`LENGTH` is any of the following:

- A value greater than zero.

  If you try to put more code and data into a memory segment greater than your specified length allows, the linker stops with an error.

- Autolength by specifying zero.

  When the length is 0, the linker lets you put as much code and data into a memory segment as you want.

NOTE There is no overflow checking with autolength. The linker can produce an unexpected result if you use the autolength feature without leaving enough free memory space to contain the memory segment. Using the `AFTER` keyword to specify origin addresses prevents this.

`> fileName` is an option to write the segment to a binary file on disk instead of an ELF program header. The binary file is put in the same folder as the ELF output file. This option has two variants:

- `> fileName`

  Writes the segment to a new file.

- `>> fileName`

  Appends the segment to an existing file.

OBJECT

Definition The `OBJECT` keyword allows control over the order in which functions are placed in the output file.

Prototype

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

It is important to note that if an object is written to the outfile using the `OBJECT` keyword, the IDE does not allow the same object to be written again by using either the `GROUP` keyword or the '*' wildcard selector.

REF_INCLUDE

Definition The `REF_INCLUDE` directive allows you to specify sections that you do not want the linker to deadstrip, but only if they satisfy a certain condition: the file that contains the section must be referenced. This is useful if you want to include version information from your source file components. You must specify the section(s) you want to keep before you use the `SECTIONS` keyword.

Prototype

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

SECTIONS

Definition A basic `SECTIONS` directive has the following form:

Prototype

```
SECTIONS { <section_spec> }
```

`section_spec` is one of the following:

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

`sectionName`	The section name for the output section. It must start with a period character. For example, `.mysection`.
`AT (loadAddress)`	An optional parameter that specifies the address of the section. The default (if not specified) is to make the load address the same as the relocation address.
`contents`	Made up of statements.

These statements can:

- assign a value to a symbol.
- describe the placement of an output section, including which input sections are placed into it.

`segmentName` is the predefined memory segment into which you want to put the contents of the section. The two variants are:

`> segmentName`	Places the section contents at the beginning of the memory segment `segmentName`.
`>> segmentName`	Appends the section contents to the memory segment `segmentName`.

Here is an example section definition:

Example
```
SECTIONS {
  .text : {
            F_textSegmentStart = .;
            footpad.c (.text)
            . = ALIGN (0x10);
            padfoot.c (.text)
            F_textSegmentEnd = .;
  }
  .data : { *(.data) }
  .bss  : { *(.bss)
            *(COMMON)
  }
}
```

SIZEOF

Definition The `SIZEOF` function returns the size of the given segment or section. The return value is the size in bytes.

Prototype `SIZEOF(segmentName | sectionName)`

SIZEOFW

Definition The `SIZEOFW` function returns the size of the given segment or section. The return value is the size in words.

Prototype `SIZEOFW(segmentName | sectionName)`

WRITEB

Definition `The WRITEB` command inserts a byte of data at the current address of a section.

Prototype `WRITEB (expression);`

`expression` is any expression that returns a value `0x00` to `0xFF`.

WRITEH

Definition `The WRITEH` command inserts two bytes of data at the current address of a section.

Prototype `WRITEH (expression);`

`expression` is any expression that returns a value `0x0000` to `0xFFFF`.

WRITES

Definition

The `WRITES` command is a string of variables with maximum length of 255 characters.

You can use `DATE` and `TIME` in conjunction with the `WRITES` command.

`DATE` returns the current date as C string (must be within parentheses).

`TIME` returns the current time as C string (must be within parentheses).

Prototype

```
WRITES (string);
```

`string` is any string within parentheses.

Examples

```
WRITES ("Hello World").
WRITES ("Today is" DATE).
WRITES ("The time is " TIME).
```

WRITEW

Definition

The `WRITEW` command inserts 4 bytes of data at the current address of a section.

Prototype

```
WRITEW (expression);
```

`expression` is any expression that returns a value `0x00000000` to `0xFFFFFFFF`.

Sample M56800 Linker Command File

A sample M56800 linker command file is in Listing 9.23. This is the typical linker command file.

Listing 9.23 Sample Linker Command File (DSP56824 EVM)

```
# ---------------------------------------------------

# Metrowerks, a company of Motorola
# sample code

# linker command file for DSP56824EVM
# using
#     external pRAM
#     external xRAM
#     internal xRAM (for compiler regs)
#         mode 3
#          EXT 0

# revision history
# 011020 R4.1 A.H. first version

# ---------------------------------------------------

# see end of file for additional notes
# additional reference: Motorola docs
#   DSP56F801-7UM.pdf
#   DSP56824EVMUM.pdf

# for this LCF:
# interrupt vectors --> external pRAM starting at zero
#      program code --> external pRAM
#         constants --> external xRAM
#      dynamic data --> external xRAM

# stack size is set to 0x1000 for external RAM LCF
# this is required for hostIO

# DSP56824EVM eval board settings:
```

```
#    ON --> jumper JG1 pins 1-2 & 3-4 (enable mode 3 upon exit
#                                      from reset)
#

# due to above jumpers, we stay in mode 3 all time for 824

# CodeWarrior debugger Target option settings
#   OFF --> "Use Hardware Breakpoints"

#   if using DSP56824EVM, JG1 overrides this next option
#    ON --> "Debugger sets OMR at Launch" option

      # note: with above option on, CW debugger sets OMR as
# OMR:
#     0 --> EX bit (stay in Debug processing state)
#     1 --> MA bit
#     1 --> MB bit

# about the reserved sections
# for this external RAM only LCF:

# p_isr -- reserved in external pRAM
# memory space reserved for interrupt vectors
# interrupt vectors must start at address zero
# interrupt vector space size is 0x80

# x_compiler_regs -- reserved in internal xRAM 1
# The compiler uses page 0 address locations 0x30-0x40
# as register variables. See the Target manual for more info.

# 56824
# mode 3 (development)
# EX = 0

MEMORY {
  .p_isr_ext_RAM    (RWX) : ORIGIN = 0x0000, LENGTH = 0x0080
  .p_external_RAM   (RWX) : ORIGIN = 0x0080, LENGTH = 0x0000
  .x_comp_regs_iRAM (RW)  : ORIGIN = 0x0030, LENGTH = 0x0010
  .x_internal_RAM_1 (RW)  : ORIGIN = 0x0040, LENGTH = 0x07C0
  .x_internal_ROM   (R)   : ORIGIN = 0x0800, LENGTH = 0x0010
  .x_internal_RAM_2 (RW)  : ORIGIN = 0x0040, LENGTH = 0x0010
  .x_reserved       (R)   : ORIGIN = 0x1600, LENGTH = 0x0A00
  .x_external_RAM   (RW)  : ORIGIN = 0x2000, LENGTH = 0xDF80
  .x_on_chip_peri_1 (RW)  : ORIGIN = 0xFF80, LENGTH = 0x0040
  .x_on_chip_peri_2 (RW)  : ORIGIN = 0xFFC0, LENGTH = 0x0040
}

# we ensure the interrupt vector section is not deadstripped here

KEEP_SECTION{ isrVector.text }

# place all executing code & data in external memory

SECTIONS {
  .interrupt_vectors_for_p_ram :
  {
      * (isrVector.text)  # from 56824_vector.asm

  } > .p_isr_ext_RAM


  .executing_code :
  {
    # .text sections

    * (.text)
    * (rtlib.text)
    * (fp_engine.text)
    * (user.text)
  } > .p_external_RAM

  .data :
  {
    # .data sections

    * (.const.data)
    * (fp_state.data)
    * (rtlib.data)
    * (.data)

    # .bss sections

    * (rtlib.bss.lo)
    * (.bss)
    # setup the heap address
    . = ALIGN(4);
    _HEAP_ADDR = .;
    _HEAP_SIZE = 0x00FF;
    _HEAP_END = _HEAP_ADDR + _HEAP_SIZE;
    . = _HEAP_END;

    # setup the stack address
    _min_stack_size = 0x1000;
    _stack_addr = _HEAP_END;
    _stack_end  = _stack_addr + _min_stack_size;
    . = _stack_end;

    # export heap and stack runtime to libraries
    F_heap_addr  = _HEAP_ADDR;
    F_heap_end   = _HEAP_END;
    F_stack_addr = _HEAP_END;

  } > .x_external_RAM
}

# -------------------------------------------------------
# additional notes:

# about the reserved sections
# for this external RAM only LCF:

# p_isr -- reserved in external pRAM
# memory space reserved for interrupt vectors
# interrupt vectors must start at address zero
# interrupt vector space size is 0x80

# x_compiler_regs -- reserved in internal xRAM
# The compiler uses page 0 address locations 0x30-0x40
# as register variables. See the Target manual for more info.

# notes:
# program memory (p memory)
# (RWX) read/write/execute for pRAM
# (RX) read/execute for flashed pROM
# data memory (X memory)
# (RW) read/write for xRAM
# (R)  read for data flashed xROM

# LENGTH = next start address - previous
# LENGTH = 0x0000 means use all remaining memory
```

10

Flash Programming

This chapter covers features of the CodeWarrior™ debugger and ELF linker command file that allow you to program Flash ROM on DSP56800 series devices that have this capability. The CodeWarrior debugger for DSP56800 has Flash drivers for both program (P) and data (X) memory. When you use the debugger with a flash configuration file and linker command file, the debugger writes your code and/or data to Flash ROM.

This chapter contains the following sections:

- Setting up the Debugger for Flash Programming
- Setting up the Linker Command File for Flash Programming
- Preparing the Hardware for Flash Programming
- Flash Programming Tips
- Flash Programming the Reset and Interrupt Vectors

NOTE This chapter assumes that you are familiar with the CodeWarrior debugger and the linker command file format for DSP56800. Familiarize yourself with these topics before programming Flash ROM on DSP56800 devices.

Setting up the Debugger for Flash Programming

In order for the debugger to download into Flash, the following options are required in the M56800 Target Settings panel:

- **Use Flash Config File**

  This option must be enabled.
- **Always load program at** debugger launch

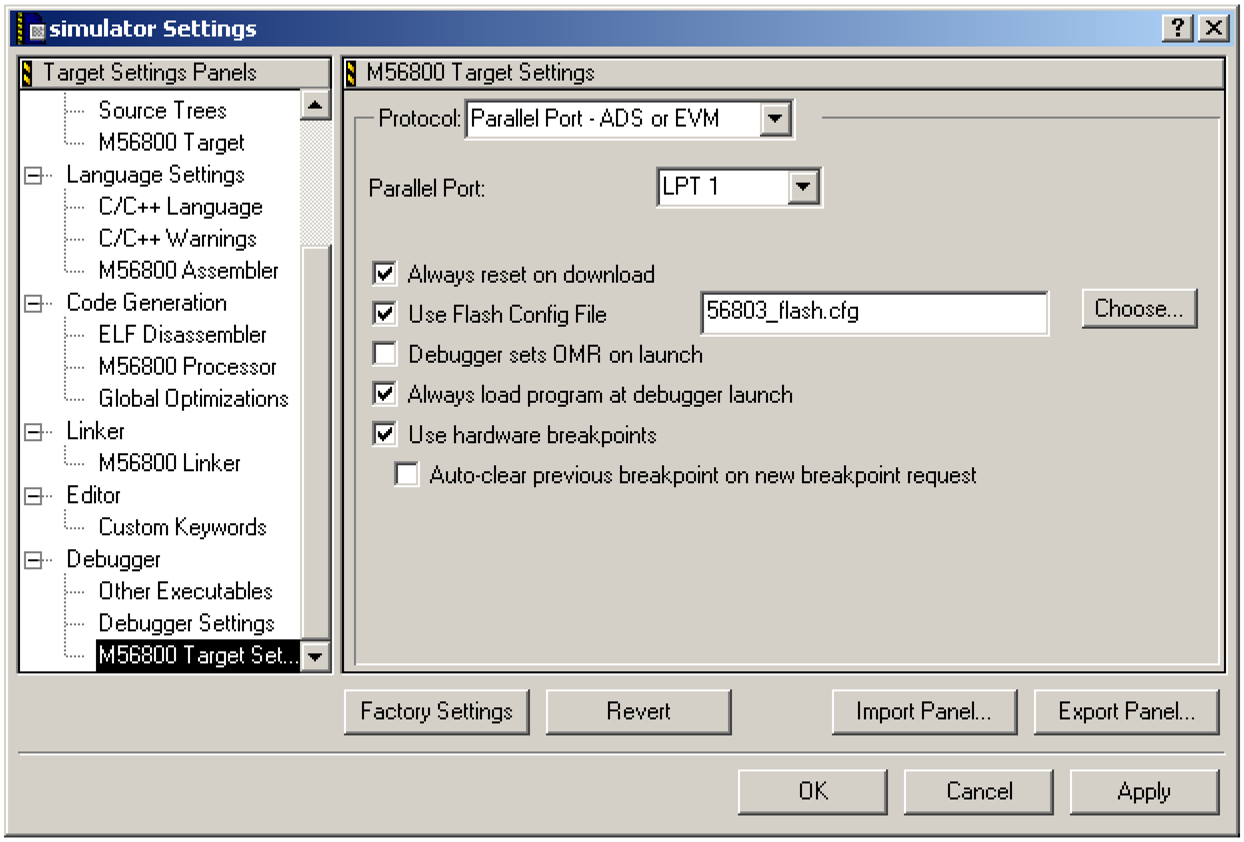
  This option must be enabled.

- **Debugger sets OMR on launch**

  This option must be disabled. The debugger does not set OMR at all when this option is disabled.

Figure 10.1 shows the **M56800 Target Settings** panel when you use minimum requirements for Flash programming.

Figure 10.1 M56800 Target Settings Panel for Programming Flash



Protocol: Parallel Port - ADS or EVM

Parallel Port: LPT 1

- [✓] Always reset on download
- [✓] Use Flash Config File: 56803_flash.cfg
- [ ] Debugger sets OMR on launch
- [✓] Always load program at debugger launch
- [✓] Use hardware breakpoints
- [ ] Auto-clear previous breakpoint on new breakpoint request

Setting up the Linker Command File for Flash Programming

To write to Flash you must properly set up your linker command file. The CodeWarrior debugger takes the link information from the `MEMORY` segments to know whether the intended memory segment in intended for ROM or RAM. If a `MEMORY` segment resides in ROM and the appropriate debugger settings are used, the debugger performs a mass erase of the data and/or code ROM region before writing to ROM.

NOTE Mass erases of Flash ROM regions for X: memory and P: memory are performed individually. For example, if you only want to flash P: memory and not X: memory, the debugger does not perform a mass erase of X: memory. This is determined by the setup in the linker command file.

Specifying P: Memory

To specify P: (program) memory you must specify your `MEMORY` segment attributes as `(RWX)`. For example:

```
.text (RWX) : ORIGIN = 0x1000, LENGTH = 0x0
```

specifies that the `.text` memory segment is intended for P: memory and starts at `0x1000` in memory. See the section "Memory Segment" for more information.

Specifying X: Memory

To specify X: (data) memory you must specify your `MEMORY` segment attributes as `(RW)` or `(W)`. For example:

```
.data (RW) : ORIGIN = 0x1000, LENGTH = 0x0
```

specifies that the `.data` memory segment is intended for X: memory and starts at `0x1000` in memory. See the section "Memory Segment" for more information.

Preparing the Hardware for Flash Programming

For the CodeWarrior debugger to write to Flash, you must have your hardware jumpered to mode 0. All EVM provide jumpers to do this. Refer to hardware manuals for EVM boards.

Flash Programming Tips

If you are programming Flash:

- Ensure your Flash data size fits into Flash memory.

  The linker command file specifies where data is written to. There is no bounds checking for Flash programming.
- The standard library I/O function such as `printf` uses large amount of memory and may not fit into flash targets.
- Use the Flash stationery when creating a new project intended for ROM.

  The default stationery contains the Flash configuration file and debugger settings required to use the Flash programmer.

Flash Programming the Reset and Interrupt Vectors

The first four P: (program) memory locations in Flash ROM are actually "mirrored" from the first four memory locations of Boot Flash. Therefore, when Flash programming the reset vectors, write the reset vectors to the beginning of Boot Flash. The interrupt vectors are located in Program Flash. Write the interrupt vectors normally, starting at P:0x0004. The Flash targets in the stationery demonstrate how the source, linker command file, and flash configuration file look.

NOTE It is important that you use the flash configuration file provided in the stationery. Using a flash configuration file with extra sections can lead to multiple erases of the same flash unit resulting in Flash programming errors.

11

Libraries and Runtime Code

You can use a variety of libraries with the CodeWarrior™ IDE. The libraries include ANSI-standard libraries for C, runtime libraries, and other code. This chapter explains how to use these libraries for DSP56800 development.

With respect to the Metrowerks Standard Library (MSL) for C, this chapter is an extension of the *MSL C Reference*. Consult that manual for general details on the standard libraries and their functions.

This chapter contains the following sections:

- MSL for DSP56800
- Runtime Initialization

MSL for DSP56800

This section explains the Metrowerks Standard Library (MSL) modified for use with DSP56800. CodeWarrior IDE for DSP56800 includes the source and project files for MSL so that you can modify the library if necessary.

Using MSL for DSP56800

CodeWarrior IDE for DSP56800 includes a version of the Metrowerks Standard Library (MSL). The MSL is a C library you can use in your embedded projects. All of the sources necessary to build MSL are included in CodeWarrior IDE for DSP56800, along with the project file and targets for different MSL configurations. If you already have a version of CodeWarrior IDE installed on your computer, the CodeWarrior installer adds the new files needed for building versions of MSL for DSP56800.

Do not modify any of the source files that support MSL.

MSL Configurations for DSP56800

There are two DSP56800 MSL libraries available. Both support standard C calls with optional I/O functionality. One library has a minimal `printf` function providing console output using debugger. The other library has full ANSI/ISO standard I/O support, including host machine console and file I/O for debugging sessions. The memory functions `malloc()` and `free()` are also supported for both libraries.

The two provided DPS56800 MSL libraries are:

MSL C 56800.lib

This library provides standard C library support without standard I/O. A minimal "thin" `printf` is provided but other `stdio` is stripped out in order to maximize performance. The `printf` sends characters to the CodeWarrior console window via the debugger. Use this library for when you need minimal `printf` support for debugging and to save space.

MSL C 56800 host I/O.lib

This library adds ANSI/ISO standard I/O support through the debugger. The standard C library I/O is supported, including `stdio.h`, `sdderr.h`, and `stdin.h`. Use this library when you want to perform `stdio` calls, including CodeWarrior console `stdout/stdin`, and host machine file I/O, for debugging.

Host File Location

Files are created with `fopen` on the host machine as shown in Table 11.1.

Table 11.1 Host File Creation Location

fopen filename parameter	host creation location
filename with no path	target project file folder
full path	location of full path

Binary and Text Files

`Stdio` call `fopen` can open files as text or binary, depending on the open mode. For DSP56800 host I/O file operations, subsequent `stdio` calls treat the file as text or binary depending on how the file was originally opened with `fopen`.

NOTE You must decide whether to open the file as text or binary.

Binary and text files are handled differently because DSP56800 char (character) is 16-bits and x86 host char is 8-bits.

- Text file I/O operations are 1-to-2 mapping.
- Binary file I/O operations are 1-to-1 mapping.

Files are created with `fopen` on the host machine as shown in Table 11.2.

Table 11.2 Host File Creation Location

file opened as	host elements	target elements
text	8-bit	16-bit
binary	16-bit	16-bit

Text File I/O

DSP56800 host I/O does 16-bit to 8-bit mapping for host text files. The host text file is handled as 8-bit elements with conversion to 16-bit elements on the target side.

For example, if you open the host file with the `fopen` mode "w", the file opens as new text file or a truncated existing text file of the file name. When `fwrite` is called, the host file writes the DSP56800 buffer of 16-elements the host file as 8-bit elements.

Binary File I/O

DSP56800 host I/O does 16-bit to 16-bit mapping for binary files. The host binary file is handled as 16-bit elements.

Allocating Stacks and Heaps for the DSP56800

Stationery linker command files (LCF) define heap, stack, and BSS locations. LCFs are specific to each target board. When you use M56800 stationery to create a new project, CodeWarrior automatically adds the LCF to the new project.

See "ELF Linker and Command Language," for general LCF information. See each specific target LCF in Stationery for specific LCF information.

Definitions

Stack

The stack is a last-in-first-out (LIFO) data structure. Items are pushed on the stack and popped off the stack. The most recently added item is on top of the stack. Previously added items are under the top, the oldest item at the bottom. The "top" of the stack may be in low memory or high memory, depending on stack design and use. M56800 uses a 16-bit-wide stack.

Heap

Heap is an area of memory reserved for temporary dynamic memory allocation and access. MSL uses this space to provide heap operations such as `malloc`. M56800 does not have an operating system (OS), but MSL effectively synthesizes some OS services such as heap operations.

BSS

BSS is memory space reserved for uninitialized data. The compiler will put all uninitialized data here. The stationery `init` code zeroes this area at startup. See the M56824 `init` (startup) code example code in this chapter for general information and the stationery `init` code files for specific target implementation details.

NOTE Instead of accessing the original Stationery files themselves (in the Stationery folder), create a new project using Stationery (see "Creating a Project") which will make copies of the specific target board files such as the LCF.

Variables defined by Stationery Linker Command Files

Each Stationery LCF defines variables which are used by runtime code and MSL. You can see how the values for these variables are calculated by examining any of the Stationery LCFs.

See Table 11.3 for the variables defined in each Stationery LCF.

Table 11.3 LCF Variables and Address

Variables	Address
_stack_addr	The start address of the stack
_heap_size	The size of the heap
_heap_addr	The start address of the heap
_heap_end	The end address of the heap
_bss_start	Start address of memory reserved for uninitialized variables
_bss_end	End address of BSS

Additional Information and Specific Target Implementation Details

See each Stationery specific target board LCF for additional comments and implementation details. Perform a search for the variable name for quick access.

Depending on the target, implementation will be different between LCFs. For example, for targets using Host I/O, considerably more heap size is allocated in the LCF.

Runtime Initialization

The default `init` function is the bootstrap or glue code that sets up the DSP56800 environment before your code executes. This function is in the `init` file for each board-specific stationery project. The routines defined in the `init` file performs other tasks such as clearing the hardware stack, creating an interrupt table, and retrieving the stack start and exception handler addresses.

The default code in the `init` function also sets the addressing mode in the modifier register (`M01`) to 0xFFFF.

The final task performed by the `init` function is to call the `main()` function.

The starting point for a program is set in the **Entry Point** field in the **M56800 Linker Settings** panel.

When creating a project from R5.0 stationery, the `init` code is specific to the DSP56800 board. See the startup folder in the new project folder for the `init` code.

Listing 11.1 Sample Initialization File (DSP56824EVM)

```
/*
  56824_init.c
  sample code
  Metrowerks, Inc., a company of Motorola
  */

#include "56824_init.h"

asm void init_M56824_()
{
  bfset #_32bit_compares,omr // debugger will override this
                             // if debugger option is on
  move #-1,x0
  move x0,m01          // set the m register to linear addressing

  move hws,la          // clear the hardware stack
  move hws,la
```

```
// init registers

  move #0,r1
  move r1,x:IPR
  move r1,x:TCR01
  move r1,x:TCR2
  move r1,x:SCR2
  move r1,x:SPCR0
  move r1,x:SPCR1
  move r1,x:COPCTL

// copy interrupt table to address 0

    move    #$80,r2             // internal interrupt size 0x80
    move    #M56824_intVec,r3   // address originally loaded
    move    #0,r1               // destination address
    do      r2,enddoA
    move    p:(r3)+,x0
    move    x0,p:(r1)+
enddoA:

// initialize compiler environment

CALLMAIN:

    // setup stack
  move #_stack_addr,r0// get stack start address
  nop
  move r0,x:<mr15       // set frame pointer to main stack top
  move r0,sp // set stack pointer too
  move #0,r1
  move r1,x:(r0)

// PLL (phase-locked loop) init for 824

    move #$0180,X:PCR1     // configure
    move #$0260,X:PCR0     // set Feedback Divider to 1/20

                           // wait for PLL lock
    move #$FFFF,y0        // an amount in keeping with data sheet
    move y0,lc
    do   lc,delay_for_pll
    nop
delay_for_pll:
                           // that should be enough time
                           // for PLL stablization
    bfset #$4000,X:PCR1    // now enable PLL for Phi Clock

// setup exception handler and interrupt levels

  move M56824_int_Addr,r1  // exception handler address
  pushr 1                  // establish exception handler
  bfset   #$0100,sr        // enable all levels of interrupts
  bfclr  #$0200,sr         // allow IPL 0 interrupts

// call main()

  move #M56824_argc,y0     // pass parameters to main()
  move #M56824_argv,r2
  move #M56824_arge,r3
  jsr main                 // call the users program
  jsr fflush
  debug
  rts
```

The startup folder includes the following:

- Stack setup
- PLL setup
- Exception handler and interrupt setup
- BSS zeroing
- Static initialization
- Jump to main

NOTE The original general-purpose runtime `init` code (FSTART) remains in the M56800 support library to provide compatibility for older projects. The MSL runtime project is: `CodeWarrior\56800 Support\msl\MSL_C\DSP_56800\Project\ MSL C 56800.mcp`

See project group runtime: init, file FSTART.c.

12

Troubleshooting

This chapter explains common problems encountered when using the CodeWarrior™ IDE for DSP56800, and their possible solutions.

Troubleshooting Tips

This chapter contains the following sections:

- The Debugger Crashes or Freezes When Stepping Through a REP Statement
- “Can’t Locate Program Entry On Start” or “Fstart.c Undefined”
- When Opening a Recent Project, the CodeWarrior IDE Asks If My Target Needs To Be Rebuilt
- "Timing values not found in FLASH configuration file. Please upgrade your configuration file. On-chip timing values will be used which may result in programming errors"
- IDE Closes Immediately After Opening
- Errors When Assigning Physical Addresses With The `Org` Directive
- The Debugger Reports a Plug-in Error
- Windows Reports a Failed Service Startup
- No Communication With The Target Board
- Downloading Code to DSP Hardware Fails
- The CodeWarrior IDE Crashes When Running My Code
- The Debugger Acts Strangely
- Problems With Notebook Computers

If you are having trouble with CodeWarrior IDE for DSP56800E and this section does not help you, e-mail technical support at: `support@metrowerks.com`

The Debugger Crashes or Freezes When Stepping Through a REP Statement

Due to the nature of DSP56800 instruction pipeline, do not set a breakpoint on a `REP` statement in the debugger. Doing so may cause the `REP` instruction to enter an infinite loop and freeze or crash the IDE.

"Can't Locate Program Entry On Start" or "Fstart.c Undefined"

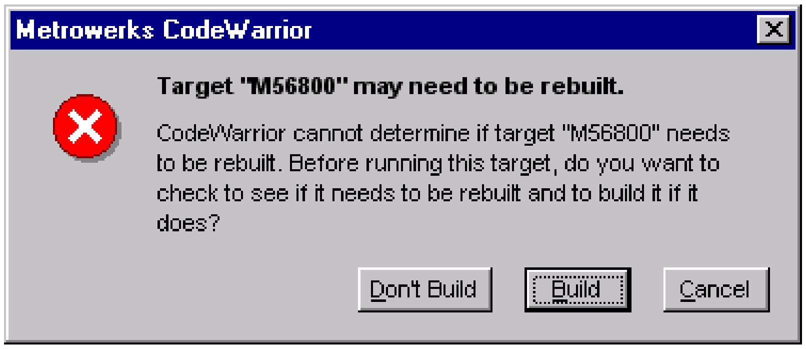
By default, the CodeWarrior stationery defines the entry point of program execution as `FSTART_`. The entry point is edited in the project target settings by selecting **Edit > M56800 Settings** from the menu bar of the Metrowerks CodeWarrior window and then M56800 Linker from the **Target Settings** panel. If the entry point is changed and not updated in the sources, linker errors are generated for undefined sources.

The FSTART.c program is defined in the MSL and may also generate errors if the CodeWarrior IDE cannot find the MSL path due to access path errors within a DSP56800 project.

When Opening a Recent Project, the CodeWarrior IDE Asks If My Target Needs To Be Rebuilt

If you open a recent project file and then select **Project > Debug** from the menu bar of the Metrowerks CodeWarrior window, the dialog box shown in Figure 12.1 appears:

Figure 12.1 Rebuild Alert


Metrowerks CodeWarrior

Target "M56800" may need to be rebuilt.

CodeWarrior cannot determine if target "M56800" needs to be rebuilt. Before running this target, do you want to check to see if it needs to be rebuilt and to build it if it does?

This dialog box informs you that the software determines if your object code needs to be rebuilt. If you have made no changes since the last build, the CodeWarrior IDE does not change your object file when you select the **Build** option.

"Timing values not found in FLASH configuration file. Please upgrade your configuration file. On-chip timing values will be used which may result in programming errors"

This indicates you have an old flash configuration file that does not include timing information. If you continue to use this file, it could result in programming errors and a shorter life for the flash memory.

To upgrade your flash configuration file, replace the existing flash configuration file with the flash configuration file from the appropriate stationery.

The stationery is located in the following directory:

CodeWarrior\Stationery\DSP56800 EABI

Locate the directory for the DSP568xxEVM processor you are using. The flash configuration file is located in the config directory.

IDE Closes Immediately After Opening

There may be a conflict with another version of the CodeWarrior IDE on your system. Running the `regservers.bat` file in the

`Metrowerks/Bin` directory usually resolves this problem when there are different versions of the CodeWarrior IDE installed on the same computer.

Errors When Assigning Physical Addresses With The `Org` Directive

You cannot use the `ORG` directive with the CodeWarrior IDE DSP56800 assembler to specify physical addresses for program (P:) and data (X:) memory.

The Debugger Reports a Plug-in Error

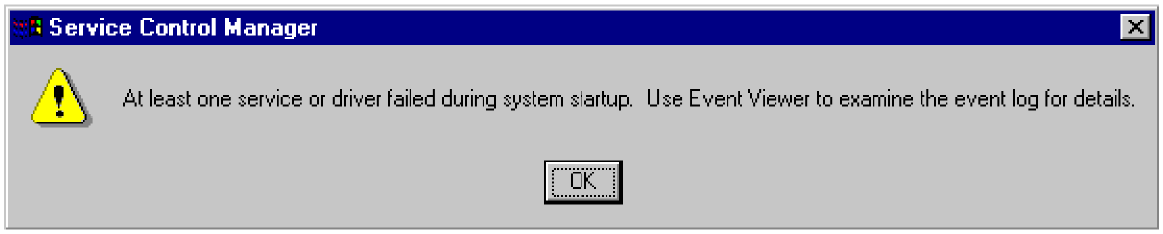
When the CodeWarrior IDE debugger reports a plug-in error, a dialog box appears that reads "Embedded DSP Plug-in Error. Can't connect to board." If you see this dialog box, check the following:

- Verify that the hardware cards are installed and seated properly.
- Verify that all of the cables are connected properly.
- Verify that power is being supplied to the DSP hardware.

Windows Reports a Failed Service Startup

When the Windows Service Control Manager reports a failed service startup, the message box shown in Figure 12.2 appears:

Figure 12.2 Service Control Manager Message Box



At least one service or driver failed during system startup. Use Event Viewer to examine the event log for details.

If you see the above message box, check the following:

- Ensure that you have not selected a conflicting address for use with the DSP hardware. The Resources Manager can help you determine whether or not there is a conflict.

- Check input/output addresses according to the operating system you are using:

  Windows 95 and Windows 98

1. To access the Resources Manager, open the Control Panel and click the **Device Manager** tab.
2. Click **Properties** to display the **Computer Properties** window.
3. Click the **View Resources** tab in the **Computer Properties** window.
4. Click the **Input/Output** radio button to view all active input/output addresses.

   Windows NT

1. To access the Resources Manager, select **Start > Programs > Administrative Tools > Windows NT Diagnostics**.
2. Click the **Resources** tab in the Windows NT Diagnostics window.
3. Click **I/O Port** at the bottom of the tab to view all currently active input/output addresses.

No Communication With The Target Board

If you are unable to establish communication with the target DSP hardware, check the following:

- Verify that the hardware boards are properly connected to the computer. Follow the installation instructions in "Getting Started".
- If you are using the Motorola ADS hardware with the ISA bus interface, ensure that you select the correct I/O address for the ISA card. If you have another device attempting to use this address, you must reconfigure that device to use another address or disable that device.
- Verify that all the hardware boards have power:
  - A green LED lights up on both the ADS and EVM boards.
  - A red LED and a yellow LED illuminate on the Domain Technologies SB-56K Emulator.
- Verify that all target settings are correct.

Downloading Code to DSP Hardware Fails

If you are unable to download code to the target DSP hardware, verify that the communications to the target hardware are working correctly.

The CodeWarrior IDE Crashes When Running My Code

Use one of the samples provided with CodeWarrior IDE for DSP56800 to verify that your system is working correctly.

The Debugger Acts Strangely

Sometimes DSP hardware can become corrupted and unusable, even after a soft reset. If the debugger has problems executing code, you might have to perform a hard reset of the DSP hardware.

To reset the EVM board, follow these steps:

1. Disconnect the power cable from the board.
2. Wait at least 5 seconds.
3. Reconnect the power supply to the EVM board. This reconnection step resets the board and clear its RAM.

To reset the ADS board, follow these steps:

1. Disconnect the power cable from the ADS board.
2. Wait at least 5 seconds.
3. Reconnect the power supply to the ADS board. This reconnection step resets the board and clear its RAM.

Problems With Notebook Computers

If you experience any problems downloading using the parallel port interface while using a notebook computer, ensure that the parallel port is set in bidirectional mode.

On Dell Latitudes, the ECP setting in CMOS has not emitted enough voltage through the parallel port. Increasing the ECP value may solve this problem.

How to make Parallel Port Command Converter work on Windows® 2000 Machines

If you encounter problems connecting to your Windows® 2000 machine using the parallel port command converter, check the following settings:

1. Verify LPT Port number matches the parallel port:
   a. Launch CCS.
   b. Select **File > Configure**.
   c. Ensure that the LPT port is set to parallel port and correct LPT number.
   d. Click **Save**.
2. Verify "Enable legacy Plug and Play" is enabled for the parallel port:
   a. Access the **Device Manager**.
   b. Access the LPT port settings window.
   c. Click the **Properties** button.
   d. In the **Properties** window, click the **Enable Legacy Plug and Play** box.
3. Verify the parallel port is set for "fast bi-directional transfer":
   a. Access the BIOS settings.
   b. Set the parallel port for fast bi-directional transfers (EEP or ECP) instead of just bi-directional.

A

Porting Issues

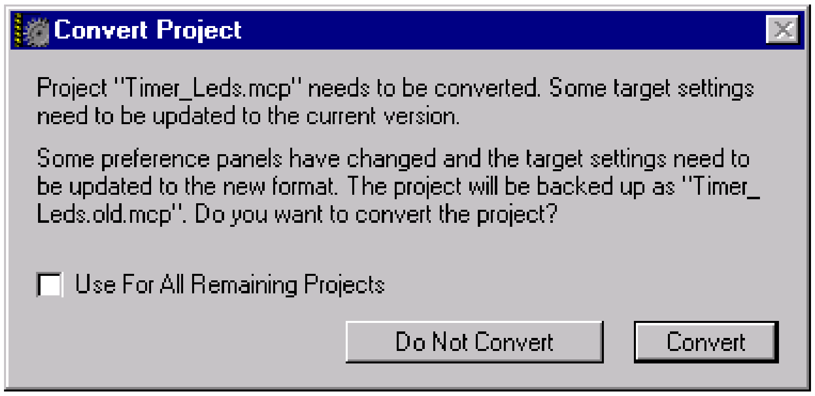
This chapter explains issues relating to successfully porting code to the most current version of the CodeWarrior™ IDE for Motorola DSP56800. This chapter lists issues related to successfully porting sources from the Suite56™ toolset and differences that occur between the CodeWarrior IDE and the Suite56 tools.

This chapter contains the following sections:

Converting the DSP56800 3.x and 4.x Projects to 5.x Projects

When you open older projects in the CodeWarrior IDE, the IDE automatically prompts you to convert your existing project (Figure 12.3). Your old project will be backed up if you need to access that project file at a later time. The CodeWarrior IDE cannot open older projects if you do not convert them.

Figure 12.3 Project Conversion Dialog



Project "Timer_Leds.mcp" needs to be converted. Some target settings need to be updated to the current version.

Some preference panels have changed and the target settings need to be updated to the new format. The project will be backed up as "Timer_Leds.old.mcp". Do you want to convert the project?

☐ Use For All Remaining Projects

Porting Motorola 56824EVM projects to the CodeWarrior IDE

Porting projects for DSP56800 processors created with the Motorola DSP56800 Suite56 toolset to the CodeWarrior assembler is based on the Motorola syntax. Virtually all your code is usable with little modification. However, porting Motorola applications to the CodeWarrior assembler require some manual intervention. To port a CodeWarrior IDE project from the Motorola Suite56:

1. Create a new project from the project stationary in the CodeWarrior IDE for your target board.
2. Convert Motorola bootstrap assembly source and interrupt tables to the CodeWarrior IDE.
3. Add your new files to the new CodeWarrior project.
4. Call your assembly startup function from `main()`.
5. Modify your linker command file.

A sample assembly source program is given below that was ported from the DSP56824 Suite56 tools to the CodeWarrior IDE that has detail information.

A simple one file assembly program written with the Motorola DSP56824EVM toolset is shown in listing Listing 12.1 This simple program blinks the PB8 LED on the 56824EVM board at a rate of 1 Hz. The same program, shown in Listing 12.2, was ported to the CodeWarrior IDE.

Listing 12.1 Motorola Suite56 Assembly Sources

```
; Program Name: SimpleLed.asm

; Equates for DSP56824 core
;==============================================================
ipr     equu    $fffb          ; Interrupt priority register
bcr     equ     $fff9          ; Bus control register

pcr1    equ     $fff3          ; PLL control register 1
pcr0    equ     $fff2          ; PLL contel register 0

pbd     equ     $ffec          ; Port B data register
pbddr   equ     $ffeb          ; Port B data direction register
pbint   equ     $ffea          ; Port B Interrupt register
;===============================================================
;                       PARAMETERS
;===============================================================
PLL_MUL equ     19               ; PLL Feedback Multiplier
Red             equ     $0100    ; Port B bit 8 is Red Led
;===============================================================
;                       Memory Space Setup
;===============================================================
        org     p:$e000                 ; warm boot
        jmp     Start

        org     p:$0000   ; Location p:$0 to p:$ff are set to nop
        dup     256
        nop
        endm

        org     p:$0000              ; start of program
        jmp     Start
;===============================================================
; MAIN
;===============================================================
        org     p:$0100        ; Starting location of this program
Start

        move    #$40,sp         ; Set stack pointer to first
                                ;location after page 0
```

```
      move    #$0000,x:bcr  ;Initialize BCR for zero wait states
                             ; Configure PLL feedback divider
      move  #(PLL_MUL-1)<<5,x:pcr0  ;3.6864 MHz * 19 = 70.042MHz
      ; Enable PLL using oscillator clock 4ac8
      move   #$4208,x:pcr1     ; Enable P
      move   #$1fff,lc
      move   #$0000,x:pbd      ; Led off
      bfset  #$0700,x:pbddr    ; Port b 8,9,10 output for Red,
                               ; Yellow and Green Leds
      move   #$0800,x:ipr      ; Enable Timer interrupts
      bfset  #$0100,sr         ; Enable all level of interrupts
      bfclr  #$0200,sr

;===============================================================
; this will make the Red Led blink using normal delays
Blink                                             ;
        jsr     Wait                              ;
        jsr     Wait                              ;
        bfchg     #Red,x:pbd             ; blink Red Led

        jmp     Blink                             ;
;===============================================================
; Wait
Wait
        move    #$1fff,a0
        move    #$03ff,y0
Up1     move    #$ffff,x0
Up2     nop
        nop
        rep     a0
        nop
        decw  x0
      bgt   Up2

        nop
        decw    y0
        bgt     Up1

        nop
        rts
```

The following assembly source (Listing 12.2) was ported to the CodeWarrior IDE to be called from C. Note that the only difference between these files is in the memory space setup. The CodeWarrior IDE does not allow you to specify memory space and location counter addresses with the ORG directive. Memory space setup must be done within a linker command file.

Listing 12.2 Converted Assembly Sources for the CodeWarrior IDE

```
; Program Name: SimpleLed.asm
  SECTION user
; Equates for DSP56824 core
;==============================================================
ipr     equu    $fffb           ; Interrupt priority register
bcr     equ     $fff9           ; Bus control register

pcr1    equ     $fff3           ; PLL control register 1
pcr0    equ     $fff2           ; PLL contel register 0

pbd     equ     $ffec           ; Port B data register
pbddr   equ     $ffeb           ; Port B data direction register
pbint   equ     $ffea           ; Port B Interrupt register
;===============================================================
;                       PARAMETERS
;===============================================================
PLL_MUL equ     19                ; PLL Feedback Multiplier
Red             equ     $0100     ; Port B bit 8 is Red Led
;===============================================================

;===============================================================
;                       Memory Space Setup
;===============================================================
  org p:
  GLOBAL FStart

NewInstx0
  jmp   FStart
;===============================================================
FStart
     move    #$40,sp       ; Set stack pointer to first
                              ; location after page 0
     move    #$0000,x:bcr  ;Initialize BCR for zero wait states
```

```
                      ; Configure PLL feedback divider
     move  #(PLL_MUL-1)<<5,x:pcr0  ;3.6864 MHz * 19 = 70.042MHz
     ; Enable PLL using oscillator clock 4ac8
     move #$4208,x:pcr1  ;Enable PLL
     move    #$1fff,lc

     move   #$0000,x:pbd        ; Led off
     bfset  #$0700,x:pbddr     ; Port b 8,9,10 output for Red,
                                ; Yellow and Green Leds
     move   #$0800,x:ipr      ; Enable Timer interrupts
     bfset  #$0100,sr         ; Enable all level of interrupts
     bfclr  #$0200,sr

;===============================================================
; this will make the Red Led blink using normal delays
Blink
        jsr     Wait
        jsr     Wait
        bfchg     #Red,x:pbd            ; blink Red Led

        jmp     Blink
;===============================================================
;                            Wait
Wait
        move    #$1fff,a0
        move    #$03ff,y0
Up1     move    #$ffff,x0
Up2    nop
        nop
        rep     a0
        nop
        decw  x0
      bgt   Up2

        nop
        decw    y0
        bgt     Up1
        nop
        rts
    ENDSEC
    END
```

Now, create a new target project, add the sources, and modify your `main` function. Your main function looks like the one in Listing 12.3 and retrieves your assembly program's `F_START` function (Listing 12.2). The default linker command file in the project stationery is used for this example.

Listing 12.3 Calling an Assembly Program from main

```
int main( void ){
  Start();
  return 0;
}
```

Porting DSP56811 to DSP56824 Projects

Refer to the following document for issues relating to porting DSP56811 designs to DSP56824 designs:

Converting DSP56L811-Based Designs to the DSP56824. October 1, 1998. Motorola, Inc.

Using XDEF and XREF Directives

The `XDEF` and `XREF` directives are not used with the CodeWarrior assembler. Use the `GLOBAL` directive to make symbols visible outside of a section.

Using the ORG Directive

Memory space and location counters cannot be updated with the ORG directive. You must use the linker command file to specify exact memory addresses rather than in the assembler. For example, if you declare:

```
  ORG P:$0020
  SECTION myISR_20
  rti
  ENDSEC
  SECTION myISR_30
  jsr foot
  rti
  ENDSEC
```

You would need to change your `ORG` directive to:

```
ORG P:
```

and your linker command file would be changed as follows:

```
MEMORY {
    .text (RWX) : ORIGIN = 0x1000, LENGTH = 0x0
    .data (RW)  : ORIGIN = 0x2000, LENGTH = 0x0
    .text2(RWX) : ORIGIN = 0x20,   LENGHT = 0x0
}

SECTIONS {
   .location_specific_code :
   {
     . = 0x20;
     *(myISR_20.text)
     . = 0x30;
     *(myISR_30.text)
   } > .text2

   .main_application :
   {
     *(.text)
     *(.rtlib.text)
     *(fp_engine.text)
     *(user.text)
   } > .text

   .main_application_data :
   {
     *(.data)
     *(fp_state.data)
     *(rtlib.data)
     *(rtlib.bss.lo)
     *(.bss)
   } > .data
```

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